МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ, МОЛОДЁЖИ И СПОРТА УКРАИНЫ

ГОСУДАРСТВЕННОЕ ВЫСШЕЕ УЧЕБНОЕ ЗАВЕДЕНИЕ «ДОНЕЦКИЙ НАЦИОНАЛЬНЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»

Кафедра электромеханики и ТОЭ
Кафедра английского языка

УЧЕБНОЕ ПОСОБИЕ
для проведения практических занятий
по английскому языку научных и технических
профессий для направления подготовки
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Учебное пособие для проведения практических занятий по английскому языку научных и технических профессий для направления подготовки «Электротехника и электротехнологии», часть 1 – Донецк: ДонНТУ, 2011. – 265с.

Пособие предназначено для студентов электротехнического факультета направления подготовки «Электротехника и электротехнологии» групп с углубленных изучением английского языка. Часть 1 пособия содержит все необходимые материалы по двадцати одному уроку для проведения практических занятий по английскому языку научных и технических профессий. Имеется приложение, в котором по каждой теме приводятся новые слова для запоминания.

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Contents

ВВЕДЕНИЕ

Первая часть учебного пособия предназначена в первую очередь для студентов 2-3 курсов, изучающих дисциплину «Английский язык научных и технических профессий» в группе с углубленным изучением английского языка. Однако оно может быть применено и как пособие по изучению английского языка во время аудиторных занятий со студентами электротехнического направления, а также при самостоятельном изучении английского языка. Пособие может быть полезно аспирантам, изучающим английский язык.

Учебное пособие предполагает интенсивную домашнюю подготовку студентов к занятиям. В связи с этим рекомендуется заготовить рабочую тетрадь по английскому языку и в ней выполнять домашние задания – готовиться к уроку. К этому же уроку относятся и новые слова, приведенные к каждому уроку в разделе APPENDIX. Каждый урок рассчитан на два-три аудиторных занятия.

Отдельные задания помечены «звёздочкой»; они являются необязательными и выполняются по желанию студентами, которые хотят повысить свой уровень знаний английского языка или улучшить оценку.

UNIT 1. FIGURES AND NUMBERS

Overview

- Reading and Vocabulary: History of Arabic numerals.
- Information transfer: Reading figures and numbers.
- Language focus: Word Formation. Negative and positive prefixes. Number prefixes. Reading very large and small quantities.
- Reading and Speaking: Our star – the Sun.

Reading and Vocabulary

Before you read

Discuss the questions below.

1. What do you know about the figures existing in the world? (Arabic, Roman, etc.)
2. What figures do Arabs make use of?
3. Why were Arabic numbers named in such a way?

Reading

The 2nd paragraph of the text has been removed. Choose from the passages **A-C (Ex.1)** the one which fits the gap in the text best of all.

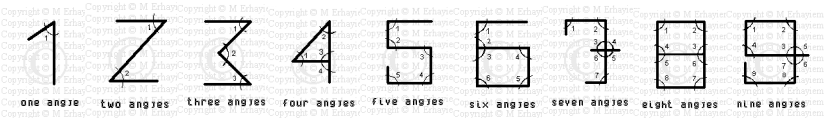
History of Arabic numerals

1. It is now universally accepted that our decimal numbers derive from forms, which were invented in India and transmitted via Arab culture to Europe, undergoing a number of changes on the way. Because of lack of authentic records, very little is known of the development of ancient Hindu mathematics. The earliest history is preserved in the 5000-year-old ruins of a city located Northeast of present-day Karachi in Pakistan. Evidence of wide streets, brick dwellings, apartment houses with tiled bathrooms, covered city drains, and community swimming pools indicates a civilisation as advanced as **that** found anywhere else in the ancient Orient. These early peoples had systems of writing, counting, weighing, and measuring, and they dug canals for irrigation. All **this** required basic mathematics and engineering.

3. The new numerals, which were invented, were not easy to influence other European inhabitants, especially the Romans. For them, a change in numeral system meant not merely learning an entire new principle for writing numbers but also

becoming familiar with strange new symbols, which were unlike **all** others before. The zero symbol itself was a source of difficulty. People found it very hard to understand how it was that a symbol, which stood for nothing, could, when put next to a numeral, suddenly multiply **its** value ten-fold. Throughout this period of uncertainty there had been a number of mathematicians who had strongly supported the new numerals. One of **these** was the Italian mathematician Fibonacci.

4. Apparently, the Arabic Numerals were originated based on the concept of trigonometry. This explanation is easily justifiable in a time where mathematics flourished in various directions. Creating appropriate mathematical symbols was, in fact, part of the process to develop advanced mathematical techniques required by the ever-expanding needs for mathematical solutions to all forms of life. The Arabs, who had great experience in inventing codes and scriptures, invented a singular symbol **that** is remarkably simple and universal. Each numeric symbol represents "Angle". Thus, symbol "1" represents "one angle," symbol "2" represents "two angles" and so on. The origin of Arabic numerals, which were defined according to the number of angles, is shown below.



Reading comprehension

Ex.1.

A. The book explained Arab arithmetic and algebra, and in it he strongly advocated use of the Hindu-Arabic numerals. No other single work contributed more towards the eventual triumph of the new numerals. Therefore, it was the mathematicians, rather than the astronomers, who ultimately ensure the almost universal adoption of the Hindu-Arabic numerals.

B. This was a period of a great flowering of cultural activity in many areas of learning, but only in astronomy was there the strength of pressure, which could change so important a part of the culture as the numeral system.

C. Towards the end of the eighth century an Indian astronomical textbook making use of the decimal place-value system was brought to Baghdad and translated into Arabic. This translation had a profound effect upon the history of written numerals

both in the Arab world itself and eventually also in the whole of the West. At that time, the Arabs were still using the Greek numeral system.

Ex.2. Match headings A-E with paragraphs 1-4 in the text. There is one heading you don't need.

A. A great contribution into the development of the new numerals units.
B. The importance of universal and simple symbols.
C. Can't do without mathematics and engineering.
D. A remarkable source of difficulty.
E. A complicated process of changes.

Ex.3. Read the text and find the answers to these questions.

1. What country is the ancestor of the decimal numbers we use today?
2. Do we know a lot about the development of ancient Hindu mathematics?
3. Why did early peoples require basic mathematics and engineering?
4. What had a profound effect upon the history of written numerals in the Arab world?
5. What numeral system did the Arabs use in the 8-th century?
6. Was changing in numerical system an easy process for the Europeans?
7. What symbol was a special source of difficulty?
8. Why is it suggested that namely trigonometry was the basis for Arabic Numerals?

Ex.4. What do the pronouns in bold in the text refer to?

1. that (para.1)
   a) evidence
   b) civilization
   c) swimming pools
2. this (para.1)
   a) early peoples
   b) people's activity
   c) irrigation
3. all (para.3)
   a) principles for writing numbers
   b) new symbols
   c) existing numerals
4. its (para.3)
   a) zero symbol
   b) any number
   c) source of difficulty
5. these (para.3)
   a) new numerals
   b) periods of uncertainty
   c) mathematicians
6. that (para.4)
   a) the Arabs
   b) codes and scriptures
   c) singular symbol

Vocabulary

Ex.1. Match the nouns from the text with the following adjectives.

1	advanced	a	numbers
2	ancient	b	symbols
3	authentic	c	engineering
4	basic	d	new principle
5	decimal	e	symbol
6	early	f	mathematics
7	entire	g	directions
8	ever-expanding	h	peoples
9	simple	i	civilization
10	universal	j	needs
11	unlike	k	techniques
12	various	l	records

Ex.2. Match the words from the text with their definitions.

1	advanced (adj)	a	make, design or think of a new type of thing
2	influence (v)	b	do a calculation in which you add a number to itself a particular number of times
3	inhabitants (n)	c	a way of solving a problem or dealing with a difficult situation
4	invent (v)	d	affect the way smb or smth develops, behaves, thinks without directly forcing them
5	lack of (n)	e	need smtn
6	multiply (v)	f	using very modern technology and ideas
7	require (v)	g	a mathematical quantity, meaning
8	solution (n)	h	people living in a particular place
9	value (n)	i	when there is not enough of smth, shortage

Ex.3. Use the correct forms of the words from Ex.2 in the following sentences.

1. This translation profoundly … the history of written numerals in the Arab world.
2. The decimal Hindu-Arabic numeral system … in India around 500 CE.

3. The numerals are arranged with their lowest … digit to the right, with higher … positions added to the left.

4. The need for finding mathematical … was vital in every field of activity.

5. Under such circumstances numbers and all related symbols had to be universally understood and adopted by all ….

6. Does their apparent … progress mean they are not doing their job properly?

7. Hindu numeral system is a pure place-value system, that is why it … a zero.

Ex.4. Fill in the correct preposition in the following word combinations from the text.

1. derive …; 2 . a number … changes; 3. … the way; 4. become familiar …; 5. stand …; 6. have great experience…; 7. according …; 8. flourish…; 9. transmit … Arab culture …Europe; 10. a change is based …; 11. need …; 12. solution … all forms of life.

Information transfer

Reading figures and numbers

Ex.1. Match the words and expressions (1-36) with the figures and numbers (a-u) below. Translate them into Russian.

1. Roman numerals; 2. Arabic numerals; 3. abstract number; 4. concrete number; 5. a four figure number (units, tens, hundreds, thousands); 6. cardinal number; 7. ordinal number; 8. positive number; 9. negative number; 10. whole number, integer; 11. fraction; 12. mixed number; 13. even number; 14. odd number; 15. prime number; 16. complex number (real part, imaginary part); 17. vulgar fraction; 18. proper fraction (numerator, horizontal line, denominator); 19. improper fraction; 20. compound (complex) fraction; 21. fractions of different denominators; 22. fractions of common denominator; 23. proper decimal fraction with decimal point and decimal places (tenths, hundredths, thousandths); 24. recurring decimal; 25. counting (natural) number; 26. real number; 27. two thirds; 28. three point six per cent; 29. a quarter (or one-fourth); 30. three-fourths; 31. zero (nought); 32. one million; 33. two thousand, five hundred and thirty eight; 34. a half (or one-half); 35. irrational; 36. conjugate complex number.

a) V; IX;
b) 2538;
c) ¼;
d) ½;
e) 1,000,000 (1m);
f) 0;
g) 3.6%;
h) 0.327;
i) π;
j) 5 kg;
k) 2^{nd}; 3^{rd}; 1^{st};
l) -8;
m) $3\frac{2}{3}$;
n) 4; 17; 13;
o) $\underline{A} = 3+2\sqrt{-1}$;
p) $\underline{A}^* = 3-2\sqrt{-1}$;
q) $\frac{3/4}{7/8}$;
r) $\frac{2}{3}$;
s) $\frac{5}{2}$;
t) $0.62762762\ldots = 0.\overline{627}$;
u) ¾

Ex.2. Read and translate the sentences below. Make sure you read the numbers and dates correctly.

1. Improper fraction 12/4 being cancelled down produces a whole number 3.
2. In English, you write a point (.) not a comma (,) in decimal numbers. You can say the numbers after point separately, for example, 23.34 is 'twenty-three point three four'.
3. You can read decimals 0.2 as point two or two-tenths, and 0.25 as point two five or twenty five hundredths.
4. Twelve is an integral multiple to two, three, four and six.
5. Eight is divisible by 4.
6. Improper fraction 3/2 is reciprocal to proper fraction 2/3.
7. The first people to fly across the Atlantic were Alcock and Brown in 1919.
8. By 1950, Heathrow was the busiest airport in Europe.
9. Shakespeare was born on 23 April, 1564 and he died on the same day in 1616.
10. Male humpbacks are up to 48ft long; females are up to 50ft long. They can weigh up to 50 tons.
11. The conjugate of a complex number is formed by reversing the sign of the imaginary term.
12. Half the 20 million homes in Britain now have a video recorder.

Ex.3. Read and translate the passage below. Learn the new words by heart.

We are familiar with numbers in various formats – integers (90; 5; 135 – fixed-point integer), numbers with a fixed number of decimal places (75.3 – fixed-point number with one decimal place), and floating-point numbers ($2.5 \cdot 10^3$ – floating-

point number). We deal mostly with fixed-point numbers; however, the floating-point numbers are widely used as well. Numbers also come in different bases. Numbers can be fixed-point or floating-point in any base system. Our ordinary number system, the decimal system, has 10 different digits (0 through 9), probably because our ancestors had 10 fingers. Thus, the decimal system has a base of 10. A binary digit is called a bit, and can have values of 0 or 1 only. The choice of the binary system is dictated by the fact that an electric circuit, or a magnetic field, etc., can be either off or on. The binary number system matches that duality because in the binary system there are only two digits.

It is necessary to understand the positional number system. The decimal number 123 does not mean the same as the decimal number 321. What is the difference? Each place is 10 times as important as the one to its right. Each place represents 10 to a power; the rightmost digit is the number of ones (tens to the zero power). 23_{10} – the subscript 10 denotes the base.

Language focus

Word Formation

In English a lot of technical terms are formed with the help of morphological ways of word – formation: **affixation** (adding of suffixes and prefixes to the word stem), **conversion** and **word composition**.

Let's study this term from electronics: semiconductor. We can divide it into three parts: *semi-conduct-or*. *Semi-* is a prefix which means 'half', while *-or* is a suffix added to the verb *conduct* to make a noun. From this, we can work out that a semiconductor is a component which half conducts, i.e. its conductivity is found between conductivities of a conductor and an insulator. Knowledge of common prefixes and suffixes can help us to work out the meaning of some unfamiliar terms in technical texts.

Negative and positive prefixes

	Prefix	Principal meaning	Examples
Negative	un- in- im- (before b, m, p) il- (before l) ir- (before r)	not, words with an opposite, negative meaning	unequal indirect immobilize illegal irrelevant
	mal- mis-	words denoting something wrong , bad, incorrect	malfunction mislead
	dis-	words denoting opposite feeling, opposite action	dismantle disorder
	anti-	against	antiglare
	de-	reduce, reverse, separate	demagnetize
	under-	too little	underestimate
Positive	re-	do again, once more	reconnect
	over-	too much	overload

Ex.1. Form the words using prefix un- and translate them.

adj. – available, like, accessible, stable, known (value), even, practical
verb – pack, bolt, charge, coil, wind, screw, button, cover
noun – balance, blocking, coupling, loading, locking, saturation

Ex.2. Form the adjectives using prefixes in- (im-, il-, ir-) and translate them.

regular, person, correct, logical, legal, legitimate, liberal, material, mature, measurable, movable, sensitive, attention, accessible, applicable, active, reparable, replaceable

Ex.3. Fill in the words from the box below. Explain the meanings of the prefixes in these words.

unprecedented; undesirable; displaced; overlapped; innumerable; discharged; unlike; replaced; replacement; recirculated; unfortunately

1. While beginning to be … by newer motor technologies brush DC motors are still very popular.
2. The only real drawback with this motor is that the brushes need periodic … due to wear.
3. However, … the brush DC motor, the "brushless" DC motor employs permanent-magnetic field excitation.
4. …, an oscilloscope's timebase is not perfectly accurate, and the trace will drift across the screen making measurements difficult.
5. The English language is enjoying … growth causing it to have nearly doubled in size.
6. Two methods of magnetohydrodynamic generation can be used: the open-cycle and the closed-cycle. In the open-cycle method the hot gas is… . In the closed-cycle method it is… .
7. When a current flows through a conductor it may heat the conductor. This heat is sometimes … and has to be reduced.
8. Prior to the works of Euclid around 300 BC, Greek studies in mathematics …. with philosophical and mystical beliefs.
9. This approach eventually … all other systems.
10. There are … applications for sensors of which most people are never aware.

Ex.4. Add the correct prefixes to the words in bold.

1. Sharon is …**weight** for her age and height. She eats very little.
2. When you have finished reading, please …**place** the books on the shelves.
3. Driving a car without a licence is …**legal**.
4. I am afraid I …**agree** with what you just said.
5. The telephone company …**connected** the phone when he failed to pay the bill.

Number prefixes. Reading very large and small quantities.

Ex.5. Look at the table below. It presents the decimal prefix symbols used in the technical language. Study them and learn by heart.

Prefix	Name	Multiple
T	tera- = a trillion	10^{12}
G	giga - = a billion	10^{9}
M	mega- = a million	10^{6}
k	kilo- = x one thousand	10^{3}
d	deci- = one tenth	10^{-1}
c	centi- = one hundredth	10^{-2}
m	milli- = one thousandth	10^{-3}
μ	micro- = one millionth	10^{-6}
n	nano- = one thousand millionth	10^{-9}
p	pico-	10^{-12}
f	femto-	10^{-15}

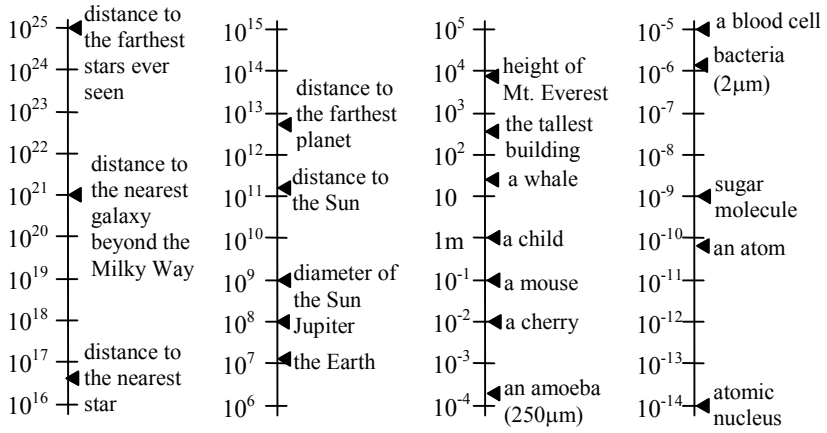
Very large and very small quantities are expressed like this:
10^{6} = ten to the power of six = one million
10^{-6} = ten to the power of minus six = one millionth.

Complete these: 10^{2} = …; 10^{3} = …; 10^{8} = …; 10^{-2} = …; 10^{-5} = …

Ex.6. Look at the diagram with the scale of dimensions. Make sentences about these dimensions:

the distance to the farthest stars, the diameter of the Sun, the diameter of the Earth, the height of Mount Everest, the length of a mouse, the diameter of a cherry, the diameter of a blood cell, the diameter of a sugar molecule.

Example: A mouse has a length of approximately ten to the power of minus one metres, i.e. ten centimetres.



Scale of dimensions (measurements in metres)

Ex.7. The above diagram is a scale of dimensions. The dimensions range from the nucleus of an atom, which has a diameter of approximately 10^{-14} m, to the radius of the known universe, which is approximately 10^{25} m.

Make sentences from the table:

Plants Animals Buildings	range in size from	the whale, the tallest building, the tallest tree,	which	has a	height length	of approximately

500m, 80m, 30m,	to	the amoeba, houses, bacteria,	which	has have	a diameter a height	of approximately	10m. 250μm. 2μm.

Reading and Speaking

Reading

Four sentences have been removed from the text. Choose from the sentences **A-F (Ex.1)** the one which fits each gap (1-4) in the text. There are two sentences you shouldn't use.

Our star – the Sun

There are nine planets in the solar system, namely: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.

What do you know today of the nearest star which lies 150 million kilometers away?

The Sun is a mass of flaming matter, the temperature at its surface is above 5,500 degrees Centigrade, the temperature in the Sun's centre is as high as 20 million degrees Centigrade. The Sun's diameter is 109 times that of the Earth and its mass is 330,000 times greater.

[1] But this does not mean that the Sun is bigger than Sirius: it is simply nearer to the Earth.

Nine planets with their satellites revolve round the Sun due to the force of universal gravitation. It takes our Earth a little more than 365 days to revolve round the Sun.

[2] It provides us with light during the day and the light of the Moon is only the reflected sunlight.

It is also important that the Sun gives us heat without which no life can exist on the Earth. It provides us with all the energy that we use every day.

When we look at the Sun, it seems a fire ball. [3] The Sun is a giant natural hydrogen bomb, equivalent to millions of man-made ones where the thermonuclear reaction proceeds continuously.

It is interesting to note that every second the Sun sends into space as much energy as mankind consumed during the whole period of its existence from the first fire of the cave-man to the establishment of the atomic power station.

Solar energy has great value for mankind.

Man has tried to use solar energy since the earliest times. [4]

It is necessary to find effective methods of utilizing this immense supply of free energy, to make our star – the Sun – serve mankind.

Reading comprehension

Ex.1.

A. But even from a brief acquaintance with some of the solar phenomena it is clear that the Sun is an ever boiling ocean.

B. The illumination of the Sun is 10 billion times stronger than that by Sirius, the brightest star of the north hemisphere.

C. Outer space is an endless road and nothing can stop man in his longing for knowledge and progress.

D. The Sun is the most important body in the Universe for mankind.

E. Methods of using the light and heat energy from the Sun are not new, but they are not very efficient yet.

F. It is possible to have an intent look at the Sun with unaided eye only two times – initially with the left eye and finally with the right eye.

Ex.2. Read the text and find the answers to these questions.

1. What is the brightest star of the north hemisphere?
2. How many planets does the solar system include?
3. What is the Sun like?
4. What temperature is observed at the Sun surface?
5. What energy does the Sun provide us with?
6. How long has man tried to use solar energy?

Ex.3. Read the statements and mark them true (T) or false (F). Give the true statements.

1. There are ten planets in the solar system, namely: Mercury, Venus, Earth, Mars, Phaeton, Jupiter, Saturn, Uranus, Neptune, and Pluto.
2. The Sun is a mass of cooling matter.
3. The Sun provides us with light during the day.
4. When we look at the Sun, it seems a fire cube.
5. Every second the Sun sends into space as much energy as mankind consumed during the whole day.
6. It is necessary to find effective methods of utilizing the Sun energy.

Speaking

Ex.4. Work in pairs, Student A and Student B. Dictate your numbers to your partner. Can your partner write them correctly?

Student A: thirty-four point five percent; six point nine seven; one third; four thousand, five hundred and sixty-seven.

Student B: three thousand, nine hundred and fifty-eight; fifty-five percent; a half; seven point six five.

UNIT 2. ARITHMETICAL OPERATIONS

Overview

- Reading and Vocabulary: The basic arithmetic operations.
- Information transfer: Doing arithmetical operations.
- Language focus: Word Formation. Prefixes expressing size, location, time and numbers.
- Reading and Speaking: A brief history of Roman Numerals.

Reading and Vocabulary

Reading

The basic arithmetic operations

Arithmetics is the oldest and most elementary branch of mathematics, used by almost everyone, for tasks ranging from simple day-to-day counting to advanced science and business calculations. Modern algorithms for arithmetic (both for hand and electronic computation) were made possible by the introduction of Hindu-Arabic numerals and decimal place notation for numbers. The earliest written records indicate the Egyptians and Babylonians used all the elementary arithmetic operations as early as 2000 BC.

The basic arithmetic operations are addition, subtraction, multiplication and division, although this subject includes more advanced operations, such as manipulations of percentages, square roots, exponentiation, and logarithmic functions.

Addition is the basic operation of arithmetics. In its simplest form, addition combines two numbers, the addends or terms, into a single number, the sum of the numbers. Addition is commutative and associative so the order the terms are added in does not matter. The identity element of addition (the additive identity) is 0, that is, adding zero to any number yields that same number. Also, the inverse element of addition (the additive inverse) is the opposite of any number, that is, adding the opposite of any number to the number itself yields the additive identity, 0. For example, the opposite of 7 is −7, so $7 + (-7) = 0$.

Subtraction is the opposite of addition. Subtraction finds the difference between two numbers, the minuend minus the subtrahend. If the minuend is larger than the subtrahend, the difference is positive; if the minuend is smaller than the subtrahend, the difference is negative; if they are equal, the difference is zero. Subtraction is neither commutative nor associative. For that reason, it is often helpful to look at

subtraction as addition of the minuend and the opposite of the subtrahend, that is $a - b = a + (-b)$. When written as a sum, all the properties of addition hold.

Multiplication is the second basic operation of arithmetic. Multiplication also combines two numbers into a single number, the product. The two original numbers are called the multiplier and the multiplicand, sometimes both simply called factors. The product of a and b is written as $a \times b$ or $a \cdot b$. When a or b are expressions not written simply with digits, it is also written by simple juxtaposition: ab. In computer programming languages and software packages in which one can only use characters normally found on a keyboard, it is often written with an asterisk: $a * b$.

Division is essentially the opposite of multiplication. Division finds the quotient of two numbers, the dividend divided by the divisor. For positive numbers, if the dividend is larger than the divisor, the quotient is greater than one, otherwise it is less than one. The quotient multiplied by the divisor always yields the dividend. Division, like subtraction, is neither commutative nor associative. It is helpful to look at division as multiplication of the dividend times the reciprocal of the divisor, that is $a \div b = a \times {}^{1}/_{b}$.

Reading comprehension

Ex.1. Read the text and find the answers to these questions.

1. What is arithmetics?
2. Why does the order of the added terms not matter in addition?
3. When is the difference positive?
4. How can we regard subtraction as addition?
5. What are factors?
6. When is the quotient greater than one?
7. Is division commutative or associative?

Ex.2. Put the questions to the following answers.

1. As early as 2000 BC.
2. No, it doesn't. This subject includes more advanced operations too.
3. They are called the addends or terms.
4. It is the opposite of addition.
5. It finds the difference between two numbers.
6. Two numbers.
7. The quotient of two numbers.

Ex.3. Correct the false information in the sentences.

1. Arithmetics can only solve simple day-to-day tasks.
2. People started to use some elementary arithmetic operations 2000 years ago.
3. Square root is a basic arithmetic operation.
4. The additive inverse is 1.
5. The difference is always positive.
6. Subtraction is both commutative and associative.
7. The quotient is never less than one.

Vocabulary

Ex.1. Put the words into the categories in the table.

Subtrahend; dividend; addends; terms; multiplier; minuend; sum; commutative; associative; add; additive identity; yields; divide; additive inverse; minus; multiplicand; positive; difference; negative; equal; product; factors; quotient; divisor.

Addition	Subtraction	Multiplication	Division

Ex.2. Match the words from the text with their definitions.

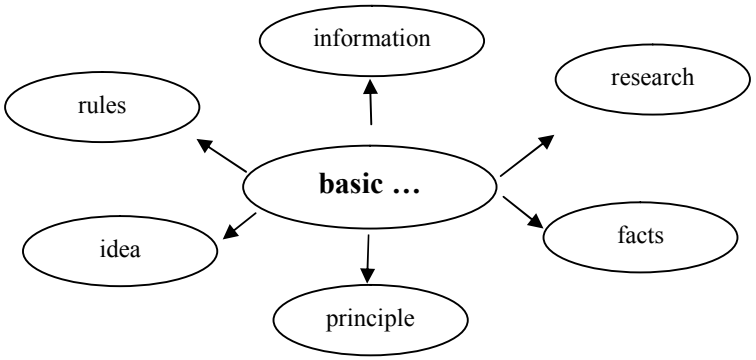
1	basic (adj)	a	the same in size, number, amount, value as something else
2	branch (n)	b	used when stating the most basic facts about something
3	character (n)	c	produce a result, answer or piece of information
4	equal (adj)	d	forming the most important or most necessary part of something
5	essentially (adv)	e	a quality or power that a substance, plant has
6	order (n)	f	a letter, mark or sign used in writing, printing or on a computer
7	property (n)	g	the way that things or events are arranged in relation to each other, so one thing is first, another thing is second
8	yield (v)	h	one part of a large subject of study or knowledge

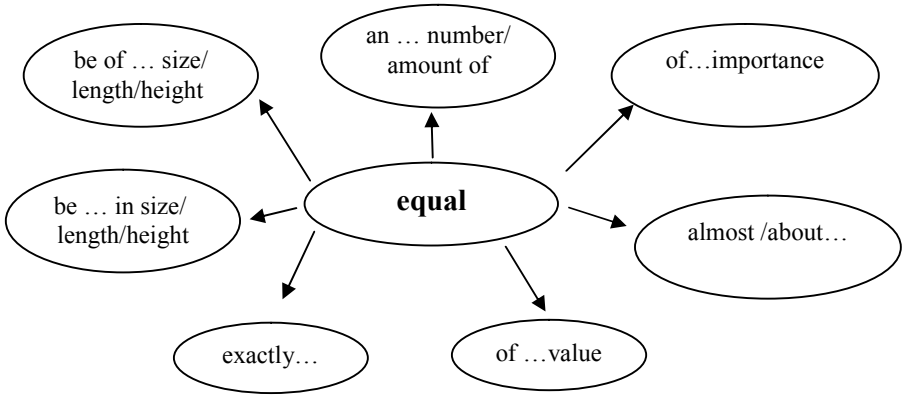
Ex.3. Replace the words in bold from Ex. 2 by their synonyms from the box.

sequence; equivalent; basically; characteristics; field; produce

1. Copper has good conductive **properties**, therefore it is widely used for cables.
2. Traditionally, the **order** of natural numbers started with 1 (0 was not even considered a number for the Ancient Greeks.)
3. The negative of a natural number is defined as a number that **yields** zero when it is added to the number.
4. Fractions can be greater than, less than, or **equal** to 1 and can also be positive, negative, or zero.
5. The system was modified **essentially** to produce the system used today.
6. The Roman number system is generally regarded as obsolete in modern usage, but is still seen occasionally in some **branches** of activity.

Ex.4. Learn by heart the collocations of the words basic and equal. Compose your own sentences with them.





Information transfer

Doing arithmetical operations

Ex.1. Remember how to read mathematical operations.
2 + 3 = 5 reads: 2 plus 3 is 5, or 2 and 3 is 5, or 2 plus 3 equals 5;
6 – 4 = 2 reads: 6 minus 4 is 2, or 4 subtracted from 6 is 2 or 6 minus 4 equals 2;
2 x 3 = 6 reads: 2 times 3 is 6, or 2 multiplied by 3 is 6, or 2 times 3 equals 6;

8 ÷ 2 = 4 reads: 8 divided by 2 is 4, or 8 divided by 2 equals 4;
x^2 reads: x squared or x to the power 2
x^3 reads: x cubed
x^4 reads: x to the fourth / x to the power 4
$\sqrt[2]{x}$ reads: (square) root x / the square root of x
$\sqrt[3]{x}$ reads: cube root (of) x
$\sqrt[4]{x}$ reads: fourth root (of) x
$(x + y)^2$ reads: x plus y all squared
$(\frac{x}{y})^2$ reads: x over y all squared

Ex.2. Read the following mathematical operations and match them with the words and expressions (1-6) given below.

$3 + 2 = 5$;	$3 - 2 = 1$;	$3 \times 2 = 6$;
$3 \cdot 4 = 12$;	$6 : 2 = 3$;	$10 / 2 = 5$;
$11 / 2 = 5(1)$;	$5^2 = 25$;	$3^3 = 27$
$4^4 = 256$	$\sqrt[2]{4} = 2$	$\sqrt[3]{216} = 6$
$\sqrt[4]{2401} = 7$	$(1 + 3)^2 = 16$	$(6 : 2)^2 = 9$

1. signs: equals sign, plus sign, minus sign, multiplication sign, division sign, root sign;
2. addition (adding): the sum, the term (item, component) of the sum;
3. subtraction (subtracting): the minuend, the subtrahend, the difference (remainder);
4. multiplication (multiplying): the multiplicand, the multiplier, factors, the product number;
5. division: the dividend, the divisor, the quotient, the remainder;
6. index of power.

Ex.3. Read and translate the sentences below. Pay attention to different ways of reading arithmetical operations. Write down these operations in numbers and signs.

1. Improper fraction 15/4 after division produces 3 in a remainder.
2. The volume of the wood block is equal to its length multiplied by height and multiplied by width.
3. The volume of the steel block equals length times height times width.
4. Fifteen equals three times five.
5. Six is three times bigger than two.
6. The circle radius is half of diameter.

Ex.4. Read the passage. Guess what it is about and propose the headline. Write down the numbers in *italics* in figures. Read the statements (1-3) below the passage and mark them true (T) or false (F).

There were *twelve point one million* children aged under *sixteen* in *two thousand*: *six point two million* boys and *five point nine million* girls. This is fewer than in *nineteen seventy-one*, when there were *fourteen point three million* children. In *two thousand*, *thirty per cent* of children in the UK were under *five*, *thirty-two per cent* were aged *five* to *nine* years and *thirty-eight per cent* were aged *ten* to *fifteen*. These proportions were similar in the *nineteen seventies*.

1. There are more boys than girls in Britain.
2. The total number of children has increased since a census in 1971.
3. In 1971 the same percentages of children were under five.

Language focus

Prefixes expressing size, location, time and numbers

	Prefix	Principal meaning	Examples
Size	semi-	half, partly	semiconductor
	equi-	equal	equidistant
	mini-	small	minicomputer
	micro-	very small	microcomputer
	macro-	large, great	macroeconomics
Location	inter-	between, among	interactive
	super-	over	supersonic
	ex-	out	exclude
	sub-	under	subschema
	infra-	below	infra-red
Time order	prime-	first	primary
	post-	after	postdated
	pre-	before	preposition
Numbers	mono-	one	monochromatic
	bi-	two, twice, double	bilingual
	tri-	three	triangle
	quad-	four	quadruple
	penta-	five	pentagon
	dec-	ten	decimal
	multi-	many	multiplexor

Ex.1. Fill in the words from the boxes below. Explain the meanings of the prefixes in these words.

A.

miniaturization; macroeconomics; semiconductors; equidistant; microchip

1. … studies large economic systems such as those of a whole country or area of the world**.**
2. … are midway between conductors and insulators.
3. This point is … from the both ends of the linear scale.
4. These nanoelectromechanical systems are the next step in … that may find their way into commercial aspects in the future.
5. … is a very small piece of silicon containing a set of electronic parts which is used in computers and other machines.

B.

interconnection; supersonic; external; submersible; infrared

1. The great majority of … aircraft today are military or experimental aircraft.
2. A small vehicle that can travel under water to very great depths in the ocean for scientific purposes is called a… .
3. … techniques have been applied in military, medical, industrial, and other disciplines.
4. In these cases, aluminum … is typically used as the conducting material.
5. Most oscilloscopes allow you to feed an … signal into the horizontal amplifier.

C.

tricycles; primary; multiwall; post-industrial; quadrant; prehistory; bicycle

1. … energy is energy found in nature that has not been subjected to any transformation process.
2. If a nation becomes … it moves on to a structure of society based on the provision of information, innovation, finance, and services.
3. The three-age system is the periodization of human … into three consecutive time periods, the Stone Age, Bronze Age, and Iron Age.
4. The … is used worldwide as a basic means of transportation.
5. While … are often associated with the small three-wheeled vehicles used by pre-school-age children, they are also used by adults for a variety of purposes.

6. The first … of the graph shows the characteristics of the diode when the source is connected with the positive to the p-side of the junction and the negative to the n-side.
7. Researchers at UC Berkeley have developed rotational bearings based upon … carbon nanotubes.

Ex.2. Fill in the correct words derived from the words in bold.

1. Electric motors operate through the **… (action)** of magnetic flux and electric current to produce rotational speed and torque.
2. As there are no written records from human **… (history),** dating of … **(history)** materials is particularly important.
3. This **… (angle)** is equilateral and that one is right-angled.
4. **… (pole)** transistors are so named because their operation involves both electrons and holes.
5. Charge flow in such transistors is due to … **(direction)** diffusion of charge carriers across a junction between two regions of different charge concentrations.
6. A … **(precious)** jewel or stone is valuable but not as valuable as a diamond, ruby.

Reading and Speaking

Reading

Ex.1. Look at the headline and the first paragraph of the text. Write 5 questions you would like to ask about the history of Roman Numerals.

A Brief History of Roman Numerals

1. Roman Numerals originated in Rome and were used by the ancient Romans almost 2000 years ago. They were originally independent symbols. In this system seven symbols are used: I V X L C D M, where I = 1, V = 5, X = 10, L = 50, C = 100, D = 500 and M = 1000. It is likely that counting began on the finger, that is why we count in tens, and Roman numerals resemble fingers so much.

2. A single stroke I represents one finger, five or a handful could possibly be represented by V and the X may have been used because if you stretch out two handfuls of fingers and place them close the two little fingers cross in an X. Alternatively, an X is like two Vs, one upside down. The other numerals like 2, 3, 6 are represented with these above symbols by placing them in a row and adding or subtracting, such as : 4 = IV (one subtracted from five), 8 = VIII (V + I + I + I), 9 = IX (one subtracted from ten).

3. You can use a roman numerals chart or conversion table to lookup roman numerals or you can easily learn how to calculate them yourself with a few simple rules. If smaller numbers follow larger numbers, the numbers are added. If a smaller number precedes a larger number, the smaller number is subtracted from the larger. For example, if you want to say 1,100 in Roman Numerals, you would say M for 1000 and then put a C after it for 100; in other words 1,100 = MC in Roman Numerals. Some more examples:

VIII = 5+3 = 8; IX = 10-1 = 9; XL = 50-10 = 40; XC = 100-10 = 90;

MCMLXXXIV = 1000+(1000-100)+50+30+(5-1) = 1984

4. Roman numerals remained in common use until about the 14th century, when they were replaced by Hindu-Arabic numerals. At present, in modern usage, the Roman number system is generally regarded as obsolete but it is still commonly used in many cases. The examples are:

- in page numbering of preliminary pages; volume numbers on spines and chapter numbers;
- in hour marks on clock and watch faces;
- in names of monarchs and Popes, e.g. Elizabeth II, Benedict XVI. These are ordinal numbers; e.g. "II" is pronounced "the second";
- to indicate months, to avoid confusion due to differing date notation order. For example, 2/10/1948 can mean 10 February 1948 or 2 October 1948; writing 2/X/1948 will make it clear that the date meant was actually the second one;
- to denote centuries. For example, *XVIII* refers to the eighteenth century, so as to avoid confusion between the *18th century* and the *1800s;*
- in CIS countries, capital Roman numerals I, II and V are sometimes used according to the regional standard GOST 2.728–74 (2002), to specify rated resistor power (in watts) in schematic symbols by inscribing the numeral along inside the symbol rectangle.

Ex.2. Match headings A-E with paragraph 1-4 in the text. There is one heading you don't need.

A. Where are Roman Numerals used in modern times?
B. What symbols are used in the Roman number system?
C. How actually is the counting done on this system?
D. What is the origin of Roman Numerals?
E. The advantages and disadvantages of the Roman number system.

Ex.3. Match the Arabic and Roman numerals.

1	2	a	D	6	29	f	DCCC
2	50	b	XXXIX	7	1000	g	L
3	5	c	II	8	800	h	C
4	100	d	V	9	500	i	X
5	10	e	XXIX	10	39	j	M

Ex.4. Complete this framework of notes to make a short summary of the text.

1. Roman Numerals were used….
2. In this system … symbols are used.
3. *I* represents… *V* is… and *X* is…
4. The rule of calculating roman numerals is…
5. In the 14th century, Roman numerals were replaced by…
6. The Roman number system is now regarded as … but it is still used in …

***Speaking**

***Get real**

Use reference books or the Internet to find some unusual, strange, or interesting statistics. Bring them into class and create a *Did you know*? board.

UNIT 3. ADVANCED ARITHMETICAL OPERATIONS AND EXPRESSIONS. MATRICES.

Overview

- Reading and Vocabulary: BELA programs.
- Information transfer: Reading advanced arithmetic expressions.
- Language focus: Plurals of some nouns borrowed from Latin and Greek. Positions on two dimensions.
- Reading and Speaking: Matrices.

Reading and Vocabulary

Before you read

Discuss the questions below.

1. What fundamental arithmetical operations do you know? Make a list of arithmetical operations and formulae you are aware of. Write 1-5 in the spaces below.

_____
_____
_____
_____
_____

2. In what cases are they not sufficient? Why?
3. What new arithmetical operations are to be added?

Reading

Skim the text as quickly as you can and choose the best headline.

A. Behaviour of electric field.
B. Your laws.
C. A new simple method of solving linear electrostatic problems.

BELA is a suite of programs for solving linear electrostatic problems. For the electrostatics problems addressed by BELA, only a subset of Maxwell's equations are required. These problems describe the behavior of electric field intensity, E, and electric flux density (alternatively electric displacement), D. There are two conditions that these quantities must obey.

The first condition is the integral form of Gauss' Law, which says that the flux out of any closed volume is equal to the charge contained within the volume. However, in differential form it is presented as follows: $\nabla \cdot D = \rho$, where ρ represents charge density.

The second is the differential form of Ampere's loop law: $\nabla \times E = 0$. Displacement and field intensity are also related to one another via the constitutive relationship: $D = \varepsilon E$, where ε is the electrical permittivity. Although some electrostatics problems might have a nonlinear constitutive relationship between D and E, BELA only considers linear problems.

To simplify the computation of fields which satisfy these conditions, BELA employs the electric scalar potential, φ, defined by its relation to E as $E = -\nabla\varphi$.

Because of the vector identity $\nabla \times \nabla\varphi = 0$ for any scalar φ, Ampere's loop law is automatically satisfied. Substituting into Gauss' Law and applying the constitutive relationship yields the second-order partial differential equation: $-\varepsilon\nabla^2\varphi = \rho$, which applies over regions of homogeneous ε. This is the equation that BELA solves – the program solves for voltage φ over a user-defined domain with user-defined sources and boundary conditions.

Reading comprehension

Ex.1. Read the statements and mark them true (T) or false (F). Give the true statements.

1. BELA is a program for solving linear electrostatic problems.
2. BELA uses all relevant Maxwell's equations.
3. All Maxwell's equations are actually unnecessary for solving electrostatic problems.
4. Magnetic field intensity and electronic flux density are described by electrostatic problems.
5. The flux equals the charge.
6. Potential φ may be determined by integration of E.
7. BELA considers both linear and nonlinear problems.
8. Boundary conditions are not essential at application of BELA-program.
9. BELA is applied to solving the second-order partial differential equation: $-\varepsilon\nabla^2\varphi = p$.

Ex.2. Read the text and choose the best answer to the questions:

1. What do linear electrostatic problem describe?

a) vector identity
b) the form of Ampere's loop law
c) behaviour of electric field intensity

2. What conditions must E and D quantities obey?
   a) Ampere's loop law
   b) Maxwell's equations
   c) Pythagorean theorem
3. What kind of problems do BELA consider?
   a) linear
   b) nonlinear
   c) scalar
4. What is the flux equal to?
   a) the charge within the volume
   b) the negative charge
   c) the charge out of volume
5. Why does BELA employ the electric scalar potential?
   a) to simplify the computation of fluxes
   b) to simplify the computation of vector identify
   c) to simplify the computation of fields
6. Where is $-\varepsilon\nabla^2\varphi=\rho$ applied?
   a) in boundary conditions
   b) over regions of homogeneous ε
   c) in nonlinear constitutive relationship between D and E

Vocabulary

Ex.1. Match the words from the text with their definitions.

1	density	a	exact similarity between two things
2	flux	b	the strength of smth, such as light, sound etc
3	identity	c	the relationship between the mass of smth and its size
4	intensity	d	the way in which two or more things are connected and affect each other
5	permittivity	e	a value expressing capacitance; dielectric constant
6	relationship	f	the rate of flow of particles, energy or a fluid through a specified area

Ex.2. Fill in the correct prepositions from the box in the following sentences.

according to; for; through; between; to; by

1) The equation is used … solving mathematic problems.
2) The conditions have been followed … a group of scientists.
3) To simplify the computation one must consider a relationship … D and E.
4) The release of noxious fumes … exhaust pipe is harmful … the environment.
5) Mathematicians have to work strictly … mathematical laws.

Ex.3. The words in this table are from the text. Fill in as many of the gaps as you can with related worlds.

Noun	Verb	Adjective	Adverb
	Satisfy		
description			
		differential	
			automatically
		electrostatic	
displacement			
	substitute		
intensity			

Information transfer

Reading advanced arithmetic expressions

Ex.1. Match the words and word combinations (1-12) with the expressions (a-k) below. Translate them into Russian.

1. raising to a power: the power, the base, the exponent (index), value of the power;
2. evolution (extracting a root): radical sign, the root (radical), the radicand, the index (degree) of the root, value of the root;
3. logarithmic calculation (taking the logarithm): logarithm sign, number whose logarithm is required, the base, the characteristic, the mantissa, the logarithm;
4. infinitesimal calculus;
5. derivative: the differential, differential sign;

6. integral (integration): the variable, constant of integration (integration constant), the integral sign;
7. arithmetical series;
8. geometrical series;
9. simple equation: the coefficients, the unknown quantity;
10. identical equation;
11. simple proportion;
12. solution.

a) $\sqrt[3]{8} = 2$;
b) $3x + 2 = 12$;
c) $4a + 6ab - 2ac = 2a(2 + 3b - c)$;
d) $3^2 = 9$;
e) $\log_{10}3 = 0.477$;
f) $\int axdx = a\int xdx = \frac{ax^2}{2} + C$;
g) $2:50 = 4:x$;
h) $x = 100$;
i) $2 + 4 + 6 + 8 + \ldots$;
j) $2 + 4 + 8 + 16 + 32 + \ldots$
k) $\frac{dy}{dx}$;

Ex.2. Read and translate the sentences below. Find out arithmetical operations and characterize them. Give your own examples concerning arithmetical operations.

1. The cube-root of minus eight gives minus two.
2. The prefix 'centi-' means ten to the power of minus two or one hundredth.
3. Effective value of nonsinusoidal voltage is equal to square root of sum of effective values of all harmonics squared.
4. Pythagorean theorem states that the hypotenuse squared is equal to sum of the legs squared.

Ex.3. Complete the text by putting a word or number in each space (1-10). **Use the words and numbers in the box.**

half; -5ºC; -40ºC; 88%; hundreds; 200; 14,000; 1989; 4000; 5000 m^2

THE JUKKASJARVI ICEHOTEL in Sweden is an interesting and cold place for a holiday. It started life as an igloo (a small house made of snow) at an art exhibition in … (1). … (2) of people visited the exhibition and some even slept there, so the builders decided to make it a hotel. The Icehotel is open for less than

… (3) of the year. Every May it melts and November it is rebuilt. It now measures … (4) and it needs … (5) tons of ice and 30,000 tons of snow to build it. This actually means that it is more than … (6) snow. The temperature inside the hotel is usually about … (7). Outside in Jukkasjarvi itself the temperature can be much lower even as low as …. (8)! Last year more than …. (9) visitors traveled … (10) km north of the Arctic Circle to sleep in thermal sleeping bags. They got a cool reception!

Language focus

Plurals of some nouns borrowed from Latin and Greek

Endings in singular	Endings in plural	Examples
-us	-i	radius – radii; stimulus – stimuli; nucleus – nuclei
-um	-a	spectrum – spectra; datum – data; referendum – referenda
-is	-es	analysis- analyses; axis – axes; basis – bases
-a	-e (is added)	formula – formulae; antenna – antennae (formulas, antennas – less formal)
-ix(ex)	-ices	appendix – appendices; matrix – matrices; index – indices (appendixes, indexes – less formal)
-on	-a	phenomenon – phenomena

Ex.1. Use the nouns in the following sentences in plural.

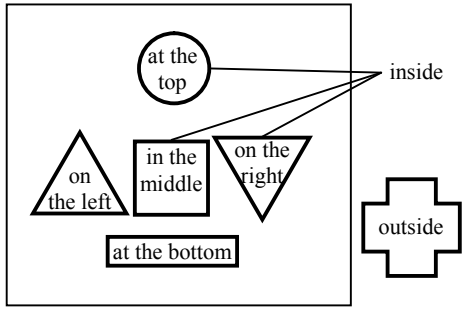
1. The radius of a cylindrical object is measured in centimeters.
2. This nucleus contains only one nucleon.
3. The city council agreed to hold a referendum on the issue in November.
4. Further analysis of the data is needed.
5. His work will be used as a basis for future research.
6. We can introduce a unit vector directed along the *x* axis.
7. A trained participant could more precisely locate rapidly presented visual stimulus.
8. The findings came from the computer analysis of digitized books.

Positions on two dimensions

Ex.1. Look at the picture below. The words give the positions of the shapes *in relation to the rectangle*.

Make questions and answers like the following:

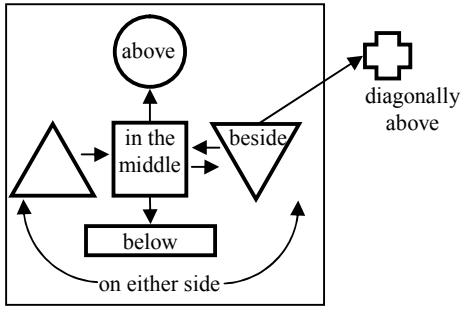
Example: What is there *at the top of* the rectangle? There is a circle at the top of the rectangle.



Ex.2. In this picture the words give the positions of the shapes *in relation to one another*.

Make questions and answers like the following:

Example: Where is the circle? The circle is above the square.



Matrices

Ex.3. Discuss the questions below.

1. What do you know about matrices? (definition, application, etc.)

2. How are the matrices added? Multiplied?

Ex.4. Match the following words and expressions (1-12) with the matrix elements given below.

1. square matrix; 2. column matrix; 3. row of matrix; 4. column of matrix; 5. subscript of the matrix elements; 6. inverse matrix; 7. third-order determinant; 8. principal diagonal of a determinant; 9. auxiliary determinant of a system of linear algebraic equations; 10. matrix equation; 11. secondary diagonal of a determinant; 12. transposed matrix

$$A=\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix};\quad B=\begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix};\quad A^{-1};\quad |A|=\begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix};\quad \begin{vmatrix} b_{11} & a_{12} & a_{13} \\ b_{21} & a_{22} & a_{23} \\ b_{31} & a_{32} & a_{33} \end{vmatrix};$$

$A\times B=C;\ A^T$

Ex.5. Read the following passage.

In Ex.5 above there is a matrix A. The elements a_{ij} are arranged in horizontal rows and vertical columns.

Give the positions of the different elements in relation to the whole matrix:

Examples: a_{31} is at the bottom, on the left.

a_{13} is in the third column from the left, at the top.

a_{12} is in the top row, in the middle.

Now give the positions of the different elements in relation to others:

Example: a_{31} is beside and to the left of a_{32}.

Ex.6. Read these sentences which give other positions of the different elements in matrix A:

a_{11} is next to, or adjacent to, a_{12}.

a_{21} is not adjacent to a_{23} because a_{22} is between them.

a_{11} is in line with a_{12} and a_{21} is in line with a_{23}.

a_{13} is near a_{23} but far from a_{31}.

Now say whether these statements are true or false. Correct the false statements.

a) a_{11} is diagonally above a_{22}.

b) a_{31} is in line with a_{22}.

c) a_{11} and a_{13} are on either side of a_{22}.

d) a_{31} is adjacent to a_{22}.
e) a_{11} is beside and to the right of a_{12}.
f) a_{33} is vertically below a_{23}.
g) a_{11} is near a_{22}.
h) a_{13} is at the bottom of the matrix, on the right.
i) a_{21} is in the middle row.
j) a_{23} is in the third column from the right.

Reading and Speaking

Reading

Matrices

A _____

There are tree types of arrays: vectors, matrices, and nested matrices. A vector is an array of just one row or column of numbers. A matrix is an array with vectors or matrices for each of its entries.

Subscripts are the numbers or variables that identify a single element or a sequence of elements in an array. Subscripts are written below an array variable. A subscript on a vector refers to the n^{th} element of a vector: V_n. A subscript on a matrix refers to an element in the m^{th} row and n^{th} column in the matrix: $A_{m,n}$.

The superscript of an array refers to a column of the array.

B _____

Linear algebra has some simple rules for how to calculate using arrays. Generally, you can apply the same operations to arrays as you would to simple variables. There are no special instructions for calculating with vectors or matrices.

If you multiply a vector by a scalar (single number), the result is a vector in which each component of the original vector has been multiplied by the scalar. You may add or subtract two vectors whenever they are of the same length. When you add two matrices together, the elements of the resultant matrix are the sums of the elements of the two original matrices. Just as with vectors, matrix addition is only defined for matrices of the same size. You can take the transpose, inverse, and determinant of matrices.

The dot product is calculated by multiplying each element of the first vector by the corresponding element of the complex conjugate of the second vector, and then summing the result.

Ex.1. Read the text and think of possible headings for the paragraphs A and B.

Ex.2. Read paragraph A and answer the question

What's the difference between ... and ...?

1. a vector;
2. a matrix;
3. a subscript;
4. a nested matrix;
5. a superscript

Ex.3. Read paragraph B and answer the questions.

1. How can arrays influence the ways of calculating?
2. What arithmetical operations can you do with a vector and a scalar?
3. What kind of result can you expect when you add two matrices?
4. How is the dot product calculated?

*Speaking

***Ex.1. Discuss advanced mathematical expressions and operations you've learned about from the text.**

***Get real**

Use reference books or the Internet to find some interesting popular scientific texts with application of mathematical operations and expressions, matrices and determinants.

UNIT 4. MEASUREMENT

Overview

- Reading and Vocabulary: Standards of measurement.
- Information transfer: Mathematical and geometrical symbols.
- Language focus: Singular/Plural verb forms. Describing measurements.
- Reading and Speaking: Systems of measuring units.

Reading and Vocabulary

Reading

Four sentences have been removed from the text. Choose from the sentences **A-E (Ex.1)** the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

Standards of measurement

1. In early times measurements were made by comparing things with parts of the human body. Early units of measurement included the distance from the elbow to the fingers, the width of the hand and the width of the fingers.

2. Some of these human measurements are still used. [1] A foot was originally the length of a man's foot. A mile was one thousand walking steps.

3. These units were only approximate, because their standard – the human body – was not constant. Governments tried to standardize them by using rods or bars of fixed lengths kept in a central public place. [2] However, these rods still varied from country to country.

4. For measurements of weight, the human body provides no such easy approximations as for length. Here nature steps in. Grains of wheat are reasonably standard in size. Weight can be expressed with some degree of accuracy in terms of a number of grains – a measure still used by jewellers. [3] Copies of this can be cast and weighed in the balance for perfect accuracy. But it is easier to deceive a customer about weight, and metal can all too easily be removed to distort the scales. An inspectorate of weights and measures is from the start a practical necessity, and has remained so.

5. During the French Revolution, scientists looked for a standard of measurement which did not change. [4]. One ten millionth of this was called one metre and became the basic unit of the metric system.

6. Other metric units are based on it. For example, the centimetre is one hundredth of a meter. A gram – the unit of weight – is the mass of one cubic centimetre of water. A standard metre was marked on a platinum bar. The accuracy of measuring instruments was checked by comparing it with another constant – the wavelength of a certain kind of light.

Notes and comments

to *step in* – to start doing / working. E.g. The student self-government may have to step in to settle the disagreement between the dean and the students.

in terms of something – expressed in units of something. E.g. If in the relationship Y(X) X is presented in terms of current while Y in terms of voltage, it is called a volt-ampere characteristic.

metal can all too easily be removed – removing metal from tares, we make them easier.

common benchmarks – conditional standards. They may be applied in different fields of action. In computer science, they are the test programs; in mechanical engineering – specimens; in power engineering – test procedure for installation.

Reading comprehension

Ex.1.

A. As with measurements of length, a lump of metal can be kept in the temples as an official standard for a given number of grains.

B. For example, the inch is based on the length of half the thumb.

C. Over the course of human history standards of measurement evolved so that communities would have certain common benchmarks.

D. They chose the distance from the Equator to the North Pole, which is one quarter of the circumference of the Earth.

E. From this 'standard' other identical rods could be copied and distributed through the community.

Ex.2. Read the text and find the answers to these questions.

1. What did early units of measurement include?
2. Why did early measurements vary?
3. How did governments try to standardize the units of measurement?
4. What can be used to measure weights?
5. When did scientists start looking for a standard of measurement which did not change?
6. How have measurements become more constant?

Ex.3. Read the statements and mark them true (T) or false (F). Give the true statements.

1. Early units of measurement included the distance from the elbow to the shoulder, the length of the hand and of the fingers.
2. A mile was originally one hundred walking steps.
3. A gram is the mass of one cubic centimetre of water.
4. Early units of measurement are not used at present at all.
5. In early times measurements were rather exact.
6. A standard metre was marked on a bar made of crystal.

Vocabulary

Ex.1. Fill in the correct preposition in the following word combinations from the text.

1. compare things … others;
2. look … a standard which does not change;
3. standard … size;
4. in terms … a number of grains;
5. deceive a customer … the price;
6. base … the theory;
7. distribute … the group;
8. mark … a platinum bar;
9. keep … a special place.

Ex.2. Fill in the words from the box below.

deceive, mark, keep, remove, make, weight, basic, check, distort, the distance

1. … measurements
2. include …
3. … in a central public place
4. express …
5. … a customer
6. become the … unit
7. … on a platinum bar.
8. … the accuracy of measuring instruments
9. … metal easily
10. … the scale

Information transfer

Mathematical and geometrical symbols

Before you start

Ex.1. Discuss the questions below.

1. What mathematical symbols do you know?
2. What geometrical symbols do you know?
3. When do we use them?
4. What are the advantages of using symbols?

Ex.2. Match the words and expressions (1-19) with the symbols (a-y) below. Translate them into Russian. Give your own examples of mathematical and geometrical symbols.

1. infinity; 2. identically equal to (the sign of identity); 3. approximately equal to; 4. unequal to; 5. greater than; 6. less than; 7. brackets; 8. parallel to (sign of parallelism); 9. similar to (sign of similarity, proportionality sign); 10. angle symbol; 11. triangle symbol; 12. perpendicular to; 13. intersection of the sets (conjunction sign); 14. union of the sets (disjunction sign); 15. double sign; 16. second order character; 17. degree mark; 18. congruent (coincidence) sign; 19. empty set sign.

a) $\pm$
b) $\neq$
c) $\approx$
d) ∞
e) $\sim$
f) $\in$
g) $\subset$
h) $\not\subset$
i) $\supset$
j) $\cup$
k) $\cap$
l) $\varnothing$
m) $\angle$
n) Δ
o) $\cong$
p) $<$
q) $>$
r) ^{o}
s) $\perp$
t) $\parallel$
u) x^2
v) ( )
w) [ ]
x) { }
y) $\equiv$

Ex.3. Read and translate the sentences below. What mathematical symbols can be used to reduce notations?

1. Right angle is such an angle having 90º.
2. Parallel lines have no intersection point.
3. If set A belongs to set B belonging to set C, then set C includes set A.
4. A triangle can't have two right angles.
5. Two triangles having two identical angles are similar.
6. At summation, common multiplier may be taken out the brackets.
7. The intersection of two lines is point.
8. If the last digit under consideration is not less than five, next to last digit is rounded up, if not it is rounded down.
9. The task set for the next few years is to increase two-three times the production of computers.
10. At resonance, the voltages U_L and U_C cancel out each other.
11. The line AB is perpendicular to line CD.
12. The line EF is parallel to line GH.

Language focus

Singular / Plural verb forms. Some peculiar cases.

We use **singular verbs** with:

a) nouns referring to **school subjects**: economics, physics, politics, etc.

I think physics is a very interesting subject;

b) nouns referring to **sports and games**: athletics, gymnastics, billiards;

c) the words **news, hair, advice, luggage, accommodation, traffic, weather, information, experience.**

The news isn't very encouraging, I'm afraid.

d) plural nouns when we talk about an **amount of money, a time period, weight, distance**.

Five hundred thousand pounds was donated to build a new hospital.

e) **group nouns** such as *family, team, group, crowd, class, company, committee* when we mean the group as a unit. But we use plural verbs when we mean the individuals who make up the group.

The team is ready to discuss the project.

We use **plural verbs** with:

a) nouns such as: *clothes, people, police, stairs, surroundings, outskirts, premises, earnings*

Police are looking into this crime.

b) nouns referring to objects that consists of two parts: *trousers, binoculars, shorts, shoes, gloves, glasses, scissors*. We can't use *a/an* or *a number* with these words. We use the phrase **pair of**…

Where are your shoes?

I was given a pair of shoes.

Ex.1. Use the correct form of the verbs: is/are, was/were.

1. Mathematics … a very difficult subject.
2. My office is three miles from my house. Three miles … a long way to walk to work.
3. Jane looked nice yesterday. Her clothes … very smart.
4. I've got two pounds. I'm going to buy a CD. Two pounds… not enough to buy a CD.
5. The classroom was empty when I walked past. The class … all on a school outing.
6. I have just cleaned the stairs, so be careful. The stairs… very slippery.
7. These trousers … very old. You should buy a new pair.

Ex.2. Finish the sentences as in the example.

1. You need a lot of experience to do this job.
   A lot of experience **is needed** to do this job.
2. We called the committee immediately.
   The committee …
3. I told them some exciting news.
   The news…
4. The hotel is in beautiful surroundings.
   The hotel surroundings…
5. She's got long blond hair.
   Her hair …
6. These shorts are too big for me.
   This pair of shorts…

Ex.3. Correct the mistakes.

1. The police is searching for the stolen painting.
2. Twenty kilometers are too far to travel to school.
3. The news are on TV at six o/clock every evening.
4. Our company are doing well, we opened up two more branches.
5. Two years are a long time to be away from home.

Describing measurements

Ex.4. Read the following passage and pay attention how we can describe measurements.

The block of wood has the properties which are measured. It has *height, length* and *width*. We say ,'This brick has a length of 3 cm' or 'This brick is 3 cm long'; 'This brick has a width of 2 cm' or 'This brick is 2 cm wide' and 'This brick has a height of 1 cm' or 'This brick is 1 cm high'. Each surface has *area*. We say 5m×7m as five metres by seven (metres) when we are talking about area. The area of the cross-section is the *cross-sectional area.* The area of all the surfaces is the *surface* area. The *volume* of the block = length x height x width (*equals* length *times* height *times* width). In a circle we can measure its radius, diameter, circumference and the area.

Ex.5*. Draw some objects on the blackboard (for example, a circle, a sphere, a rectangular prism, a triangle, a square, a rectangle and so on) and describe what properties of these objects we can measure. Use sentences like this:

We can measure ….. of a circle.
This circle has a radius of … .
The length of ... is … .
The rectangle is … cm long.

Ex.6. Complete the sentences (1-8) below by putting one word in each space. Use the words in the box.

area, capacity, distance, length, liquid, speed, weight, height

Did you know?

1. The … of the Eiffel Tower in Paris is about three hundred metres.
2. The … of the Charles Bridge in Prague is five hundred and sixteen metres.
3. The surface … of Lake Balaton in Hungary is five hundred and ninety-three square kilometers.
4. The maximum … limit on expressways in Poland is one hundred and ten kilometers per hour.
5. The … of the bell in Dubrovnik's city tower is two thousand kilograms.
6. The … between Bratislava and Budapest is about two hundred kilometers.
7. A magnum champagne bottle can hold one point five litres of ….
8. The engine ... of a Formula One car is three thousand cubic centimeters.

Rewrite the measurements in the text as numbers and abbreviations. Use the numbers and abbreviations in the box.

516m 110kph 3000cc (or cm^3) 200km 300m 1.5l 593km^2 2000kg

Ex.7. Read the statements and mark them true (T) of false (F). Give the true statements.

1. Duration is measured in degrees Centigrade.
2. The second is a unit of time.
3. Speed is measured in kilograms per hour.
4. The watt is a unit of electrical resistance.
5. The gram is a unit of mass.
6. Liquid measurements are made in litres or cubic decimetres.

Ex.8. Give the true answers to these questions.

1. What is the area of your classroom?
2. How tall are you?
3. What is the speed limit on the roads in your town?
4. How fast can you run?
5. What is the area of your desk?
6. How much does your bag weigh?
7. How much did you weigh when you were born?
8. How far is it from your town to the capital city?

Reading and Speaking

1. Before SI units were widely adopted around the world, the British systems of English units and later imperial units were used in Britain, the Commonwealth and the United States.

2. Many Imperial units remain in use in Britain despite the fact that it has officially switched to the SI system. Road signs are still in miles, yards, miles per hour, and so on, people tend to measure their own height in feet and inches and milk is sold in pints, to give just a few examples. Land area is measured in acres and floor space in square feet, particularly for commercial transactions.

3. The metric system is a decimal system of measurement based on its units for length, the metre and for mass, the kilogram. Metric units of mass, length, and electricity are widely used around the world for both everyday and scientific purposes. The metric system features a single base unit for many physical quantities.

4. Other quantities are derived from the standard SI units. Multiples and fractions of the units are expressed as powers of ten of each unit. Unit conversions are always simple because they are in the ratio of ten, one hundred, one thousand, etc., so that convenient magnitudes for measurements are achieved by simply moving the decimal place: 1.234 metres is 1234 millimetres or 0.001234 kilometres.

5. The International System of Units (abbreviated as SI from the French language name *Système International d'Unités*) is the modern revision of the metric system. It is the world's most widely used system of units, both in everyday commerce and in science. The SI was developed in 1960 from the metre-kilogram-second (MKS) system. At its development the SI also introduced several newly named units that were previously not a part of the metric system.

6. There are two types of SI units, base units and derived units. Base units are the simple measurements for time, length, mass, temperature, amount of substance, electric current and light intensity. Derived units are constructed from the base units, for example, the watt, i.e. the unit for power, is defined from the base units as $m^2 \cdot kg \cdot s^{-3}$. Other physical properties may be measured in compound units, such as material density, measured in kg/m^3.

Ex.1. Read the text and choose the best title for it.

1. Modern measuring devices.
2. Basic units of measurement.
3. Measuring systems.
4. Development of SI.

Ex.2. Match headings A-G with paragraph 1-6 in the text. There is one heading you don't need.

F. The force of traditions.
G. Derivatives of standard units.
H. Metric system.
I. How to measure physical properties.
J. Base and derived units.
K. Contemporary revision of the metric system.
L. Imperial system.

Ex.3. Answer the questions using the information from the text.

Which system uses some newly named units?
was developed on the basis of the other system?
is still traditionally used in some spheres of life?
has a lot of quantities derived from basic units?
has a very simple way of unit conversions?
is the world's most widely used one?

Ex.4. Complete the following sentences with the information from the text using the question words in brackets as prompts.

1. The British systems of English units were used … (When?)
2. In Britain, road signs are still in … (What units of measurement?)
3. Metric units of mass, length, and electricity are widely used … (Where? What for?)
4. Unit conversions are always simple … (Why?)
5. The SI was developed … (When?)
6. There are two types of SI units … (What?)
7. Base units are the simple measurements for … (What?)
8. Derived units are constructed from … (What?)

***Speaking**

***Ex.1. Find out additional information about the history of measurement. For example, what are the connections between human bodies and measurement? Which countries developed the earliest standard systems? Why did they need them?**

UNIT 5. MEASUREMENTS AND INSTRUMENTATION

Overview

- Reading and Vocabulary: Measurements and instrumentation.
- Information transfer: Legends on the instrument scales.
- Language focus: Quantifiers. How much, how many. Some, any, no.
- Reading and Speaking: Electric pointer instruments.

Reading and Vocabulary

Reading

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

Measurements and instrumentation

1. *Measured variable* and *process variable* are both terms for the physical quantity that is to be measured. The *measured value* is the actual value which is measured or recorded, in engineering units (e.g. the level is 1252 mm).

2. A *primary element* or *sensor* is the device which converts the measured value into a form suitable for further conversion into an instrumentation signal. An orifice plate is a typical sensor. A *transducer* is a device which converts a signal from one quantity to another (e.g. a Pt100 temperature transducer converts a temperature to a resistance). A *transmitter* is a transducer which gives a standard instrumentation signal (e.g. 4-20 mA) as an output signal.

3. *Measuring span*, *measuring interval* and *range* are terms which describe the difference between the lower and upper limits that can be measured. *Turndown* is the ratio between the upper limit and the lower limits where the specified accuracy can be obtained.

4. *Error* is a measurement of the difference between the measured value and the true value and accuracy is the maximum error which can occur between the process variable and the measured value when the transducer is operating under specified conditions. [1] The commonest are absolute value, as a percentage of the actual value, or as a percentage of full scale.

5. [2] A wire wound potentiometer, for example, can only change its resistance in small steps. *Resolution* is used to define the smallest step in which a reading can be made.

6. In many applications, the accuracy of a measurement is less important than its consistency. *Repeatability* is defined as the difference in readings obtained when the same measuring point is approached several times from the same direction.

7. *Hysteresis* occurs when the measured value depends on the direction of approach. Mechanical backlash and stiction are common causes of hysteresis.

8. The accuracy of a transducer will be adversely affected by environmental changes, particularly temperature cycling, and will degrade with time. Both of these effects will be seen as a *zero shift* or a change of sensitivity (known as a *span error*).

9. [3] Commonly the sensor will change as a first-order lag with time constant T, as shown in Fig. 1. For a step change in input, the output reaches 63 per cent of the final value in time T, and it follows that a significant delay may occur for a dynamically changing input signal.

10. A second order response occurs when the transducer is analogous to a mechanical spring/viscous damper. The step response depends on both the damping factor b and the natural frequency ω_n. The former determines the overshoot and the latter the speed of response. For values of $b < 1$ damped oscillations occur. [4] For $b > 1$, the system behaves as two first-order lags in series.

11. Intuitively, $b = 1$ is the ideal value but this may not always be true. If an overshoot to a step input signal can be tolerated a lower value of b will give a faster response and settling time within a specified error band. The signal enters the error band then overshoots to a peak which is just within the error band as shown in Fig. 2. Many instruments have a damping factor of 0.7 which gives the fastest response time to enter and stay within a 5 per cent settling band.

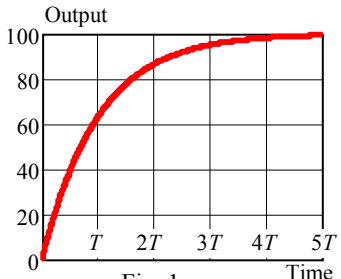


Fig. 1

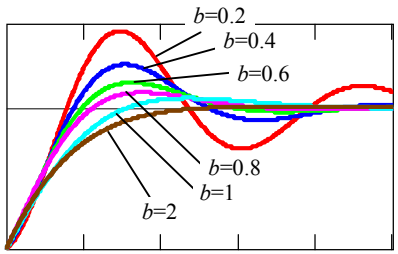


Fig. 2

Notes and comments

The commonest – the most common things.

Mechanical backlash and stiction – they occur if something is loosened or moves with sufficient friction.

an inherent coarseness – here "imperfection".

Reading comprehension

Ex.1.

A. Error can be expressed in many ways.

B. A sensor cannot respond instantly to changes in the measured process variable.

C. Many devices have an inherent coarseness in their measuring capabilities.

D. The signals from most primary sensors are inconvenient for direct processing.

E. The case where $b = 1$ is called *critical damping*.

Ex.2. Read the text and find the answers to these questions.

1. What is the difference between a sensor and a transducer?
2. What are the common causes of hysteresis in measurements?
3. How does the accuracy of a transducer change with time?
4. How is the repeatability of a test defined?
5. What is a zero shift?
6. What value of a damping factor do many instruments have?

Ex.3. Read the statements and mark them true (T) or false (F). Give the true statements.

1. Error is a measurement of the difference between the measured value and the true value.
2. A sensor is a device which converts a signal from one quantity to another.
3. A wire wound potentiometer can change its power.
4. The accuracy of a measurement is always the most important quantity.
5. A sensor responds instantly to changes in the measured process variable.
6. A damping factor of 0.7 gives the fastest response time to enter.

Ex.4. Answer which paragraphs of the text above (1-11) consider the following topics:

a) definition of terms; b) dynamic effects; c) accuracy and error; d) causes of possible error.

Vocabulary

Ex.1. Fill in the correct preposition from the box in the following word combinations from the text.

for; between; of; in; on; with; to; into; under

a. suitable…

7. change …sensitivity

b. ratio …
c. percentage… full scale
d. difference …
e. depend …
f. degrade … time
8. a step change … input
9. analogous…
10. operate … specified conditions
11. convert smth … smth
12. smth is affected … environmental changes

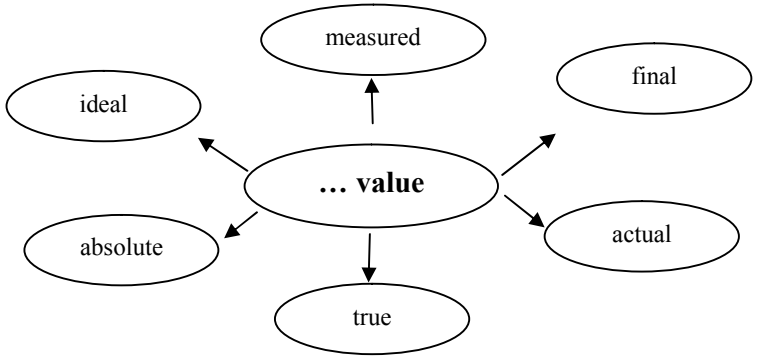
Ex.2. Fill in the words with prepositions from Ex.1.

1. Error band is a measurement of worst-case error. This is the best specification to determine if a gauge is … an application.
2. A sensor is a device that measures a physical quantity and … it … a signal which can be read by an instrument.
3. The output signal of such a sensor is linearly proportional to the value. The sensitivity is then defined as the … output signal and measured property.
4. Nonlinearity is defined by the amount the output differs from ideal behavior over the full scale of the sensor, often noted as a ….
5. The sensor may be sensitive to properties other than the property being measured. Operation of sensors can … the temperature of their environment.
6. If the sensitivity is not constant over the range of the sensor, that is there is … this is called nonlinearity.

Ex.3. Match the verbs and nouns / word combinations as they are used in the text. Some verbs are used more than once.

	Verbs		Nouns / word combinations
1	affect	a	the lower and upper limits
2	change	b	its resistance in small steps
3	convert	c	readings
4	give	d	specified accuracy
5	measure	e	a faster response
6	obtain	f	the physical quantity
7	operate	g	a signal from one quantity to another
8	record	h	a standard instrumentation signal
		i	under specified conditions
		j	a value
		k	a temperature to a resistance
		l	the accuracy of a transducer
		m	the fastest response time

Ex.4. Learn by heart the collocations of the word value. Give your own definitions of these collocations like this:
The measured value is the actual value which is measured or recorded in engineering units.



Ex.5. Match the notions (1-8) from the text with their definitions (a-h).

1	error band	a	a signal applied to a device, element, or system
2	full scale	b	the change in baseline level of the output voltage of an accelerometer immediately after a mechanical shock.
3	input signal	c	the time required for a system to react to some signal
4	output signal	d	the algebraic difference between endpoints, where one endpoint is actual offset voltage and the other endpoint is the upper limit of the range
5	process variable	e	the normal mode error band defined by the maximum deviation from its specified value.
6	span error	f	a signal that comes out of an electronic system
7	speed of response	g	the deviation of transducer response from its best straight line (BSL), defined by lines on either side of its BSL and including the maximum deviation measured for a given normal mode
8	zero shift	h	the current status of a process under control

Information transfer

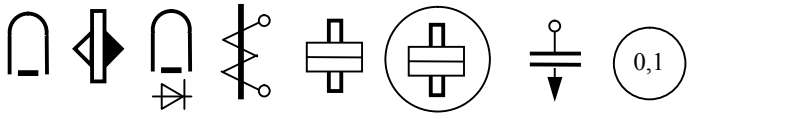
Legends on the instrument scales

In accordance with the requirements, the scale of a measuring instrument is to have the instrument name, its type as well as the following legends:

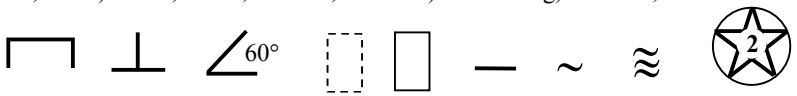
- current kind, type of a measuring system, accuracy rating;
- level of the voltage used for the insulation test;
- type of the protection from the influence of outside fields;
- working position, a serial number and a model year.

Some of the legends are given in Figure.

Ex.1. Match the elements of a measuring instrument legends named below with the symbols in the Figure.



a) b) c) d) e) f) g) h)



i) j) k) l) m) n) o) p) q)

1. Measuring system: 1.1 D'Arsonval system with movable magnet; 1.2 D'Arsonval system with movable frame; 1.3 electrodynamic system; 1.4 ferrodynamic system; 1.5 electrostatic system; 1.6 electromagnetic system; 1.7 magnetoelectric system with a diode.
2. Normal position of an instrument: 2.1 horizontal; 2.2 vertical; 2.3 angularly 60°.
3. Accuracy rating 0.1.
4. Current kind: 4.1 DC; 4.2 AC; 4.3 three-phase current.
5. Shield: 5.1 from the electric fields; 5.2 from the magnetic fields.
6. Insulation is checked under voltage 2kV.

Language focus

Quantifiers

1. How much and How many?

Uncountable nouns		Countable nouns	
How much liquid does the bottle contain?		How many crystals are there?	
no none of not …any little a little not much some much a lot of lots of plenty of all	liquid	no none of not …any few a few not many some /several many a lot of lots of plenty of all / every	crystal (s)

2. Some, any, no.

	Positive	Question	Negative
	some	any	not any/no
People	someone/ somebody	anyone/ anybody	no one /not anyone nobody / not anybody
Things	something	anything	nothing / not anything
Places	somewhere	anywhere	nowhere / not anywhere
	a lot of /lots of too many too much	many much	not many not much

Note: compounds of some, any, no + singular verb.
There is something wrong with the computer.

Ex.1. Read the dialogue and choose the correct word.

A: There is **nothing /something** (1) more annoying than losing **anything / something** (2)**.**

B: What have you lost?

A: My keys. They must be **anywhere/ somewhere** (3) in the house, but I've got **no/any** (4) idea where. I can't find them **nowhere/anywhere** (5). They can't be **somewhere/anywhere** (6) else but here. **No one/Someone** (7) must have hidden it.

B: Why would **no one/anyone** (8) hide your keys? There is **any/no** (9) reason for **anyone/no one** (10) to do **something/nothing** (11) so silly.

A: I need **some/any** (12) help to find them. I have to go **anywhere/somewhere** (13) important this afternoon.

B: Calm down. It's **some/no** (14) use getting angry about **anything/something** (15) like this. There are **no/some** (16) keys on the chair.

Ex.2. Complete the sentences using the words expressing quantity.

1. How … electrons does an atom of sodium possess?
2. How … oxygen does the atmosphere contain?
3. An orange contains … seeds.
4. …people can speak more than 5 languages.
5. … ammeters are connected in series with the circuit carrying the current to be measured.
6. … ammeter must be connected to a source of voltage.
7. Nearly … of the current flows through the shunt, and only a small fraction flows through the meter.
8. A number of electrical laws apply to… electrical networks.

Ex.3. Complete the sentences using the words from the box.

few, a few, little, a little

1. This coffee is bitter. It needs … more sugar.
2. I'd love to come to the beach. I just need … minutes to get ready.
3. There are … people who are as hard-working as James.
4. I have … work to do before I leave.
5. There's … coffee left. We need to buy some.

Reading and Speaking

Electric pointer instruments

Instruments of *D'Arsonval measuring system* with a movable frame or a movable magnet without a diode measure an average component of a current or a voltage. Instruments with a diode measure a half-period average value of a current or a voltage. These are the *instruments of direct current*. Such voltmeters have comparatively big input impedance. In order to guarantee high sensitivity of the instrument the feed wires carrying the measured current are made thin and light.

This is the disadvantage of this system, because such instruments cannot be overloaded. The feed wires may be easily burnt.

In *electromagnetic instruments* the measuring coil is immovable and may be made of thick wire. That's why these instruments are able to withstand the high overload. However, they have low accuracy rating. Voltmeters have comparatively little input impedance and while working with high-impedance load they give great inaccuracy as well as distort the current form in a load. These instruments measure effective value and are used in both DC- and AC-circuits.

Instruments of electrodynamic system have a massive immovable coil with a movable light coil inside which is placed on one and the same axis with the pointer. Coils are connected in series or in parallel. Working principle is based on electrodynamic interaction of the coil currents. These instruments have high accuracy; they are used to measure DC- and AC-circuits. However, they are sensitive to overload and the influence of outside magnetic fields. To enhance the coil interaction, a ferromagnetic core is involved. These are the instruments of *ferrodynamic measuring system*. These instruments are not sensitive to outside magnetic fields but their accuracy is lower.

Electrostatic system. Measuring mechanism of an instrument contains two fixed plates and a movable one which is segmental in shape and under the action of the electric field force it enters the gap between the two fixed plates. The instrument practically consumes no energy. However, its impedance is determined by the instrument capacitance being 4-10 pF.

Combined electronic instruments (for instance, Ц-4300) are designated to measure direct and sinusoidal currents and voltages as well as resistance.

***Ex.1. Using the information from the text fill in the table and compare different measuring instruments.**

Measuring instruments	design	measure	used in	advantage	dis-advantage
D'Arsonval					
electromagnetic					
electrodynamic					
ferrodynamic					
electrostatic					
combined electronic					

Ex.2. Put the questions to the following answers.

1. To guarantee high sensitivity of the instrument.
2. Because the measuring coil is immovable and may be made of thick wire.
3. It is based on electrodynamic interaction of the coil currents.
4. To enhance the coil interaction.
5. No, it doesn't. The instrument practically consumes no energy.

Ex.3. Answer the questions using the information from the text.

Which measuring instrument

a) has a comparatively big input impedance
b) cannot be overloaded
c) withstands the high overload
d) has a comparatively little input impedance
e) distorts the current form in a load
f) has high accuracy
g) is not sensitive to outside magnetic fields
h) has a parameter determined by the instrument capacitance

UNIT 6. PLANE GEOMETRY

Overview

- Reading and Vocabulary: Finite element analysis.
- Information transfer: Geometric figures.
- Language focus: Quantifiers. Too and enough.
- Reading and Speaking: Construction and properties of geometric figures.
- Writing. Description of a geometric object.

Reading and Vocabulary

Before you read

Discuss the questions below.

1. What sections of geometry do you know? Make a list of geometrical terms you are aware of. Write in the spaces below.

_____
_____
_____
_____
_____

2. What are the major objects of geometry? How are they defined?
3. What plane figures do you know?
4. Do you know the formula for definition of sum of angles of arbitrary convex polygon? Write it down.

Reading

Skim the text as quickly as you can and choose the best headline.

A. A map of Massachusetts.
B. Solutions for the simplest geometries.
C. Triangulation of a problem.
D. Finite element analysis.
E. Think of the primary topic of the text. Give the reasons.

Although the differential equations that describe φ appear relatively compact, it is very difficult to get closed-form solutions for all but the simplest geometries. That's where finite element analysis comes in. The idea of finite elements is to break the problem down into a large number of regions, each with a simple geometry (e.g. triangles). For example, Figure 1 shows a map of the Massachusetts broken down into triangles.

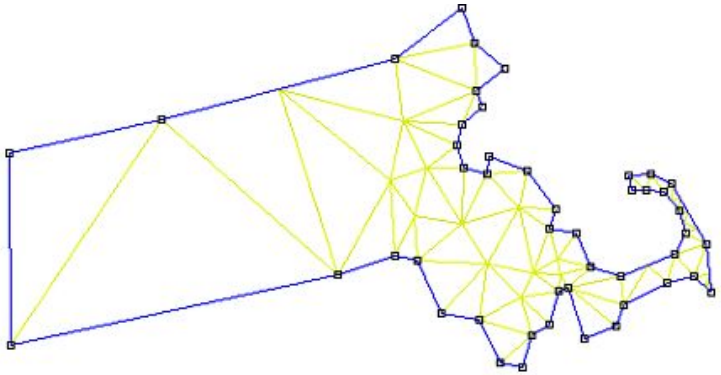


Figure 1. Triangulation of Massachusetts

Over these simple regions, the "true" solution for φ is approximated by a very simple function. If enough small regions are used, the approximate φ closely matches the exact φ.

The advantage of breaking the domain down into a number of small elements is that the problem becomes transformed from a small but difficult to solve problem into a big but relatively easy to solve problem. Specifically, triangulation of the problem results in a linear problem with perhaps tens of thousand of unknowns. However, techniques exist that allow the computer to solve for all the unknowns in only seconds.

BELA uses triangular elements. Over each element, the solution is approximated by a linear interpolation of the values of φ at the three vertices of the triangle. The linear algebra problem is formed by choosing φ on the basis of minimizing the total energy of the problem.

Reading comprehension

Ex.1. Read the statements and mark them true (T) or false (F). Give the true statements.

1. It is very difficult to get closed-form solutions for all geometries.
2. The idea of FEA is to minimize the problem.
3. Computer techniques solve the problem in dozens of seconds.
4. In Finite Element Analysis, a region of calculation is broken down into equilateral triangles.
5. Finite Element Analysis belongs to numerical methods of analysis.

6. Having made the triangulation of the problem one can have a linear problem.
7. BELA uses geometrical elements.
8. BELA-program uses Finite Element Analysis.

Ex.2. Read the text and choose the best answer to the questions:

1. Where does FEA come in?
   d) simple geometry
   e) solids
   f) linear interpolation
2. What does FEA deal with?
   g) complex geometrical objects
   h) simple geometrical objects
   i) geometrical terms
3. Why should one break the problem down?
   g. because he/she needs small elements
   h. because he/she needs the total energy to be minimized
   i. because he/she has to use computerized techniques
4. What is the aim of the triangulation of the problem?
   j. to have a linear problem
   k. to have a linear interpolation
   l. to have a map of simple regions

Vocabulary

Ex.1. Match the words from the text with their definitions.

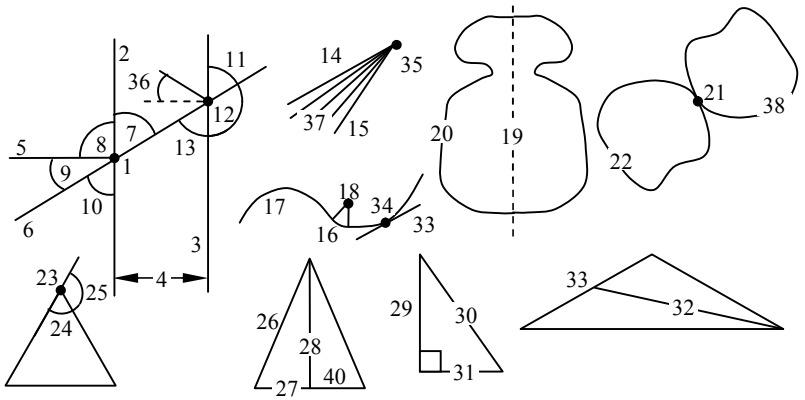
1	equation	a	a method of finding your position by measuring lines and angles of a triangle on a map
2	finite	b	smth that is not known
3	linear interpolation	c	the point at which the sides of an angle intersect
4	analysis	d	a careful examination of something in order to understand it better
5	unknown	e	able to be counted, having an end or a limit
6	vertex (pl. vertices)	f	a statement in mathematics that shows that two amounts or totals are equal

Information transfer

Geometric figures

Ex.1. Match the words and expressions (a-j) with geometric figures and their parts (1-33) below.

a) point;
b) line: straight line, curved line, tangent to curve, point of contact;
c) parallel lines;
d) distance between the straight lines;
e) perpendicular on line;
f) angle: the angular point (vertex), the arms of angle, right angle, reflex angle, acute angle, obtuse angle, alternate angle, corresponding angle, straight angle, adjacent angle, supplementary angle, complementary angle, bisector of the angle;
g) ray: pencil of rays;
h) curvature: centre of curvature, radius of curvature;
i) symmetry: symmetrical figure, axial (line) symmetry, axis of symmetry, central (point) symmetry, point of symmetry;
j) triangle: equilateral triangle, the vertex (pl. vertices), the interior angle, the exterior angle, isosceles triangle, the sides (legs), the base, the perpendicular (an altitude), acute-angled triangle, perpendicular bisector of the sides, median, obtuse-angled triangle, right-angled triangle, the hypotenuse, the cathetus (pl. catheti).



Ex.2. Read and translate the theorem below. Give your own examples of geometric theorems and explain their geometric meaning.

According to the Pythagorean theorem, the sum of the squares of the legs (of a right triangle) is equal to the square of the hypotenuse.

Language focus

Quantifiers

Too and enough

Enough + noun, Adjective + enough means sufficient of something.

Too + adjective, many, much has a negative meaning, shows there is more of something than is needed, **an excess** of something.

Too + few, little has a negative meaning, shows there is less of something than is needed, **a lack of** something.

Other ways of expressing quantities are:

Uncountable nouns			Countable nouns	
a negligible a small an (in)sufficient a considerable a large an enormous an excessive	amount quantity	of energy	a very small a small an (in)sufficient a considerable a large a great an excessive	number of crystals

Ex.1. Complete the sentences using the words from the table.

1. Our bodies contain a very … of water.
2. A … of whales are found in the Pacific Ocean.
3. There is a … of stars in the universe.
4. For a rich man one dollar is a … of money, but for a poor man it is a … amount.
5. It takes a … of time to increase the production of steel.
6. The sea contains an… of liquid.
7. Nuclear stations give off … of carbon dioxide.

Ex.2. Choose the correct phrase in each sentence.

1. Unless they have (a lack of / a sufficient amount of / an excessive amount of) water, plants will not grow.
2. If you have (a sufficient amount of / an excess of / too little) clothing, you will be too cold.
3. (Too much / a lack of / an excess of) iron causes anaemia.
4. If your food has not (excessive /enough / insufficient) calories, you will not have enough energy.
5. (The right quantity of / too many / too few) vitamins is necessary for health.
6. If you have (an insufficient amount of / an excessive amount of / little enough) clothing, you will be too hot.
7. In case of (an excessive amount of / too little / little enough) current a fuse is melt and breaks the circuit.
8. If you supply a lamp with (an insufficient quantity of / an excessive amount of / a lack of) voltage it shines dimly.

Ex.3. Complete the answers to the questions using the prompts in the brackets and the words in the box.

sufficient, insufficient, too much, excessive, enough, too

1. Why can't you take a photograph? (light) – Because the light …. .
2. Why has the tyre burst? (air pressure) – Because the air pressure … .
3. Why does the light shine brightly? (current) – Because there is … .
4. Why will the boat sink? (cargo) – Because there is … .
5. Why can the plane leave the ground? (speed) – Because the speed … .
6. Why can't you cut a diamond? (hard) – Because it is … .
7. Why does a cork float? (light) – Because it is … .
8. Why was the motor stopped? – Because its load was … .
9. Why has the current relay been actuated? – Because the current … .
10. Why has the time relay failed to function? – Because the time … .

Reading and Speaking

Before you read

Discuss the questions below.

1. What is the smallest number of lines to make a geometric figure?
2. Do you know a figure which has all sides equal but no right angles at the corners?

Read the text and check whether your answers were right.

Reading

Construction and properties of geometric figures

A _____

A plane figure bounded by any number of straight lines can be given the general name of sides. A three-sided figure is called a *Triangle*; a four-sided figure, a *Quadrilateral*; a five-sided figure, a *Pentagon*; a six-sided figure, a *Hexagon*; an eight-sided figure, an *Octagon*; a ten-sided figure, a *Decagon*.

A regular polygon is a polygon having sides and angles equal. The corners of a polygon are called its *Vertices.* The sum of all the sides of a polygon is called the *Perimeter*.

B _____

It is a polygon having but three sides. This is the smallest possible number of lines that could be used to enclose a figure. There are several special forms of triangles. The sum of the three angles of any triangle equals two right angles or 180°. From this will be seen that each angle of an equilateral triangle equals ⅓ of 180° or 60°.

C _____

It is the best known quadrilateral or four-sided figure, which has all four sides equal and all of the angles right angles.

D _____

This figure is similar to the square in that its opposite sides are parallel and its angles are all right angles but the sides of it are not necessarily all equal. If the rectangle is divided into two parts by a diagonal, it will be seen that two equal right triangles are formed.

E _____

It is a quadrilateral the opposite sides of which are equal and parallel. The diagonally opposite angles in a parallelogram are equal. Any two adjacent angles are supplementary angles, their sum being 180°. It will be noticed that the rectangle is a special case of a parallelogram, or a rectangle is a parallelogram having right angles.

When a parallelogram has all four sides equal, thus resembling a square except that it does not have right angles at the corners, it is called a *Rhombus.*

The *Trapezoid* (or *Trapezium*) is a quadrilateral with only two sides parallel. Pieces of this shape are often encountered in sheet metal work and in boiler and tank work. Railway embankments and cuts have trapezoidal sections.

F _____

There is a set of important curves whose shape can be obtained by cutting a cone at different angles. Hence the name *conic sections.* They include the *parabola*, *hyperbola* and *ellipse*, of which the circle is a special case.

A circle is a curve such that all points on the curve are equidistant from a given point. This point is called the centre, the distance from the center to the curve is called the radius.

Reading comprehension

Ex.1. Read the text and put the heading from the box into the correct place in the text.

The circle	The parallelogram	Polygons	The triangle	The square	The rectangle

Ex.2. Answer the questions using the information from the text.

1. What is a special case of parallelogram?

2. Which of geometric figure is most similar to the square?
3. What makes a polygon regular?
4. Which of quadrilateral figures has got only two parallel sides?

Speaking

Ex.1. In pairs discuss and describe geometric figures.

Ex.2. In pairs think of one of the most useful laws of mathematics, namely geometry. Try to make the definitions.

***Ex.3. Think of and give examples of application of geometric elements and expressions in engineering.**

***Ex.4. Work in pairs. Role play the situation. Students are preparing for the math exam. They are talking about problems they have got in geometry and are revising definitions and laws.**

Writing

***Ex.1. Give a description of any geometric object. Calculate the area of it.**

UNIT 7. GEOMETRY. SOLIDS

Overview

- Reading and Vocabulary: Volumes and surfaces of solids.
- Information transfer: Solids.
- Language focus: Adjectives. Adjective – forming suffixes. Comparing things.
- Reading and Speaking: Ancient engineering. Solid figures in engineering.
- Writing. Describing ancient structures.

Reading and Vocabulary

Before you read

Discuss the questions below.

1. What plane figures do you know?
2. Do you know what solids mean?
3. What solids do you know?
4. What is the difference between solids and plane geometry objects?

Reading

Read the text focusing on the information distinguishing the solids.

Volumes and surfaces of solids

A Prism is a body having two opposite faces equal and parallel, the other faces being flat planes connecting the edges of the two parallel faces. The two equal and parallel faces are called the *bases* of the prism. The other faces are the *lateral* (side) *faces.* The lateral faces of a prism are all parallelograms and lateral edges are therefore equal and parallel lines.

A Right Prism is one whose lateral edges are all perpendicular to the bases, so that the lateral faces are all rectangles.

A Rectangular Solid, or **Rectangular Prism,** is a prism all of whose faces are rectangles. A brick is a rectangular prism. A cube is a special case of a rectangular prism in which all the faces are square.

In any right prism the volume is obtained by multiplying the area of one base by the altitude, or the length of one of the lateral edges.

An Oblique Prism is a prism whose lateral edges are not perpendicular to the bases.

The volume of an oblique prism may be calculated in either of two ways. We may calculate the area of a base and multiply it by the altitude. If more convenient, we may calculate the area of a section taken perpendicular to the edges and multiply it by the length of one edge.

A Cube is a prism bounded by six equal square faces. If we let e = one edge, then the area of one face = e^2. Hence, letting S = the total surface:

$$S = 6e^2.$$

The volume of a cube is given by the formula: $V = e^3$.

A Cylinder is much like a prism, having parallel bases, but having a curved lateral surface. In geometry, the section of a cylinder may be of any curved shape; but in practical work we always think of a cylinder as being round, that is, of circular section.

If a cylinder is cut off square at the ends, it is called a *Right Cylinder* and its bases are circles. Shafts, pipes, and round rods of any sort are right cylinder. Steam engine cylinder, steam and water pipes, etc., are hollow cylinder, and the volume of metal contained in them is the difference between the volumes of the outer and inner cylinders.

The volume of a solid right cylinder is obtained by multiplying the area of one end by the length of the cylinder:

$$V = \pi r^2 h, \text{ or } .7854 d^2 h.$$

A Pyramid is a solid figure formed by a polygon, called the *base* and a series of triangles meeting at a common point called the *vertex* or *apex.*

A Regular Pyramid is one whose base is a regular polygon and whose vertex is directly above the center of the base.

The volume of a pyramid is the product of the area of the base times one-third the altitude. In other words a pyramid contains one-third the volume of a prism having the same base and altitude.

The Cone. – A Cone is much like a pyramid but has a circle for a base. The most common form is the *right cone* in which the apex is directly over the centre of the base. Like the pyramid, the volume of cone is obtained by multiplying the area of the base by one-third the altitude. In a right cone, every point in the edge of the base is equally distant from the apex. This distance is called the *slant height* of the cone.

The Sphere is the geometrical name for a round or ball-shaped solid. The surface of a sphere is just 4 times the area of circle of the same diameter (= 4 πr^2). The volume of a sphere equals 1/6 times π times the diameter cubed

$$\frac{1}{6}\pi d^3 \text{ or } \frac{4}{3}\pi r^3.$$

Reading comprehension

Ex.1. Read the statements and mark them true (T) or false (F). Give the true statements.

1. A cube has equal and parallel faces.
2. The lateral edges of the prism can't be equal.
3. A cube is a kind of right prism in which all the faces are rectangles.
4. The section of a cylinder may be of any curved shape.
5. A regular pyramid is a geometric object whose base is a triangular polygon.
6. A cone, like a pyramid, has a circle for a base.
7. A sphere is a shape which can be obtained by cutting a cone at different angles.

Ex.2. The words below come from the text. Choose the correct meaning of the words as they are used in the text.

1. edge (noun)
   a) the line formed by meeting two surfaces
   b) the part of an object that is furthest from its centre
   c) the thin sharp part of a blade or tool that cuts
2. lateral (adj)
   a) relating to a sound produced by breath passing along one or both sides of the tongue
   b) relating to the sides of something
3. altitude (noun)
   a) the height of a thing above a reference level, especially above sea level or above the earth's surface
   b) the perpendicular distance from the base of a geometric figure to the opposite vertex, parallel side, or parallel surface
   c) the angular distance of a celestial object above the horizon.
4. section (noun)
   a) representation of a solid object as it would appear if cut by an intersecting plane, so that the internal structure is displayed

   b) one of several components; a piece
   c) a square area of land in the US that is one mile long on each side
5. face (noun)
   a) the front part of a clock or watch where the numbers and hands are
   b) a planar surface of a geometric solid
   c) the surface of the front of the head from the top of the forehead to the base of the chin and from ear to ear

Vocabulary

Ex.1. Look at the groups of words below and answer the following question. Use your dictionary where necessary.
Which word is the odd one out in each group? Why?

1. horizontal, vertical, angular, right
2. perimeter, sum, radius, diameter
3. circumference, ellipse, pyramid, cube
4. point, vertex, distance, apex
5. calculate, multiply, add, cut
6. circular, curved, oval, square

Ex.2. Fill in the gaps with a suitable word from the text.

1. We can … the area and … it by the altitude.
2. The two … and … faces are called the bases of the prism.
3. Steam and water pipes are … cylinders.
4. A cone is much like … but has a circle for a base.
5. … is the geometrical name for a round solid.

Information transfer

Solids

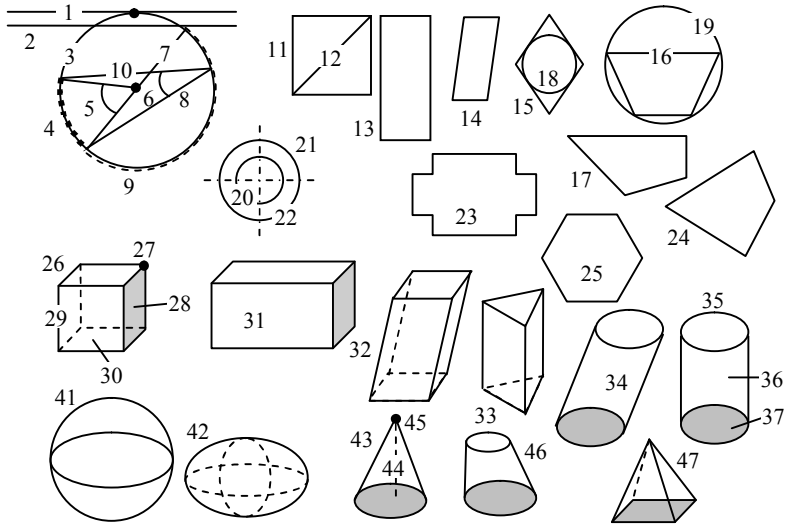
Ex.1. Match the words and expressions (a-k) with geometric figures or solids and their parts (1-47) below.

a) circle: centre, circumference (periphery), diameter, semicircle, radius, circumcircle (circumscribed circle), inscribed circle, secant, chord, tangent, segment, arc, sector, angle subtended by the arc at the centre, circumferential angle, concentric circles, ring (annulus);

b) quadrilateral: parallelogram, square, diagonal, rectangle, rhombus (rhomb, lozenge), trapezium, deltoid (kite), irregular quadrilateral, polygon, regular polygon;

c) cube: square (a plane, plane surface), edge, corner, base;

d) parallelepiped;
e) prism: triangular prism, quadratic prism;
f) cylinder: a right cylinder, base (a circular plane), curved surface;
g) sphere, hemisphere;
h) ellipsoid of revolution;
i) cone: apex, height of the cone (cone height);
j) truncated cone (frustum of a cone);
k) quadrilateral pyramid.



Ex.2. Read and translate the sentences below. Refer to the figures and solids mentioned above and characterize them. Give your own examples concerning geometrical figures and solids.

1. The diameter is the distance across a circle.
2. Equation ($y^2 + x^2 = R^2$) describes a circle of radius R centered at the origin.
3. Formula $2\pi rh$ gives the curved surface area of a right cylinder of radius r and height h.
4. A square has maximum area from different rectangles of the same perimeter.

Language focus

Adjective - forming suffixes

Adjective –forming suffixes	**noun + - less**	absence of quality, without	hopeless seamless
	noun + - ous	like, full of	enormous
	noun + - ful	presence of quality of something, characterized by	helpful useful
	verb + - able - ible	capable of doing something or being or undergoing some actions	breakable comparable visible
	noun + - al (ial) - ic - ical - ar	having the quality of	industrial specific electrical circular
	verb + - ant - ent	presence of quality	resistant different

Ex.1. Form the adjectives from the following words and use them to fill in the gaps in the passages below.

1. An ac motor can be made with … **(vary)** speed characteristics but only within certain limits.
2. Industry builds ac motors in … **(differ**) sizes, shapes, and ratings for many types of jobs.
3. … (**System**) errors can sometimes be compensated for by means of some kind of calibration strategy.
4. The Babylonians had solid knowledge of almost all aspects of … **(element)** arithmetic circa 1850 BC.
5. The Arabs also learned this … **(value)** method of calculation.
6. This sensor is … **(line)** because the ratio is constant at all points of measurement.
7. The Large Hadron Collider might currently be the largest and most … **(power**) physics machine.
8. Water has come into the radio and now it is completely … **(use)**.

Ex.2. Form the adjectives from the words and complete the sentences.

1. I'm **attracted** by this scheme. I find it very attractive.
2. What level of radiation can be **permitted**? How much radiation is…
3. Wind power and solar power can be **renewed** but electricity production from these … sources of energy is sometimes criticized for being variable.
4. There are a lot of **hazards** in a mine. Mining environment is very …
5. I have never met anyone who **boasts** as he does. He's extremely …
6. I don't know where you find all that **energy**. You're very …

Comparing things

Structure	Meaning
as + adjective +as	similarity of 2 objects
be similar to	
(exactly) the same as	one thing is exactly like something else
twice/three times/half as + adjective + as	comparing of 2 objects
not as (so) + adjective + as	in negative sentences
less + adjective + than	for 2 objects, opposite of more … than
the least + adjective + of /in	for more than 2 objects, opposite of the most…of /in
the + comparative, the + comparative	two things change together or one thing depend on another thing
comparative + and + comparative	something increases or decreases
very + adjective	emphasizing words used before adjectives
much /a lot/a little / a bit + comparative	
by far + superlative	

Ex.3. Put the adjectives in brackets in comparative forms and use the words from the box to fill in the gaps.

very, much, a lot, less, the, not as…as

Air turbines have numerous advantages. They have … (1) lower costs, … (2) (good) efficiency than competing systems. In terms of electrical energy output, the systems of air turbines are …. (3) expensive than competing wind power systems. The … (4) (close) air turbines are placed to wherever they are needed, … (5) … (6) (cheap) power lines and other infrastructure are. Air turbines can operate at … (7) … (8) (high) wind speeds than conventional wind turbines. Air turbines are

… visible … (9) conventional wind turbines. Noise impact is reduced due to the … (10) high altitude operation of the air turbines.

Ex.4. Fill in the gaps with the words in the box.

not as … as, a bit, by far, very, a little, as … as

1. I can't understand you. Could you speak … louder, please?
2. A calculator is … the simplest example of solar energy application.
3. She is … more intelligent that the other girls in the class.
4. Solar energy is … the most endless supply of energy.
5. A fuel-cell is twice … efficient … a regular internal-combustion engine.
6. Solar or wind energies are … predictable … tidal power.
7. Rise and fall of tides is … cyclic.

Ex.5. Complete the sentences using comparative + and + comparative or the + comparative.

1. … (many) people are opening their own business these days.
2. Cars are getting … (cheap) as the years go by.
3. If a car is new, it is valuable. … a car is, … it is.
4. We worked hard. We were very tired. … we worked, … we became.
5. … (young) you are, … (easy) you find it to learn things.

Ex.6. Read the sentences and pay attention how we can express similarities.

1. An electrodynamic voltmeter is similar to a wattmeter in that it has two measuring coils.
2. The output signal will be the same as the input signal.
3. It looks like a calculator and weighs the same.
4. Their car is exactly the same as yours.
5. Water is eight hundred times as dense as air.
6. Microvolt potentiometer is similar to the constant resistance potentiometer but designed to minimize the effects of contact resistance and thermal emf.

Ex.7. Read the statements and mark them true (T) or false (F). Give true statements.

1. Electricity produced by a thermal power station is much cheaper than that one produced by a hydroelectric power plant.
2. Stabilized voltage after the rectifier is similar to that obtained from the battery.

3. Underwater turbines are as clean and non-polluting as the surface wind turbines.
4. Underwater tidal power is by far the most expensive kind of energy.
5. Wind power is the least potential renewable source of energy.

Reading and Speaking

Before you read

Think of the examples of geometric objects / shapes / figures which were in use in ancient people life.

Skim the text as quickly as you can and choose the best headline.

A. Geometric objects of the past
B. Ancient engineering
C. Good jobs and good pay

Reading

The Great Wall of China was built across northern China to protect the **population**. Before the third century BC there were lots of smaller walls and these were joined together to make one long, **defensive** wall. The work was done by enormous gangs of forced **labourers** and many of them died doing the work. The wall is over 2000km long, 3.5m high, and 4.5m wide at the top. It is made of earth covered with stone.

The Egyptian pyramids are a famous symbol of ancient Egypt. The stone structures were usually **tombs** for pharaons. The pyramids have square bases with sloping sides which meet at an **apex**. The first pyramid was built in about 2600 BC and is over 140m high. One of the biggest pyramids is made of enormous stone blocks which weigh up to 200 tonnes each. It is estimated that 20-25,000 people worked for 20 years to build each pyramid.

Reading comprehension

Ex.1. Now read the text more carefully and say whether the statements are true (T) or false (F).

1. The Great Wall of China was to keep people safe.
2. Building the Great Wall was easy for the workers.
3. The pyramids were built before the Great Wall of China.
4. Pyramids are lots of different shapes.
5. The Egyptian pyramids were built to protect people.

Ex.2. Match the words in bold in the text with the definitions (1-5) below.

1. A place where people are buried.

2. Protecting somebody against attack.
3. The top, or the highest part, of something.
4. All the people who live in a country.
5. People who do hard physical work outdoors.

Ex.3. Use the information in the text to give your own definition of words (1-4) below.

1. A wall; 2. A gang; 3. A stone block; 4. Slopping sides.

Speaking

Ex.1. Use the information in the text to answer the questions (1-6) below about 1) The Great Wall of China and 2) The first pyramid in Egypt.

1. Where is it?
2. What is it?
3. When was it built?
4. What is it made of?
5. Who built it?
6. How big is it?

Ex.2. In pairs think of and discuss the application of different solid figures in engineering.

Ex.3. In pairs characterize and describe solid forms. Focus on some common points.

Writing

Ex.1. Use the prompts below to write a paragraph about Hadrian's Wall (the northern boundary of the Roman Empire).

- Between England and Scotland
- A defensive wall
- Built in 122-6 AD
- Built by soldiers
- Made of earth and stone
- 117km long, 6.5m high, 3m wide

***Get real.** **Find out about an ancient structure in your country.**

UNIT 8. ELECTRIC CURRENT

Overview

- Reading and Vocabulary: Electric current.
- Information transfer: Circuit symbols. Labelling components and describing their functions.
- Language focus: Adjectives: types of comparison. Like / as. Linking words expressing contrast.
- Reading and Speaking: Electrical practical units.

Reading and Vocabulary

Before you read

Think of such a physical phenomenon as electric current; its types, application, importance. Imagine our life without it. Share your opinion and discuss in class.

Reading

Read through the gapped text quickly. Think about what information might be missing.

Electric current

Ever since Volta first produced a source of continuous current, men of science have been forming theories on this subject. For some time they could see no real difference between the newly discovered phenomenon and the former understanding of static charges. [1] In addition to it, Ampere gave the current direction: he supposed the current to flow from the positive pole of the source round the circuit and back again to the negative pole.

We consider Ampere to be right in his first statement but he was certainly wrong in the second, as to the direction of the current. The student is certain to remember that the flow of current is a direction opposite to what he thought.

Let us turn our attention now to the electric current itself. The current which flows along wires consists of moving electrons. What can we say about the electron? [2] We also know that that charge is negative. As these minute charges travel along wire, that wire is said to carry an electric current.

In addition to travelling through solids, however, the electric current can flow through liquids as well and even through gases. [3]. Some liquids, such as melted metals for example, conduct current without any change to themselves. Others, called electrolytes, are found to change greatly when the current passes through them.

When the electrons flow in one direction only, the current is known to be d.c., that is, direct current. The simplest source of power for the direct current is a battery, for a battery pushes the electrons in the same direction all the time (i.e., from negatively charged terminal to the positively charged terminal).

The letters a.c. stand for alternative current. [4] The a.c. used for power and lighting purposes is assumed to go through 50 cycles in one second. One of the great advantages of a.c. is the ease with which power at low voltage can be changed into an almost similar amount of power at high voltage and vice versa. Hence, on the one hand alternative voltage is increased when it is necessary for long-distance transmission and, on the other hand, one can decrease it to meet industrial requirements as well as to operate devices at home.

Although there are numerous cases when d.c. is required, at least 90 per cent of electrical energy to be generated at present is a.c. In fact, it finds wide application for lighting, industrial, and some other purposes.

One cannot help mentioning here that Yablochkov, Russian scientist and inventor, was the first to apply a.c. in practice.

Notes and comments

Let us turn … . Note the use of *bare infinitive* after *let*.
… minute charges … Note *minute* here as *little* and not as the *time interval*.
50 *cycles in one second* is usually reduced to 50 *cps* (cycles per second).
One cannot help mentioning means *one must mention*.

Reading comprehension

Ex.1. Four sentences have been removed from the text. Choose from the sentences (A-E) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

G. In both cases it produces some important effects to meet industrial requirements.

H. The current under consideration flows first in one direction and then in the opposite one.

I. We know the electron to be a minute particle having an electric charge.

J. The power of a direct current is determined as voltage times current.

K. Then the famous French scientist Ampere (after whom the unit of current was named) determined the difference between the current and the static charges.

Ex.2. Read the text and find the answers to these questions.

1. Who was the first to produce a source of continuous current?

2. Who was the unit of current named after?
3. Who determined the difference between the current and the static charges?
4. What did Ampere suppose?
5. What can you say about an electron?
6. What charges do you know?
7. When does a wire carry an electric current?
8. Do liquids conduct current?
9. What can you say about the electrolytes?
10. What do you call d.c.?
11. What is the advantage of a.c.?
12. Where is a.c. used?
13. Who first applied a.c.?

Ex.3. Read the statements and mark them true (T) or false (F). Give the true statements.

1. Electrons flow from the positively charged terminal of the battery to the negatively charged terminal.
2. Ampere supposed the current to flow from the negative pole to the positive one.
3. Static electricity is used for practical purposes.
4. Static electricity is not very high in voltage and it is easy to control it.
5. The direct current is known to flow first in one direction and then in the opposite one.
6. The direct current used for power and lighting purposes is assumed to go through 50 cycles a second.

Ex.4. Put two questions to each paragraph of the text. Ask your group mates to answer them.

Ex.5. Give a heading to each paragraph of the text. Explain why you have given such a heading.

Vocabulary

Ex.1. Find the words in the text with these meanings.

a) the complete circle that an electric current travels
b) an object that provides a supply of electricity for smth
c) one of the points at which you can connect wires in an electric circuit
d) a flow of electricity through a wire

e) one of the two points at which wires can be attached to battery in order to use its electricity
f) a piece of thin metal used for carrying electrical currents or signals
g) a flow of electricity that moves in one direction only
h) a very small piece of matter with a negative electrical charge that moves around the nucleus of an atom
i) a flow of electricity that changes direction regularly and quickly
j) electricity that is not flowing in a current, but collects on the surface of an object and gives you a small electric shock

Ex.2. Work out the meanings of the following words from the text.

1. current
2. table
3. iron
4. power
5. needle
6. pressure
7. scale
8. wire
9. state
10. generation

Ex.3. Look through the text and find the words which are considered to be international, e.g. static, diode. Make a list of them and check it with a partner. Make your own sentences with these words.

Ex.4. Work with a partner. Write a word with the opposite meaning to the following. You can find some words in the text.

1. former (n)
2. understanding (n)
3. advantage (n)
4. charge (v)
5. increase (v)
6. direct (adj)
7. positive (adj)
8. continuous (adj)
9. different (adj)
10. right (adj)

Information transfer

Circuit symbols

Labelling components and describing their functions

Before you start

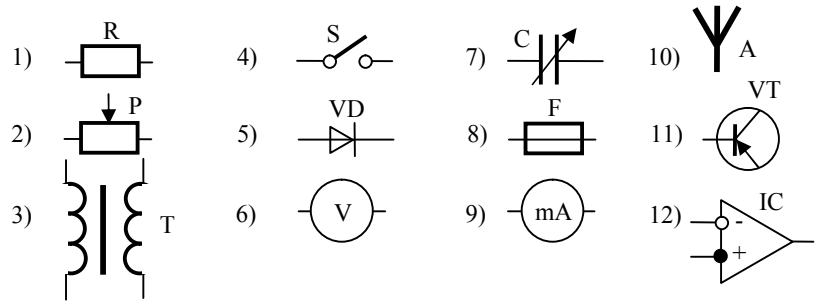
In electrical engineering, the simulation principle is generally used. It means that the real devices are presented by their mathematical or physical simulation. Mathematical simulation includes the system equation generation. While physical simulating the real devices are replaced by the equivalent schemes or circuits which involve special symbols. Two questions we may need to answer when we describe components are: 1) What is it called? 2) What does it do? In other words, we need

to be able to: 1) label components; 2) describe their functions. Look at the Figure below. Here are some circuit symbols.

Ex.1. Label the circuit symbols of the Figure with the terms from the box below.

We can use these ways of labelling components: 1) It **is called** a protractor;
2) It **is known as** a battery.

potentiometer, semiconductor diode, milliammeter, integrated circuit (or amp), resistor, transformer, switch, capacitor, aerial, transistor, voltmeter, fuse



Ex.2. Describe the function of each circuit element presented above (1-12) using the prompts (a-l) below.

We can describe the function of components like this: 1) A generator **provides** electricity. 2) A battery **changes** chemical energy into electricity. 3) A fuse **protects** a circuit.

We can **emphasize** function by using the following pattern:

The function of a fuse is to protect a circuit.

a) varies capacitance in a circuit;
b) rectifies alternating current;
c) adds resistance to a circuit;
d) measures very small currents;
e) breaks a circuit
f) protects a circuit;
g) varies the current in a circuit;
h) steps a.c. voltages up or down;
i) receives RF signals;
j) measures voltages;
k) is used as amplifier;
l) is used as operational amplifier

Language focus

Adjectives: types of comparison
Like / as

Like is used:

- for similarities
- in a structure: feel / look / smell / sound / taste + like + noun
- in a structure: like + nouns, pronouns or the -ing form to similarity or contrast.

As is used:

- to say what smb or smth really is (jobs or roles)
- in certain expressions: as usual, as…as, as much, such as, the same as
- in a structure: accept / be known / class /describe /refer to /regard / use + as
- in clauses of manner to mean "in the way that".

Ex.1. Fill in the gaps with *like* or *as.*

1. A: Tara is a wonderful artist.
   B: Yes. No one else can paint … her.
2. A: I wish Sarah would stop being so immature.
   B: I agree. She acts … a child sometimes.
3. A: How shall I tie my shoelaces?
   B: Do it … we taught you.
4. A: The play last night was fantastic.
   B: Yes. The lead actor was wonderful … Macbeth.
5. A: What does Mark do for a living.
   B: He works… a hotel manager.
6. A: What kind of meal is it?
   B: I'm not sure. It tastes … beef.
7. A: I've just bought this dress.
   B: Gosh. It's exactly the same … the one I bought.
8. A: I'm sure I know that man.
   B: Me too. He looks … my old maths teacher.
9. A: It was far too hot in that room.
   B: I know. It was … being in an oven.
10. A: Eric Clapton is very talented, isn't he?
    B: Yes. He is known … one of the greatest rock musicians of our time.
11. A: What is Peter cooking?
    B: I don't know. It smells … fish.

Linking words expressing contrast

Linking words show the logical relationship between pieces of language longer than a sentence, sentences or parts of a sentence. It is a good idea to use them while you are constructing a text. They can help to make clear the structure of what is being said; what speakers think about what they are saying or what others have said.

Read the following linking words or discourse markers (when they introduce a passage or paragraph) and pay attention **how** and **where** they are used in sentences and what the punctuation is.

- **but** (links two contrasting ideas, put between these contrasting parts of the sentence): We'll be using motor racing to promote our products, **but** we will also be using it to promote good and safe driving.
- **although / even though (**more emphatic than although**) / though (**informal**) + clause** (at the beginning or in the middle of the sentence): **Although / even though /though** it was summer, it was chilly. **Or:** It was chilly **although / even though /though** it was summer.
- **in spite of / despite + noun / -ing form (**at the beginning or in the middle of the sentence**): In spite of / despite** his qualification, he couldn't get a job. **Or:** He couldn't get a job **in spite of / despite** his qualification.
- **however/ nevertheless (**at the beginning of the sentence, a comma is always used after **however): The** man fell off the ladder. **However/ Nevertheless**, he wasn't hurt.
- **while/whereas (**links two contrasting ideas, put between these contrasting parts of the sentence**):** He drives a car, **while/whereas** she drives a motorbike.
- **on the other hand (**at the beginning or in the middle of the sentence**)**: Cars aren't environmentally friendly. **On the other hand,** bicycles are. **Or**: Bicycles, o**n the other hand,** are.

We can also describe contrast and differences using **comparative degree**, words and phrases like **rather than, unlike, differ from, is/are different from, in contrast to.**

Ex.1. Read and translate the sentences. Pay attention to the ways of expressing contrast / differences.

1. An electrostatic voltmeter has **much bigger** resistance **than** an electromagnetic one.

2. High-voltage transformers are three-phase **rather than** single-phase.
3. A transformer has no electric connection between windings **while** an autotransformer has it.
4. A transformer without a ferromagnetic core is a linear element that's why it may be calculated **with greater accuracy than** a nonlinear transformer having a steel core.
5. A magnetoelectric voltmeter with a diode is able to measure alternating voltages **but** it is used only in case of sinusoidal waveforms.
6. Instruments of accuracy rating 2.5 are used for everyday measurements **whereas** ones having accuracy rating 0.1 are used as standard instruments.
7. **Unlike** an electric cell or battery, a fuel cell does not run down or require recharging; it operates as long as the fuel and an oxidizer are supplied continuously from outside the cell.

Ex.2. Read the sentences. Fill in the gaps with the correct word / phrase expressing contrast from the box.

nevertheless, although, in spite of, while, but, however

1. … she felt ill, she didn't call a doctor.
2. This house is beautiful. … , it is in poor condition.
3. I typed the reports, … Joanne interviewed a client.
4. … my being tired, I watched the late film.
5. I had a great holiday. …, it rained all the time.
6. My teacher is very kind. …., she can be strict at times.
7. Sarah is kind … not very reliable.
8. Lane likes classical music, … Susan doesn't.

Ex.3. Read the statements and mark them true (T) or false (F). Give true statements.

1. Electricity produced by a thermal power station is much cheaper than that one produced by a hydroelectric power plant.
2. A thermal power station releases many chemicals into the surrounding air, while a nuclear power station is rather clear plant.
3. Like a synchronous machine, an induction motor is able to produce electricity.
4. Stabilized voltage after the rectifier is similar to that obtained from the battery.

5. In contrast to the alternating current, a direct current does not change its direction.

6. Both thermal power stations and nuclear power plants use the turbogenerators.

Ex.4. In pairs find linking words and discourse markers in the text. Discuss their meaning and usage.

Reading and Speaking

Before you read

Ex.1. What are these things? What do these words have in common?

Biro - Braille - guillotine - Hoover - Jacuzzi - Levis - Stetson

Ex.2. What do you know about SI? Put the following standard international (SI) units given in the box into the correct column.

amp – Celsius – curie – hertz – joule – Kelvin – Newton – ohm – pascal – volt – watt			
Chemistry (1 unit)	Electricity (6 units)	Physics (2 units)	Temperature (2 units)

Reading

Read the text and complete the gapped passages with one of practical units.

Electrical practical units

The three practical units, the ohm, ampere, and volt, provide standards for comparison. They are defined as follows.

The … is the first primary unit, and the international … is defined as the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 gm. in mass, of uniform cross-sectional area and of length 106.300 cm.

The … is the second primary unit. The international … is the unvarying electric current which, when passed through a solution of nitrate of silver in water, in accordance with a specification, deposits silver at the rate of 0.00111800 gm. per second.

The … is the third primary unit and is the electric pressure which, when applied steadily to a conductor whose resistance is one international … , will produce a current of one international …. Further, the international … is the energy expended per second by an unvarying electric current of one international … under an electric pressure of one international … .

The original ampere was based on the magnetic effect of a current instead of the present electro-chemical effect.

Reading comprehension

Ex.1. Now read the text more carefully and say whether the statements are true (T) or false (F).

1. The units you deal with in the text are practical because you use them in your everyday life.
2. The international ohm is the resistance of a column of mercury to an alternating current.
3. Electric current has deposits of silver when it passes through a water solution.
4. Resistance of a conductor causes a current of one international ohm.

Ex.2. Work in pairs. Write five questions about electrical practical units. Now work with a different partner, close your books and ask each other your questions.

Speaking

Ex.1. Complete the definitions (1-11) below with the units and the people in corresponding boxes.

amp – Celsius – curie – hertz – joule – Kelvin – Newton – ohm – pascal – volt – watt

Andre Marie Ampere (1775-1836) – Anders Celsius (1701-1744) – Marie Curie (1867-1934) – Heinrich Hertz (1857-1894) – James Prescott Joule (1818-1889) – Lord Kelvin (1824-1907) – George Simon Ohm (1787-1854) – Blaise Pascal (1623-1662) – Sir Isaac Newton (1643-1727) – Count Alessandro Volta (1745-1827) – James Watt (1736-1819)

1. A … is a unit of pressure equal to one Newton per square metre. It's named after …, a French scientist.
2. A … is a unit of force. It's named after …, an English mathematician.

3. … is the temperature scale that has the freezing point of water as 0°C and the boiling point as 100°C. The scale was developed by a Swedish astronomer, …

4. A … is an amount of electric power. It is equal to one joule per second. It's named after …., a Scottish engineer and inventor.

5. A … is a unit of electric force. It's named after …, an Italian physicist and pioneer in the study of electricity.

6. An …is a unit of electric current. It's named after …, a French mathematician and physicist, a pioneer in electrodynamics.

7. An …is a unit of electrical resistance named after …, a German physicist.

8. A …is a unit of energy after …, a British physicist.

9. … is the temperature scale that registers absolute zero (-273.15°C) as 0 K. It's named after …, a British scientist.

10. A … is a frequency equal to one cycle per second. It's named after …, a German physicist.

11. A … is a unit of radioactivity. It's named after …, a Polish-born chemist who discovered radioactivity in several elements.

Ex.2. Read the definitions in exercise 1 again. Find the words that mean the person who:

1. studies the elements and their compounds;
2. studies the universe;
3. studies the physical properties of materials;
4. thinks of new machines;
5. develops new ideas about a subject.

***Ex.3. Discuss these questions with a partner:**

1) which of the words in Exercises 1 and 2 are you familiar with in your language?
2) is anything named after a person in your country?

***Ex.4. Find out which things in this list are named after a person. Can you add similar words from your language?**

Mouse (for a computer) – Bunsen (burner) – Diesel – Geiger (counter) – Laboratory – Morse (code) – Tarmac – Text (book) – Hysteresis (loop)

UNIT 9. TYPES OF ELECTRIC CURRENT

Overview

- Reading and Vocabulary: Types of electric current (part A).
- Language focus: -ed or -ing Adjectives.
- Reading and Speaking: Types of electric current (part B).
- Writing: A report on types of electric current.

Reading and Vocabulary

Before you read

Discuss the questions below.

1. Think of the ways an electric current can be generated. Make a list of apparatus which can be the source of current.

2. What do you think if a type of electric current depends on a type of apparatus? Discuss this question in groups.

Reading

Scan the text and find out if your answers in **Before you read** are correct.

Types of electric current (Part A)

An electric current may be produced in a variety of ways, and from a number of different types of apparatus, e.g. an accumulator, a d.c. or an a.c. generator, or a thermionic valve. Whatever the source of origin, the electric current is fundamentally the same in all cases, but the manner in which it varies with time may be very different. This is shown by the graph of the current plotted against time as a base, and a number of examples are illustrated in Fig.1.

(1) … represents a steady direct current (D.C.) of unvarying magnitude. Such as is obtained from an accumulator.

(2) …represents a D.C. obtained from a d.c. generator, and consists of a steady D.C. superimposed on which is a uniform ripple of relatively high frequency, due to the commutator of the d.c. generator. As the armature rotates the commutator segments come under the brush in rapid succession and produce a ripple in the voltage which is reproduced in the current.

(3) … represents a pulsating current varying periodically between maximum and minimum limits. It may be produced by adding a D.C. to an A.C. or vice versa. The d.c. component must be the larger if the current is to remain unidirectional. All

the first three types of current are unidirectional, i.e. they flow in one direction only.

(4) … represents a pure alternating current (A.C). The current flows first in one direction and then in the other in a periodic manner, the time of each alternation being constant. In the ideal case the current varies with time according to a sine law, when it is said to be sinusoidal. Considering the time of a complete cycle of current (a positive half-wave plus a negative half-wave) as equal to 360°, the instantaneous values of the current are proportional to the sine of the angle measured from the zero point where the current is about to rise in the positive direction.

(5) … represents a type of A.C. with a different wave form. Such an A.C. is said to have a peaked wave form, the term being self-explanatory.

(6) … represents an A.C. with yet another different wave form. Such an A.C. is said to have a flat-topped wave form, the term again being self-explanatory. Both this and the previous example represent cases of A.C. having non-sinusoidal wave forms.

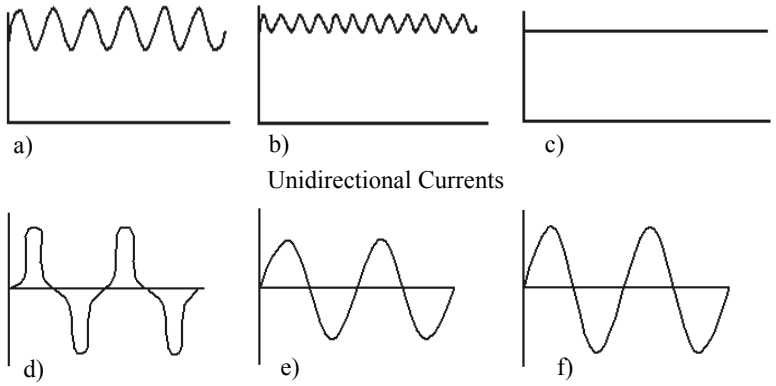


Fig.1. Types of Electric Current

Note. … *the current is about to rise* … "to be about to do" means to be going to do smth, to be ready to do smth.

Reading comprehension

Ex.1. Examine the figures and match them with the appropriate description of the types of electric current.

Ex.2. Read the statements and mark them true (T) or false (F). Give the true statements.

1. The electric current is the same; consequently you may not discover different ways of its production.
2. An accumulator is exclusively designed to store energy.
3. A generator produces one type of electric current.
4. The commutator of the d.c. generator makes current uniformly rippled.
5. The armature rotation causes the commutator segments movement.
6. Types of current in Fig. 1(d, e, f) are unidirectional.
7. An electrical current with a flat-topped waveform has different peaks.
8. Peaked and flat-topped wave forms are said to be sinusoidal.

Ex.3. Answer these questions in pairs.

1. What type of current is obtained from an accumulator?
2. What does a direct current from a d.c. generator consist of?
3. How do the commutator segments come under the brush?
4. Why do the commutator segments move?
5. Why must d.c. components of a pulsating current be the larger?
6. How does the electrical current vary in the ideal case?
7. What are the instantaneous values of the current like?

Vocabulary

Ex.1. Fill in the correct prepositions from the box in the following phrases.

in, against, with, of, to

1. … a variety of
2. … all cases
3. … time
4. … time
5. due …
6. … one direction
7. consist …
8. … a periodic manner
9. according …
10. proportional…

Ex.2. Match the words (1-7) from the text with their definitions (a-g).

1	accumulator	a	a number denoting the relative measure of a quantity
2	armature	b	any of devices which controls the direction or volume of flow of liquid or of electricity
3	frequency	c	a small wave
4	generator	d	an iron framework wound with copper wire, fixed between the poles of a magnet
5	magnitude	e	an apparatus which accumulates
6	ripple	f	the number of times a periodic phenomenon or process occurs in a unit of time, e.g. the number of cycles / sec of an a.c.
7	valve	g	an apparatus for converting mechanical energy into electricity

Ex.3. Complete the sentences below. Use the adjectives and adverbs from the box.

pulsating, instantaneous, unidirectional, constant, proportional, periodic, steady, peaked, periodically, sinusoidal

1. The experiment is being carried out under the conditions where the current flows in one direction. … current is the most essential requirement.
2. The students have learned from the lecture by prof. Ivanov that a … current varies … between maximum and minimum limits.
3. A … manner of current flowing is typical for a pure alternating current.
4. Hazardous environment of new production requires … room temperature.
5. The curve shows a … form of the wave in the graph of the current.
6. Modern methods of … communication should be made readily accessible both to teachers and students.
7. According to a sine law the current flows in a … wave form.
8. This rectifier circuit ensures … flow of current.
9. If the graph of two quantities is a straight line, then the two quantities are directly ….. and the equation relating them is analogous to y = mx.

Ex.4. Find synonyms to the following words in the text. Some have more than one synonym.

a) various - …
b) identical - …
c) unvarying - …
d) turn round - …
e) reproduce - …
f) quick - …
g) stay - …
h) permanent - …
i) full -
j) line - …

Ex.5. In the text find the expression from another language. Guess what language it is from; what it means and what its abbreviation is.

Language focus

-ed or -ing Adjectives

Many adjectives in scientific writing are formed by adding **-ed** or **-ing** to verbs. Actually, these words are the forms of participles, but they often used as adjectives and they are often confused.

-ed adjectives (Past participles)

These adjectives are used to

1. describe how people feel:

He was **surprised** to find that he had been upgraded to first class.
I was **confused** by the findings of the report.

2. indicate a completed action:

magnetized rock: rock that has been made into a magnet
diffused light: light that is spread out

'-ing' adjectives (Present participles)

These adjectives are used to

1. describe things and situations which are the source (cause) of feeling or emotion:

Being upgraded to first class is **surprising**.
The findings of this report are **confusing**.

2. indicate a certain action that is performed by the noun or occurs to the noun:

grinding machine: machine that crushes substances into small bits
recording mechanism: device that records sound

3. indicate an ongoing process

a **roasting** chicken (still cooking)

Ex.1. Decide which adjective from the following pairs should be used to fill in the gaps.

1. A substance that combines metals with oxygen is an … .
   a) oxidizing agent b) oxidized agent
2. Water that has been purified is … .
   a) distilled water b) distilling water
3. A device that has been adjusted for errors is a … .
   a) calibrating instrument b) calibrated instrument

4. A device that adjusts other instruments is a ….
   a) calibrating instrument b) calibrated instrument
5. A gas that has been reduced in volume by pressure is a ….
   a) compressed gas b) compressing gas
6. A bar that attaches one moving part of a machine to another is a ….
   a) connecting rod b) connected rod
7. A wire that is covered with a nonconductor is an ….
   a) insulated wire b) insulating wire

Ex.2. Translate the terms consisting of Participle 1 or Participle 2 and a noun.

Actuating mechanism**,** actuating pressure, actuating cylinder, translating system, halving circuit, reacting region, detecting element, adding element, alternating current.

Balanced amplifier**,** distributed amplifier, closed antenna, broken circuit, accelerated flight, assisted take-off, forced cooling, estimated performance.

Ex.3. Form the -ed and -ing adjectives from the verbs in the box and fill in the gaps.

grow; fry; break; fall

1. … children need a lot of food.
2. … children often move out of the house.
3. … dishes and shouts could be heard in the kitchen.
4. … dishes were all over the floor.
5. … trees are a danger to hikers.
6. … trees littered the forest floor.
7. … potatoes smell delicious.
8. There were some … potatoes on the plate.

Ex.4. Form the -ed and –ing adjectives from the verbs in brackets and choose the right form for each sentence.

1. The people I work with are … with their jobs. (satisfy)
2. We thought that the instructions were … . (confuse)
3. It's an … little story. You should read it. (amuse)
4. Do you feel … about them? (worry)
5. All this information is making me … . (confuse)

Reading and Speaking

Before you read

Examine the Fig.2. Describe them and say what type of current they illustrate. Share your opinion with a partner.

Reading

Types of electric current (part B)

Although the current isn't essentially influenced by the source of origin, it can be very different in a wave form. The Fig.2 illustrates the graphs of current against time.

(a) represents an example of an oscillating current, and is similar in shape to (f) in Fig.1 except that it has a much higher frequency. [1] However, an alternating current has a frequency determined by the apparatus supplying the circuit.

(b) represents another type of oscillating current which is known as damped. The current again has a constant frequency, but its amplitude is damped, i.e. it dies down. [2]

(c) represents yet another type of oscillating current, this time known as a modulated current. [3] It may even die down to zero.

The next three examples represent various types of transient currents. [4]

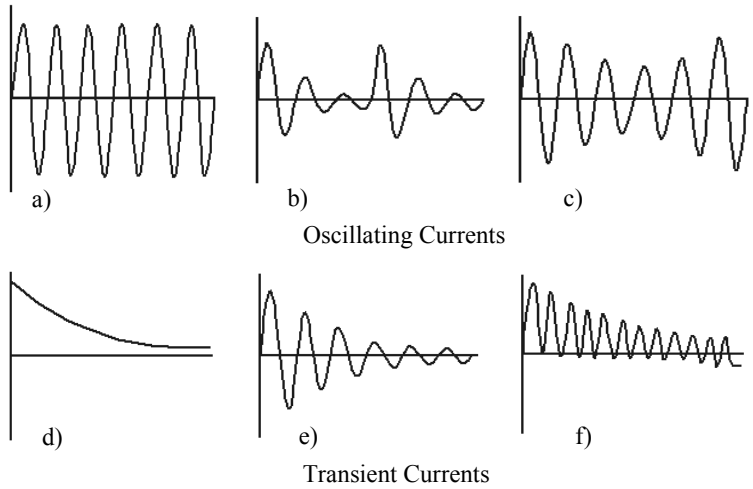


Fig.2. Types of Electric Current

(d) The first example shows a current dying away to zero, and is an example of a unidirectional transient. Theoretically, it takes an infinite time to reach absolute zero.

(e) represents a simple a.c. transient. The current gradually dies down to zero as in the previous case, but this time it is an A.C. that is dying away.

(f) represents a peculiar, but not uncommon, type of a.c. transient. [5] The positive half-waves die away much more rapidly than the negative half-waves grow, so that the final amplitude is very much reduced.

The above examples do not represent all the types of current encountered, but they serve as illustrations of what may be expected. [6] In modern electrical engineering alternating currents play a predominant part, so that a knowledge of the a.c. circuit is of basic importance.

Reading comprehension

Ex.1. Six sentences have been removed from the text. Choose from the sentences (A-G) the one which fits each gap (1-6) in the text. There is one sentence you shouldn't use.

A. The amplitude varies rhythmically between maximum and minimum values.

B. It will be observed that in all the above cases the current consists of either or both unidirectional and alternating components.

C. An oscillating current is usually regarded as one having a frequency determined by the constants of the circuit.

D. The current is initially unidirectional, but it gradually becomes an ordinary A.C.

E. There is only one of many possible alternatives with such values.

F. These transient currents usually die away extremely rapidly, and times are generally measured in microseconds.

G. Then it is brought back to its original value

Ex.2. Read the statements and mark them true (T) or false (F). Give the true statements.

1. Alternating and oscillating currents have the same physical and electric features and qualities, but are different in shape.
2. A frequency of oscillating current is affected by the source of its origin.
3. An oscillating current is defined as damped in case its frequency is damped.
4. When the amplitude of oscillating current varies rhythmically between maximum and minimum values, such a current is known as a modulated current.
5. The period of transient currents death is extremely short.

6. Alternating currents are not as common in electrical engineering as direct current.

***Speaking**

1. In pairs, describe each type of electric current (text A and text B).
2. Classify the information under the following headings:

Unidirectional currents	Alternating currents	Oscillating currents	Transient currents

and make the presentation.

3. Make a comparative analysis of different types of electric current.
4. Role-play. Draw a graph and show it to your partner. Ask him / her to guess the type of electric current.

***Writing**

Write a report on types of electric current. Use extra information.

UNIT 10. CURRENT AND VOLTAGE

Overview

- Reading and Vocabulary: Direct and alternating current.
- Information transfer: Plots. Coordinate systems.
- Language focus: Adverbs. Formation of adverbs. Adverbs with two forms.
- Reading and Speaking: Voltage. Current and voltage laws.

Reading and Vocabulary

Before you read

Discuss the questions below.

1. What do you know about the difference between direct and alternating current?
2. Do we always have to use ac? Why / Why not?
3. Is the application of these types of current different? If yes, how does it differ?

Reading

Direct and alternating current

A direct current (D.C.) flows continuously through a conducting circuit in one direction only, although it may not be steady so far as magnitude is concerned. It is unidirectional in character. An alternating current (A.C.), on the other hand, continually reverses in direction, as its name implies. Starting from zero, it grows in one direction, reaches a maximum, dies down to zero again, after which it rises in the opposite direction, reaches a maximum, again dying down to zero. It is thus continually changing in magnitude as well as direction, and this continual change causes certain effects of far-reaching importance.

It can be shown that high voltages are desirable for the economic transmission of a given amount of electric power. Take, for example, the transmission of 3 000 kW. If the transmission voltage is 100 volts the current must be 30,000 amperes, but if the transmission voltage is 30,000 volts the current is only 100 amperes. The cross-section of the cables transmitting the power is determined by the current to be carried, and so in the former case the cables would need to be very much larger than in the latter case. It is true that the high-voltage cable would need to have more insulation, but even so, it would be very much cheaper than the larger low-voltage cables. A high voltage is therefore essential for the economic transmission of electric power.

Again, a.c. generators can be designed and built for much higher voltages than can d.c. generators, the voltage of the latter being limited by the problem of sparking at the commutator, a component which is absent in the a.c. generator. Then there is the most important factor that it is easy to transform a.c. power from one voltage to another by means of the transformer, an operation that is denied to the d.c. system. The transformer also enables the voltage to be stepped down at the receiving end of the transmission line to values which can readily be used by the various consumers. If necessary, it can be converted to the d.c. form for actual use, although this is not often necessary. There are certain processes for which D.C. is either essential or at any rate desirable but the utilization of electric power in the a.c. form is growing steadily. At the present day, by far the greater part of the generation, transmission, and utilization of electric power is carried out by means of a.c.

Reading comprehension

Ex.1. Read the statements and mark them true (T) or false (F). Give the true statements.

1. Direct current is always steady in all its parameters.
2. Alternating current sometimes reaches maximum before dying down to zero again.
3. A.c. always changes its direction but its magnitude changes depending on the voltage.
4. The cross-section of the cables transmitting the power is determined by both the current and the voltage.
5. The high-voltage cables should have more insulation than low-voltage cables.
6. It is always necessary to convert ac into dc for actual utilization of electric power.

Ex.2. Put the questions to the following answers.

1. No, it changes both: its magnitude and direction.
2. It can be only 100 amps.
3. It is determined by the current to be carried.
4. No, there isn't such a component in ac generators.
5. By means of a transformer.
6. At the receiving end of a transmission line.

Ex.3. Answer what type of the current

- never changes its direction?

- starts from zero?
- rises in different directions?
- determines the cross section of the cables transmitting the power?
- can be transformed from one voltage to another?
- changes both direction and magnitude?
- can change only magnitude?
- is mainly used for generation, transmission and utilization of electric power?

Vocabulary

Ex.1. Fill in the correct preposition from the box in the following word combinations from the text.

through, in, to, for, from…to, out, down to, into

1. reverse … direction
2. convert …
3. step …
4. transform …one voltage … another
5. be desirable …
6. change … magnitude
7. be essential …
8. die …
9. flow …
10. carry …

Ex.2. Use the correct forms of the verbs, words and prepositions from Ex.1 in the following sentences.

1. In the intermediate substations the voltage … to 11kV.
2. The input transducer measures the speed and … it … a voltage.
3. The current which … the satellite circuit is regulated by a relay.
4. What happens if current flow in an electromagnet … direction?
5. The resistance of some metals steadily decreases as their temperature is lowered and then suddenly … zero resistance at very low temperatures.
6. Voltage … … … when the load (at a specified power factor) is reduced from the rated or nominal value to zero.
7. Substations are used to … power … one … level … another.

Ex.3. Fill in the gaps with the correct linking word from the box which are used in the text. Match the linking words with their meanings in (a-g) below.

although, as far as, on the other hand, as well as, therefore, by means of, on the one hand

1. Copper is a good conductor, … it's widely used in cables.
2. Power engineering is a subfield of engineering that deals with the generation, transmission and distribution of electric power … the electrical devices connected to such systems.
3. … power engineering is concerned with the problems of three-phase ac power, a significant fraction is concerned with the conversion between ac and dc power.
4. Transformer is an electrical device used to transfer an alternating current or voltage from one electric circuit to another … electromagnetic induction.
5. … I can tell, the testing of the machine should cost about £ 500.
6. … underwater tidal power appears to be safe for fish and for submarines; … we don't know what are the possible side effects to the environment due to placement of turbines underwater.

a) to the degree, extent or amount that
b) in addition to, positive addition
c) in contrast to
d) for that reason or cause; consequently or hence
e) through the use of, owing to
f) (contrastive) from another, opposing point of view
g) from one point of view

Information transfer

Plots. Coordinate systems

These notions are widely used in engineering. A **plot** is a graphical technique for presenting a data set drawn by hand or produced by a mechanical or electronic plotter. It is a graph depicting the relationship between two or more variables used, for instance, in visualizing scientific data.

A **coordinate system** is a system which uses one or more numbers, or **coordinates**, to uniquely determine the position of a point or other geometric element.

Ex.1. Discuss the questions below.

1. What coordinate systems do you know?
2. What types of function do you know?
3. What are the ways of plotting the functions?

Ex.2. Match the words and expressions given (a-g) with numbers of figure parts below (1-24). Translate them into Russian.

a) system of right-angled coordinates: axes of coordinates (coordinate axes), axis of abscissas (x-axis), axis of ordinates (y-axis), origin of coordinates, quadrant (I-IV: 1st to 4th quadrant), positive direction, negative direction, point in the system of coordinates and its coordinates, value of the abscissa (the abscissa), value of the ordinate (the ordinate);

b) plane curve: the gradient (slope) of the curve, the ordinates' intersection of the curve, the root of the curve;

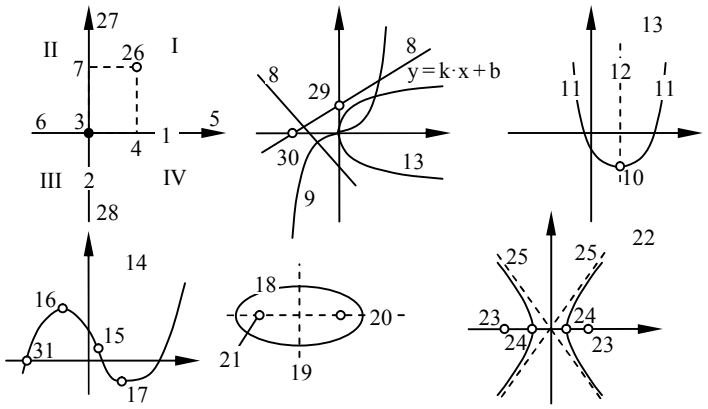
c) inflected curves;

d) parabola (a curve of the second degree): branches, vertex, axis;

e) a curve of the third degree: maximum of the curve, minimum of the curve, point of inflexion (of inflection);

f) ellipse: transverse axis (major axis), conjugate axis (minor axis), focus (pl. foci) of the ellipse;

g) hyperbola: foci, vertices, asymptotes.



Language focus

Adverbs. Formation of adverbs

- adjective + **ly** = adverb
  soft – softly
- adjectives ending in **-le** drop the **-e** and take **-y**

  probable – probably
- adjectives ending in consonant **+y** drop the **-y** and take **-ily**
  heavy- heavily
- adjectives ending in **-l** take **-ly**
  careful – carefully
- adjectives ending in **–ic** usually take **-ally.**
  tragic – tragically

But: public – publicly

The following adverbs have the same form as the adjective:

fast	hard	early	late
high	low	deep	long
near	straight	right	wrong

and the adverb from **good** is **well.**

The following words end in **-ly**, but they are **adjectives**:
friendly, likely, lively, lonely, lovely, silly, ugly.
He's a friendly person.

We use the word **way / manner** to form their adverbs.
He talked to me in a friendly way/manner.

The adverbs loud(ly), cheap(ly), quick(ly) and slow(ly) are often used without **-ly** in everyday English.
Don't talk so loud/ loudly.

Ex.1. Write the adverbs of the adjectives in the list in the correct box.
Cheerful, dramatic, quiet, probable, systematic, easy, noisy, quick, possible, lazy, simple, happy, hopeful, pretty, energetic.

-ly	le → -ly	consonant + y → -ily	-ic → ally
cheerfully			

Ex.2. Underline the correct item.

The house was 1) quiet/ quietly. It had been snowing 2) heavy/heavily all day and the ground was covered in a 3) soft/softly white blanket. 4) Sudden/Suddenly, there was a 5) loud/loudly knock at the door. I jumped up 6) nervous/nervously. "Who's that" I called 7) anxious/anxiously. There was no reply. I 8) slow/slowly opened the door and looked outside. A rush of 9) cold/coldly air entered the house. I 10) quick/quickly shut the door and turned around, then I saw the most 11) horrible/horribly creature I had ever seen standing in front of me.

Adverbs with two forms

Some adverbs have two forms, one with and one without -ly. Compare these examples.

flying high - highly motivated; doing fine - finely-chopped onions

Ex.3. Complete the sentences with the correct form of the adverb. In which examples does the meaning alter significantly? Try to guess and explain the meanings of the adverbs.

hard hardly

1. We all work extremely… .
   Some countries can… feed their own people.

easy easily

2. Manchester won the match… .
   Relax! Take it …

late lately

3. I hate when people arrive… .
   What have you been doing…?

sure surely

4. " Can you lend me some money?" "…"
   …. you can see that your plan just wouldn't work?

wrong wrongly

5. He was… accused of being a spy.
   At first everything was great, but then it all went …

free freely

6. He talked… about his criminal past.
   The prisoner walked…. after twenty years in jail.

most mostly

7. What do you like … about me?
   She worked wherever she could, … in restaurants.

wide widely

8. She has traveled… in Europe and Asia.
   When I got home, the door was … open.

Reading and Speaking

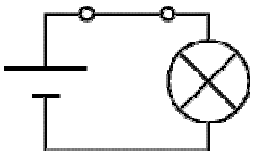
Reading

Ex.1. Read the title and the 1st paragraph of the text. Think of 10 words and phrases you can expect to read in the text.

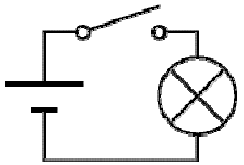
Voltage

1. Voltage and current are vital to understanding electronics, but they are quite hard to grasp because we can't see them directly. The voltage between two ends of a path is the total energy required to move a small electric charge along that path, divided by the magnitude of the charge.

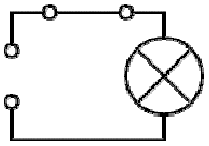
Voltage attempts to make a current flow, and current will flow if the circuit is complete. It is possible to have voltage without current, but current cannot flow without voltage. See the relationship between voltage and current in the schemes below.



Voltage and Current
The switch is closed making a complete circuit so current can flow.



Voltage but No Current
The switch is open so the circuit is broken and current cannot flow.



No Voltage and No Current
Without the cell there is no source of voltage so current cannot flow.

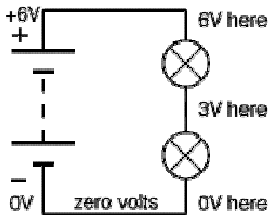
2. There are some essential definitions about voltage everyone should always remember.

- Voltage is a measure of the **energy carried by the charge.** Strictly speaking, voltage is the "energy per unit charge".
- Voltage is **supplied by the battery** (or power supply).
- Voltage is **used up in components**, but not in wires.
- We say **voltage across** a component.

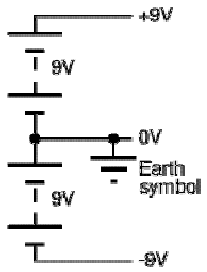
- Voltage is measured in **volts**, **V**.
- Voltage is measured with a **voltmeter**, connected in **parallel**.
- The symbol **V** is used for voltage in equations.

3. A common use of the term "voltage" is in describing the voltage dropped across an electrical device (such as a resistor). The voltage drop across the device can be understood as the difference between measurements at each terminal of the device with respect to a common reference point (or ground). The voltage drop is the difference between the two readings. Two points in an electric circuit that are connected by an ideal conductor without resistance and not within a changing magnetic field, have a voltage of zero. Any two points with the same potential may be connected by a conductor and no current will flow between them. Zero volts could be any point in the circuit, but to be consistent it is normally the **negative terminal of the battery or power supply**. You will often see circuit diagrams labelled with 0V as a reminder.

4. Some circuits require a dual supply with **three** supply connections as shown in the lower diagram. For these circuits the zero volts reference point is the **middle terminal** between the two parts of the supply. On complex circuit diagrams using a dual supply the earth symbol is often used to indicate a connection to 0V, this helps to reduce the number of wires drawn on the diagram. The diagram shows a ±9V dual supply, the positive terminal is +9V, the negative terminal is -9V and the middle terminal is 0V.



5. The voltage between *A* and *C* is the sum of the voltage between *A* and *B* and the voltage between *B* and *C*. The various voltages in a circuit can be computed using Kirchhoff's circuit laws. When talking about a.c. there is a difference between instantaneous voltage and average voltage. Instantaneous voltages can be added for d.c. and a.c., but average voltages can be meaningfully added only when they apply to signals that all have the same frequency and phase.



Reading comprehension

Ex.1. Match headings A-F with paragraph 1-5 in the text. There is one heading you don't need.

A. Zero volts for circuits with a dual supply.
B. Voltage is the cause, current is the effect.
C. Addition of voltages.
D. Voltage at a point and 0V (zero volts).
E. You must know that.
F. Kirchhoff's circuit laws.

Ex.2. Read the text and choose the answer which is not correct for each of the following questions.

1. The voltage is
   a) the energy carried by the charge
   b) the total energy required to move a small electric charge along the path, divided by the magnitude of the charge
   c) the measure of total energy in the circuit
2. When the switch is not closed
   a) the current cannot flow
   b) the circuit is broken
   c) the current can flow
3. Voltage is supplied by
   a) a capacitor
   b) a power supply
   c) dry cell
4. Voltage can be measured with
   a) a potentiometer
   b) oscilloscope
   c) D'Arsonval galvanometer
5. The voltage drop is
   a) any reduction in the supply voltage in a complete electrical circuit
   b) the voltage loss measured across the entire circuit
   c) measurements at each terminal of the device

Ex.3. Look at the groups of words below. Which word is the odd one out in each group? Why?

1. device, component, wire, resistor
2. lead, connection, voltage, conductor
3. flow, pass, restrict, move
4. close, open, break, trip
5. let, enable, permit, prohibit

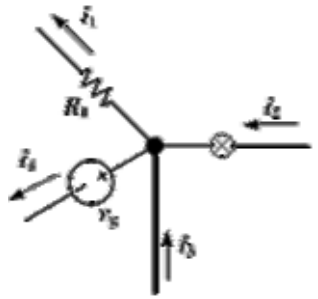
6. cause, make, result from, result in
7. power supply, battery, cell, transformer

***Speaking**

Ex.1. In pairs think of and name the principal laws applied to study current and voltage. Answer the following questions:

1. What are Maxwell's equations? Write them down.
2. What does Ohm's law state?
3. What does Kirchhoff's First Law state?
4. Why is Kirchhoff's Current Law also known as Kirchhoff's Junction Law? Can you write down the equation of this law?
5. What does Kirchhoff's Voltage Law describe?
6. What do you know about positive and negative Signs in Kirchhoff's Voltage Law?

Ex.2. Comment on the diagram of Kirchhoff's Current Law given below. Draw the similar diagram of Kirchhoff's Voltage Law.



UNIT 11. PROPERITES OF ALTERNATING CURRENT

Overview

- Reading and Vocabulary: Properties of alternating current.
- Information transfer: Understanding diagrams.
- Language focus: Adverbs. Place of adverbs in a sentence. Order of adverbs in a sentence.
- Reading and Speaking: Phase and Phase Difference.

Reading and Vocabulary

Before you read

Discuss the questions below.

1. What are the differences between a.c. and d.c.?
2. What values can be changed in d.c. and a.c.?
3. What engineering units concerning voltage and current do you know? What do they measure? Write them down on the blackboard.

Reading

Properties of alternating current

1. A d.c. power source, such as a battery, outputs a constant voltage over time. Of course, once the chemicals in the battery have completed their reaction, the battery will be **exhausted** and cannot develop any output voltage. But until that happens, the output voltage will **remain** essentially constant. The same is true for any other source of d.c. electricity: the output voltage remains constant over time.

2. By contrast, an a.c. source of electrical power **changes** constantly in amplitude and regularly changes polarity. The changes are smooth and regular, endlessly repeating in a succession of identical cycles, and form a sine wave.

3. Because the changes are so regular, alternating voltage and current have a number of properties **associated with** any such waveform. These basic properties include the following list:

4. Cycle. The complete series of changes consisting of the **growth** and decay **of** the voltage or current in one direction, together with its growth and decay in the reverse direction, is called one cycle.

5. Frequency. One of the most important properties of any regular waveform identifies the number of complete cycles *it* goes through in a fixed period of time. For standard measurements, the period of time is one second, so the frequency of the wave is commonly measured in cycles per second (cycles/sec) and, in normal

usage, is expressed in units of Hertz (Hz). It is represented in mathematical equations by the letter 'f.' In North America the ac power system operates at a frequency of 60 Hz. In Europe, the power system operates at a frequency of 50 Hz.

6. Period. Sometimes we need to know the amount of time which **is required** to complete one cycle of the waveform, rather than the number of cycles per second of time. The minimum time interval elapsing before the same instantaneous value recurs is called the periodic time or the period. This is logically the reciprocal of frequency. Thus, we can also say that period is the time duration of one cycle of the waveform. It is measured in seconds/cycle. A.c. power at 50 Hz will have a period of 1/50 = 0.02 seconds/cycle. A 60 Hz power system has a period of 1/60 = 0.016667 seconds/cycle.

7. Wave Form. The shape of the graph of the voltage or current, when plotted against time as a base, is called the wave form or wave shape. The ideal aimed at is *that* of the sine wave. The sine goes through 360° in a complete cycle. The time scale on the wave form of a voltage or current is usually represented in degrees, 360° being considered the equivalent of the time corresponding to 1 cycle, or the periodic time. 180° is considered as a half-cycle, i.e. the duration of the voltage or current in one direction only. Since these degrees may not always coincide with the geometrical degrees through which the rotating member of a machine has been rotated, *they* are called electrical degrees, in order to distinguish *them* from geometrical degrees.

8. Amplitude. Another thing we have to know is just how positive or negative the voltage is, **with respect to** some selected neutral reference. With d.c., this is easy; the voltage is constant at some measurable value. But a.c. is constantly changing, and yet it still powers a load. Mathematically, the amplitude of a sine wave is the value of that sine wave at *its* peak. This is the maximum value, positive or negative, that *it* can **attain**. However, when we speak of an a.c. power system, it is more useful to refer to the effective voltage or current. This is the rating that would cause the same amount of work to be done (the same effect) as the same value of d.c. voltage or current would cause. For a sine wave, the effective voltage of the a.c. power system is 0.707 times the peak voltage (Vp). Thus, when we say that the a.c. line voltage in the US is 120 volts, we are referring to the voltage amplitude, but we are describing the effective voltage, not the peak voltage of nearly 170 volts. The effective voltage is also known as the root mean square (rms) voltage.

Reading comprehension

Ex.1. Continue the following definitions.

1. One cycle is …
2. Frequency identifies …
3. The periodic time is …
4. The reciprocal of frequency is …
5. The ideal wave shape is …
6. Half-cycle is …
7. Mathematically, the amplitude of a sine wave is …
8. Effective voltage or current would cause …

Ex.2. Write the questions to the following answers.

1. ……..?
   A dc power source.
2. ……..?
   Because they repeat endlessly in a succession of identical cycles.
3. ……..?
   It is commonly measured in cycles per second.
4. ……..?
   In a complete cycle.
5. ……..?
   As these degrees do not always coincide with the geometrical degrees.
6. ……..?
   This is the maximum value, positive or negative, that it can attain.
7. ……..?
   It is 0.707 times the peak voltage.

Ex.3. Read the statements and mark them true (T) or false (F). Give the true statements.

1. Period is the interval of time needed for a signal to be repeated.
2. The output voltage from any source of d.c. electricity does not change over time.
3. Periodic time or the period is the parameter directly proportional to frequency.
4. Voltage or current can have only two waveforms or wave shapes: sinusoidal and parabolic.
5. The time scale on the wave form of a voltage or current is usually represented in minutes or seconds.
6. The rms value is the effective value of a varying voltage or current. It is the equivalent steady dc value which gives the same effect.

Vocabulary

Ex.1. Match the verbs (1-12) from the text with the suitable nouns and noun phrases (a-l). Learn these collocations by heart and compose your own sentences with some of them.

1	attain	a	the reaction
2	change	b	output voltage
3	complete	c	a constant voltage
4	describe	d	constant over time
5	develop	e	in a succession
6	distinguish	f	polarity
7	form	g	the same value
8	output	h	from geometrical degree
9	recur	i	a sine wave
10	refer	j	a value
11	remain	k	effective voltage
12	repeat	l	to the voltage amplitude

Ex.2. Match the words in bold in the text to their synonyms in the box. Use some words from the box in the correct form to fill in the gaps in the following sentences.

reach, increase of, stay, vary, worn out, need, concerning, connected with

1. Some kinds of loads … d.c. to power them.
2. Since the range of the output signal is always limited, it will eventually … a minimum or maximum when the measured property exceeds the limits.
3. Noise is a random deviation of the signal that … in time.
4. Sensors … measuring very small changes must have very high sensitivities.
5. In most cases, a microsensor reaches a significant … speed and sensitivity compared with macroscopic approaches.
6. This fault may be due to the … brushes.

Ex.3. Select the word from the three alternatives which is most similar in the meaning to the words as they are used in the text.

1. battery (para.1)
   a) a group of many things of the same kind
   b) an object that provides a supply of electricity for smth
   c) an object that provides heat for homes
2. develop (para.1)
   a) grow into a larger state
   b) use land by building on it
   c) produce smth
3. properties (para.3)
   a) the things that someone owns
   b) something suitable, correct for the situation
   c) quality or power that belongs naturally to smth
4. decay (para.4)
   a) natural chemical change that causes the slow destruction of smth
   b) change from success to a state of being poor
   c) decrease in value of smth
5. elapsing (para.6)
   a) passing
   b) stretching material
   c) smth that can be easily changed
6. plotted (para.7)
   a) smth set in the connected events as a base for a story
   b) planned against sb
   c) drawn to show figures
7. powers (para.8)
   a) moves powerfully and quickly
   b) energy that can be used to make a machine work
   c) supplies power to a vehicle or machine

Ex.4. What do the pronouns in *italics* in these sentences refer to?

1. One of the most important properties of any regular waveform identifies the number of complete cycles *it* goes through in a fixed period of time. (para.5)
2. The ideal aimed at is *that* of the sine wave. (para.7)
3. ...*they* are called electrical degrees, in order to distinguish *them* from geometrical degrees. (para.7)
4. Mathematically, the amplitude of a sine wave is the value of that sine wave at *its* peak. (para.8)
5. This is the maximum value, positive or negative, that *it* can attain. (para.8)

Information transfer

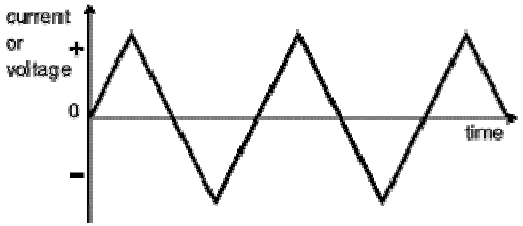
Understanding diagrams

Diagrams play an important role in understanding different concepts used in electrical engineering. It is sometimes difficult to explain and understand technical notions and processes without the use of visual aids. Electricians and engineers draw, for instance, circuit diagrams to help them design the actual circuits. Circuit diagrams are used to show how all the components are connected together to make a circuit. If we compare diagrams with real circuits, we will see that they are very similar and diagrams are a big help for engineers.

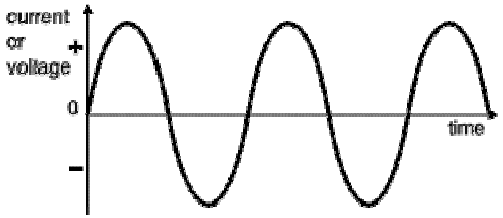
Ex.1. Match the statements (1-5) with the diagrams (A-E) below. Add you own comments to each diagram.

1. Varying d.c. from a power supply without smoothing, not suitable for electronics.
2. This is a.c. from a power supply. This shape is called a sine wave.
3. This triangular signal is a.c. because it changes between positive (+) and negative (-).
4. This is steady d.c. from a battery or regulated power supply, it is ideal for electronic circuits.
5. Smooth d.c. from a smoothed power supply, suitable for some electronics.

A



B



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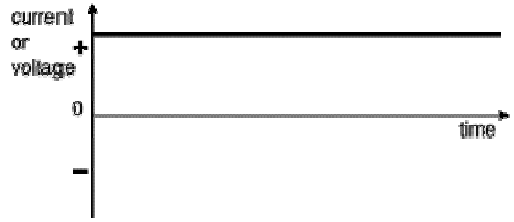
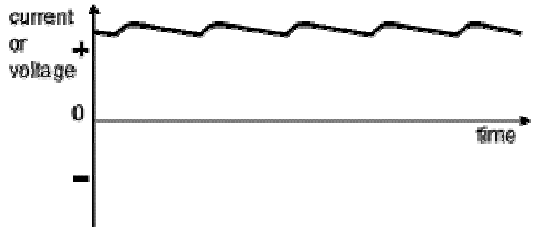
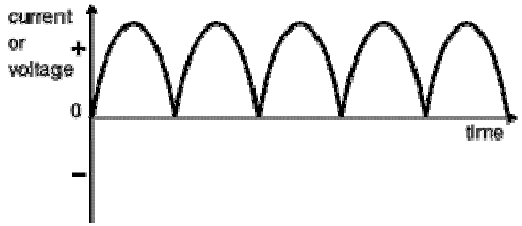


D



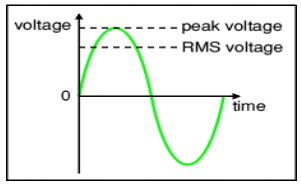
E



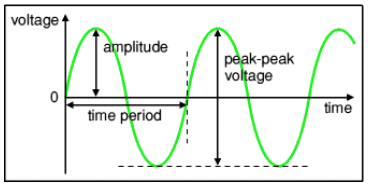
Ex.2. Describe the following diagrams (1-4) below. Give as much information about them as you can answering the questions:

1. How would you call each diagram?
2. What voltage properties are described in diagrams 1 and 2? Give the definitions of properties using the information in the diagrams.
3. What components are depicted in diagrams 3 and 4? What is the function of each component? What is the difference between diagram 3 and 4? What circuits can these diagrams represent?

1.



2.



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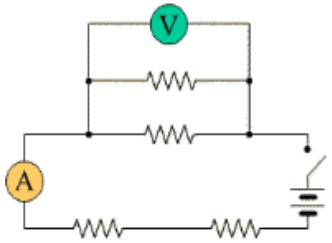

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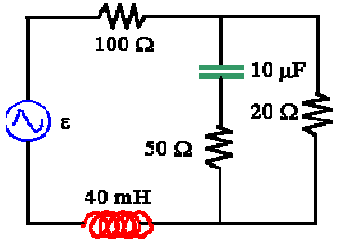


Language focus

Adverbs
Place of adverbs in a sentence

- Usually: **verbs + adverbs**, but **adverbs + adjectives, other adverbs and participles**.

He speaks softly.
She is amazingly beautiful.
He drove very fast.
Computers are extremely used nowadays.

- **Adverbs of manner** go before the main verb, after the auxiliary or at the end of the sentence.

She easily passed the exam.
We are eagerly waiting for his letter.
He acted foolishly.

- **Adverbs of degree** go before an adjective, an adverb or a main verb, but after an auxiliary.

This is totally unacceptable.
They arrived rather early.
We absolutely love her sense of humour.
I don't quite understand what you mean.

- **Adverbs of frequency** go after auxiliary and the verb to be, but before the main verb.

He is always ready to help.
Sam often complains about his salary.

- **Adverbs of place and time** usually go at the end of the sentence.

There is a café nearby.
I'll meet you tomorrow.

Some one-syllable adverbs of time such as **soon, now and then,** go before the main verb, but after the auxiliary or the verb to be.

She then told him what had happened.
He will soon inform us about his decision.

We can put an adverb at the beginning of a sentence if we want to emphasize it.

Slowly, he closed the door behind him.
Yesterday, I met the President.

Order of adverbs in a sentence

When there are two or more adverbs in the same sentence, they usually come in the following order: **manner – place – time.**

The baby slept quietly in his cot all night long.

If there is a **verb of movement**, such as go, come, leave in the sentence, then the adverbs come in the following order: **place – manner – time.**

He came to work by bus this morning.

Ex.1. Put the adverbs in brackets in the correct place in the sentences.

One of the most famous fashion designers of the 20-th century was Gianni Versace.

1. At the age of eighteen, Versace began working for his mother and learned the skills of dressmaking and design. (quickly)
2. He enjoyed designing coloured clothes. (brightly)
3. He worked throughout his career. (very hard)
4. By 1982, he was famous and had won the first of many awards. (incredibly)
5. His clothes were popular with famous musicians, such as Elton John and George Michael. (extremely)

6. He was asked to design costumes for ballets, shows and concerts. (frequently)
7. He was respected by other fashion designers. (greatly)
8. Versace died in 1997, at the age of fifty. (sadly)

Ex.2. Form the adverbs from adjectives in brackets and put them in the correct place in the sentences.

1. The simplest type of transformer consists of two coils of wire, insulated from one another. (electrical)
2. Transformers are classified according to their uses. (frequent)
3. Audio transformers are designed to operate over a wide range of frequencies with a flat response. (near)
4. We use a.c. electricity to power our television, lights and computers. (common)
5. Some kinds of loads require d.c. to power them and others can operate on either a.c. or d.c. (easy)
6. Direct current power is fed through a center tap which is connected to a transformer. (essential)

Ex.3. Find the adverbs in the text and comment on their type and place in the sentence.

Reading and Speaking

Before you read

Discuss the questions below.

1. What is a phase?
2. Compare the phases which current passes through with the phases of the moon. Use the prompts in the brackets (new moon, full moon, waning moon).

Reading

Ex.1. Read the title and the 1st paragraph of the text. Think of 5 questions you would like to find the answers to after reading the text.

Phase and Phase Difference

1. During the interval of time necessary for a current to pass through one complete cycle, it passes through various phases starting from zero, rising up to maximum, and dying down again to zero. In fact it has a different phase for each different interval of time. In the a.c. case, however, this comprises only half a cycle,

for the whole series of values are then repeated in the opposite (negative) direction. Other electrical quantities, such as voltage, power, etc, in addition to current go through various phases from 0° to 360°; indeed all quantities which vary in a periodic manner do so.

2. When two voltages or two currents are considered together, however, or when a voltage and current are considered simultaneously, the frequency being the same, they may not pass through the same phase at the same instant of time. For example, two currents may be such that, although their frequency may be the same, their phase at a particular instant of time may be different. One may pass through its maximum value at the instant when the other has a zero value or some other value not its maximum value; the two currents are then said to have a phase difference. Phase difference is the difference, expressed in electrical degrees or time, between two waves having the same frequency and referenced to the same point in time. If one current has its maximum value at the same time that the other is zero, the two currents are said to be in quadrature; they have a phase difference of 90°. Phase difference, because it is constant in a circuit where steady conditions obtain, is much more important in a.c. work than the actual phase which varies from instant to instant.

3. If we imagine the graphical depiction of the phase difference then it is measured by the distance between the points where the two graphs cross the base line in the same direction. This distance is measured in electrical degrees, the scale being obtained by considering the distance corresponding to one complete cycle as 360°. The current that is ahead in phase is said to lead the other current, while this current is said to lag behind the first current. Similarly, when considering two voltages, one is said to lead and the other to lag. Again, a voltage may lead the current that it produces, the current lagging behind the voltage.

Reading comprehension

Ex.2. Match short summaries (A-E) with paragraph (1- 3) in the text. There are two summaries you don't need.

A. How to get single phase from three phases.
B. Different phase in each different period of time.
C. Various phases at a particular moment of time and phase difference.
D. The difference between single-phase current and three-phase current.
E. One leads, the other lags.

Ex.3. Read the text and answer the following questions.

1. What phases does the ac pass through?

2. Do voltage and current pass through the same phase when considering simultaneously?
3. What is phase difference?
4. Do we take frequency into consideration when speaking about phase difference?
5. Why is phase difference much more important in a.c. work than the actual phase?
6. What units is phase difference measured in?
7. What does it mean: one current leads the other current, while this current lags behind the first current?

Speaking

Ex.1. Read the situation.

Imagine that two athletes are running around a race track at **the same speed and direction** but they started at different positions on the track.

Discuss the questions using the prompts in the box.

1. Can we say that a phase difference is analogous to these two athletes? Why?/Why not?
2. Is it important that the speed and direction of movement are equal?
3. What happened if they were at different speeds?
4. What are different speeds analogous to in this example?
5. What is time difference analogous to in this example?

pass a point at different instants in time; time difference is a constant; the phase difference is undefined and would only reflect different starting positions; does not exist.

Ex.2. Prove that time zones are also analogous to phase differences.

UNIT 12. INDUCTANCE

Overview

- Reading and Vocabulary: Unit of Inductance.
- Language focus: Word Formation. Noun-forming suffixes. Compound nouns.
- Reading and Speaking: Types and Importance of Inductance.
- Writing : A report on the theme “Inductance”.

Reading and Vocabulary

Before you read

Discuss the questions below.

1. What are the sources of magnetic field? Are they of natural origin? Discuss the answers in groups.
2. How well are you aware of such physical phenomenon as inductance? Explain the point of this phenomenon.

Reading

Scan the text and find out if your answers in **Before you read** are correct.

Unit of Inductance

When a current flows through a conductor it sets up a magnetic field in the neighbourhood of the conductor. This is negligible in its effects in a number of cases, but there are also many cases where this magnetic field exerts a profound effect upon the circuit. [1] If the current is steady, the magnetic flux is constant and produces no effect upon the circuit, but if the current changes then the strength of the magnetic field also changes. If the current increases, the total number of lines of magnetic flux is increased, so that the total number of flux-linkages is also increased. It is, however, a fundamental law that whenever the number of flux-linkages changes, an e.m.f. is induced in the circuit linked with the flux [2].

Unit of Inductance. The unit of inductance is the henry, and a circuit is said to possess an inductance of 1 henry if 1 volt is induced when the current changes at the rate of 1 ampere per second. [3]. This induced e.m.f. always acts in such a direction as to oppose the change of current in the circuit, and also the magnetic flux linked with it. [4] Examples of this effect are found in the field circuit of an ordinary generator or motor, the field circuit being highly inductive. When switched into circuit the current does not immediately rise to its full value, but grows relatively slowly. [5].

Reading comprehension

Ex.1. Five sentences have been removed from the text. Choose from the sentences (A-F) the one which fits each gap (1-5) in the text. There is one sentence you shouldn't use.

A. The symbol for inductance is L, so that a circuit possesses an inductance of L henries if L volts are induced due to a rate of change of current of 1 ampere per second.

B. This e.m.f. is proportional to the rate of change of linkages, and one volt is induced when the linkages change at the rate of 1 Weber per second.

C. When the switch is opened, the current tends to continue as evinced by the spark at the opening contacts.

D. The magnetic field created by the current is represented by lines of magnetic flux, these lines consisting of closed loops which are interlinked with the electric circuit, which is itself necessarily a closed circuit.

E. Flux linkages cause a great number of changes of the magnetic field.

F. Thus, if the current is rising, inductance tends to oppose its growth, and if the current is falling inductance tends to oppose its decay.

Ex.2. Read the statements and mark them true (T) or false (F). Give the true statements.

1. The magnetic field set up by a current flow through a conductor is unimportant to have an effect upon the circuit.
2. Lines of magnetic flux consisting of open loops are isolated from the electric circuit.
3. The magnetic flux is constant provided that the current is pulsating.
4. The e.m.f. is induced in the circuit connected with the flux where the number of linkages changes.
5. The induced e.m.f. is unidirectional with the current in the circuit.
6. When the circuit is energized, the current grows rather slowly.

Ex.3. Choose the correct answer to complete these sentences.

1. When the switch is closed the current tends…
   a) to continue b) to pulsate c) to alternate
2. The induced e.m.f. always acts in such a direction as ... the change of current in the circuit.
   a) to provide b) to support c) to oppose
3. If the current is falling, inductance tends to oppose...
   a) its decay b) its faint c) its flourishing

4. The e.m.f. is proportional to ... of change of linkages.
   a) the turn b) the rate c) the direction
5. If the current changes, then the strength of ... also changes.
   a) the magnetic field b) the molecular field c) the geomagnetic field
6. The magnetic field created by the current is represented by the lines of ...
   a) free stream b) magnetic flux c) jet flow

Vocabulary

Ex.1. Match the words (1-5) from the text with their definitions (a-e).

1	conductor	a	a region of space, surrounding a moving charge (e.g. in a conductor)
2	linkage	b	the product of the area of a surface and the average normal component of the magnetic induction over that surface.
3	loop	c	smth that allows electricity or heat to travel along it or through it
4	magnetic field	d	closed circuit
5	magnetic flux	e	a system of links or connections

Ex.2. For each item 1-5, complete the second sentence, so that it has a similar meaning to the first sentence. Use one word from the box each time in the correct form.

oppose, set up, exert, interlinked, evince

1. The magnetic field profoundly affects the circuit.
   The circuit_____ the magnetic field.
2. A current flowing through a conductor establishes a magnetic field.
   A magnetic field _____ a current.
3. Closed loops are connected with the electric circuit.
   The electric circuit _____ closed loops .
4. The spark indicates that the current tends to continue.
   _____ the current tends to continue.
5. The induced emf always acts in such a direction as to prevent the change of current.
   The change of current _____ the induced emf .

Ex.3. Match the beginnings of the sentences (1-4) with their endings (a-d).

1	A spark at the opening	a	means potential difference
2	Inductance	b	is a synonym to a word combination «power circuit»
3	Emf	c	can be explained as the property of an electric circuit
4	A field circuit	d	occurs like a flash of light caused by electricity

Ex.4. Fill in the correct prepositions, then make sentences using the completed phrases.

up, upon, through, in, by, to, at, with

1. to flow … a conductor
2. to be proportional …
3. to produce an effect …
4. to be interlinked …
5. … the rate of
6. to be negligible …
7. to be represented …
8. to set … a magnetic field

Language focus

Word Formation
Noun-forming suffixes

	Suffix	Principal meaning	Examples
Noun – forming suffixes	**verb +** **- tion** **- ion** **- ation**	process, state, the action name	revolution production formation
	verb + **- ment**	state, the result of the action	adjustment
	verb + **- er**	doer of the action	driver
	verb + **- al**	action of doing something	removal
	adjective + **- ancy (-ance)** **- ency (-ence)**	abstract notions, actions, processes, quality of	resistance constancy
	adjective + **- ness**	condition of, or degree of being something	rapidness
	adjective + **- ity**	state, quality	reliability purity

Ex.1. Form the nouns from the following verbs and use them to fill in the gaps in the passages below.

convert, compute, rely, agree, dissipate, measure, verify

The experimental … (1), based on the … (2) of the radiator and case temperatures is aimed to determine the degree of … (3) of the thermal computation and to know the power dissipated by each one of the transistors of the converter.

The … (4) was first operated as to deliver a nominal power and then the temperatures of the cases and of a radiator point close to each of the case were measured. This allowed us to establish that the power … (5) of the transistors during switching was 3.8 and 3.9 W respectively. The results of the thermal … (6) are in good … (7) with the experiment.

Ex.2. Form the nouns from the following words and use them to fill in the gaps in the passages below.

different, apply, characterize, divide, frequent, expect

An a.c. motor is particularly well suited for constant-speed … (1). Its speed is determined by the … (2) of the a.c. voltage applied to the motor terminals. An a.c. motor can be made with various speeds … (3) but only within certain limits. There is a big … (4) between a.c. motors in sizes, shapes, and ratings depending on types of jobs. There is the … (5) of a.c. motors into series, synchronous, and inductive motors. The life … (6) of an a.c. motor insulation system decreases rapidly if its operating temperature exceeds recommended temperatures.

Ex.3. Each of these verbs has a related noun ending in *-er* or *-or* which refers to an instrument or component. Complete the line of nouns. Translate them. You have met these nouns in this and earlier units.

Example: to record – a recorder

1. oscillate;
2. transmit;
3. transform;
4. charge;
5. rectify;
6. process;
7. amplify;
8. collect;
9. detect;
10. tune;
11. protect;
12. convert;
13. break;
14. receive;
15. translate.

Ex.4. Study the verb and two related nouns below. One noun is used for a component, the other is an abstract noun used for a property. For example,

amplify amplifier amplification

Fill in the gaps in the table.

Verb	Noun (component)	Noun (property)
Absorb		
Attenuate	Attenuator	
		Communication
Conduct		Conductivity
		Generation
	Inductor	
Modulate		Modulation
Reflect	Reflector	
Resist		
	Revolver	
	Rotor	

Compound nouns

A compound noun is a noun that is made up of two or more words. They are mainly formed using the following combinations of words:

Noun	+	Noun	toothpaste
Adjective	+	Noun	blackboard, monthly ticket,
Verb	+	Noun	swimming pool
Preposition	+	Noun	underground
Noun	+	Verb	haircut
Noun	+	Preposition	hanger on

The two parts may be written in a number of ways:

1. they can be joined together: **bed + room = bedroom**;
2. they can be joined using a hyphen: **check-in**;
3. they can appear as two separate words: **full moon.**

Ex.5. Choose the correct answer for each question. Say how the compound noun is formed in each case. Pay attention how each compound noun is spelt.

1. Where's the bride- … ?
   a) to-be c) in-law
   b) woman d) to-marry
2. Has he got a valid driving … ?
   a) card c) permission
   b) allowance d) licence
3. I must fit a burglar … to my house.
   a) alarm c) warning
   b) bell d) stop
4. The government was accused of a cover- … .
   a) on c) screen
   b) up d) over
5. He was killed in an air … .
   a) strafe c) raid
   b) attack d) bombing
6. The ship was hit by a … missile.
   a) sea c) controlled
   b) directed d) guided
7. The association has issued a new … .
   a) announcement c) bulletin
   b) statement d) brief
8. The estate … in the High Street is selling my house.
   a) shop c) dealer
   b) merchant d) agent
9. He's had a nervous … , I'm afraid.
   a) collapse c) break
   b) breakdown d) attack

Ex.6. Study these examples of compound nouns: a signal generator = equipment for generating signals; a cassette player = equipment for playing cassettes; a battery tester = equipment for testing batteries.

What do we call equipment for …

1. playing CDs?
2. receiving radio (signals)?
3. charging batteries?
4. filtering (out) noise?
5. synthesizing speech?
6. cleaning cassette heads?
7. amplifying (the) power (of a signal)?
8. sensing vibration?
9. scanning (the human) body (for disease)?
10. for transmitting energy?
11. rectifying current?
12. suppressing signals?

Ex.7. Shorten the following phrases using compound nouns as in the example:

a room for stores – a storeroom

1. a tape for measuring up to 300 cms
2. size of cables
3. reduction in cost
4. two periods of three months
5. plugs with 3 pins
6. two steel boxes for the tools

Ex.8. In text A find the examples of compound words, explain the ways of their formation.

Reading and Speaking

Before you read

1. Think of the answers to the following questions.
   a) What do types of inductance depend on?
   b) How are they characterized?
   c) Why is inductance important?

Discuss your answers with a partner.

2. Scan the text and find out if your answers to the questions in 1 are right.

Reading

Types and importance of inductance

[1] When inductance is due to flux linking with the same circuit that carries the current, it is called self-inductance, in order to distinguish it from inductance due to flux linking with the circuit due to current in a neighbouring circuit, which is called mutual inductance. In the latter case, two circuits are said to possess mutual inductance if a change of current in one circuit causes an e.m.f. to be induced in the other circuit.

[2] Two circuits are said to possess a mutual inductance of L henries if L volts are induced in one circuit due to a rate of change of current of 1 ampere per second in the other circuit. The circuit in which the current is changing is called the primary circuit, while the circuit in which the e.m.f. is induced is called the secondary circuit. When two circuits possess mutual inductance, either circuit can be employed as the primary, the value of the mutual inductance being the same, no matter which circuit is the primary and which is the secondary.

[3] Inductance is a property of a circuit, just as is resistance, and is therefore possessed by d.c. as well as a.c, circuits. In d.c. circuits, however, its effects are not apparent when the current is steady, and are only noticeable when the current is started or stopped, or when it changes in value. The reason for this is that the induced e.m.f. resulting from inductance is due to the rate at which the current, and therefore the flux, is changing. If the current does not change, there is no induced e.m.f. In a.c. circuits, on the other hand, the current is always changing, and therefore the e.m.f. of self-induction is always present. This modifies the value of the current and has far-reaching effects.

Reading comprehension

Ex.1. Now read the text more carefully and choose the most appropriate heading from the list A-D for each paragraph (1 – 3) of the text. There is one extra heading which you do not need to use.

A. The change of current in the circuit.
B. Importance of inductance in a.c. circuit.
C. Mutual inductance.
D. Primary and secondary circuits.

Ex.2. Answer these questions.

1. What is called self – inductance?
2. What is mutual inductance?
3. What kind of circuit is called the primary circuit?
4. Which circuit is called the secondary circuit?
5. Which type circuit possesses inductance?
6. What does the induced emf depend on?
7. What type of inductance is always present in a.c. circuits?

Ex.3. What do the words in bold refer to in the text?

1. in order to distinguish **it** from inductance…
2. in **the latter** case…
3. either **its** effects are not apparent…
4. when **it** changes in value…
5. The reason for **this** is…
6. **This** modifies the value…

Speaking

Ex.1. Reading between the lines. Answer the following questions.

a) What circuit property is inductance?

b) What does the author mean when he states that the emf of self-inductance modifies the value of the current and has far – reaching effects?

c) Which effects does he imply?

Ex.2. Group work. Distinguish between

a) mutual and self-inductance.

b) primary and secondary circuits.

Ex.3*. Search for the extra information on a unit of inductance: who introduced it, why and when.

Writing*

Write a report on the theme "Inductance".

UNIT 13. IRON LOSS

Overview

- Reading and Vocabulary: Hysteresis.
- Language focus: Word Formation. Verb-forming suffixes. Conversion.
- Reading and Speaking: Eddy current loss.
- Writing: An article on the dissipation of energy.

Reading and Vocabulary

Before you read

In groups, discuss the questions below.

1. From the title of the text, try to guess what sort of information you are going to learn.
2. What does the term "hysteresis" mean?

Reading

Hysteresis

When a specimen of iron is carried round a magnetic cycle, a certain dissipation of energy takes place. To build up a magnetic field requires the expenditure of a certain amount of energy, and this energy is not all returned when the magnetic field is destroyed, if iron is the medium. [1] If the iron be now magnetized in the reverse direction, the same process is repeated, with the result that when the iron is brought back to its initial state of magnetization, an amount of energy has been expended in taking the iron round its magnetic cycle. [2] This effect of the dissipation of energy, due to the lagging of the flux behind the magnetizing force, is called hysteresis, and the closed curve shown in Fig.1 is called a hysteresis loop. [3]

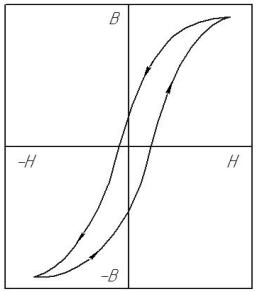


Fig.1. Hysteresis Loop

B – flux density; *H* – magnetizing force in ampere-turns per cm

It can be proved that the energy dissipated in taking the iron round a magnetic cycle is proportional to the area of the hysteresis loop, so that it is desirable to employ iron having a narrow hysteresis loop. [4] This energy wasted per second constitutes a loss, measured in watts, and is known as the hysteresis loss. [5] This is usually expressed by saying that the hysteresis loss is proportional to B^x where x

has a value approximately equal to 1.6 at moderate flux densities, but which may reach a value as high as 4 for extremely high flux densities.

Reading comprehension

Ex.1. Five sentences have been removed from the text. Choose from the sentences (A-F) the one which fits each gap (1-5) in the text. There is one sentence you shouldn't use.

A. If the current is rising, inductance tends to oppose it.

B. In addition to being proportional to the frequency, it also depends, in a somewhat complicated manner, upon the maximum flux density attained.

C. This lost energy is dissipated in the iron in the form of heat.

D. The relation between the various values of *B* and *H* (in both positive and negative directions) is shown in Fig.1.

E. It should be noted that as the value of *H* is raised and lowered, the curve progresses in the direction indicated by the arrows.

F. When subjected to alternating magnetization, the loop is traversed once for every cycle of the current, and so the energy wasted per second is proportional to the frequency.

Ex.2. Decide whether these statements are true or false.

1. The energy is spread in a specimen of iron when the current is rising.
2. The lost energy turns into heat.
3. The iron is carried round the closed loop.
4. Some amount of energy can be received in taking the iron round its magnetic cycle.
5. The effect of dissipation of energy is induced by the lagging of the flux.
6. The amount of the dissipated energy is influenced by the type of the current.

Ex.3. Read questions 1-7 below to make sure you understand what kind of information in the text each question is asking for. For each question, choose the best answer, A, B, C.

1. A certain dissipation of energy occurs
   - A. when a specimen of iron rotates round a magnetic cycle.
   - B. when the contacts are open.
   - C. when the phase difference takes place.
2. A certain amount of energy is required
   - A. to turn a coil.
   - B. to produce a spark.
   - C. to build up a magnetic field.
3. When the iron is magnetized again in the reverse direction to its initial state,
   - A. the core pivots between the poles of magnetic field.
   - B. the process is repeated and the iron turns round its magnetic cycle.
   - C. a sinusoidal emf is induced.
4. The energy lost in the iron should be
   - A. directly proportional to the area of the hysteresis loop.
   - B. inversely proportional to the area of the hysteresis loop.
   - C. proportional to the frequency squared.
5. The hysteresis loss depends
   - A. on the direction of a curve progress.
   - B. on the armature resistivity.
   - C. on the maximum flux density.
6. The effect of energy dissipation is due to the fact the flux is
   - A. progressing behind the magnetizing force.
   - B. accelerating.
   - C. suppressed.

Vocabulary

Ex.1. Find the words in the text that mean:

a. magnetic induction
b. the action of spending or using energy
c. the act of wasting energy
d. to move or develop more slowly than others
e. a delay in magnetic induction
f. the fact of no longer having smth, e.g. energy wasted in a circuit

Ex.2. Fill in the spaces in these sentences with suitable prepositions. The sentences are similar to some in the text.

i. The hysteresis loop is shown … the figure.
ii. The energy has been wasted … taking the iron … its magnetic cycle.
iii. The iron was subjected … alternating magnetization.
iv. The form of the curve is very dependent … maximum and minimum values.

Ex.3. Match the adjectives and nouns from the text that go together.

1	certain	a	curve
2	closed	b	value
3	complicated	c	energy
4	high	d	state
5	initial	e	cycle
6	lost	f	manner
7	magnetic	g	amount
8	maximum	h	direction
9	reverse	i	density

Language focus

Word Formation. Verb-forming suffixes

	Suffix	Principal meaning	Examples
Verb- forming suffixes	**adjective + - ate**	to make something have a particular quality	activate
	adjective + - ify	to affect something in a particular way, or become something	solidify
	adjective + - en	to make	harden
	adjective, noun + - ize/ - ise	to make	centralize

Ex.1. Answer the questions using the verbs corresponding to the words in bold, like this:

Have they made their house more **modern**? – That's right, they **modernized** it last year.

1. Do you need much **purer** solution? – Yes, we'll have to … it.
2. Your plan of doing the job is too complicated. – I'm sure it's possible to … it. (make it **simple**).
3. Do you want a **shorter** desk? – You are right, I want you to … it by 10 cm.
4. Measurement noise can be one reason to make the settling band **wider**. – So, we must … it considerably to provide a meaningful measure.

5. The sensor should have a **digital** output for this application. – That is, we should … the output signal.
6. There is a sensitivity error, but the sensor is still **linear**. – So, we can … the signal.

Ex.2. Form the verbs from these nouns and adjectives by changing the spelling or by using the suffix "-en".

1. blood	4. strength	7. deep
2. proof	5. width	8. wide
3. fright	6. length	9. deaf

Conversion

Conversion is the process of forming a new word in a different part of speech without changing its form, without adding any derivative elements so that the basic form of the original and the basic form of the derived words are the same. It is one of the most important ways of word-formation in present English.

The most frequent types of conversion are the following:

- from noun to verb. This type seems especially important as conversion is considered to be the main method of English verb-formation. For instance : water - to water, air – to air, cause – to cause;
- from verb to noun, for instance: to fall out – fall out; to drop – a drop, must – a must, to blow – a blow;
- from adjective to noun and to verb, for instance: empty – to empty.

The words formed with the help of conversion are translated into Russian depending on their function in the sentence. The context can also help translate these words correctly. Study two sentences:

1 – The investigations of the problem showed that his *approach* to it was misleading.

2 – They usually *approach* problems from many sides.

In the 1st sentence the word *approach* is a noun and in the 2nd sentence – a verb, so these sentences should be translated in the following way:

1 – Изучение проблемы показало, что его *подход* к ее изучению был неправильным; and 2 – Они обычно рассматривают проблемы всесторонне.

Ex.3. Define what part of speech the words in bold are. Translate the sentences.

1. a) A set is defined as any collection of things related for any **reason.**
   b) I always weigh and **reason** everything carefully.

2. a) This length is six **times** as long as the first one.
d) Five **times** nine equals forty five.
e) However many **times** the experiment is repeated, the final velocity is always the same.
3. a) The main **concern** of an engineer is the rate at which work is being done.
b) The articles **concern** the contribution of the Russian mathematicians to the theory of probability.
4. a) One of the most recent **results** was the creation of a new discipline, mathematical logic.
b) Such a process **results** in dramatic changes in the end product.

Ex.4. Use the words from the box in pairs of the sentences. Define what part of speech these words should be. Translate the sentences.

amount, cry, rest, can, increase, complete, bottle, attempt

1. a) An … was made to perform the operation.
b) From this, we may … to deduce all other theorems by purely logical argument.
2. a) A science is more than a large … of information on some subject.
b) These … to refusal from a deeper understanding of the phenomenon.
3. a) Physicists suppose the medium in which light waves propagate to be at … .
b) These statements … on some suppositions.
4. a) The … description of these phenomena gave rise to many new ideas in mathematics.
b) To … the system of numbers, mathematicians had to introduce irrational numbers.
5. a) My grandmother … the juice and … the pickles.
b) My grandmother put the juice in … and the pickles in … .
6. a) Sometimes one just needs a good … .
b) The baby … all night.
7. We need … productivity to see … in profits.

Ex.5. Read the text, look at the words in bold and say:
- what suffixes are used to form them,

- which of them are antonyms and synonyms,
- what words are compound ones,
- what words can be converted into another part of speech.

A **resistor** is a circuit element designed to insert **resistance** in the circuit. A resistor may be of **low** value or of extremely **high** value.

Resistors in **electronic** circuits are made in a **variety** of sizes and shapes. They are **generally** classed as **fixed**, **adjustable** or **variable** depending upon their **construction** and **use**. Resistors required to carry a **comparatively** high current and dissipate high power are usually of the **wire-wound** ceramic type.

An adjustable resistor is usually of the wire-wound type with a metal collar which may be moved along the **resistance wire** to **vary** the value of the resistance placed in the circuit. In **order** to change the resistance, the contact band must be **loosened** and moved to the desired position and then **tightened** so that it will not **slip**.

Ex.6. Complete the table with the words related to those which are given.

Noun	verb
Result	
	measure
	indicate
Dissipation	
	cycle
Direction	
	expand
Loss	
	express
Iron	

Reading and Speaking

Before you read

Discuss the following questions.

1) What types of energy loss in the circuit do you know?
2) Why do they occur?
3) What does the term "eddy current" mean:
   a) a whirling movement of water;
   b) an electric current induced by an alternating magnetic field.

Eddy current loss

Another loss occurring in iron subjected to alternating magnetization is the eddy current loss. In addition to being ferromagnetic, iron is also an electric conductor. When the flux density changes, e.m.f.'s are therefore induced in the iron itself, and if **these** e.m.f.'s act upon closed electric paths, electric currents are produced. These currents in the iron are called eddy currents, and constitute a source of loss of energy, since the eddy paths have definite resistance, although difficult to calculate, and when a current flows through a resistance a loss of energy occurs, this being converted into heat.

The dissipation of energy due to **this** cause continues so long as the eddy currents flow, and therefore constitutes a loss of power, which is measured in watts. **This** power is proportional to the square of the current, which is proportional to the eddy e.m.f. **This**, in turn, is proportional to the maximum flux density, and so the eddy current loss is proportional to B^2. Again, the induced eddy e.m.f, is proportional to the rate of change of flux, and this is proportional to the frequency, so that the loss is also proportional to f^2.

The eddy current loss is therefore proportional to f^2B^2, as compared with fB^x in the case of the hysteresis loss.

Eddy currents may also occur in neighbouring masses of iron, and even in neighbouring conductors or conducting materials other than iron.

Reading comprehension

Ex.1. Decide whether these statements are true or false.

1. Invariable magnetization can cause the eddy current loss.
2. E.m.f is induced in the iron when the flux density is steady.
3. Eddy currents are produced by e.m.f.'s.
4. When the current flow stops, loss of energy occurs.
5. A loss of energy is measured in watts.
6. Frequency and alternating flux are independent of one another.

Ex.2. Choose the correct answer to complete these sentences.

1. Eddy currents occur in
   a) a winding b) an iron c) a load
2. The dissipation of energy constitutes
   a) a loss of power b) a loss of heat c) a loss of rate
3. The power loss is proportional to the square of ...
   a) maximum flux density b) frequency c) current
4. The eddy paths have ...
   a) definite resistance b) balanced value c) a wave form
5. Electric currents are produced because emf's act upon ...
   a) graphers b) load resistances c) closed electric paths.

Ex.3. Complete the passage below by choosing a maximum of three words from the text to fill the spaces.

Alternating magnetization causes ….. in iron. Then emf's induced in it produce electric currents which are called …… . These currents …… and …… of energy. This, in turn, constitutes …… proportional to the square of the current.

Ex.4. What do the words in bold in the following sentences or phrases refer to in the text?

a) **These** emf's act upon closed electric paths.
b) .. to **this** cause continues so long as eddy currents flow.
c) **This** power is proportional to the square of the current.
d) **This**, in turn, is proportional to the square of the maximum flux density.

Speaking

Ex.1. In groups, discuss the following.

a) the subject of the text as a whole;
b) the purpose of each paragraph.

You may use the verbs: describe, give, illustrate, introduce.

Ex.2*. Prepare a presentation: "Hysteresis and eddy current losses".

Focus on the source, occurrence, measurement, whether there is something in common between these two phenomena, compare them.

Writing*

Ex.1. Write the article on the dissipation of energy.

UNIT 14. HEATING EFFECT OF AN ELECTRIC CURRENT

Overview

- Reading and Vocabulary: Heating effect of an electric current.
- Information transfer: Describing diagrams.
- Language focus: Describing component parts. Linking words expressing positive addition.
- Reading and Speaking: What is heat?

Reading and Vocabulary

Reading

Four sentences have been removed from the text. Choose from the sentences **A-E (Ex.1)** the one which fits each gap **(1-4)** in the text. There is one sentence you shouldn't use.

Heating effect of an electric current

The production of heat is perhaps the most familiar among the principal effects of an electric current, either because of its development in the filaments of the electric lamps or, may be, because of the possible danger from overloaded wires.

As you know, of course, a metal wire carrying a current will almost always be at a higher temperature than the temperature of that very wire unless it carries any current. [1] Thus, the current can be detected by the heat developed provided it flows along the wire.

The reader is certain to remember that the heat produced per second depends both upon the resistance of the conductor and upon the amount of current carried through it. As a matter of fact, if some current flew along a thin wire and then the same amount of current were sent through a thicker one, a different amount of heat would be developed in both wires. When the current is sent through the wire which is too thin to carry it freely, then more electric energy will be converted into heat than in the case of a thick wire conducting a small current.

Let us suppose now that a small current is flowing along a thick metal conductor. [2] If, however, our conductor were very thin while the current were large, the amount of generated heat would be much greater than that produced in the thick wire. In fact, one could easily feel it. Thus, we see that the thinner the wire, the greater the developed heat. [3]

Needless to say, such heat is greatly desirable at times but at other times we must remove or, at least, decrease it as it represents a waste of useful energy. In

case heat is developed in a transmission line, a generator or a motor, it is but a waste of electric energy and overheating is most undesirable and even dangerous. It is this waste that is generally called "heat loss" for it serves no useful purposes and does decrease efficiency. Nevertheless, one should not forget that the heat developed in the electric circuit is of great practical importance for heating, lighting and other purposes. Owing to it, we are provided with a large number of appliances, such as: electric lamps, that light our homes, streets and factories, electrical heaters that are widely used to meet industrial requirements, and a hundred and one other necessary and irreplaceable things which have been serving mankind for so many years.

In short, many of the invaluable electrical appliances without which life would seem strange and impossible at present can be utilized only because they transform electric energy into heat.

The production of heat by an electric current is called heating effect. One might also name its light effect provided the heat in the conductor is great enough to make it white-hot, so that it gives off light as well as heat. Take the filament of an electric lamp as an example. [4] By the way, were we able to look inside a hot electric iron, we should see that its wires were glowing too. A similar statement could be applied as well to almost any electric heating device. All of them give off a little light and a lot of heat.

Notes and comments

that very wire means *the same wire*.

… provided … Here it means *under condition, if*

If our conductor were … while the current were … . Note the plural of the verb "to be". This is the rule for *if-* second condition sentences.

to meet … requirements means *to fulfill satisfy requirements*.

Reading comprehension

Ex.1.

A. On the contrary, the larger the wire, the more negligible is the heat produced.

B. It means that an electric current passing along a wire will heat that wire and may even cause it to become red-hot.

C. It is called power loss.

D. Under such conditions the only way to discover whether heat has been developed is to make use of a sensitive thermometer because the heating is too negligible to be detected by other means.

E. We know it to glow because of heat.

Ex.2. Read the text and find the answers to these questions.

1. How can the current be detected?
2. What are the principal effects of an electric current?
3. Why does the current-carrying wire become red-hot?
4. What does the heat produced per second depend upon?
5. Why is the heat developed in a transmission line undesirable?
6. What do we call the heating effect of an electric current?
7. When does the conductor become white-hot?
8. What happens inside any electric heating device?

Ex.3. Work in pairs. Discuss the following problems.

1. Is it possible to
   a) convert electric energy into heat?
   b) obtain heat from the sun using radiant energy?
   c) look inside a hot electric iron?
2. Is it desirable sometimes to remove heat? Why /Why not?
3. Does heat decrease efficiency? Why /Why not?
4. When is overheating most undesirable and even dangerous?

Vocabulary

Ex.1. Fill in the gaps with the words from the box.

overheating, efficiency, appliances, radiant, energy, give off, freely, consumers, red-hot, heat

1. You are familiar with … effect of the current.
2. Different electrical … are used.
3. … is most undesirable and even dangerous.
4. Heat loss decreases …
5. It is possible to convert electric … into heat.
6. We can obtain heat from the sun by employing … energy.
7. The great current flowing through a conductor may cause it to become …
8. All heating devices … a little light and a lot of heat.
9. A thick wire carries current more … than a thin one.
10. Electrical … transform electric energy into heat.

Ex.2. Read the words, define the meaning of the prefixes, translate them.

1. irreplaceable	5. invaluable	8. outstanding
2. supernatural	6. discharge	9. semiconductor
3. overloaded	7. indirectly	10. impossible
4. reaction		

Ex.3. Translate the word combinations (1-22) into Russian and (a-n) into English using the expressions (1-22).

1. as a matter of fact	9. in case of	16. all over the world
2. in fact	10. at times	17. with the aid of
3. needless to say	11. in short	18. as far as
4. at least	12. by means of	19. nevertheless
5. thanks to	13. owing to	20. as well as
6. because of	14. in spite of	21. by the way
7. as to	15. instead of	22. as well
8. sometimes		

a) из-за выделяемого тепла
b) при помощи электрического нагревательного прибора
c) благодаря химической реакции
d) в случае уменьшения кпд
e) что касается тепловой потери
f) по крайней мере, внутри лампочки
g) иногда это желательно
h) короче говоря
i) во всём мире
j) что касается нити накала
k) вместо механической энергии
l) несмотря на разность потенциалов
m) поскольку температура увеличивается
n) насколько мне известно.

Ex.4. Match the correct preposition from the box with the verbs from the text. Learn the collocations by heart. Use them in your own sentences.

through, along, per, with, upon, into, in

1. flow…
2. produced ... second
3. depend…
4. carry …
5. send … the wire
6. convert …
7. develop ...
8. provide smb … smth
9. transform smth … heat

Information transfer

Describing diagrams

In electrical engineering, information can be conveyed not only in texts, but also in diagrams so it is necessary to combine information from these sources of information. Two kinds of diagram are often used in electronics.

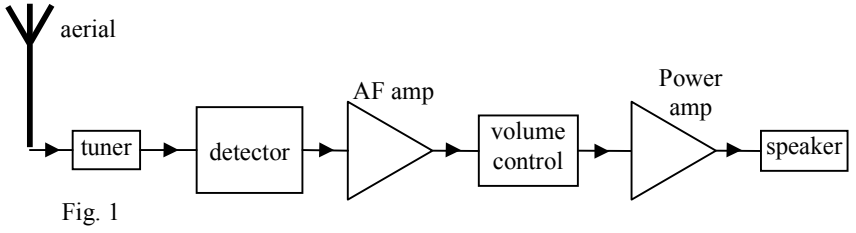


Fig. 1

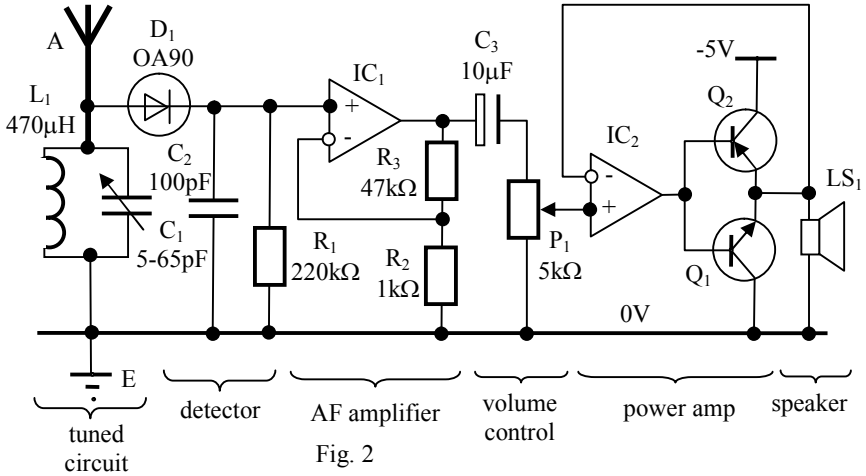


Fig. 2

Although electronic devices may look complicated, they are made up of common basic units (building blocks) connected together. The function of each of these units and the path of the signals between them can be shown in a **block diagram.** In Fig.1 you can see, for example, the block diagram of a simple radio. A block diagram shows not only what components are used but you can understand the function of each unit. This is known as a system approach to electronics. For

example, in Fig.1 the tuner selects the required signal, the detector then separates off the audio part of the signal, and the AF amplifier (amp) amplifies it.

The connections and values of the components inside these basic units can be shown in a **circuit diagram** using standard electronic symbols. Fig.2 shows the circuit diagram for the simple radio.

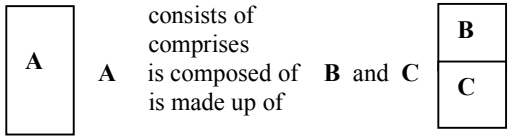
Ex.1. Answer the questions below using the information given above and the diagrams.

1. What are two types of diagrams mentioned in the passage above? What is the difference between them?
2. What do we call the approach to electronics which focuses on the function of units?
3. The diagram of which device is given in Fig. 1 and 2?
4. What blocks does it consists of?
5. How are the blocks connected?
6. What is the function of each block?
7. What does a tuner do?
8. What is the function of a detector?

Language focus

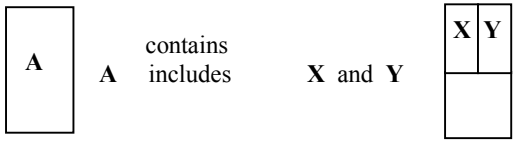
Describing component parts

The following verbs can be used to break down a piece of equipment into its component parts. Study how these verbs are used.



Looking at **Fig.1** above (in Information transfer) **we** can say:
The radio **consists of / is composed of / is made up of / comprises** a tuner, a detector, and an AF amplifier (**these are the parts of the radio**).

Using the verb **comprise**, we can also start our description with the blocks:
A tuner, a detector, and an AF amplifier **comprise** the radio.



The radio **contains** a tuner and a detector. It also **includes** an AF amplifier (a tuner, a detector and an AF amplifier are **inside** the radio).

Speaking about connections, we can use *to be connected, to be linked.*

Ex.1. Read the passage below and pay attention how we can describe the components of the items.

The volume control consists of a ten-microfarad electrolytic capacitor connected in series with a five-kilohm potentiometer (pot). The positive terminal of the capacitor is connected to the output of the AF amplifier and the wiper of the pot is connected to the power amp. The third terminal of the pot is connected to the zero voltage supply rail, which is earthed. The power amp includes two-transistor amplifier. AF amplifier contains the resistive potential divider R_2-R_3. The detector does not contain a coil.

Ex.2. Use the above mentioned verbs in correct form to complete the descriptions of:

1) Electric commutators.

They typically … of a set of copper contacts which are fixed around the circumference of the rotating part of the machine. Commutators also … a set of spring-loaded carbon brushes fixed to the stationary part of the machine that complete the electrical circuit from the rotor's windings to the outside of the machine.

2) Fixed resistors.

Some resistors are cylindrical. They … the actual resistive material in the centre (composition resistors, now obsolete) or on the surface of the cylinder (film resistors). They also … a conducting metal lead projecting along the axis of the cylinder at each end.

3) Capacitors.

A capacitor is … of two electrodes, or plates, each of which stores an opposite charge. A capacitor also … an insulator or dielectric to separate these two conductive plates.

Ex.3. Choose any electrical devices from the box (or think of your own example) and write your own description of them. Where possible, draw a diagram to illustrate the breakdown into components.

transformer, a carbon resistor, a lamp circuit, a relay, a filament bulb, a rectifier, a smoothing circuit, a power supply

Linking words expressing positive addition

You can introduce a related comment or additional piece of information using one of these words:

and, both…and, too, besides (this/that), moreover, what is more, in addition to, also, as well as, furthermore.

Note the following:

- *furthermore* and *moreover* are formal, used to introduce information that adds to what has previously been said. They are used, as a rule, at the beginning of a sentence and are separated by commas.

  Local people would like a new road. Moreover, there are economic reasons to build it.

- *also* is less formal, adds a reason or idea. It can be used at the beginning or within a sentence.

  You can stay at our house. Also, I can check the plane times for you. Or: I can also check the plane time for you.

- *besides (this/that)* is more informal and used to add a reason. It can be used at the beginning of a sentence and it is separated by a comma.

  June isn't a good month to go there. Besides, I want to finish my exams first.

- *too* is used at the end of a sentence or clause.

Ex.4. Translate the following sentences paying attention to **both**, **both** … **and**.

1. **Both** Lomonosov **and** Rihman were great scientists; **both** of them studied atmospheric electricity.
2. **Both** these devices were constructed in our country.
3. Electricity is used **both** in industry **and** in everyday life.
4. **Both** nuclear power **and** solar energy will be widely used in future.
5. **Both** chemical energy **and** mechanical energy can be transformed into electricity.

Ex.5. Fill in the gaps with the words from the box.

moreover, also, as well, in addition to, besides, what is more, furthermore, and, as well as

1. As a matter of fact, since no current can flow unless there is a voltage source, we … refer to these sources as current sources.
2. … the voltage source, we need to have wires … other components to build an electric circuit.
3. … the frequency dependent components, real-life resistors contains a noise source.
4. For this reason, the voltage between both polarities of the secondary battery reduces. …., the voltage between both ends of the capacitor increases.
5. The current only flows from the positive terminal, through the resistor, and into the negative terminal of the battery. ..., the current does not change as a function of time.
6. If the quality of the power supply is in question, it's advisable to also use a universal surge protector … the voltage converter.
7. We provide comprehensive solutions to meet our clients' needs for effective and reliable electrical supply for their clients and for their own production process…. .
8. In this case we recommend you test the assembly at two different voltages and … you'll have to create two separate test programs.

Reading and Speaking

Reading

What is heat?

What makes one thing hot and another cold? What do the terms "hot" and "cold" really mean?

Scientists are known to have worked for a long time to find an answer to the last question. They decided at last that the manifestation of heat was caused by a weightless substance of liquid called "caloric" which flew from a hot body to a cold one. However, experience showed that certain heat effects could not be explained by the above theory, namely: the development of heat owing to friction as well as the temperature changes during the compression or expansion of a gas. M.V. Lomonosov was the first to state that heat phenomena were due to molecular motion. His statement proved to be correct years after his death.

At present, we know heat to be a form of energy. Besides, we are quite familiar with the fact that all substances are made of little particles called molecules. These are so minute that a single drop of water, for example, contains millions of them. Although a drop of water left on the table may seem to be at rest, every of its

molecules is really moving about, colliding with other molecules, pushing them, and changing direction. Of course, while one molecule is travelling, all the other millions of molecules in the drop of water are doing the same thing.

What process takes place when we place a kettle full of cold water on the fire, in other words, when we want to heat water? The molecules begin to move much faster then, so that every time there is a collision, they jump away from each other much farther than they did before. As a result, the drop of water becomes larger, that is to say, it expands. In scientific language this property is called expansion.

The faster molecular movement makes the water first warm and then hot. On taking the kettle from the fire, we expect the molecules to slow down, and indeed the water begins to get cold. When the tea is said to be "hot", it really means that its molecules are travelling very fast. On the contrary, they are moving more slowly, when the tea is cold.

Heat and temperature are closely connected. To show that similar quantities of heat may produce different effects in different substances is not difficult at all. Placing a needle on the fire at the same time as a kettle of cold water, we find that the needle is red-hot before there is any marked difference in the water temperature.

One must say here that a red-hot needle receives far less heat than a kettle full of boiling water but its temperature is nevertheless much higher. But if we place a red-hot needle in the boiling water, although the latter is certain to possess far more heat than the former, the needle gives up heat to the water and not vice versa. When two bodies at different temperatures are brought into contact, we expect the warmer body to get cold while the colder one will be warmed. In this case, heat is said to flow from one body to the other by conduction.

As for expansion caused by heating, it is useless and even dangerous in some cases while in others one cannot do without it. For example, to measure temperature we use a thermometer, that is the instrument based on the expansion of bodies when heated.

Ex.1. Read the statements and mark them true (T) or false (F). Give the true statements.

1. All heat effects can be explained by the movement of a weightless substance of liquid called "caloric".
2. Heat phenomena are caused by molecular motion.
3. Heat is a form of mechanical energy.
4. Heat is the example of thermal energy.
5. Water expands when we boil it.
6. The faster molecules move, the hotter water becomes.

7. Heat conduction is the flow of thermal energy through a substance from a higher- to a lower-temperature region.

8. Expansion caused by heating is always useless and even dangerous.

Ex.2. Translate the following questions and answer them.

1. Что такое тепло?
2. Почему люди предполагали, что тепло – это невесомое вещество?
3. Могли ли люди наблюдать некоторые тепловые эффекты?
4. Что происходит благодаря трению и сжатию?
5. Какие тепловые явления установил Ломоносов?
6. Из чего состоит вещество?
7. Как называются мельчайшие частицы вещества?
8. Что происходит, когда тело нагревается?
9. Какой прибор используется для измерения температуры?

Ex.3. Complete these notes from the text to make a short summary of the text.

The statement that heat phenomena are … can be easily proved.

All substances are made of …. which … all the time.

When we place a kettle full of cold water on the fire, the molecules…

The faster molecular movement causes the water … and, on the contrary, when the molecules move more slowly, water..

Similar quantities of heat may produce… in different substances. To show that we can…

If we place a red-hot needle in the boiling water…

This is called … which is one of the three basic methods of heat transfer.

Heat causes expansion which is…

***Speaking**

Ex.1. Work in groups. Speak on how different types of energy can be converted into heat energy. Use the ideas from the boxes below and think of your own examples.

Types of energy:
mechanical, electrical, chemical, light from the sun, energy from friction

Actions:
bounce a ball; use electrical stove elements, toasters, hair dryers, light bulbs; eat food; sun's rays warm the earth's surface; rub your hands; sharpen a pencil; make a skid mark with your bike; use the brakes on your car

UNIT 15. ELECTRIC CIRCUIT

Overview

- Reading and Vocabulary: Electric circuit.
- Language focus: Present Forms. Expressing cause and effect.
- Reading and Speaking: Battery charger.

Reading and Vocabulary

Reading

Parts of four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (1-4) in the text. There is one sentence you shouldn't use.

Electric circuit

The electric circuit is the subject to be dealt with in the present text. But what does the above term really mean? We know the circuit to be a complete path which carries the current from the **source of supply** to the load and then carries it again from the load back to the source.

The purpose of the electrical source is to **produce** the necessary electromotive force required for the flow of current through the circuit.

The path along which the electrons **travel** must be complete otherwise no electric power can be supplied from the source to the load. Thus we close the circuit when we **switch on** our electric lamp. If the circuit is broken or, as we generally say "opened" anywhere, [1]. Hence, we break the circuit when we switch off our electrical devices.

Generally speaking, the current may pass through solid conductors, liquids, gases, vacuum, or any combination of these. It may flow in turn over transmission lines from the power stations through transformers, cables and switches, through lamps, heaters, series circuits, parallel circuits and short circuits.

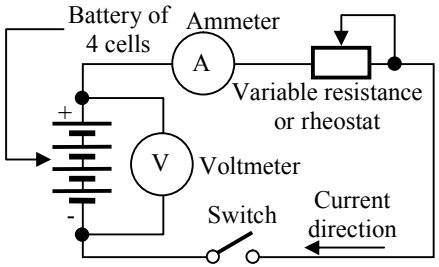
To understand the difference between series, parallel and short circuit connections is not difficult at all. When electrical devices are **connected** so that the current flows from one device to another, [2]. Under such conditions the current flow is the same in all parts of the circuit, as there is only a single path along which it may flow. The electrical bell circuit is considered to be a typical example of a series circuit.

The parallel circuit **provides** two or more paths for the passage of current. The circuit is divided in such a way that part of the current flows through one path, and part through another. The lamps in your room and your house [3].

Now we will turn our attention to the short circuit [4]. The short circuit is produced when the current is **allowed to** return to the source of supply without control and without doing the work that we want it to do. The short circuit often **results from** cable fault or wire fault. Under certain conditions, the short may **cause** fire because the current flows where it was not supposed to flow. If the current flow is too great a fuse is to be used as a safety device to stop the current flow.

The fuse must be placed in every circuit where there is a danger of overloading the line. Then all the current to be sent will pass through the fuse.

When a short circuit or an overload causes more current to flow than the carrying capacity of the wire, the wire becomes hot and sets fire to the insulation. If the flow of current is greater than the carrying capacity of the fuse, the fuse melts and opens the circuit.



A simple electric circuit

A simple electric circuit is illustrated in the picture on the left. In this figure a 4-cell battery has been used, the switch being in an open position. If the switch is in closed position, the current will flow around the circuit in the direction shown by the arrow.

Notes and comments

… the subject to be dealt with … . Note the use of *infinitive* and *the passive voice*. To *deal* here means to *work with*, to *consider*.

to carry the current means *to let current flow*.

to set fire means *to ignite*.

Reading comprehension

Ex.1.

A. are generally connected in parallel.
B. the current is known to stop everywhere.
C. sometimes called “the short”.
D. they are said to be connected in series.
E. the input voltage is absent.

Ex.2. Read the text and find the answers to these questions.

a. What is the subject of discussion in the text?

b. What is an electric circuit?
c. What is the function of an electric source?
d. What does the term “closed circuit” mean?
e. Why does the current flow when the circuit is closed?
f. How can we prevent current from flowing through the circuit?
g. What kinds of circuits do you know?
h. What do we mean by the term “short circuit”?
i. What does a short circuit often result from?
j. What safety device is used in the circuit when the current is too great?
k. What do you call a fuse?
l. How can current cause fire?
m. When does a wire become hot and set fire to the insulation?

Ex.3. Read the statements and mark them true (T) or false (F). Give true statements.

1. If the circuit is shorted, the current is known to stop everywhere.
2. If one and the same current flows through all elements, they are said to be connected in series.
3. The short circuit is produced when the switch is closed.
4. A fuse protects a circuit of overloading.
5. If the fuse melts, it opens the circuit.
6. Inside a battery current flows from the positive terminal to negative one.

Vocabulary

Ex.1. Match the words in bold (1-9) in the text with their synonyms (a-l). There are 3 synonyms you shouldn’t use. Pay attention what meaning the words (1-9) have in the text.

1. source of supply	4. switch on	7. allow
2. produce	5. connect	8. result from
3. travel	6. provide	9. cause

a) pass through	e) power supply unit	i) create, make
b) link, join	f) journey	j) purpose
c) let, permit	g) offer, supply	k) turn on
d) lead to, result in	h) caused by	l) affect

Ex.2. Fill in the words from the box below.

supply, complete, electric, short, conditions, battery, position, arrow, fire, safety

1. … path
2. source of …
3. … circuit
4. 4-cell …
5. … lamp
6. under certain …
7. switch in a closed …
8. direction shown by the…
9. fuse is a … devise
10. great current sets…

Ex.3. Match the words from the text with their definitions. Use the words in the sentences below.

1	carrying capacity	a	a defect in a circuit or wiring caused by imperfect connections, poor insulation, grounding, or shorting
2	danger	b	material that prevents current from escaping or entering where it is not wanted, used esp. to separate conductors
3	device	c	amount of power used by electrical and electronic equipment; object of power delivery in circuit
4	fault	d	the direction or line along which something travels or moves
5	fuse	e	the maximum amount of electrical current which a cable can carry before sustaining deterioration
6	insulation	f	thin metal in the form of a thread usually covered in plastic, used to take electricity from one place to another
7	load	g	any electronic or electromechanical machine or component from a transistor to a disk drive
8	path	h	a safety device that protects electric circuits from the effects of excessive electric currents
9	wire	i	hazard, troublesome situation

1. The current … is limited both through the thermal properties of the materials used for the contacts and connections and the insulation elements.
2. The company makes … to measure the motor speed.
3. These materials are frequently used as …: fiberglass, mineral wool, cellulose, foam. Asbestos is no longer used because airborne particles may cause lung disease.
4. This tester can be used to locate where an underground cable … lies.
5. A … commonly consists of a current-conducting strip of easily fusible metal; whenever the circuit is made to carry a current larger than that for which it is intended, the strip melts to interrupt it.

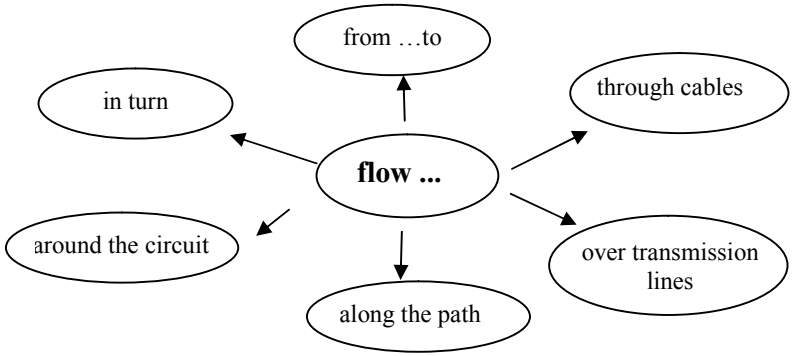
6. For convenience, the different … are numbered in order of decreasing size, the number being known as the gauge, the higher the gauge the smaller the diameter.

Ex.4. Match the verbs (1-9) with the prepositions in the box.

with, for, from, in, between, to, along, through

1. deal …
2. difference …
3. travel …
4. provide smth …smb
5. divide …
6. turn attention …
7. pass …
8. set fire …
9. result …

Ex.5. Study the collocations of the verb flow with different prepositions. Learn them by heart. Study how they are used in the text. Give your own sentences with this verb.



Language focus

Present Forms

Study the following table.

Present Simple	Present Continuous	Present Perfect	Present Perfect Continuous
permanent situations or states Siemens new drive system offers great precision at reasonable price.	**temporary situations** Designers of new conversion equipment are demanding new diode operating characteristics.	**recently completed actions** Siemens Components have just issued a new catalogue for thermistors.	**actions started in the past and continuing up to the present** He has been studying device modeling for 5 years.
repeated/habitual actions (with frequency adverbs) A circuit often requires a power supply that provides negative as well as positive voltage.	**actions happening at or around the moment of speaking** In the case we are considering now, the average current remains unchanged.	**actions which happened at an unstated past time and are connected with the present** The company has introduced the new type of isolation transformer.	**past actions of certain duration having visible results or effects in the present** They have been carrying out this complicated test all morning.
permanent truths or laws of nature Water freezes at 0°C.	**fixed arrangements in the near future** They are publishing a new Designer's manual of discrete Schottky diodes next week.	**personal experiences/ changes which have happened** She has graduated from the depart-ment of Electrical Engineering of Brighton Polytechnic.	**emphasis on duration (usually with for, since or how long)** They have been studying ways of splitting uranium atoms for almost 10 years.
timetables / reviews The paper presents a converter using Zero current switches.		**emphasis on number** She has published two books on the control of resonant converters.	

Ex.1. Match the sentences with the meaning of the tense used in each of them.

1	Electronic motor drives fall into one of two categories: AC and DC.	a	fixed arrangements in the near future
2	We use robots on the production line for routine assembly jobs.	b	recently completed action
3	They always offer a 24-hour technical back-up service.	c	actions started in the past and continuing up to the present
4	There have been too many unplanned shutdowns over the past few months.	d	emphasis on number
5	What's happened? Is there a problem? - I think the gears have seized up.	e	permanent truth
6	We have already done a stock check three times this month.	f	past actions of certain duration having visible results or effects in the present
7	The building work is starting in week 23.	g	repeated/habitual actions
8	They have been using IGBT technology since 1990s.	h	actions happened at an unstated past time
9	I am very tired. I've been trying to get onto the Internet all morning.	i	permanent situations or states

Ex.2. What tense form is mainly used in the text Electric circuit? Explain why namely this tense form is used in the text.

Ex.3. Read the passage below. What tense are the verbs in bold used in? Explain the usage of these tense forms.

Although the complexity of drive designs **is increasing**, quality **is rising**, as well. Drives **are** also **coming** in smaller packages with each generation. The trend **is** similar to that of the personal computer: more features, better performance, and lower cost with successive generations. Unlike computers, however, the reliability and ease of use of drives **has** dramatically **improved.** And also unlike computers, today's typical drive **doesn't spew** gratuitous harmonics into your distribution system nor **does** it **affect** your power factor. Drives **are** increasingly **becoming** plug-and-play devices. As electronic power components **improve** in reliability and **decrease** in size, the cost and size of drives **will continue** to decrease, and their performance and ease of use **will only get** better.

Ex.4. Fill in with Present Simple or Continuous.

1. 'I (1) … (phone) about the factory visit next Friday. What should I do when I (2) … (arrive)?'

'Park in the visitors' car park, it (3) ... (be) directly opposite the gatehouse.'

'Thank you, I (4) … (look forward) to seeing you on Friday.'

2. 'This (5)… (be) the main factory area. We (6) … (walk) past the printing machine now. It (7) … (print) in four colours at the moment.

'What (8) … (go) on over there?'

'They (9) … (set up) the machine for a new run.'

'How long (10) ... that usually …(happen)?'

'It usually (11) … (take) about twenty minutes.'

'What (12) … (happen) at the far end?'

'That (13) … (be) the packing line. The workers (14) … (wrap and load) the goods onto pallets ready for transportation.'

Ex.5. Put the verbs in brackets into Present Perfect or Present Perfect Continuous.

1. 'Someone (1)… (report) a fault on one of your copiers.'
   'That's right. It (2) … (not work) properly for the last few days.'
2. Our usual supplier (3) … (let) us down and I (4) … (look) through your parts catalogue all morning.
3. 'What do you think of the new supplier?'
   'We (5) … (not have) any problems so far. We (6) … (call) them in three times this month. We (7) … (liaise) very closely with them since last summer.'
4. 'How long (8) … your company … (be) in business?'
   'We (9) … (manufacture) components for car production plants in Europe for over 40 years.'

Ex.6. Form sentences using the words given below.

1. lift, the heavy, can, Electric, objects, crane.
2. finds, industry, energy, in, application, Electric, wide.
3. day, use, every, Do, devices, you, electrical?
4. to a significant, since 2006, oil consumption, Renewable, have, decline in, in the United States, biofuels, contributed.
5. doesn't, very much, in London, He, lives, he, like it, but.
6. been, in the garden? How long, working, she, has

Ex.7. Put all the possible questions to the following sentences.

1. The UK currently generates about 0.8 per cent of its electricity from hydroelectric power stations – most of which are found in the Scottish Highlands.
2. My best friend and I have known each other for over fifteen years.

Expressing cause and effect

Study the following sentences:

1. Insulation breakdown **causes** short circuits.
2. When a short circuit **causes** more current **to flow** than the carrying capacity of the wire, the wire becomes hot.
3. Current flows through the filament **causing** the bulb **to light.**

A. These sentences contain a cause and an effect. When a cause and an effect both are noun phrases we can link them as follows (as in sentence 1 above):

cause → effect

Insulation breakdown	causes results in produces leads to is the cause of gives rise to	short circuits.

We can also put the effect first:

effect ← cause

Short circuits	are caused by result from arise from are the effect of are the result of are the consequence of are due to	insulation breakdown.

When a cause has several effects or when an effect has a number of possible causes, we put **can** or **may** before the causative expression.

Worn brushes **may / can** cause sparking.

Instead of **the** cause / effect / result / consequence of, we can write **one** cause / effect / result / consequence of.

A worn commutator is **one** cause of sparking.

B. Another way to connect a cause and an effect is to use the following structures (as in sentences 2 and 3):

cause smth / smb **to do** smth; **make** smth / smb **do** smth or
causing smth / smb **to do** smth; **making** smth / smb **do** smth

Ex.8. Find the sentences expressing a cause and an effect in the text 'Electric circuit'.

Ex.9. Match causes (1-5) and effects (a-e). Link them using expressions in Part A. Write 2 sentences for each example, one with the cause first, the other with the effect first.

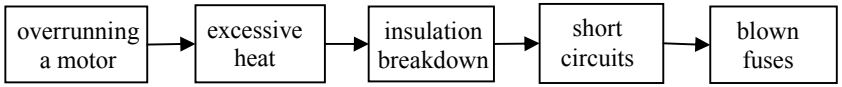
1. eddy currents	a) bad joints
2. excessive heat	b) breakdown of the motor
3. faulty soldering	c) power losses in transformers
4. faulty earth connections	d) damage to semiconductor
5. exceeding the motor rating	e) serious accidents

Ex.10. Items (1-7) can be causes or effects of items (a-g). Match the pairs. Write sentences to show the relationship between these pairs.

For example: mains frequency interference – hum. Mains frequency interference results in hum.

1. distortion	a) interference on radios
2. noise generated within components	b) too high a recording level
3. overheating a transistor	c) the tape rubbing against the head
4. dirty heads	d) scratches on records
5. a build-up of oxide on the head	e) hiss
6. jumping	f) damage
7. unwanted signals	g) poor recordings

***Ex.11. Describe this cause and effect chains.**



Ex.12. Fill in the gaps with the verbs *cause* and *make* in the correct form.

1. The wind turbine works in the following way. The wind blows on the blades and … them rotate.
2. This … the shaft to rotate at a speed of about 30 – 60 rpm.

3. There are two shafts – a low-speed and a high-speed. The first shaft is attached to a large gear, the second one is attached to a small gear. The large gear … the small gear turn and the small gear … the high-speed shaft to rotate.

Ex.13. Match causes (1-5) and effects (a-e). Link them using the structures in Part B (*causing to do* and *making do*).

1. The current rises sharply.	a) The heating system is turned off.
2. The current passes through the water.	b) The water breaks down into hydrogen and oxygen.
3. The current flows through the conductor.	c) Electrons are emitted.
4. The thermostat contacts open at 20°C.	d) The circuit-breaker opens.
5. The cathode is heated.	e) A magnetic field is set up round the conductor

Reading and Speaking

Before you start

Discuss the questions below.

1. What is a battery charger?
2. Why is it necessary to charge the battery?
3. What properties should a battery charger have?

Reading

Battery charger

The power to drive an electronic circuit is normally provided by an AC mains power supply but batteries are often used for portable equipment. Secondary cells can be recharged to their original voltage and can therefore be used many times over.

Recharging is done using a battery charger which consists of a mains power supply with a DC output slightly larger than the required battery EMF. A current is driven through the battery in the opposite direction to its normal output current. The block diagram of a battery charger is shown in Fig. 1 below.

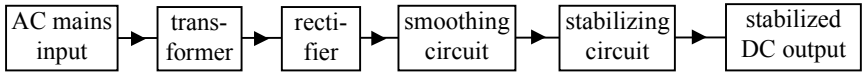


Fig. 1

The first stage consists of a transformer which steps down the voltage of the AC mains. The charger is switched on and off by a double-pole switch connected in

series with the mains input. A neon lamp, connected across the primary of the transformer, shows when the charger is on. A fuse is connected in the live side of the supply to protect the transformer.

The second stage is a bridge rectifier which converts an AC voltage into a DC voltage. This can be made from discrete components but more usually consists of four diodes contained in one package. It is mounted on an aluminium heatsink to keep the diodes from overheating.

The third stage is a smoothing circuit. It removes the fluctuations in the DC output of the rectifier. It consists of a large electrolytic capacitor connected in parallel with the rectifier.

The final stage is a stabilizing circuit consisting of a transistor biased by two resistors and a Zener diode. This prevents the output from changing when the load varies. NiCad batteries have such a small internal resistance that the charger must produce a constant current output.

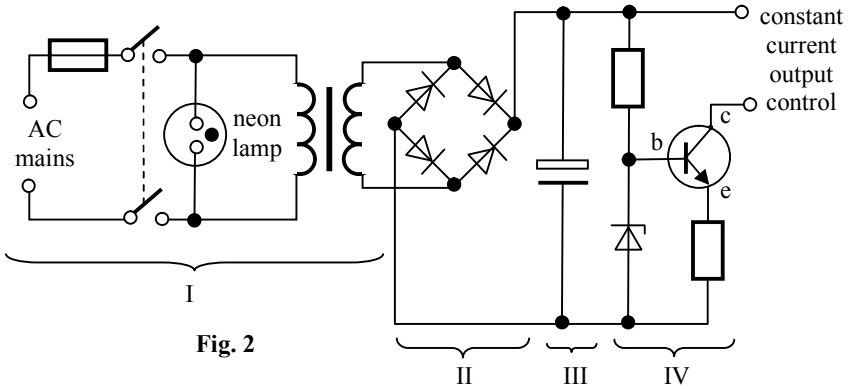


Fig. 2

Ex.1. Answer the questions using the information from the text and the block diagram of a battery charger.

1. When do we use battery chargers?
2. What blocks does a battery charger consist of?
3. What is the function of each block?
4. What can a bridge rectifier be made from?
5. What does a smoothing circuit consist of?
6. What does a stabilizing circuit consist of?
7. Why does a charger produce a constant current output?

Ex.2. Study the circuit diagram of a battery charger in Fig.2. Match the names of the components (1-13) with their functions (a-m) given below.

Component/Unit:

1. transformer
2. double-pole switch
3. neon lamp
4. fuse
5. bridge rectifier
6. aluminium heatsink
7. smoothing circuit
8. stabilizing circuit
9. diode
10. electrolytic capacitor
11. transistor
12. resistor
13. Zener diode

Function in a battery charger:

a) steps down the AC mains voltage
b) restricts current flow mainly to one direction
c) prevents the output from changing when the load varies
d) stores charge temporarily
e) keeps the diodes from overheating
f) controls current flow
g) shows when the charger is on
h) removes the fluctuations in the DC output of the rectifier
i) resists the flow of current in an electronic circuit.
j) protects the transformer
k) maintains an almost constant voltage
l) converts an AC voltage into a DC voltage
m) switches the charger on and off

Ex.3. Using the information from the text and the circuit diagram answer the question:

How are the following components connected in the circuit and why are they connected in such a way?

a) double-pole switch
b) neon lamp
c) fuse
d) electrolytic capacitor
e) transistor
f) resistors
g) Zener diode

***Speaking**

Ex.1. Find in the textbooks or draw yourself block diagrams or circuit diagrams of some simple devices and describe them. Ask each other as many questions as you can concerning the names, functions, connections, mounting of the components in the diagrams.

UNIT 16. MAGNETISM

Overview

- Reading and Vocabulary: Magnetism.
- Information transfer: Understanding and describing graphs.
- Language focus: Present Forms (continuation).
- Reading and Speaking: Magnetic materials.

Reading and Vocabulary

Reading

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (**1-4**) in the text. There is one sentence you shouldn't use.

Magnetism

1. In studying the electric current, we observe the following relation between magnetism and the electric current: magnetism is produced by the current and on the other hand the current is produced from magnetism.

Magnetism is mentioned in the oldest writings of man. [1] However, nobody knew who discovered magnetism and where and when the discovery was made. Of course, people could not help repeating the stories that they had heard from their fathers who, in their turn, heard them from their own fathers and so on.

2. One story tells us of a man called Magnus whose iron staff was pulled to a stone and held there. He had great difficulty in **pulling his staff away**. Magnus carried the stone away with him in order to demonstrate its attracting ability to his friends. [2]. According to another story, a great mountain by the sea possessed so much magnetism that all passing ships were destroyed because all their iron parts fell out. They were pulled out because of the magnetic force of that mountain. The earliest practical application of magnetism was connected with the use of a **simple** compass consisting of one small magnet pointing north and south.

3. A great step forward in the scientific study of magnetism was made by Gilbert, the well-known English physicist (1540-1603). He carried out **various** important experiments on electricity and magnetism and wrote a book where he **put together** all that was known about magnetism. He proved that the earth itself was a great magnet. Reference must be also made here to Galileo, the famous Italian astronomer, physicist and mathematician. He took great interest in Gilbert's achievements and also studied the properties of magnetic materials. He experimented with them trying to **increase** their attracting power. [3].

4. At present, even a schoolboy is quite familiar with the fact that in magnetic materials, such as iron and steel, the molecules themselves are **minute** magnets, each of them having a north pole and a south pole. When iron and steel are magnetized, the molecules arrange themselves in a new orderly way instead of the disarrangement in which they neutralize each other. **Dividing** a bar magnet into two parts, one finds that each of the two parts is a magnet having both a north pole and a south pole. Thus, we obtain two magnets of a smaller size instead of having a single one of a larger size. [4] We can magnetize an iron bar even if we place it near a strong magnet, rubbing the magnet is not required for that process.

5. Not only iron bars can become magnetized. Physicists have discovered that treatment of oversaturated solutions with a magnetic field changes the process of crystal formation. The magnetic field orientates and rearranges the molecules of water, so under the influence of a magnetic field water changes its basic physical and chemical properties, namely density, surface tension and electric conductivity. Salt solubility changes to an especially remarkable extent. These new properties were used for practical purposes. For instance, magnetized water forms almost no scales on boiler walls. Moreover, water retains its newly acquired qualities for a few days even when it has been withdrawn from the magnetic field. The water "remembers" the magnetic field.

Notes and comments

… *people could not help repeating* … means *people could not stop themselves repeating this*

… *a mountain by the sea* … means *close to the sea*.

Reading comprehension

Ex.1.

A. One of his magnets, for example, could lift objects weighing 25 times its own weight.

B. Dividing one of these two smaller magnets into two will give us the same result.

C. This unfamiliar substance was called Magnus after its discoverer, this name having come down to us as "Magnet".

D. The simplest electromagnet is a coil carrying current.

E. Romans, for example, knew that an object looking like a small dark stone had the property of attracting iron.

Ex.2. Read the text and answer which paragraph

1. describes the properties of magnetized water

2. tells the legends behind the phenomenon of magnetism
3. is about changes in the structure of metals under the influence of magnets
4. says that magnetism has been known to people for centuries
5. describes changes taking place in magnetized water
6. proves that magnetism has always been the subject of scientific investigations
7. mentions the relation between magnetism and the electric current

Ex.3. Point out which of these sentences contains the information from the text above.

1. Magnetism, along with electricity, belongs to a larger phenomenon, electromagnetism, or the force generated by the passage of an electric current through matter.
2. In magnetic materials the molecules themselves are minute magnets.
3. Many physicists experimented with magnetism trying to find practical application of this interesting phenomenon.
4. A magnetic compass works because Earth itself is like a giant bar magnet.
5. The new properties of magnetized water were used for practical purposes.
6. The term *magnetism* is derived from *Magnesia,* the name of a region in Asia Minor where lodestone, a naturally magnetic iron ore, was found in ancient times.

Ex.4. Translate the following questions into English and answer them.

1. Существует ли связь между электричеством и магнетизмом?
2. Знаете ли вы, кто открыл магнетизм?
3. Кто доказал, что наша Земля является большим магнитом?
4. Что вы знаете о магнетизме?
5. Каковы свойства магнита?
6. Кто интересовался достижениями Гильберта?
7. Какие магнитные материалы вы знаете?
8. Какие свойства материалов изучал Галилей?

Vocabulary

Ex.1. Study the derivatives of the words *arrange* and *magnet* which are used in the text. Explain how they are formed, what parts of speech they are and what their meanings are.

Arrange – disarrangement – rearrange.

Magnet – magnetic – magnetized – magnetism.

Ex.2. Fill in the gaps with the derivatives. Find what derivatives of these words are used in the text.

Verb	Noun	Adjective
	experiment	
		demonstrative
electrify		
	saturation	
dissolve		soluble
	variety	
relate		

Ex.3. Match the words (1-7) which are in bold in the text with their antonyms (a-g). Use the antonyms to fill in the gaps in the sentences (1-6) below.

1	minute	a	decrease, diminish
2	simple	b	combine, connect
3	various	c	huge, large
4	put together	d	complex
5	pull away	e	separate, take apart
6	increase	f	join, link, unite
7	divide	g	same

1. To do this experiment you will need 2 bowls. Fill one bowl with hot water and another with the … amount of cold water.
2. There is a … network of roads round the city.
3. When the capacitor begins to discharge, its voltage … .
4. Whenever you place two pieces of metal in water, and apply electricity, the water … into its basic molecules, Hydrogen and Oxygen (H2O).
5. When … your batteries in series you are doubling the voltage while maintaining the same capacity rating (amp hours).
6. Because iron is a relatively good conductor, it cannot be used in a transformer, as intense eddy currents would appear due to the magnetic field, resulting in … losses.

Ex.4. Fill in the words from the box below.

lift, compass, earth, attracting power, iron staff, iron bar, magnetism, rubbing, coil, minute

1. …is produced by the current.

2. Magnus' … was pulled to a stone being a large magnet.
3. A simple … consists of one small magnet pointing north and south.
4. Gilbert proved that the … itself was a great magnet.
5. Galileo experimented with magnetic materials trying to increase their … .
6. In magnetic materials, the molecules themselves are … magnets.
7. On placing an unmagnetized … near a strong magnet, we magnetize it.
8. Iron bar is magnetized by the strong magnet without … it.
9. Galileo's magnets could … objects weighing 25 times their own weight.
10. The simplest electromagnet is a … carrying current.

Information transfer

Understanding and describing graphs

Vocabulary describing growth and decline of different processes is one of the most important areas for those studying electrical engineering. This vocabulary is especially needed to accurately communicate the ups and downs of processes when making a presentation using graphs and statistics.

Study the table of **verbs** and related **nouns** used to describe changes. The past form of irregular verbs is given in brackets.

Direction	Verb	Noun
Up	peak	
	reach a peak	
	go up (went up)	
	increase	increase
	rise (rose)	rise
Down	decline	decline
	decrease	decrease
	plummet	
	drop	drop
	fall (fell)	fall
	go down (went down)	
Level	level off	
	remain constant/stable	
	fluctuate	
	recover	

To describe a change more precisely the following **adjectives and adverbs** can be used:

Adjectives: slight; gradual; steady; steep, sharp; sudden; fast.

Adverbs: slightly; gradually; steadily; steeply; sharply; suddenly; fast.

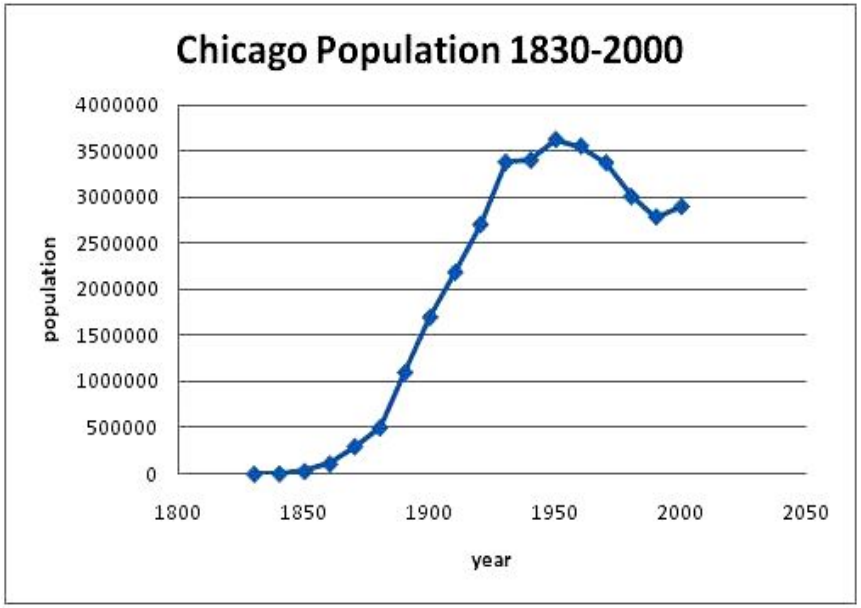
Prepositions used to describe changes.

Study two sentences: Old price of a cup of coffee – 60 p.
New price of a cup of coffee – 70 p.

We can express this change in price in the following ways:

Coffee price increased ***by*** 10 p, or: Coffee price increased ***to*** 70 p; or: There was a price increase (or rise) ***of*** 10 p.

Ex.1. Read the description of the following graph. Pay attention to how the verbs, nouns, adjectives and adverbs are used in the description.



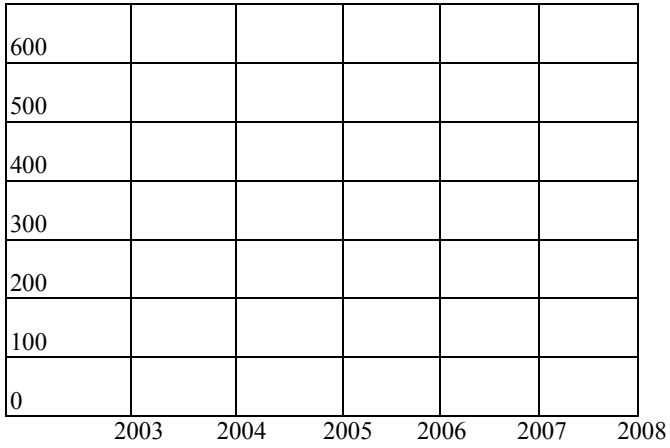
From 1830 to 1950 the population of Chicago **increased significantly**. The population **peaked** in 1950 at approximately 3.6 million people. Between 1950 and

1990 the population **decreased steadily**. Between 1990 and 2000 there was a **slight increase** back to approximately 2.9 million people.

Ex.2. Read the description of changes in sales of two products – AMAT and BMAT – and build up a graph for each product on the axis of coordinates below.

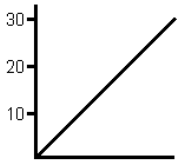
We launched AMAT product in 2002 and in the following three years sales rose steadily to a peak of 550.000 in 2005. The following year it fell fast to 450.000. Then in 2007 it went up again to settle around 500.000. In 2008 it remained constant at the same figure.

BMAT product was launched in 2004. Sales increased sharply in 2005 to reach 250.000 and then rose again by 200.000 in 2006 to reach 450.000. 2007 sales were also good – the end of the year figure went up to 580.000. Then, in 2008 the sales dropped slightly – they were down to 550.000.

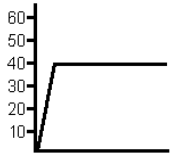


Ex.3. Fill in the gaps with one of the verb from the box in the correct form.

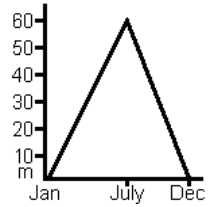
peak; level off; plummet; increase/rise/go up; recover; fluctuate; decrease/drop/fall/go down



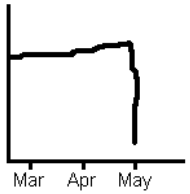
1. Sales … to 30% last month.



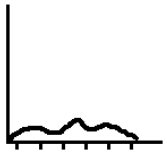
2. Profit … at 40% last year.



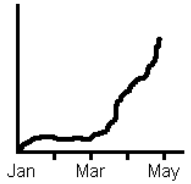
3. Sales … at 60 million and then …



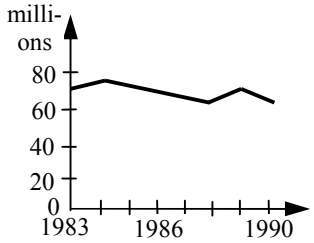
4. Sales of the new product unfortunately … in May.



5. In the last six months, sales….



6. Things looked bad at the beginning of the year, but in March sales began to….



Ex.4. Describe the graph on the left showing the sales of singles in the UK over a seven-year period using the words from the table and descriptions in previous exercises.

Language focus

Present Forms (continuation)

Ex.1. Choose the correct form of the verbs. Remember state verbs can't be used in Continuous forms.

1. Pete (has been knowing, has known) Jane for many years.
2. She says that she (has always loved, has always been loving) the theatre.
3. Shhhhh! Be quiet! The children (are sleeping, have been sleeping).

4. It (is depending, depends) on what the weather (is being, is) like on the weekend.
5. Pierre (has owned, has been owning) that car for over ten years.
6. Don't forget to take your umbrella. It (rains, is raining).
7. Susan (has wanted, has been wanting) to marry Harry ever since she first saw him.
8. I am not sure what the word "serendipity" (is meaning, means).
9. I'm sorry I can't hear what you (say, are saying) because everybody (has talked, is talking) so loudly.
10. He (seems, is seeming) nervous that's why he can't answer such a simple question.
11. I (am believing, believe) that she was just silly when she said that. She didn't mean it.
12. Pete (has been belonging, has belonged) to the club for ten years.
13. I (am liking, like) pizza more than any other type of fast food.
14. Justin (has written, is writing currently) a book about his adventures in Tibet.

Ex.2. Put the verbs in Present Simple or Present Continuous bearing in mind these verbs can be state and dynamic.

1. **have**
   a) She … a bath every evening.
   b) He … a party next weekend.
   c) They … (not) a car.
   d) … you … a good time at the moment?
2. **taste**
   a) My husband …always … the food while I'm cooking! It's very annoying.
   b) This cake … funny.
   c) This coffee … (not) right.
   d) The chef … the soup whether it is spicy or not.
3. **see**
   a) They often … a film on Fridays.
   b) Luke … the doctor now.
   c) I … (not) what you mean.
   d) Ron and Mary … each other now. They have been dating for two weeks.
4. **think**
   a) What … you … about the war?
   b) I … too much about my ex-boyfriend.

   c) I … that I should look for a new job.
   d) Right now they … about buying a new car.
5. **smell**
   a) Why … you … the soup?
   b) The soup … delicious.
   c) The roses … lovely in your garden this summer.
6. **feel**
   a) She … his arm on her shoulder.
   b) I … much better today.
   c) I … we should go home now.
7. **look**
   a) What … you … at?
   b) I … for my grammar book. Do you know where it is?
   c) She … great, he has lost some weight.
   d) It … as if it might rain.

Ex.3. Fill in: has - have been in/to, has - have gone to.

1. 'Where's Stevens? I haven't seen him for days.'
   ' He (1) …. to America to design a new assembly line.'
   'How long (2) ... he … America?' - 'Three days.'
2. 'What about Milton and Knowles?'
   'They (3) … to London. They (4) … some car production plants in Europe and now they are in London to discuss the question of manufacturing the components for these plants.'
3. 'Where is Mark? - 'He (5) … a travel agent's to buy a ticket for the plane and he hasn't come back yet.'

Ex.4. Fill in: already, still, ever, since, just, nowadays, for.

1. The steel industry is … one of the most important fields of application for electric drives.
2. The steel process technology is evolving very quickly ….
3. I have been working as an electrical engineer at a steel plant … about 10 years and the researchers of this plant have … developed many entirely new techniques … then.
4. They have … introduced the family of ultra-fast recovery diodes which offer the best combination of diode operating characteristics which have been … developed.

Ex.5. Compose Wh-questions using the prompts given below. Use the verbs in the appropriate tense form and put the words in the correct word order.

1. How often / you / service / the pump?
2. Why /you / clean water / flush / through this particular pump / of every shift /at the end /?
3. What gaskets / they / on this machine/ replace / yet ?
4. Which gauges / they / recalibrate / now?
5. Which / fail / mechanical and electronic components ?
6. How long /moving parts / he / lubricate / ?
7. When /you / this unit / usually / disconnect /?

Ex.6. Fill in the gaps with the verbs in Present Simple or Present Continuous, Present Perfect or Present Perfect Continuous.

1. 'Who (1) … (be) in charge of the construction project?'

'We (2) … (take on) a civil engineer on a temporary contract. In fact we (3) … (have) a project meeting at 3 p.m. this afternoon to allocate responsibilities. Why (4) … you …(join) us?'

2. 'How (5) ….things … (go)?' - 'Everything (6) … (go) very well. We (7) … just … (finish) laying the cabling and we (8)… (wait) for the safety inspector to give us the go-ahead to continue.'
3. (9) '….. (be) the new control system in operation?'

'Not quite. The engineers (10) … (test) it just now. They (11) … (test) it for three hours.'

'(12) ….you … (train) all the operators on it?'

'Yes, we (13) ... (organize) two training sessions for the whole team this week. The old and the new systems (14) … (operate) in tandem since last week.'

Ex.7. Fill in the gaps with the verbs from the box in the correct tense form (Present Simple or Present Continuous, Present Perfect or Present Perfect Continuous).

consist, drive, flow, result, match, improve, operate, decrease

1. Slow down! You … at the highest possible speed, you can cause an accident.
2. Cycling the pumps on and off for one hour … in too high surges of electrical current to start the motor and now the motor is out of order.
3. Our new cleaning unit … of two tanks for solvents, a pump and a washing unit.

4. Electric generators … steadily … in reliability and … in size for the last few years.
5. Sewage usually … through sewer pipes under the force of gravity to a wet well location but today the pump is used so the sewage … much quicker now.
6. The pump … at the speed much higher its rated speed since the beginning of this shift.
7. The pump operation is very effective now and the outflow … the average inflow so far.

Reading and Speaking

Magnetic materials

All materials have magnetic properties. These characteristic properties may be divided into five groups: 1) diamagnetic; 2) paramagnetic; 3) ferromagnetic; 4) antiferromagnetic; 5) ferrimagnetic.

Only ferromagnetic and ferrimagnetic materials have properties which are useful in practical applications that's why we will speak mainly about them.

Ferromagnetic properties are confined almost entirely to iron, nickel and cobalt and their alloys. The only exceptions are some alloys of manganese and some of the rare earth elements.

Ferrimagnetism is the magnetism of the mixed oxides of the ferromagnetic elements. These are variously called ferrites and garnets. The basic ferrite is magnetite, or Fe_3O_4, which can be written as $FeO{\cdot}Fe_2O_3$. By substituting the FeO with other divalent oxides, a wide range of compounds with useful properties can be produced. The main advantage of these materials is that they have high electrical resistivity which minimizes eddy currents when they are used at high frequencies.

The important parameters in magnetic materials can be defined as follows:

- *permeability* is the flux density B per unit of magnetic field H. It is usual and more convenient to quote the value of relative permeability μ_r, which is $B/\mu_0 H$. Ferromagnetic and ferrimagnetic materials have moderate to high permeabilities. The permeability varies with the applied magnetic field, rising to a maximum at the knee of the B–H curve and reducing to a low value at very high fields. The two important values are the *initial permeability*, which is the slope of the magnetization curve at $H = 0$, and the *maximum permeability*, corresponding to the knee of the magnetization curve.
- *saturation* – when sufficient field is applied to a magnetic material it becomes saturated. Any further increase in the field will not increase the magnetization and any increase in the flux density will be due to the added field.

● *remanence, B_r and coercivity, H_c* are the points on the hysteresis loop at which the field H is zero and the flux density B is zero, respectively. It is assumed that in passing round this loop, the material has been saturated. If this is not the case, an inner loop is traversed with lower values of remanence and coercivity.

These materials also exhibit magnetic hysteresis, where the intensity of magnetization of the material varies according to whether the field is being increased in a positive sense or decreased in a negative sense. When a ferromagnetic material is magnetized in one direction, it will not relax back to zero magnetization when the imposed magnetizing field is removed. It must be driven back to zero by a field in the opposite direction. If an alternating magnetic field is applied to the material, its magnetization will trace out a loop called a hysteresis loop. When the magnetization is cycled continuously around a hysteresis loop, there is an energy loss proportional to the area of the included loop. This is the *hysteresis loss*, and it is measured in joules per cubic metre. High hysteresis loss is associated with permanent magnetic characteristics exhibited by materials commonly termed *hard* magnetic materials, as these often have hard mechanical properties. Those materials with low hysteresis loss are termed *soft* and are difficult to magnetize permanently.

Ferromagnetic or ferrimagnetic properties disappear reversibly if the material is heated above the Curie temperature, at which point it becomes *paramagnetic*, that is effectively non-magnetic.

Ex.1. Match the notions referring to magnetic materials in the box with the definitions (1-12):

permeability, magnetization curve, saturation, initial permeability, maximum permeability, remanence, coercivity, magnetic hysteresis, hysteresis loss, magnetic flux density, magnetic field intensity

1. It corresponds to the knee of the magnetization curve.
2. It is the flux density B per unit of magnetic field H.
3. It is the point on the hysteresis loop at which the flux density B is zero.
4. It is measured in amperes per meter (A/m).
5. It is the phenomenon when the intensity of magnetization of the material varies according to whether the field is being increased in a positive sense or decreased in a negative sense.
6. It is the slope of the magnetization curve at $H = 0$.
7. It is measured in joules per cubic metre.
8. A graphical curve showing the relation between magnetic induction B and magnetizing force H for a magnetic material.

9. It is the state of magnetic material when any further increase in the field will not increase the magnetization.
10. It is measured in Newton-meters per ampere (Nm/A), also called teslas (T).
11. It is the point on the hysteresis loop at which the field H is zero.
12. It varies with the applied magnetic field.

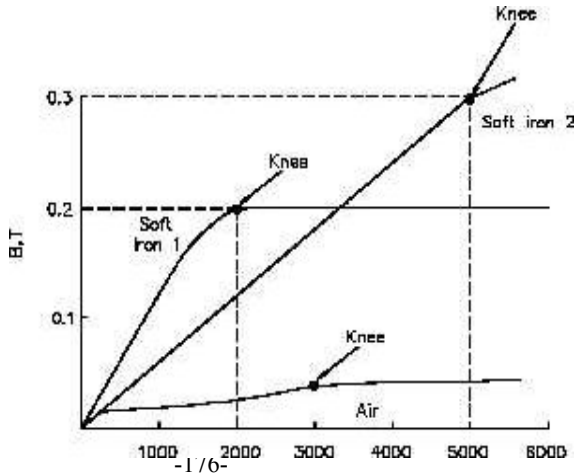
Ex.2. Fill in the columns with the synonyms (1-6) below:

Alternative names for the field *B*	Alternative names for the field *H*

1. Magnetic flux density
2. Magnetizing field
3. Magnetic field
4. Magnetic field intensity
5. Magnetic induction
6. Magnetic field strength

Ex.3. Look at the picture below which shows the *B- H* curves for two types of soft iron cores plotted for typical values. Read the description of the curve for soft iron 1 and continue the descriptions for soft iron 2 and air (which is nonmagnetic) in the similar way.

The curve for soft iron 1 shows that flux density B increases rapidly with an increase in flux intensity H, before the core saturates, or develops a "knee". Thereafter, an increase in flux intensity H has little or no effect on flux density B. Soft iron 2 needs … before it … its saturation level at … .
Air, which is …, …



Ex.4. Complete these notes with the information from the text to make a short summary of the text.

Magnetic properties of the materials may be divided into five groups:

1. diamagnetic
2. …
3. …
4. …
5. …

Only … and … materials have properties which are useful in practical applications. … properties are confined to some metals and … . Ferrimagnetism is …. The main advantage of these materials is … .

The important … in magnetic materials are

1. permeability
2. …
3. …
4. …

Ferromagnetic and ferrimagnetic materials have … to … permeabilities.

These materials also exhibit magnetic …, … loss, which is measured in … . Hard magnetic materials have … hysteresis loss, the materials with low … are termed… and they are … to magnetize permanently.

Ferromagnetic or ferrimagnetic properties disappear… .

UNIT 17. ELECTRICAL MEASUREMENTS (PART 1)

Overview

- Reading and Vocabulary: Voltmeters.
- Information transfer: Understanding and describing pie charts.
- Language focus: Past Forms. Past Simple versus Past Continuous.
- Reading and Speaking: Oscilloscopes.
- Writing: Write a report.

Reading and Vocabulary

Before you read

1. Think of instruments and meters used for measuring physical magnitudes. Make a list of them. Compare it to your partner's one.
2. In class discuss the principles of functioning instruments rely on. Ask your teacher if you need.
3. Have you ever used an instrument to measure voltage, electric current, temperature, etc? If yes, which one and what for.
4. Read the text and find out if your answers in "Before you read" are correct.

Reading

Five sentences have been removed from the text. Choose from the sentences **A-F** (**Ex.1**) the one which fits each gap (**1-5**) in the text. There is one sentence you shouldn't use.

Voltmeters

The measurement of any physical quantity applies a determination of its magnitude in terms of some appropriate unit. It follows, therefore, that before we can measure we must decide upon a system of units which will be convenient for the purpose.

Electrical measurements can be classified broadly as either absolute measurements, or secondary measurements. [1] They are of interest only to the specialist, the very large majority of the measurements made in practice being secondary, or comparison, measurements.

Electrical measuring instruments can be divided into three classes: indicating instruments, recording instruments and integrating instruments.

Indicating instruments are fitted with a pointer which moves over a fixed scale and their characteristic is that they give an immediate indication of the value of the current, voltage or other quantity being measured.

Recoding instruments, or graphers, as they are sometimes called, carry a pencil or pen, which presses on to a travelling ribbon of paper, and thus makes a continuous chart or record of the values measured.

Integrating instruments or electricity supply meters, differ fundamentally from the other two groups, since instead of indicating or recording, these instruments add up the total amount consumed over any given period.

A voltmeter is an instrument used for measuring the electrical potential difference between two points in an electric circuit. [2] Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter. Voltmeters are made in a wide range of styles. Instruments permanently mounted in a panel are used to monitor generators or other fixed apparatus. Portable instruments, usually equipped to also measure current and resistance in the form of a multimeter, are standard test instruments used in electrical and electronics work. Any measurement that can be converted to a voltage can be displayed on a meter that is suitably calibrated; for example, pressure, temperature, flow or level in a chemical process plant.

General purpose analog voltmeters may have an accuracy of a few percent of full scale, and are used with voltages from a fraction of a volt to several thousand volts. [3] Specially calibrated test instruments have higher accuracies, with laboratory instruments capable of measuring to accuracies of a few parts per million. Meters using amplifiers can measure tiny voltages of microvolts or less.

The potentiometer works by balancing the unknown voltage against a known voltage in a bridge circuit. As measurement devices, **potentiometers** are designed in four categories: constant resistance, constant current, thermocouple and microvolt potentiometers. [4] Essentially, a potentiometer uses a known resistance and a sliding contact to determine the voltage of the circuit. A metering device is attached to one end of the circuit, which registers when the sliding contact has reached a level that does not allow current to pass through it (at zero volts). The user then determines the position of the contact, and uses it to calculate the voltage of the circuit.

The constant resistance potentiometer is a variation of the basic idea in which a variable current is fed through a fixed resistor. These are used primarily for measurements in the millivolt and **microvolt range.**

Microvolt potentiometer is a form of the constant resistance potentiometer but designed to minimize the effects of contact resistance and thermal emf. This equipment is satisfactorily used down to readings of 1000 nV or so.

[5] Potentiometers for use with thermocouples also measure the temperature at which the thermocouple wires are connected, so that cold-junction compensation may be applied to correct the apparent measured EMF to the standard cold-junction temperature of 0 degrees C.

Reading comprehension

Ex.1.

A. The first class measurements are rarely undertaken and, generally speaking, are used only for periodic checks upon the accuracy of primary standards.

B. The difference between a voltmeter and ammeter seems to be fundamental.

C. These instruments are used to measure voltage levels in low power circuits.

D. Digital meters can be made with high accuracy, typically better than 1%.

E. Another development of the standard types was the 'thermocouple potentiometer' especially adapted for temperature measurement with thermocouples.

F. The voltmeter works by measuring the current through a fixed resistor, which is proportional to the voltage across the resistor.

Ex.2. Read the statements and mark them true (T) or false (F). Give true statements.

1. A voltmeter is an instrument used for determining the magnitude of voltage.
2. Recording instruments are fitted with a pointer and scale.
3. Before one starts measuring he must consider on the most suitable system of units.
4. Voltmeters are devices which don't have portable models and must be mounted in a panel.
5. A voltmeter can't be used for measuring tiny voltage.
6. A potentiometer is attached to the field circuit to balance the current.
7. The idea in which d.c. current flows through a resistor is the basis of the constant resistance potentiometer.

Ex.3. Complete the sentences below using a maximum of four words.

1. The user fixes the position of the sliding contact to ...
2. The voltmeter works by ..., which is proportional to the voltage across the resistor.
3. ... may have an accuracy of a few percent of full scale.
4. Stationary instruments are used to ...
5. Potentiometers with thermocouples measure the temperature at which ...

Vocabulary

Ex.1. Match the words (1-8) with their definitions (a-h).

1	accuracy	a	the ability of a substance to resist the flow of an electric current
2	amplifier	b	the quality of being accurate
3	electrical potential difference	c	a thin piece of metal that points to a number or direction on a piece of equipment
4	pointer	d	a set of marks with regular spaces between them on a tool for measuring
5	resistance	e	the difference in voltage between two points on an electric circuit
6	resistor	f	a device, consisting of two dissimilar metallic conductors used to
7	scale	g	a piece of electrical equipment that makes sound louder
8	thermocouple	h	a piece of wire or other material used for increasing electrical resistance

Ex.2. Complete the definitions using the information from the text. Learn these definitions by heart.

Indicating instruments are…
Recording instruments are…
Integrating instruments are…

Ex.3. Write synonyms to the following words. Find a word with the similar meaning in the text.

1. main
2. similarity
3. precision
4. indicator
5. unimportant
6. attached
7. change
8. very small
9. put smth right

Ex.4. Complete the following sentences using appropriate preposition or prepositional phrase from the box.

across, in the form of, against, capable of, by use of, through, in a wide range of, over, convenient for

1. The indication is momentary and the values are measured … a meter.
2. The unknown voltage is balanced … a known voltage in a bridge circuit.
3. The maximum voltage sends sufficient current … the correct number of ampere-turns.
4. Voltmeters are made … styles.

5. Graphers provide information … a continuous chart of values measured.
6. The instrument measures the current … a resistor.
7. A pointer moves … a scale.
8. The system to be applied is … the purpose.
9. A new test instrument is equipped by a thing … measuring the heating effect.

Ex.5. Make the collocations Adverbs + Adjectives as they are used in the text.

1	broadly	a	mounted
2	directly	b	different
3	especially	c	classified
4	fundamentally	d	used
5	generally	e	measured
6	permanently	f	speaking
7	primarily	g	adapted
8	rarely	h	undertaken
9	satisfactorily	i	calibrated
10	suitably	j	used

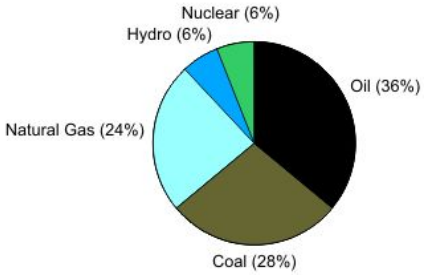
Information transfer

Understanding and describing pie charts

A **pie chart** (sometimes called as a circular graph) is a circular chart divided into sectors, illustrating relative magnitudes or frequencies or percents. Together, the sectors create a full disk. It is named for its resemblance to a pie which has been sliced. A pie chart is an appropriate means of representing percentages of a whole: each part is represented by a slice equal to the proportion of the part. Such a chart is useful to demonstrate overall proportions. Pie charts work particularly well when the slices represent 25 or 50% of the data.

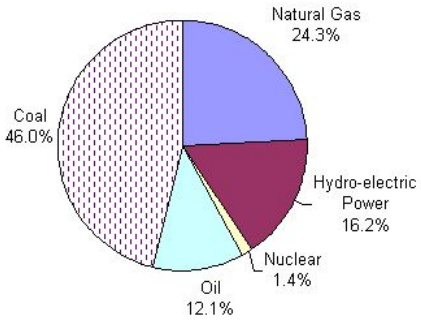
Ex.1. Look at the pie chart below and read the description.

This pie chart shows the percentages of world primary energy consumption by fuel type in 2007. Most of our energy, 36%, came from oil. Our next largest sources of energy are coal and natural gas, that is 28% and 24% respectively. It is interesting to note that renewable energy, which is healthier for the environment and sustainable, accounts for the smallest percent of our consumption, only 12% altogether.



Ex.2. Look at the pie chart below and fill in the gaps in the sentences describing it using the words from the box.

came	comprised	less than	made up	one-eighth	proportion
supplied	three-quarters	accounted for	was	was produced	

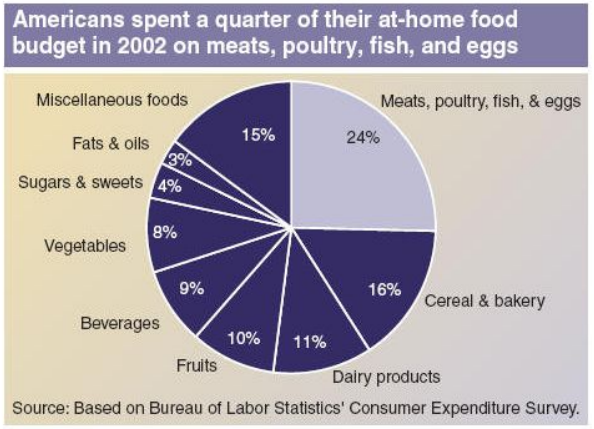


1. In 1970, coal production … 46% of US electricity production.
2. Almost a quarter of US electricity in 1970 … using natural gas.
3. Hydro-electric power stations … just over 16% of US power in 1970.
4. Nuclear power … less than 2% of US electricity supplies in 1970.
5. The main fuel used to generate electricity in 1970 in the US … coal.
6. Almost half of US electricity in 1970 …from coal.
7. About … of US electricity came from oil-fired power stations.
8. Gas and coal provided … of US electricity in 1970.

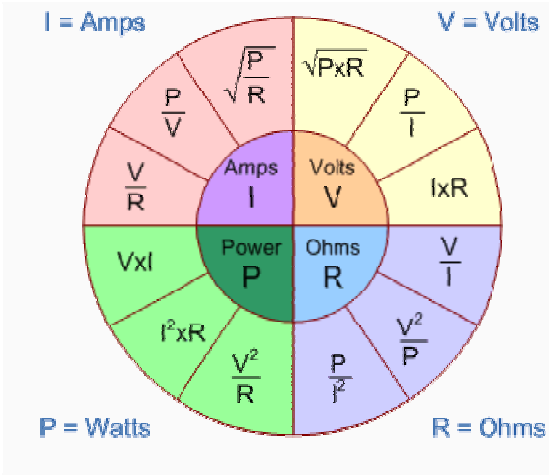
9. Nuclear power contributed a tiny … of US electricity in 1970.
10. Renewable sources of electricity, such as hydroelectric power, made up … 17% of US electricity in 1970.
11. Gas and oil … just over a third of US electric power.

Ex.3. Write the description of the pie chart below using the words from the box.

overall	area of expenditure		percentage of spending		total over
account for	comprise	go on	in conclusion	constitute	add up



Ex.4. Look at the picture and comment on how the equations for finding voltage, current, resistance and power are condensed into a simple Ohms Law pie chart for use in DC circuits and calculations. Give as many examples as possible of pieces of information you can obtain from this chart.



Language focus

Past Forms

Past Simple	Past Continuous	Past Perfect	Past Perfect Continuous
past actions which happened one after the other He arrived from the airport at 8:00, checked into the hotel at 9:00, and met the others at 10:00.	**action in the middle of happening at a stated past time** "What were you doing at 7.30 last night?" - "I was watching television."	**past action which occurred before another past action or before a stated past time** A Dutch physicist Musschenbroek had invented a capacitor named the Leyden jar before Kleist's discovery became widely known.	**action continuing over a period up to a specific time in the past** An Italian scientist Volta had been studying electricity for many years before he showed that it could be made to travel from one place to another by wire.

past habit or state Andre Marie Ampere devoted himself to the study of electricity and magnetism.	**past action in progress interrupted by another past action. The longer action is in the Past Cont., the shorter is in the Past Simple.** While I was fixing the equipment the mixture exploded.	**complete past action with visible results in the past** She was very disappointed because she had failed the test.	**past action of certain duration with visible results in the past** They were wet because they had been walking in the rain.
complete action or event which happened at a stated past time Michael Faraday constructed the first electric dynamo in 1831.	**simultaneous past actions** While I was sunbathing, Tim was swimming.	**it is the past equivalent of the Present Perfect** (He can't find his watch. He has lost it.) He couldn't find his watch. He had lost it.	**it is the past equivalent of the Present Perfect Con.** (She is going to the doctor. Her leg has been aching for two days.) She went to the doctor. Her leg **had been aching** for two days.
action which happened at a definite past time although the time is not mentioned. The action is not connected with the present Faraday used the rotating magnetic field principle to design the motor.	**background description to events in a story** She was flying to Paris. The sun was shining.		

Time expression used with:	
Past Simple	yesterday, last week etc, (how long) ago, then, just now, when, in 2007
Past Continuous	while, when, as
Past Perfect	for, since, already, after, just, never, yet, before, by, by the time etc
Past Perfect Continuous	for, since

Ex.1. Put the verbs in brackets into the Past simple or the Past continuous. Explain why you use this or that tense-form.

A. The sun (1) … *was shining*…(shine) and the birds (2) … (sing) as Mike (3) … (drive) down the country lane. He (4) … (smile), because he (5) … (look forward) to the journey ahead. Mike (6) … (enjoy) driving, especially when he (7) … (go) somewhere new. Then, suddenly, the engine (8) … (begin) to make a strange noise and the car (9) … (stop) dead in the middle of the road. Mike (10) … (try) to start it, but nothing (11) … (happen). He (12) … (sigh), then (13) … (get out) of the car. As he (14) … (push) the car to the side of the road, Mike (15) … (start) to wish he had stayed at home.

B. John (1) … (enter) his flat and (2) … (close) the door. He (3) ... (hang up) his coat when he (4) … (hear) a strange noise. A tap (5) ... (run) in the kitchen. He (6) … (walk) into the kitchen and (7) … (turn) it off. Then, he (8) … (freeze). Someone (9) … (stand) behind him. He (10) … (take) a deep breath and (11) ... (turn) around. His flatmate, Steve, (12) … (lean) in the doorway. 'You (13) … (give) me a fright!' John exclaimed. Steve (14) … (laugh) at him. John (15) … (start) to laugh, too. 'I (16) … (think) you had gone to London today,' he said. 'No, (17) ……. (reply) Steve. 'Unfortunately, I (18) ……. (miss) the train.'

Ex.2. Put the verbs in brackets into the Past simple, the Past continuous or Present continuous. In some sentences, you should put the words in brackets in the right places.

1. Yesterday David …*was crossing* … (cross) a street when a truck …*turned*… (turn) the corner very fast and almost … *hit* … (hit) him.
2. During the study period in class yesterday, it … (be) hard for me to concentrate because the student next to me … (hum).
3. Last Monday while we … (watch, in our living room) an exciting game on television, the electricity … (go) out. So we … (go) outside, … (get) into the car, … (turn) on the radio, and … (listen) to the rest of the game. The next day the car battery … (be) dead.
4. The police … (outwit) a thief yesterday. They … (surround) the jewelry store while he … (stuff, still inside) his pockets with diamonds.
5. Yesterday we had a houseful of children for my son's sixth birthday party. In the middle of the party, the phone … (ring), so I had to leave the children alone for a moment. When I … (come) back into the room, most of the children … (play, still) together nicely. However, over in the corner, Bobby … (pull) Annie's hair. I quickly … (run) over and … (tell) Bobby to stop.
6. TEACHER: You're late again. You were supposed to be here ten minutes ago. Where were you?

   MICHAEL: I … (look) for a place to park.

   TEACHER: … (you, find) one?

   MICHAEL: Yes, but there's a parking meter that has a 15-minute limit. So every 15 minutes I'll have to go out and put some more money in the meter.

   TEACHER: Maybe you should start taking the bus to school.

   MECHAEL: I … (take) the bus a couple of days ago and ended up miles from school. That's why I was absent from class.
7. BOB: My office mate, Jack, really makes me angry!

   SUE: Why?

   BOB: Well for one thing, he … (interrupt, always) me. I can barely get a sentence out of my mouth.

   SUE: Is that all?

   BOB: No. He … (ask, always) me to write his reports for him. I have enough reports of my own without doing his reports too!

   SUE: So how did you and Bob get along at work today?

   BOB: Same old stuff. While I … (try) to explain something to him, he … (interrupt) me, not just once but repeatedly. And once again he … (ask) me to write a report that the boss had asked him to write. I … (refuse).

   SUE: Good for you. Jack needs to write his own reports.

Ex.3. Complete the sentences with the verbs that seem right to you. Put them into the Past simple or the Past continuous.

1. Last Saturday while Sandy … *was cleaning* …out the attic, she … *found* … her grandmother's wedding dress.
2. Two days ago, Peter … all of his money out of the bank and … a new car. Yesterday, while he … to work, he lost control of his steering and … another car. He wasn't hurt, but the accident completely … his new car.

3. Last night we suddenly … up from a sound sleep when we … a noise about 3:00 A.M. I thought it was a burglar, but it was only a cat that … along the window sill.

4. Two days ago I … my friends Ann and Andy at their apartment. They … the dishes when I … . They … quickly, and we all … down and … about old times.

5. When I … to/at the airport, Lisa … for me in the baggage claim area. As soon as she … me, she … her arms and … something. I couldn't hear because the people around me … so much noise.

6. Mary … outside the flowers when it … to rain. So of course, she … off the hose and let nature take care of her garden.

Reading and Speaking

Before you read

1. What do you think the following abbreviations *a CRO, DSO, O – scope* stand for?

2. Think of the different types of electronic test instruments. Talk on their scope. Share the experience of using them in practical work, in case someone has it.

Oscilloscopes

An **oscilloscope** (also known as a **scope**, **CRO**, **DSO** or, an **O-scope**) is a type of electronic test instrument that allows observation of constantly varying signal voltages, usually as a two-dimensional graph of one or more electrical potential differences using the vertical or 'Y' axis, plotted as a function of time, (horizontal or 'x' axis). Although an oscilloscope displays voltage on its vertical axis, any other quantity that can be converted to a voltage can be displayed as well. In most instances, oscilloscopes show events that repeat with either no change, or change slowly.

Oscilloscopes are commonly used to observe the exact wave shape of an electrical signal. In addition to the amplitude of the signal, an oscilloscope can show distortion, the time between two events (such as pulse width, period, or rise time) and relative timing of two related signals.

Oscilloscopes are used in the sciences, medicine, engineering, and telecommunications industry. General-purpose instruments are used for maintenance of electronic equipment and laboratory work. Special-purpose oscilloscopes may be used for such purposes as analyzing an automotive ignition system, or to display the waveform of the heartbeat as an electrocardiogram.

Originally all oscilloscopes used cathode ray tubes as their display element and linear amplifiers for signal processing, (commonly referred to as CROs). The

cathode-ray oscilloscope works by amplifying the voltage and using it to deflect an electron beam from a straight path, so that the deflection of the beam is proportional to the voltage.

However, modern oscilloscopes have LCD or LED screens, fast analog-to-digital converters and digital signal processors. Although not as commonplace, some oscilloscopes used storage CRTs to display single events for a limited time. Oscilloscope peripheral modules for general purpose laptop or desktop personal computers use the computer's display, allowing them to be used as test instruments.

Reading comprehension

Ex.1. Answer the following questions based on the information from the text.

1. What is the principle of the cathode ray oscilloscope work?
2. What physical quantity can be displayed by an oscilloscope?
3. What can we observe with the help of oscilloscopes?
4. Oscilloscopes are used in telecommunication industries. What are further fields of their application?
5. What kind of system may be analyzed by special-purpose oscilloscopes?

Ex.2. Write the meaning of these abbreviations in full.

1. CRO …
2. DSO …
3. LCD …
4. LED …
5. CRT …

Ex.3. Choose the correct answers to complete these sentences.

1. A scope uses amplified voltage ... an electron beam.
   a) to deflect b) to detect c) to dissipate
2. Constantly varying signal voltages are observed as ... of electrical potential differences.
   a) a point image b) a digital display c) a two-dimensional graph
3. An oscilloscope can show ...
   a) distortion b) direction c) damage
4. General – purpose instruments are used for ...
   a) connection of a three-phase load.
   b) maintenance of electronic equipment.
   c) transmission of power.

5. ... were used in all original oscilloscopes as a display element and linear amplifiers.

a) x-ray units b) portable appliances c) cathode ray tubes

6. Modern oscilloscopes have ... screens.

a) light emitting diode b) yellow or red coloured c) conventional

Ex.4. Complete the spaces (1-6) in the paragraph below by choosing the appropriate word, phase or clause from the box. Note there are more choices than spaces, so you will not need to use all of them.

by maintaining a uniform air gap, be measured directly by, electron beam, the flow of power, control, a fixed resistor, be heated up to, double-sag, measuring instruments, by amplifying

Electrical quantities cannot (1) … comparison with a material standard. An electric effect can only be measured by allowing it to act against some known force or (2) …. . So we need electrical (3) … . Some groups of instruments have a lot in common, other differ fundamentally. A voltmeter works, e.g. by measuring the current through (4) … . An oscilloscope works (5) … the voltage and using it to deflect an (6) … from a straight path.

***Speaking**

1. Discuss common and different points about types of instruments appropriate for particular measurement. What type do you prefer, why?
2. Reading between the lines.

What do you understand by the words "absolute measurement", "secondary measurement", "accuracy of primary standards". In groups, compare your ideas.

3. In groups, compare analog and digital voltmeters.
4. Class work. Discuss the principle operation of an oscilloscope and voltmeter.

***Writing**

Write a report "Latest innovations in the field of test instruments". Search for some additional information and introduce it in writing.

UNIT 18. ELECTRICAL MEASUREMENTS (PART 2)

Overview

- Reading and Vocabulary: Ammeters.
- Information transfer: Understanding and describing bar charts.
- Language focus: Past Simple versus Present Perfect.
- Reading and Speaking: Application of ammeters.
- Writing. A report "Electrical measurement today. Methods and equipment."

Reading and Vocabulary

Before you read

1. Remember the instruments you use in a laboratory or practice.
2. Try to explain their use as you have already learned about some of them.

Reading

Ammeters

An **ammeter** is a measuring instrument used to measure the electric current in a circuit. Instruments used to measure smaller currents, in the milliampere or microampere range, are designated as *milliammeters* or *microammeters*. Early ammeters were laboratory instruments which relied on the Earth's magnetic field for operation. By the late 19th century, improved instruments were designed which could be mounted in any position and allowed accurate measurements in electric power systems.

Types of ammeters.

1. The D'Arsonval galvanometer is this type of ammeters. It uses magnetic deflection, where current passing through a coil causes the coil to move in a magnetic field. The modern form of this instrument uses two spiral springs to provide the restoring force. By maintaining a uniform air gap between the iron core of the instrument and the poles of its permanent magnet, the instrument has good linearity and accuracy. Basic meter movements can have full-scale deflection for currents from about 25 microamperes to 10 milliamperes and have linear scales.

2. Ammeters of this type use a piece of iron which moves when acted upon by the electromagnetic force of a fixed coil of wire. This meter responds to both direct and alternating currents (as opposed to the moving coil ammeter, which works on direct current only). The iron element consists of a moving vane attached to a pointer, and a fixed vane, surrounded by a coil. As alternating or direct current flows through the coil and induces a magnetic field in both vanes, the vanes repel

each other and the moving vane deflects against the restoring force provided by fine helical springs. The non-linear scale of these meters makes them unpopular.

3. In such types of ammeters, there is electrodynamic movement which uses an electromagnet instead of the permanent magnet of the d'Arsonval movement. This instrument can respond to both alternating and direct current.

4. In these ammeters, a current passes through a wire which expands as it heats. Although these instruments have slow response time and low accuracy, they were sometimes used in measuring radio-frequency current.

5. Ammeters of these types do not have any moving part. They use an analog to digital converter (ADC) to measure the voltage across the shunt resistor; the digital display is calibrated to read the current through the shunt.

6. There is also a whole range of devices referred to as this type. In these ammeters the amount of current is summed over time giving as a result the product of current and time, which is proportional to the energy transferred with that current. These can be used for energy meters (watt-hour meters) or for estimating the charge of battery or capacitor.

7. This ammeter measures very low electrical current, usually from the picoampere range at the lower end to the milliampere range at the upper end. They are used for sensitive measurements where the current being measured is below the theoretical limits of sensitivity of other devices, such as Multimeters. Most ammeters of this type use a "virtual short" technique and have several different measurement ranges that must be switched between to cover multiple decades of measurement. Other modern ammeters use log compression and a "current sink" method that eliminates range switching and associated voltage spikes.

Reading comprehension

Ex.1. Scan the text and choose the suitable heading from this list for each paragraph of the text. These are types of ammeters. Note that there is one extra.

A. Picoammeters	E. Digital ammeters
B. Moving iron	F.Induction
C. Moving coil	G. Hot wire
D. Electrodynamic meters	H. Integrating ammeters

Ex.2. Read the statements and mark them true (T) or false (F). Give true statements.

1. In their operation modern ammeters rely on the Earth's magnetic field.
2. A D'Arsonval galvanometer uses magnetic deflection thus preventing coil movement.
3. Moving iron instruments are only usable on d.c.

4. An electrodynamic meter can respond to both a.c. and d.c.
5. In integrating ammeters the amount of current is pointed on a scale.
6. Hot wire ammeters are common for radiofrequency current measuring as they are rather precise.
7. A digital ammeter uses ADC.

Ex.3. Find information in the text to complete the sentences. Use a maximum of four words.

1. Instruments which are used to measure small currents are called ... .
2. Modern galvanometer uses ... to provide the restoring force.
3. The iron element consists of a ... and a ... .
4. The digital display is calibrated to ... .
5. In integrating ammeters the amount of current ... resulting in the product of current and time.
6. Most picoammeters use ... .

Ex.4. Work in pairs. Answer the following questions.

1. What had changed about ammeters by the late 19th century?
2. What features do electrodynamic and d'Arsonval movements rely on?
3. What makes moving-iron ammeters unpopular?
4. Where are picoammeters used?
5. What is the method of some modern picoammeters functioning?

Vocabulary

Ex.1. Find the words and phrases in the text which mean the following.

1. a piece of wire used in a circuit to control current diverting to a different direction.
2. a piece of equipment that changes numerical quantities in terms of physical variables into the form of characters or digits.
3. a strength that is capable of bringing smth back.
4. the degree to which the moving part on a measuring instrument moves away from zero.
5. a piece of equipment able to respond to a very slight stimulus.
6. a sudden large increase in a rate of some physical variable.
7. a process of making data more concise.
8. a space between two parts.
9. a twisted piece of metal that returns to its shape after it has been pressed down.

Ex.2. Give the antonyms to the adjectives given below. Find them in the text. Use a dictionary if you need.

1. insensitive
2. different
3. unpopular
4. exclusive
5. high
6. big
7. late
8. inaccurate
9. out of date
10. varied
11. diversified
12. temporary
13. fast
14. segregating
15. disproportionate
16. lower

Ex.3. Fill in the correct preposition, then make your own sentences using the completed phrases.

1. to respond ...;
2. to be proportional ... the energy;
3. to be used ... energy meters;
4. to rely ...;
5. to be acted ... by the electromagnetic force;
6. to consist ...;
7. to read the current ... the shunt;
8. to be summed ... time;
9. ... the lower / upper end;
10. devices referred ... as ammeters.

Ex.4. Make word partnerships as they are used in the text.

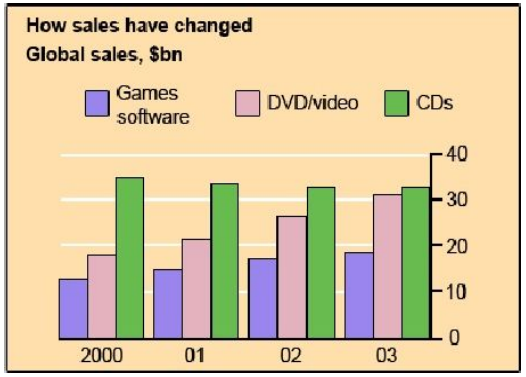
1	accurate	a	force
2	air	b	scale
3	digital	c	measurement
4	electrodynamic	d	resistor
5	electromagnetic	e	gap
6	linear	f	vane
7	magnetic	g	spring
8	moving	h	deflection
9	shunt	i	movement
10	spiral	j	display

Information transfer

Understanding and describing bar charts

A **bar chart** or **bar graph** is a chart with rectangular bars with lengths proportional to the values that they represent. The bars can be plotted vertically or horizontally. Bar charts are used for plotting discrete (or 'discontinuous') data i.e. data which has discrete values and is not continuous. A bar graph is used to compare the amounts or frequency of occurrence of different characteristics of data and to make generalizations about the data quickly.

Ex.1. Look at the bar chart below and read the description. Pay attention how to describe this type of graph.



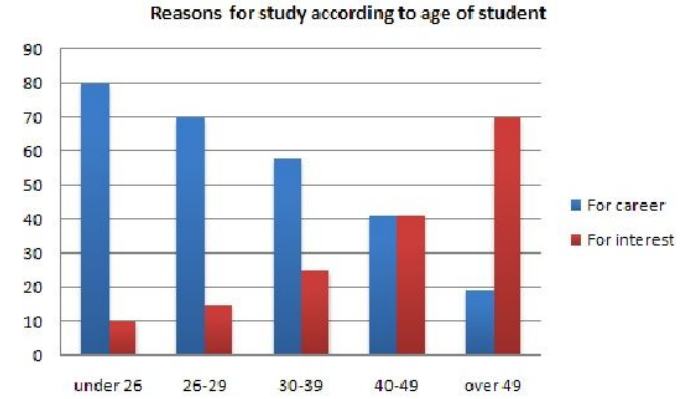
The chart shows the changes in the sales of video material DVDs, games software and CDs around the world in billions of dollars over a three-year period. It can be seen that the sales of videos/DVDs and games software have increased, while the sales of CDs have gone down slightly.

Between 2000 and 2003, the sale of videos and DVDs rose by approximately 13 billion dollars. In 2000, just under 20 billion dollars worth of these items were sold, but in 2003, this figure had risen to a little over 30 billion dollars.

The sales of games software also rose during this period, but less sharply. Sales increased from about 13 billion dollars in 2000 to just under 20 billion dollars three years later. By contrast, during the same time period, the sale of CDs fell from 35 billion dollars in 2000 to about 32.5 billion dollars in 2003.

Ex.2. The chart below shows the main reasons for study among students of different age groups. Summarize the information by selecting and reporting the main features, and make comparisons where relevant. Use the words from the box.

gradual decrease in percentage gradually decline by increase with percentage increase slowly in comparison to



Ex.3. Study the bar charts below and answer the questions.

A.

1. According to the graph, how much money did Toby spend on movies and games?

a) $20 b) $25 c) $30

2. Which student spent the most on food and snacks?

a) Amy b) Dan c) Toby

3. What is the total amount that Amy spent?

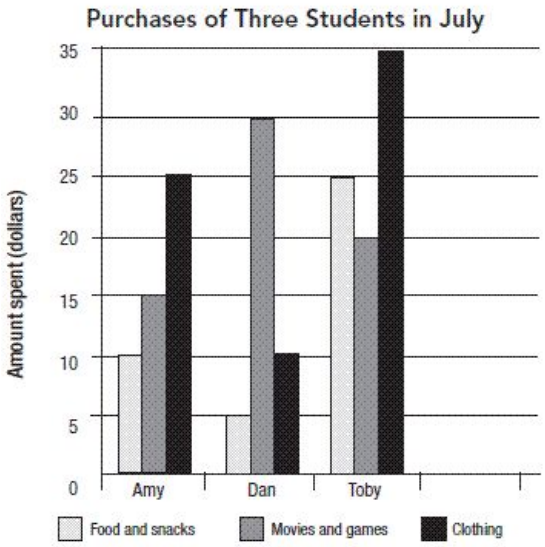
a) $45 b) $50 c) $65

4. How much did all three students spend on clothing?

a) $70 b) $80 c) $85

5. What did Dan spend the majority of his money on?

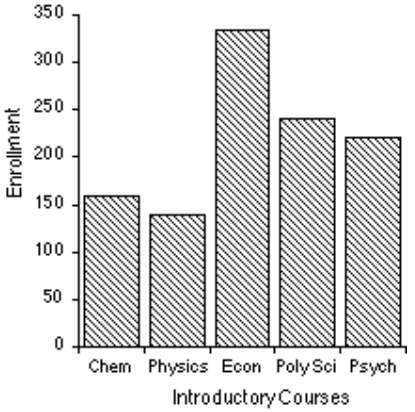
a) food and snacks b) movies and games c) clothing



B.

1. Which course has the most students enrolled in it?
2. Order the courses by enrollment from lowest to highest.
3. The enrollment in Economics is approximately how many times bigger than the enrollment in Chemistry?
4. Approximately how many students were enrolled in the course with the most students?
5. Approximately how many more students are in Economics than in Physics?

Enrollment in Introductory Courses at Union University



Language focus

Past Simple versus Present Perfect

Past Simple	Present Perfect
complete action which happened at a *stated* time in the past She **left yesterday.** (When did she leave? **Yesterday**.)	**complete action which happened at an unstated time in the past** Don **has left** for Madrid. (We don't know when he left; unstated time; he's now there or on his way there.)
past action which is *not connected with the present* and happened at a definite past time not mentioned I **met** John Lennon. (I won't meet him again; he's dead. – period of time finished.)	**past action which is *connected with the present* and happened at a definite past time not mentioned** **I've spoken** to Richard Gere. (I may speak to him again. – period of time not finished yet.)
to give details of the news He **announced** the decision to Parliament this morning.	**to announced news or give new information** The Prime Minister **has decided** to call a general election.

Ex.1. Complete the sentences with Past Simple or Present Perfect of the verbs in brackets.

1. I ...*knew*...Tim when he was a child, but I haven't seen him for many years. I … *have known*... Larry, my best friend, for more than 20 years. (know)
2. The company and the union finally … on salary raises two days ago. Since then, they … on everything, and the rest of the negotiations have gone smoothly. (agree)
3. Mark … a trip to Asia last October. He … many trips to Asia since he started his own import-export business. (take)
4. Ivan … the violin with the London Symphony since 1990. Last year he … Beethoven's violin concerto at one of the concerts. (play)
5. When she was in college, Julia … home at least once a week. Now she has a job and is living in Chicago. In the last six months she … only three letters to her parents. (write)
6. Our university … 121 students to study on other countries last year. In total, we … 864 students abroad over the last ten years. (send)
7. Masaru is a pilot for JAL. He … nearly 8 million miles during the last 22 years. Last year, he … 380,000 miles. (fly)
8. Mark missed his physics examination this morning because he … . He … a lot since the beginning of the semester. He'd better buy a new alarm clock. (oversleep)

Ex.2. Put the verbs in brackets into Past Simple or Present Perfect.

Dear Tom,

Thank you for your letter. It 1) ..***arrived.***. (arrive) yesterday and I 2) … (decide) to write back immediately. You see, my agent 3) … (find) me a part in a new film and I'm going to Hollywood next week! I 4) … (speak) to Robert Redford on the phone about the part and I'm meeting him as soon as I arrive. The film is a re-make of a 1956 thriller which I 5) … (see) hundreds of times. It starred Marilyn Monroe who, as you know, I 6) … (meet) when I was a little girl. Yesterday I 7) … (buy) lots of new clothes and I 8) … (already/start) packing. Well, I must rush now. There's so much to do!

Love,

Sharon.

Ex.3. Fill in with Past Simple or Present Perfect.

1. A: ..***Have you been***… (you/be) on holiday this year?

B: No, I … (can/not) go, because I … (break) my leg in August and …. (have) to stay in hospital.

2. A: … (you/visit) the National Museum yet?
   B: Yes, I … (be) there three times, but I … (not/see) everything yet.
3. A: I'm ever so sorry, Jim, but I … (burn) your dinner. Maria … (phone) and I ... (forget) about the food.
   B: That's okay. I … (already/eat).
4. A: I … (buy) a new dress yesterday, but when I … (arrive) home, I … (find) a hole in the seam.
   B: What … (you/do)? … (you/take) it back to the shop?
   A: No, I … (not/be) into town yet. I'll do it this afternoon.
5. A: Your hair … (grow) a lot since I last … (see) you.
   B: Yes. I … (want) to get it cut yesterday but I … (be) too busy.
6. A: I … (never/fly) before and I'm very nervous about it.
   B: I … (feel) like that the first time I … (fly), but I thoroughly … (enjoy) it.
7. A: I … (lose) my glasses. … (you/see) them anywhere?
   B: No. Where … (you/put) them?
   A: I … (put) them on the table a minute ago, but they're not there now.
8. A: … (you/ever/meet) anyone famous?
   B: Yes, I … (speak) to Paul McCarthey and I … (see) John Lennon before he was killed.
9. A: Where … (you/go) on holiday?
   B: To Rhodes. … (you/be) there?
   A: Yes, I … (go) there last year. We … (swim) every day. It was great!
10. A: How's your job, Mike?
    B: I … (just/start) a new one. I … (leave) the old one because they … (not/pay) me enough money.
11. A: When … (you/leave) school?
    B: I … (leave) in 1980, I … (finish) university in 1984 and I … (have) three jobs since then.
12. A: … (you/see) "Barabas" on TV last night?
    B: No I … (see) it so many times already that I … (not/want) to watch it again.

Reading and Speaking

Before you read

In pairs, think of the situation when you need an ammeter. Make a list of examples of their possible use and compare it to the other's. Find one the most complete and including the most unusual application.

Application of ammeters

The majority of ammeters are either connected in series with the circuit carrying the current to be measured (for small fractional amperes), or have their shunt resistors connected similarly in series. **[1] They** must not be connected to a source of voltage; they are designed for minimal burden, which refers to the voltage drop across the ammeter, which is typically a small fraction of a volt. They are almost a short circuit.

Ordinary Weston-type meter movements can measure only milliamperes at most, because the springs and practical coils can carry only limited currents. To measure larger currents, a resistor called a shunt is placed in parallel with the meter. The resistances of shunts are in the integer to fractional milliohm range. **[2] This** allows the meter to measure large currents. Traditionally, the meter used with a shunt has a full-scale deflection (FSD) of 50 mV, so shunts are typically designed to produce a voltage drop of 50 mV when carrying **their** full rated current.

Zero-center ammeters are used for applications requiring current to be measured with both polarities, common in scientific and industrial equipment. Zero-center ammeters are also commonly placed in series with a battery. In **this** application, the charging of the battery deflects the needle to one side of the scale (commonly, the right side) and the discharging of the battery deflects the needle to the other side. A special type of zero-center ammeter for testing high currents in cars and trucks has a pivoted bar magnet that moves the pointer, and a fixed bar magnet to keep the pointer centered with no current. **[3]**

Since the ammeter shunt has a very low resistance, mistakenly wiring the ammeter in parallel with a voltage source will cause a short circuit, at best blowing a fuse, possibly damaging the instrument and wiring, and exposing an observer to injury.

In AC circuits, a current transformer converts the magnetic field around a conductor into a small AC current, typically either 1 A or 5 A at full rated current, **that** can be easily read by a meter. **[4]** A portable hand-held clamp-on ammeter is a common tool for maintenance of industrial and commercial electrical equipment, which is temporarily clipped over a wire to measure current. Some recent types have a parallel pair of magnetically-soft probes that are placed on either side of the conductor.

Reading comprehension

Ex.1. Read the text. Choose from sentences A-E one which fits each gap (1-4) in the text. One sentence does not fit anywhere.

A. Nearly all of the current flows through the shunt and only a small fraction flows through the meter.

B. In a similar way, accurate AC/DC non-contact ammeters have been constructed using Hall effect magnetic field sensors.

C. In either case, the current passes through the meter or (mostly) through its shunt.

D. The voltage derived from the phase-shifter is constant in magnitude.

E. The magnetic field around the wire carrying current to be measured deflects the moving magnet.

Ex.2. Answer the questions using the information from the text.

1. How are ammeters connected to a circuit?
2. What type of meters is used to measure small currents? Why?
3. What kind of device is applied to measure larger currents?
4. What is a current flow in the circuit with a shunt resistor?
5. What is the designated purpose of the shunt?
6. What applications are required in scientific and industrial equipment?
7. What is the needle position influenced by?
8. What does a zero-centre ammeter have for testing currents in automobiles? Why?
9. What events can a short circuit cause?
10. What does a current transformer do?

Ex.3. Choose the correct answer to complete these sentences.

1. The majority of ammeters have ...
   a) a power-factor relay b) a shunt resistor c) a rotary shaft
2. Ammeters are designed for ... , which refers to the voltage drop across the ammeter.
   a) minimal burden b) zero potential c) peak-point load
3. A resistor to measure large currents is placed ...
   a) in series with the battery b) in parallel with the meter
   c) over a wire
4. Zero-centre ammeters are used to measure current ...
   a) with both polarities b) with a succession of half-waves
   c) with neutral polarity

5. A special type of zero-centre ammeter has ...
   a) beam-positioning magnet b) energy-analyzing magnet
   c) pivoted-bar magnet
6. The ammeter wired in parallel with a voltage source will cause a short circuit because ...
   a) the ammeter has different values of voltage and current
   b) the no-load current has a reactive component
   c) the ammeter shunt has a very low resistance

Ex.4. What do the words in bold refer to in the text? They are in bold in the text as well.

1. **They** must not be connected to ...
2. **This** allows the meter to measure ...
3. ... when carrying **their** full-rated current
4. In **this** application, the charging of the battery ...
5. … **that** can be easily read by a meter

***Speaking**

Ex.1. Comment on the following phrases from the text "Ammeters":

a "virtual short" technique
a "current sink" method

Prove you understand the essential point of these methods. Try to be convincing. Support your ideas giving examples.

***Ex.2. Try to find some information about the origin of the following type names: Weston-type meter; Hall effect magnetic field sensor.** If these are people, find out as much as possible about them and, of course, the reason why the devices are called after them. Introduce the information in class**.**

***Ex.3. Role-play. Prepare cards with the description of ammeter types and cards where students have only names of ammeter types.** Play it like a traditional forfeit card play. You take any card from those offered by your partner and guess the particular type described in it. In case you choose a card with a type name, you have to describe this particular type. Give points and choose a winner. Try to make it easy and fun.

***Writing**

Write a report "Electrical measurement today. Methods and equipment."

UNIT 19. ENERGY AND ITS SOURCES

Overview

- Reading and Vocabulary: Energy.
- Language focus: Past Forms (continuation). Past Simple, Past Perfect, Past Perfect Continuous. Linking words for giving examples.
- Reading and Speaking: Traditional sources of energy.

Reading and Vocabulary

Reading

Four sentences have been removed from the text. Choose from the sentences **A-E** (**Ex.1**) the one which fits each gap (**1-4**) in the text. There is one sentence you shouldn't use.

Energy

1. In the language of science, energy is the ability to do work. There are various forms of energy. We distinguish heat energy where motion or rise in temperature is caused by heat like a fire in your fireplace; mechanical energy, that is the energy of motion; chemical energy that is the chemical reaction causing changes, food and fuel both store chemical energy; electrical energy when motion, light or heat is produced by an electrical current like the electric coils on your stove; gravitational energy where motion, like water going over a dam, is caused by gravity's pull. One might also mention the two kinds of mechanical energy – potential and kinetic, potential energy being the energy of position while kinetic energy is the energy of motion.

2. It is well known that one form of energy can be changed into another. [1] Water falling from its raised position, energy changes from potential to kinetic energy. The energy of falling water is generally used to turn the turbines of hydroelectric stations. The turbines in their turn drive the electric generators, the latter producing electric energy. Thus, the mechanical energy of falling water is turned into electric energy. The electric energy, in its turn, may be transformed into any other necessary forms. [2] Thus, in the above-mentioned example when water is falling from its raised position, it certainly loses its potential energy, that energy changing into kinetic energy.

3. The rising standards of modern civilization and growing industrial application of the electric current result in an increasing need of energy. [3] We need it to do a lot of useful things that are done by electricity. However, the energy resources of the world are decreasing while the energy needs of the world are increasing. These needs will continue to grow as more motors and melted metals are used in industry and more electric current is employed in everyday life.

4. We use many different energy sources to do work for us but they all can be classified into two groups – renewable and nonrenewable. Most of the energy we use comes from fossil fuels, such as coal, natural gas and oil. These energy sources are called nonrenewable because their supplies are limited. Once these natural resources are used up, they are gone forever. Oil, for example, was formed millions of years ago from the remains of ancient sea plants and animals. We can't make more oil in a short time. [4] Uranium is converted to a fuel and used in nuclear power plants.

5. Renewable energy sources include biomass, geothermal energy, hydropower, solar energy, and wind energy. They are called renewable energy sources because they are replenished in a short time so they can be used over and over again. We use renewable energy sources mainly to make electricity. In 2008, about 19% of global final energy consumption came from renewable energy sources. They generate much less pollution, both in gathering and in production, than nonrenewable sources.

6. Electricity is different from the other energy sources because it is a secondary source of energy. We have to use another energy source to make electricity. The sources of energy usually employed to produce current are either chemical, as in the battery, or mechanical, as in the electromagnetic generator. Chemical sources of current have a limited application; so the great quantities of electric energy generated today come from various forms of mechanical energy.

Reading comprehension

Ex.1.

A. More energy may be obtained from the nuclear reactions.
B. Uranium is another nonrenewable source, but it is not a fossil fuel.
C. Every year we need more and more energy.
D. When an object loses its potential energy, that energy is turned into kinetic energy.
E. A waterfall may serve as an example.

Ex.2. Give short answers to the following questions.

1. Are there various forms of energy?
2. Can one form of energy be changed into another form?
3. Does a generator produce mechanical energy?
4. Can the energy of falling water be used to drive turbines?
5. Is potential energy the energy of motion?
6. Is kinetic energy the energy of position?
7. Do we need more and more electric energy every year?
8. Do you use electric energy every day?

9. What sources of energy do you know?

Ex.3. Choose the correct continuation of the following sentences.

1. The motor changes electrical energy into
   a) heat energy b) chemical energy c) mechanical energy
2. The generator changes mechanical energy into
   a) chemical energy b) electrical energy c) light energy
3. The battery changes chemical energy into
   a) solar energy b) heat energy c) electric energy
4. The electric furnace changes electric energy into
   a) heat energy b) chemical energy c) mechanical energy
5. The vacuum cleaner changes electrical energy into
   a) light energy b) mechanical energy c) solar energy

Ex.4. Point out which of the sentences contains the information from the text.

1. Energy comes in many forms, kinetic, potential, heat, mechanical, etc.
2. It is quite possible that some day coal and other fuels will be replaced by atomic energy.
3. Solar stations will produce cheap electric energy in the near future.
4. Waterfall is the example of a situation in which the total energy is fixed and there is a continuous transformation from potential energy to kinetic energy.
5. The experiments on atmospheric electricity were made by many outstanding scientists.
6. Renewable energy involves natural phenomena such as sunlight, wind, tides, plant growth, and geothermal heat.

Vocabulary

Ex.1. Match the words (1-11) with the words (a-j) to form collocations as they are used in the text. Then match the words (1-11) with their antonyms (k - v).

1	continue	a	in temperature	k	kinetic
2	falling	b	energy	l	lead to
3	increasing	c	potential energy	m	fall in
4	industrial	d	forms of energy	n	acquire
5	be caused by	e	to grow	o	rising
6	limited	f	things	p	same
7	lose its	g	heat	q	useless
8	potential	h	need of energy	r	domestic
9	rise	i	application	s	stop

10	useful	j	water	t	decreasing
11	various			v	wide

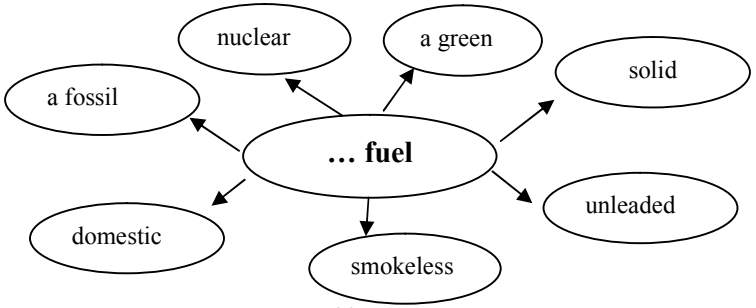
Ex.2. Form sentences using the following expressions. Pay attention to the prepositions used in the expressions.

1. to play a part in
2. to go on foot
3. to do without
4. to make use of
5. to be familiar with
6. to contribute to
7. to flow like water
8. in their turn
9. come from
10. be used up
11. go forever

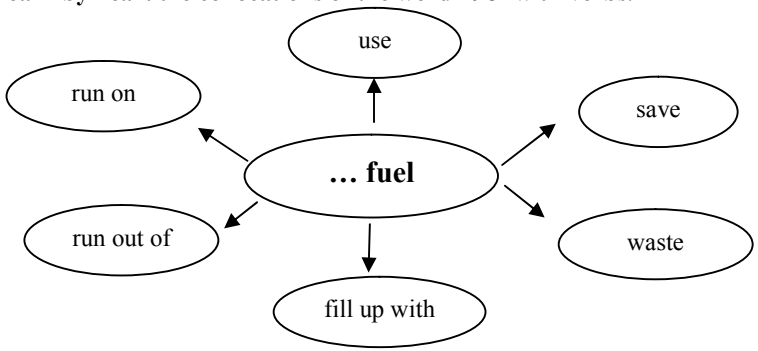
Ex.3. Translate the following groups of words into English. Use them in your own sentences.

1. в повседневной жизни
2. промышленное применение
3. важное применение
4. преобразовывать механическую энергию в…
5. постоянный ток
6. в результате
7. благодаря электричеству
8. вызывать изменения
9. вырабатывать электричество
10. химические источники тока
11. ископаемые виды топлива
12. загрязнять окружающую среду
13. потребление энергии

Ex.4. Learn by heart the collocations of the word fuel with adjectives. Compose your own sentences with them.



Ex.5. Learn by heart the collocations of the word fuel with verbs.



Ex.6. Use collocations from Ex. 4 and 5 to fill in the gaps in the sentences below.

1. Global warming may be caused by burning … fuels.
2. … fuel, also known as biofuel, is a type of fuel distilled from plants and animal materials.
3. … fuel means fuel which does not produce visible smoke when burned.
4. The use of some … fuels (eg. coal) is restricted or prohibited in some urban areas, due to unsafe levels of toxic emissions.
5. Will this engine … unleaded fuel?
6. We advise motorists to … on the cheap days, not only to save money for the household budget but also to support the petrol stations offering the cheapest rates.
7. Proper care and maintenance of your vehicle can … up to 20% in … .
8. On 23 July 1983, Air Canada Flight 143, a Boeing 767-200 jet, … at 7,920 m altitude, about halfway through its flight from Montreal to Edmonton.

Language focus

Past Forms (continuation)

Ex.1. Fill in Past Simple or Past Perfect then state which action happened first.

1. After Thomas Brown … (discover) that certain dielectrics … (perform) better when charged up at a slower rate of oscillation he … (patent) this idea.
2. The scientists … (devise) a new term “elastic stress” only after they … (discover) the property of dielectrics to absorb unusually large quantities of charge.

3. Benjamin Franklin … (investigate) the Leyden jar and … (prove) that the glass … (store) the electric charge but not the water as others … (assume) before that.

4. Some decades … (pass) before the scientists in the nineteenth century … (realize) that an electric motor was an electric dynamo run in reverse.

5. After the Newcomen engine … (be) in service for a time, the people … (discover) that the valves that … (control) the steam could be automated.

Ex.2. Fill in Past Simple, Past Perfect or Past Perfect Continuous.

I'm sorry I (1) … (leave) without you last night, but I told you to meet me early because the show started at 8:00. I (2) … (try) to get tickets for that play for months, and I (3) … (not want) to miss it. By the time I finally left the coffee shop where we were supposed to meet, I (4) … (have) five cups of coffee and I (5) … (wait) over an hour. I (6) … (have) to leave because I (7) … (arrange) to meet Kathy in front of the theater.

When I (8) … (arrive) at the theater, Kathy (9) … (pick, already) the tickets and she was waiting for us near the entrance. She (10) … (be) really angry because she (11) … (wait) for more than half an hour. She said she (12) … (give, almost) and (13) … (go) into the theater without us.

Kathy told me you (14) … (be) late several times in the past and that she would not make plans with you again in the future. She mentioned that she (15) … (miss) several movies because of your late arrivals. I think you owe her an apology. And in the future, I suggest you be on time!

Ex.3. Choose the correct item. Identify the tense form and explain its usage.

1. Scarcely ..... out of the window when I saw a flash of light.
   a) had I looked c) had I been looking
   b) I was looking d) was I looking
2. It wasn't raining when I looked out of the window; the sun was shining. But it ..... earlier. That's why the ground was wet.
   a) Rained c) had rained
   b) was raining d) had been raining
3. She was not interested in the book because she ..... it.
   a) hadn't understood c) wasn't understanding
   b) didn't understand d) hadn't been understanding
4. I got lost in the forest because I took the road I ..... before.
   a) didn't never take c) had never taken
   b) never took d) didn't take

5. He ..... ill for three days, so his mother wanted to bring him to a doctor, but he didn't want to go.
   a) had felt c) had been feeling
   b) felt d) was feeling
6. Her face was stained with tears and her eyes were red. She ..... .
   a) cried c) had been crying
   b) was crying d) had cried
7. We ..... TV for ten minutes when the electricity went off
   a) watched c) had watched
   b) were watching d) had been watching
8. He had been away for many years and when he visited his native town, he saw that it ..... greatly.
   a) changed c) had been changing
   b) was changing d) had changed

Ex.4. Circle the correct form of the verbs in parentheses. Remember state verbs can't be used in continuous forms.

1. While Frank (was, was being) in Florida, he met his ex-wife.
2. We (were having, had) lunch on the picnic table in the backyard when the rain started.
3. The thief looked into his rear-view mirror and (was realizing, realized) that he (was being, was) followed by a police car.
4. They (had had, had been having) that house for thirty years when they sold it.
5. Lionel (was being, was) crazy as a teenager.
6. She (was seeing, saw) a tall, dark-haired man outside in the garden.
7. At the airport I (was recognizing, recognized) the man I had to pick up from the photo the company had given me.

Ex.5. Form sentences using the words given below.

1. the project, done, research, We, a lot of, we, started, before, had.
2. electricity, had been, 40 years, before, practical DC, built, a really, studying, generator, Thomas Edison, he, in the 1880s, for nearly.
3. circuit, teaching, George Simon Ohm, was, at college, published, when, his work, he, the galvanic, in Cologne, about.
4. last night, watching, When, called, I, my favourite, was, show on television, Carol.

Ex.6. Put all the possible questions to the following sentences.

1. Russian scientists contributed greatly to the science of electricity.
2. Before we parked our car, we had collected the ticket.

Linking words for giving examples

Paragraphs 4, 5 and 6 in the text "Energy" classify sources of energy. There are sentences like this: "We use many different energy sources to do work for us but they all can be classified into two groups – renewable and nonrenewable". We can support a classifying sentence by giving an example: "Fossil fuels, like coal, natural gas and oil are called nonrenewable energy sources because their supplies are limited".

The following linking words are used **to give examples:**
such as, like, for example, for instance, especially, in particular.

- **Such as** is used especially in written English when giving one or two typical examples when there are many others: It is difficult to get even basic foods such as bread and sugar.
- **For instance** is slightly less formal than **for example** and is used in more spoken English: Some people are good at languages. Take Katie, for instance.
- In written English people usually use **for example, for instance** or **such as** rather than **like.**

Ex.7. Look through the text "Energy" and find the linking words used for giving examples.

Ex.8. Fill in the gaps with the correct linking word from the box. Some of them cab be used twice.

for example	like	in particular	for instance	such as	especially

1. The speaker talked about magnetic materials in general and about ferromagnets ….
2. Solar furnaces illustrate just one of the numerous ways to harness the sun. Using semiconductors, scientists, … , have transformed solar energy into electric energy.
3. … , when we are cold, we can jump up and down to get warmer.
4. Some cold walls, … in old houses with solid walls, draw atmospheric moisture to them, rather as windows do.
5. Large electrical goods … television sets and washing machines are widely used in everyday life.

6. Things … glass, paper and plastic can all be recycled.
7. Try to avoid fatty foods … cakes and biscuits.

Reading and Speaking

Reading

Ex.1. Look at the headline and the introduction to the text below. Write several questions you would like to know the answers to after reading the text.

Traditional sources of energy

Energy is required to run a large number of things, from homes to cars to electronics. While new energy sources are being sought after at a **steady rate**, there still remain several more traditional sources of energy. These traditional energy sources are well-established energy sources that are used the world over to make civilization **run smoothly.**

1. Coal is a non-renewable fossil fuel that supplies electrical power to power systems. Coal was created by fossilized dead plants on the bottom of swamps millions of years ago being heated and pressurized. Coal is also used as a means for making materials such as tar, plastic and steel. **Emission-free coal** is in development to reduce the amount of pollution produced by burning coal. There is also research in place to find a way to contain the greenhouse gases that are put off by burning coal to keep them from entering the atmosphere.

2. Natural gas is a non-renewable fossil fuel used for a number of different things. Natural gas can be used as a heating source in homes, fuel for stoves, and to run hot water heaters and other appliances. This energy source is also used to produce materials such as steel, brick, antifreeze, and explosives. Natural gas is also being looked to as an alternative fuel source for transportation. This fuel source produces fewer **harmful emissions** than other sources.

3. Uranium is the main source of nuclear energy, which is non-renewable. To process uranium into nuclear energy, the atoms of uranium must be **split to release their energy.** Most nuclear energy is produced from the specific uranium type U-235 because of the relative ease of splitting its atoms. Nuclear power is primarily used to provide electricity. When nuclear energy is produced, there is hardly any carbon dioxide produced. However, there is **radioactive waste** produced, which can be damaging to the environment and a detriment to the health of humans.

4. Crude oil, also known as petroleum, is a non-renewable energy source used to produce several different products. Gasoline for transportation is one use for petroleum, used in both personal vehicles and transportation such as jets and semi-

trucks. Ink, crayons, tires, ammonia and bubble gum are also products of petroleum. Refining petroleum and producing products using petroleum give off several different emissions, such as carbon dioxide, carbon monoxide and sulfur dioxide, which can cause acid rain. Because of this, **environmental laws** have been put into practice to reduce the **emissions of oil production** and protect the environment.

Ex.2. Give the definitions to the words which are in bold in the text.

Ex.3. Which energy source according to the text:

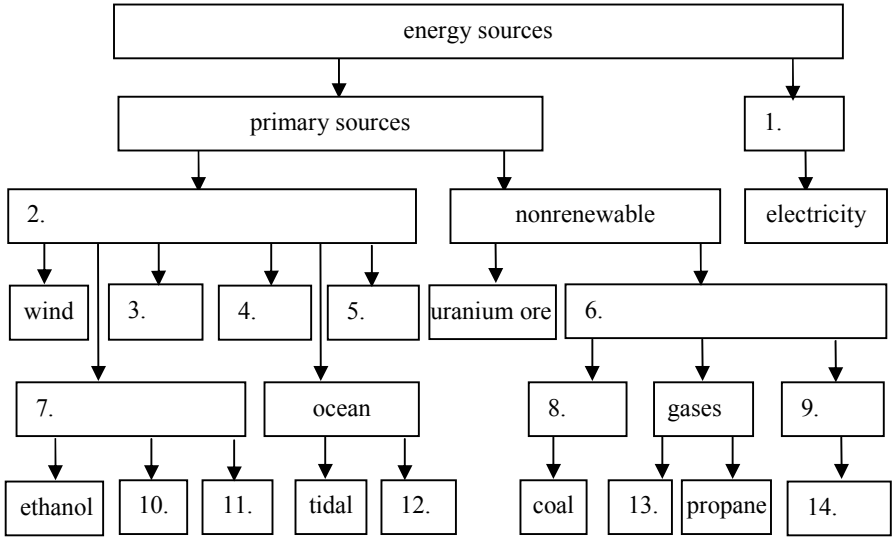
- is used to produce several different products
- is used not only as a source of energy
- produces hardly any carbon dioxide
- is not a fossil fuel
- can be used as an alternative fuel source for transportation
- is primarily used to provide electricity
- produces fewer harmful emissions than other sources.

Ex.4. Which paragraph mentions the information about

- the research to find a way to contain the greenhouse gases to keep them from entering the atmosphere
- different emissions which can cause acid rain
- a specific type of a chemical element
- some environmental laws
- how the source of energy was created

Speaking

Ex.1. Complete the diagram from the list given below. Write as many classifying sentences as you can and add examples to support your classifying sentences using the linking words for giving examples.



a) secondary sources
b) solids
c) geothermal
d) crude oil
e) methane gas
f) liquids
g) natural gas
h) solar
i) wave
j) biodiesel
k) renewable
l) fossil fuel
m) hydroelectric
n) biomass

***Ex.2. Explain and draw the diagram of the process of continuous transformation from kinetic energy to potential energy when we throw a ball into the air. Say what kind of energy the ball has when it:**

- is on the ground and not moving
- is tossed into the air
- reaches its maximum height and when its velocity is 0
- falls to the ground

UNIT 20. RENEWABLE SOURCES OF ENERGY (PART 1)

Overview

- Reading and Vocabulary: Wind energy.
- Language focus: Structures: used to / would do; be/get used to doing. Verb Tense Review. Linking words to express effect and result.
- Reading and Speaking: Biomass and biofuel.
- Writing: A report about different types of biofuels.

Reading and Vocabulary

Reading

Wind Energy

A part of the last (5th) paragraph of the text has been removed. Choose from the passages **A-C (Ex.1.)** the one which fits the gap in the text best of all.

[1] Wind energy is defined as the "power generated by harnessing the wind, usually by windmills". In scientific terms, wind energy is the "force" of winds blowing across the earth's surface.

[2] Airflows can be used to run wind turbines. Modern wind turbines range from around 600 kW to 5 MW of rated power, although turbines with rated output of 1.5-3 MW have become the most common for commercial use; the power output of a turbine is a function of the cube of the wind speed, so as wind speed increases, power output increases dramatically. Areas where winds are stronger and more constant, such as offshore and high altitude sites, are preferred locations for wind farms. Typical capacity factors are 20-40%, with values at the upper end of the range in particularly favourable sites.

[3] Globally, the long-term technical potential of wind energy is believed to be five times total current global energy production, or 40 times current electricity demand. This could require wind turbines to be installed over large areas, particularly in areas of higher wind resources. Offshore resources experience mean wind speeds of 90% greater than that of land, so offshore resources could contribute substantially more energy. When harnessed, wind energy can be converted into mechanical energy for performing work such as pumping water, grinding grain. The amount of kinetic energy within Earth's atmosphere is equal to about 10,000 trillion kilowatt-hours. An efficient windmill can produce approximately 175 watts per square meter of propeller-blade area at a height of 25m. In 2006, a total of

73,904 MW was generated, so if each windmill has 2 sq. meters of area, that equals to over 200,000 wind turbines working throughout the globe.

[4]

- Wind energy is free, clean and non-polluting. The generation of wind power does not produce any by-products that could be harmful to the environment. There are no chemicals involved, no waste production, it's squeaky clean.
- Suitable for less sunny regions. This creates the possibility of generating energy non-stop, during day and night.
- Dovetails well with other systems. The generated wind energy can be used full time in residential or commercial applications combined with your regular power supply. It can also act as a back-up in case your residential supply line fails.
- Simple technology. There is nothing too complex, mechanically, in terms of designing and building wind turbines.
- Cheap electricity. Wind energy is relatively cheap as compared to other sources. The estimated cost of generating one kilowatt-hour by wind power is about 8¢, as compared to 5¢ for typical hydropower and 15¢ for nuclear power.
- Safe, if properly maintained.

[5]

- Aesthetically disturbing. Some people just don't like the look of giant whirling blades structures outside their window.
- Inconstant nature of the wind. It might be windy, or not. Who knows. Constructions companies try to place turbines in the most windy areas, even though at times, it still might not be as windy.
- Affects the bird population. Birds and other flying creatures have trouble seeing the turbines. Although special coloring patterns and slower moving blades have reduced this problem.
- Wind farms generate noise in quiet, rural sites. Construction companies tried to solve this by moving the turbines offshore (in the middle of a lake or a river).

Reading comprehension

Ex.1.

A. Wind energy depends upon the wind in an area and therefore is a variable source of energy. The amount of wind supplied to a place and the amount of energy produced from it will depend on various factors like wind speeds and the turbine characteristics.

B. Though wind power is non-polluting, the turbines may create a lot of noise, which indirectly contributes to noise pollution.

C. A number of companies are working on solving this problem. A company called Verdant Power came up with an idea of placing wind turbines underwater. This new free-flow hydropower technology utilizes underwater currents to harvest energy. The advantages are that this system is out of sight, hidden deep in rivers or oceans. Some disadvantages could be the cost of installation and maintenance. An Ontario-based company is also working to an alternative approach, by placing "turbines" floating hundreds of feet high above the ground! This could pose a risk for airplanes thought, or act as a giant conducting wire for lightning bolts.

Ex.2. Match headings A-F with paragraphs 1-5 in the text. There is one heading you don't need.

A. Technical potential of wind energy.
B. Renewable energy debate.
C. What is wind energy?
D. Advantages of wind energy.
E. Wind turbines capacity.
F. Disadvantages of wind energy.

Ex.3. Put questions to the following answers.

1. To run wind turbines.
2. It is a function of the cube of the wind speed.
3. Offshore and high altitude sites.
4. 40 times current electricity demand.
5. Offshore resources.
6. Into mechanical energy.

Ex.4. Say whether these sentences are about pros and cons of wind energy. What advantages or disadvantages mentioned in the text do these sentences refer to?

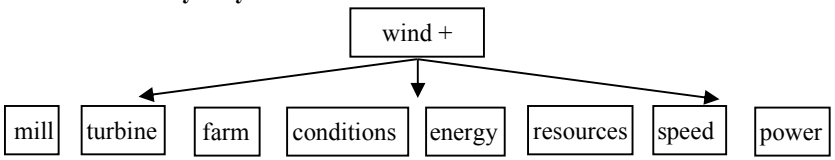
1. Wind energy does not cause green house gases or other pollutants.
2. It is possible to generate energy 24 hours a day.
3. The landscape should be left in its natural form for everyone to enjoy.
4. Wind turbines can be built in both the developed and third world.
5. The cost of producing wind energy has come down by at least eighty percent since the eighties.
6. The strength of the wind is not constant and it varies from zero to storm force.
7. Each turbine can generate the same level of noise as a family car traveling at 70 mph.

Vocabulary

Ex.1. Match the words and word combinations (1-10) with their definitions (a-k).

1	commercial use	a	smth additional that is produced during a natural or industrial process
2	back-up	b	continuing for a long period of time, relating to what will happen in the distant future
3	by- product	c	regarding something; concerning something
4	capacity factors	d	the average rate at which it covers distance
5	come up with	e	smth that you can use to replace smth that does not work or is lost
6	in terms of smth	f	the power which is available at a specified output of a device under specified conditions of operation
7	long-term	g	the ratio of the distance traveled by the air to the time taken to cover the distance
8	rated output power	h	is one which is undertaken for a business purpose, rather than hobby, recreational, educational, or other purposes
9	the mean speed	j	to think of an idea, answer
10	wind speed	k	the ratio of average actual use to the available capacity of an apparatus or industrial plant to store, process, treat, manufacture, or produce

Ex.2. Study and translate the following examples of the collocations of the word "wind" with other nouns. Use some of them in the sentences below. What collocations are synonyms?



1. Large … are needed to provide entire communities with enough electricity.
2. … are available in a range of sizes which means a vast range of people and businesses can use them.

3. The amount of energy produced will depend on various factors like … and the turbine characteristics.

4. There are some disadvantages for …, which may put a dampener in its popularity.

5. Though … is non-polluting, the turbines may create a lot of noise, which indirectly contributes to noise pollution.

6. Since wind energy will require knowledge of the weather and … on long-term basis, it may be a bit impractical.

7. A … is a building or structure with parts that turn around in the wind, used for producing electrical power or crushing grain.

Ex.3. Match the verbs in the box with noun phrases (1 -16) as they are used in the text.

install, harness, dovetail, move, contribute, run, vary, experience, affect, create, produce, blow, range, generate, place

1. … the wind
2. … wind turbines
3. … across the earth's surface
4. … from around 600 kW to
5. … wind turbines
6. … mean wind speeds
7. … substantially more energy
8. … by-products
9. … energy non-stop
10. … well with other systems
11. … the possibility
12. … turbines in the most windy areas
13. … the bird population
14. … noise in quiet, rural sites
15. … the turbines offshore
16. … from zero to storm force

Ex.4. Use the verbs from the box in Ex.3 in the correct form.

1. Once the wind turbine is built the energy it … does not cause green house gases or other pollutants.

2. Remote areas that are not connected to the electricity power grid can use wind turbines … their own supply.

3. The largest single turbine available today can only provide enough electricity for 475 homes, when … at full capacity.

4. Solar energy involves capturing and … the sun's energy.

5. These machines can be … either on the shoreline or in deeper waters offshore.

6. Combustion releases pollution, such as carbon monoxide and sulfur dioxide, which may … to acid rain and global warming.

7. When water flows through a dam, it activates a turbine, which … an electric generator.

8. When we add energy to an object, its atoms and molecules … faster increasing its energy of motion or heat.

Ex.5. Match the following verbs to their synonyms from the box in Ex.3 above.

1. position
2. promote
3. include
4. modify
5. fix
6. impact
7. make
8. match
9. undergo

Language focus

Structures used to / would do; be/get used to doing

- **used to do** describes **past habits, states** or long-lasting **actions and situations** which are now finished.

We **used to live** in a small village, but now we live in London.

- **would do** describes only **past events and actions**. It **cannot** be used to refer to **past states**.

I **would wait** for you nearly every afternoon after school and then we **would stroll** home together across the park.

But: I **used to be** an administrative assistant (Not: I ~~would be~~ an administrative assistant). Be – a state verb.

- We use the **Past Simple** and not **used to** when we
  - refer to a single action which happened at a definite time in the past

I **bought** a new bike yesterday (Not: I ~~used to~~ buy a new bike yesterday.)

  - say how many times an action happened

I **went** to the gym several times. (Not: I ~~used to~~ go to the gym several times.)

  - say how long an action took

I **lived** in San Diego for five years. (Not: I ~~used to~~ live in San Diego for five years.)

- In questions and negatives we usually use "Did you use to…?" and "I didn't use to …" but **not** "Would you …?" and "I wouldn't …"

We **would go** out much in the winter months.

But: **Did** you **use to go** out much in the winter months?

We **didn't use to go** out much in the winter months.

- **be used to + noun / pronoun / -ing** form means be accustomed to something, that something is normal, not unusual, isn't strange or new for us.

I **am** used **to driving** on the left because I've lived in Britain for a long time.

- **get used to +noun / pronoun / -ing** form means become accustomed to something. We use this structure to talk about the process of something becoming normal for us.

If you want to live alone you will have to **get used to doing** everything yourself.

Ex.1. Read the sentences and say whether they are correct or wrong. Give the correct sentences. Pay attention to the structures *used to, would* and *Past Simple.*

1. Yesterday I used to buy a new car.
2. When I was I child, I used to play football every Saturday.
3. My mother would live in India when she was young.
4. After finishing medical school, John trained as a cardiologist.
5. My friends and I would go out to a disco every weekend in the summer.
6. My grandfather says winters would be colder when he was young.
7. When I was a student, I would go climbing at weekends with my friends.
8. Susie used to go to a party last weekend.

Ex.2. There is a mistake in every sentence. Correct them. Sometimes there are two right versions.

1. She would always be beautiful when she was young.
2. I used to go to the beach yesterday.
3. James would always have a very important test last week.
4. Jamie would always have a dog when she was a child, but now she has a cat.
5. I used to graduate from Georgetown University in 1992.
6. I would always be fat, but I lost a lot of weight in high school.

Ex.3. Make the sentences negative and interrogative.

1. He would constantly embarrass himself by asking stupid questions in class.
2. They used to spend Easter with us every year until we moved.

Ex.4. Choose the correct item. Explain the difference between *used to do smth* and *be used to doing smth.*

1. When I was a child I ... go swimming in the lake.
   a) used to b) am used to
2. I ... in front of an audience. I am a teacher.
   a) used to speak b) am used to speaking
3. As a father I ... the mess my children make every evening.
   a) used to clean up b) am used to cleaning up
4. In the army I ... at six every morning.
   a) used to get up b) am used to getting up
5. My grandmother ... 5 miles to go to church on Sundays.
   a) used to walk b) is used to walking
6. I ... the paper after lunch. That's one of the things I really enjoy
   a) used to read b) am used to reading
7. After all this time I have become quite ... this program.
   a) used to operate b) used to operating

Ex.5. Read the situations. Complete the sentences using the structure *be / get used to smth / doing smth* and the verbs in bold. Some sentences are negative.

1. Frank **lives** alone. He doesn't mind this because he has lived alone for 15 years. It is not strange for him. He … alone.
2. I bought some new shoes. They felt a bit strange at first because I … them.
3. Our new flat is on a very busy street. I expect we'll … the noise, but at the moment it's very disturbing.
4. Diane has a new job. She has to **get** up much earlier now than before - at 6.30. She finds this difficult because she … up so early.
5. Brenda's husband **is** often away from home. She doesn't mind this. She … him … away.
6. When Mark arrived to England it was very difficult for him to **drive** on the left. Now after three years, it's no problem for Mark. He … on the left.

Verb Tense Review

Ex.6. Put the verbs in brackets into the correct tense form (Present Simple, Past Simple, Present Perfect, Past Perfect, Present Perfect Continuous, Past Perfect Continuous).

1. It is already 9:30 PM and I … (wait) here for over an hour. If John …(not get) here in the next five minutes, I am going to leave.
2. I … (be) really angry at John yesterday. By the time he finally arrived, I … (wait) for over an hour. I almost left without him.
3. I … (see) many pictures of the pyramids before I … (go) to Egypt. Pictures of the monuments are very misleading. The pyramids are actually quite small.
4. Sarah … (climb) the Matterhorn, … (sail) around the world, and … (go) on safari in Kenya. She is such an adventurous person.
5. Sarah … (climb) the Matterhorn, … (sail) around the world and … (go) on safari in Kenya by the time she turned twenty-five. She … (experience) more by that age than most people do in their entire lives.
6. When Melanie … (come) into the office yesterday, her eyes were red and watery. I think she … (cry).

Ex.7. Put the verbs in brackets into the correct tense form. Mind about dynamic (continuous) and state (non-continuous) verbs.

1. a) Look, I… (have) two tickets for the circus.
   b) Look, I … (hold) two tickets for the circus.
2. a) We … (be) there for more than half an hour by the time the show began.
   b) We … (wait) there for more than half an hour by the time the show began.

3. a) Sam … (sit) in the seat next to me when the clown threw a bucket of water at me.
b) Sam … (be) in the seat next to me when the clown threw a bucket of water at me.
4. a) One clown was juggling while he … (balance) a glass of wine on his head.
b) Clown was juggling while he … (have) a glass of wine on his head.
5. a) I …(love) the circus ever since I was a child.
b) I … (go) to the circus ever since I was a child.
6. a) Right now, I … (see) two elephants doing tricks in the ring.
b) Right now, I … (look) at two elephants doing tricks in the ring.

Linking words to express effect and result

The following linking words are used to express effect and result:

such/so … that, so, consequently, therefore, as a result, for this reason.

They are all used in a similar way: "The company are expanding. Therefore / Consequently / As a result, they are taking on extra staff."

- **Therefore** means for this reason: She already had a lot of experience and therefore seemed the best candidate for the job.
- **So** is more informal than **therefore** and is more common in everyday English: They had not eaten all day, so they were very hungry.
- **So that** explains the outcome of an action.
- **As a result** and **consequently** are used to say that because of a particular situation, something else happens or is true: Economic growth slowed down as a result of inflation.
- **For this reason** is used to explain the reason for something.

Ex.8. In the text "Wind energy" above find the sentences containing linking words expressing effect and result.

Ex.9. Fill in the gaps with linking words: ***as a result of, so that,*** **therefore,** ***consequently, for this reason.***

1. The simplest type of transformer consists of two coils of wire, electrically insulated from one another and arranged … a change in the current in one coil will produce a change in voltage in the other.
2. Spell check programs do not recognize when you have used the wrong word. …, you must still read your work carefully.
3. … the pilots' strike, all flights have had to be cancelled.

4. … , in 1983 a more comprehensive survey was carried out in the area with two objectives – to map structure in reconnaissance form, and to look for evidence of Westphalian strata with a view to coal development.
5. The cell phone is thin and light and … very convenient to carry around.

Reading and Speaking

Reading

Ex.1. Look at the headline and the introduction to the text below. Write several questions you would like to know the answers to after reading the text.

Biomass and biofuel

In a few decades the fossil energy sources like oil and coal we use nowadays will be exhausted. To avoid this we either must change our lifestyle and the habit of wasting energy or we have to find other ways to get energy without exploiting the earth. One way of doing this is getting energy from biomass.

Biomass is organic material made from plants and animals. It is a renewable energy source because firstly, we can always grow more trees and crops, and waste will always exist and secondly, because the energy it contains comes from the sun. Through the process of photosynthesis, plants capture the sun's energy. When the plants are burned, they release the sun's energy they contain. In this way, biomass functions as a sort of natural battery for storing solar energy. Biomass doesn't include fossil fuels, which take millions of years to create.

When burned, the chemical energy in biomass is released as heat. Wood waste or garbage can be burned to produce steam for making electricity, or to provide heat to industries and homes. Burning biomass is not the only way to release its energy. In fact, biomass has many possibilities as a renewable energy source. High energy crops grown specifically to be used as fuel are being developed, and scientists are beginning to consider agricultural and animal waste products as possible fuel sources. Biomass can be converted to other usable forms like methane gas, or fuels such as ethanol and biodiesel.

In general, there are two main approaches to using plants for energy production: growing plants specifically for energy use, and using the residues from plants that are used for other things. The best approaches vary from region to region according to climate, soils and geography. Biomass briquettes are increasingly being used in the developing world as an alternative to charcoal. The technique involves the conversion of almost any plant matter into compressed briquettes that typically have about 70% the calorific value of charcoal.

Biofuels are a wide range of fuels which are in some way derived from biomass. The term covers solid biomass, liquid fuels and various biogases. Biofuels are

gaining increased public and scientific attention, driven by factors such as oil price spikes, the need for increased energy security, concern over greenhouse gas emissions from fossil fuels, and government subsidies.

Biofuels provided 1.8% of the world's transport fuel in 2008.

Biomass energy advantages.

- Biomass is very abundant. It can be found on every square meter of the earth.
- It is easy to convert to a high energy portable fuel such as alcohol or gas.
- It is cheap in contrast to the other energy sources.
- Biomass production can often mean the restoration of waste land (e.g. deforested areas).
- It may also use areas of unused agricultural land and provide jobs in rural communities.

Biomass energy disadvantages. There really are not that many. But we do need to look at the whole picture when trying to see if biomass is a good alternative fuel to fossil fuel such as coal or oil.

- It could contribute a great deal to global warming and particulate pollution if directly burned.
- It takes more energy to plant, cultivate and harvest the crops and trees than it is worth to get a net energy gain. It also takes up more water from the earth and other fossil fuels to make the fertilizers and fuels for planting and harvesting and it also takes up more land for the crops and trees.
- Biomass collection is difficult.
- Biomass crops are not available all year. Corn, wheat, barley and the like are seasonal crops. Trees are also a slow growing resource even though they are renewable.

Ex.2. Read the statements and mark them true (T) or false (F). Give the true statements.

1. Fossil fuels are one of the kinds of biomass.
2. We can release energy of biomass only by burning it.
3. Scientists are developing high-energy crops grown specifically to be used as fuel.
4. To produce energy we can use only the plants grown specifically for energy use.
5. Biomass can hardly be converted to other usable forms.
6. Biofuels are gaining popularity mainly because of government subsidies.

7. Biofuels provided a small portion of the world's transport fuel in 2008.

Ex.3. Say whether these sentences are about advantages or disadvantages of biomass energy. What advantages or disadvantages mentioned in the text do these sentences refer to?

1. When direct combustion of plant mass is not used to generate energy and fermentation, pyrolysis are used instead, there is minimal environmental impact.
2. Alcohols and other fuels produced by biomass are efficient, viable, and relatively clean-burning.
3. Biomass energy is available throughout the world.
4. It produces carbon dioxide and other greenhouse gases when burning.
5. On a small scale there is most likely a net loss of energy – energy must be put in to grow the plant mass.
6. Still an expensive source, both in terms of producing the biomass and converting it to alcohols.

Speaking

Ex.1. Answer the questions using the information from the text. Use word combinations given below.

1. exhaust fossil energy sources
2. release the sun's energy
3. take up more water from the earth
4. gain increased public and scientific attention
5. concern over greenhouse gas emissions
6. contribute a great deal to global warming
7. provide jobs in rural communities
8. change our lifestyle
9. seasonal crops
10. get a net energy gain
11. wide range of fuels
12. high energy portable fuel
13. restoration of waste land
14. capture the sun's energy

1. Why can we say that biomass functions as a sort of natural battery for storing solar energy?
2. What is the difference between biomass and fossil fuels?
3. "When burnt, the chemical energy in biomass is released as heat" – Can we name this process the energy conversion?
4. How can we change our lifestyle to save the fossil energy sources like oil and coal which are widely being exhausted nowadays?
5. In your opinion – if biomass is a good alternative fuel to fossil fuel such as coal or oil or not?

***Writing**

Write a report about different types of biofuels – solid biomass, liquid fuels and various biogases. Pay attention to advantages and drawbacks of each type of fuel.

UNIT 21. RENEWABLE SOURCES OF ENERGY (PART 2)

Overview

- Reading and Vocabulary: Solar energy.
- Language focus: Future forms.
- Reading and Speaking: Tidal / Ocean energy.
- Writing. A project "Energy of future".

Reading and Vocabulary

Before you read

1. Discuss the kinds of power that fall under the category of green energy. Emphasize those kinds the use of which is economically expedient.
2. Find out examples of green energy which can be of local interest.

Reading

Solar energy

1. Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly from the sun, or from heat generated deep within the earth. Included in the definition is electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, and biofuels and hydrogen derived from renewable resources. Renewable energy replaces conventional fuels in four distinct areas: power generation, hot water and space heating, transport fuels, and rural (off-grid) energy services. During the five-years from the end of 2004 through 2009, worldwide renewable energy capacity grew at rates of 10–60 percent annually for many technologies.

2. Solar Energy is radiation produced by nuclear fusion reactions deep in the Sun's core. Solar energy travels to Earth through space in discrete packets of energy called photons. A photon is defined as a packet or quantum of a wave-like fluctuations in electric and magnetic fields traveling through free space or a material medium. The simplest example of solar energy use is your calculator. As long as there is light in the room, the calculator will always work by converting light into useful energy. The solar cells on a calculator are called photovoltaic cells and are made of semiconductors, like silicon.

On the side of Earth facing the Sun, a square kilometer at the outer edge of our atmosphere receives 1,400 megawatts of solar power. Only half of that amount reaches Earth's surface. The amount of light that reaches any point on the ground depends on the time of day. The total radiation power varies only slightly, and any considerable change would alter or end life on Earth.

Greenhouses and solariums are common examples of the direct use of solar energy, having glass surfaces that allow the passage of visible light from the sun but slow down the escape of heat and infrared energy. No power source is entirely impact-free.

So solar energy has both advantages and disadvantages.

3.
- Clean, non-polluting.
- Renewable, endless supply that belongs to no one.
- Works best in the sunniest, often the poorest, parts of the world.
- Dovetails with other clean systems.
- Flexible and modular – systems can be resized.
- Safe.

4.
- Some research and development not funded.
- Electricity produced is more expensive.
- Cannot be used as the only system in cloudy places.
- Energy has to be stored in batteries, hydrogen, water or other matter.

5. Renewable energy, after its generation, needs to be stored. A combination of renewable energy plants, as well as solar power plants is essential for this type of energy supply because solar power plants can only produce energy when the sun shines.

So some political and economical issues get rise.

Storing solar energy at night and during cloudy days can be very expensive. Nevertheless, solar power is the second-fastest-growing energy source today. If solar energy is absolutely free, why isn't everything powered by it? There are costs involved in creating, running and maintaining your solar (photovoltaic) system. There is a lot of hardware needed to set up this system. Typically, around $32,000 is needed for a photovoltaic system. Also, an installed photovoltaic system will cost somewhere around $9 per peak Watt.

Parts of Europe and Japan are extremely focused and are investing heavily on the solar energy industry. The political commitment and support has promoted the development of solar electricity especially in Germany and Japan. At the end of 2009, cumulative global photovoltaic (PV) installations surpassed 21 GW and PV power stations are popular in Germany and Spain. Solar thermal power stations operate in the USA and Spain, and the largest of these is the 354 megawatt (MW) SEGS power plant in the Mojave Desert.

The Greenpeace organization predicts that this political dedication forecasts that solar electricity sector is at a start of a massive transformation and expansion over

the few decades. The objective is to increase the usage and demand for solar electricity while substantially lowering the greenhouse gas emissions.

It should be noted, however, that this kind of a transformation will not happen by itself, and needs the support of both the consumers and the industry.

Reading comprehension

Ex.1. Scan the text and choose the suitable heading from this list for each part (1-5) of the text. Note there are more headings than parts so you will not use all of them.

A. Advantages
B. Political and economical questions
C. Energy investment
D. Sources of renewable energy
E. Solar energy
F. Disadvantages

Ex.2. Read the statements and mark them true (T) or false (F). Give true statements.

1. There are some attempts of using green energy although there are no areas where it could replace traditional fuels.
2. Unfortunately, renewable energy tends to decline through out the world.
3. A calculator can be offered as the simplest example of using solar energy.
4. The fact that the sun never stops radiating is a clue why the amount of light doesn't depend on the time of day.
5. Greenhouses and solariums are typical examples of the direct use of solar energy.
6. Green power sources are totally harmless and safety for the environment.
7. One of the advantages of renewable energy use is that it doesn't need any technology and equipment to be stored as it is used exclusively in a direct way.
8. Storing and using solar energy doesn't require high costs, as it is endless and is derived from natural process.
9. PV power stations are widely spread in all countries.

Ex.3. Complete the following statements, based on the information in the text, using a maximum of four words.

1. At the end of 2009, … surpassed 21 GW.
2. In its various forms, renewable energy derives directly from … .
3. All energy sources give rise to … .
4. A combination of plants is … .
5. The calculator works by … .
6. Glass surfaces of solariums and greenhouses let sun light in but slow down … .

7. Solar energy has to be stored … .

Vocabulary

Ex.1. Complete the following definitions using the information from the text. Learn these definitions by heart.

Solar energy is …
A photon is …
Renewable energy is …

Ex.2. Match the verbs (1-8) from the text with their meanings (a-h).

1	alter	a	to make a statement saying what is likely to happen in the future
2	convert	b	to prepare the equipment that will be needed for an activity
3	derive	c	to change or to make someone or smth change
4	dovetail	d	to make smth full again, esp with a supply of water etc
5	forecast	e	to provide people with smth that they need
6	replenish	f	to change smth into a different form
7	set up	g	to develop or come from smth else
8	supply	h	to fit together perfectly

Ex.3. Give the synonyms to the verbs given in Ex.2. Use a dictionary if you need.

Ex.4. Complete the sentences below. Use the adjectives from the box. There are two words more so you don't need to use all of them.

massive, conventional, flexible, renewable, distinct, considerable, essential, polluting

1. The share of … sources in electricity generation is growing.
2. Solar hot water systems make an important contribution and replace … installations.
3. Subject to a particular geographic position the energy saving program of the country needs two groups of quite … solar systems.
4. The development of new hardware is … for this type of energy supply.
5. Scientists and researchers have been working on a problem of … expansion of green energy use.
6. Local green energy systems are distinguished as … and modular systems.

Ex.5. Give opposites to the adjectives from Ex.4. Use a dictionary if you need. Make your own sentences.

Language focus

Future forms

Future Simple (Will)	Be Going To	Future Continuous	Future Perfect
decisions taken at the moment of speaking (on-the-spot decision) Since it's getting dark, **I'll** turn on the light.	**actions intended to be performed in the near future** She**'s going to** visit her parents tomorrow.	**actions in progress at a stated future time** He**'ll be sunbathing** in Hawaii this time next week.	**actions which will be finished before a stated future time** She **will have come** back **by the end** of July. **Note: by** or **not... until/till** are used with Future Perfect. **Until/till** are normally used with Future Perfect only in negative sentences**.** She **will** have finished **by** 8 o'clock. (Not: ~~until/till~~) She **won't** have finished **until** 8 o'clock.
hopes, fears, threats, promises, warnings, offers, predictions, requests, comments with: expect, hope, believe, I'm sure, I'm afraid, probably I'm afraid I'll be a little late.	**planned actions or intentions** Now that they've settled in their new house, they'**re going** to have a party.	**actions which are the result of a routine (instead of Present Cont.)** **I'll be seeing** John tomorrow. (We work in the same office so we'll definitely meet.)	
actions or predictions which may (not) happen in the future She'**ll probably buy** the dress. (prediction) **or actions which we cannot control and will inevitably happen** He **will be** ten next year.	**evidence that something will definitely happen in the near future** Ann **is going to** have a baby. Look at the dark clouds in the sky! It'**s going** to rain.	**when we ask politely about people's arrangements to see if they can do sth for us or because we want to offer to do sth for them** **Will you be going to** the supermarket? Can you buy me some tea?	
things we are not sure about or haven't decided to do yet She'**ll probably be** promoted. (not sure yet)	**things we are sure about or we have already decided to do in the near future** He'**s going to** be promoted. (The boss has decided to do it.)		
Present Simple (future meaning)	**Present Continuous (future meaning)**	**Future Perfect Cont.**	
timetables/programs The plane **reaches** London at 9.45.	**fixed arrangement in the near future** Sally **is seeing** her dentist this week.	**duration of an action up to a certain time in the future.** By the end of this year she **will have been working** here for two years.	

Time expression used with:	
Will/Be Going To/ Fut. Cont.	tomorrow, tonight, next week/month, in two/three etc days, the day after tomorrow, soon, in a week/month etc
Future Perfect	before, by, by then, by the time, until (only in negative sentences)
Fut. Perf. Cont.	by ... for

Ex.1. Match the sentences (1-8) with (a –h) and fill in the correct tense.

1. She'll call us 1.....	a. until it ... (stop) raining.
2. I don't know 2.....	b. as soon as I ... (can).
3. What ... (you/do) 3.....	c. if you ... (come) home late.
4. Turn the lights off 4.....	d. as soon as she ... (reach) London.
5. Don't go out 5.....	e. if you have an accident.
6. I ... (write) to you 6.....	f. what ... (you/buy)?
7. He will be angry 7.....	g. when he ... (leave).
8. If I give you £5, 8.....	h. before you ... (go) to bed.

Ex.2. Complete the dialogue using the correct future form.

A: What 1) *..are you doing*...(do) tonight?

B: I 2) ... (try) to finish my homework because I 3) ... (go) to my cousin's wedding on Saturday and I 4) ... (not/be able) to do it then.

A: What time 5) ... the wedding ... (start) on Saturday?

B: The ceremony 6) … (begin) at 2 o'clock, then I 7) ... (go) to the party in the evening.

A: 8) ... any of your friends ... (be) there?

B: Well, my cousin says I can bring a friend. 9) ... (you/do) anything on Saturday night?

A: No, but I 10) ... (feel) shy if I don't know anyone.

B: Never mind. It 11) ... (be) a big party and I'm sure you 12) ... (have) a great time.

A: Ok, then. Thanks very much.

Ex.3. Put the verbs in brackets into the correct future form.

Dear Debbie,

Since you want to know what I 1) *...'m doing*... (do) next week, I thought I'd write and let you know. It 2) ... (be) a very busy week. On Monday I 3) ... (go) to York. I 4) ... (probably/be) there for three days, and by Wednesday I 5) .... (meet) every important artist in the town. If everything goes well, I 6) .... (go) to Newcastle on Thursday morning. There I 7) .... (meet) the chairman of the Arts Council. Then on Friday and Saturday I 8) ... (visit) several small towns in the area to see what their galleries are like. By Sunday I 9) .... (travel) for days and I imagine I 10) ... (be) very tired, so it looks like I 11) ... (not/come) to your party on Sunday night. Sorry! I hope you 12) ... (invite) me to the next one. Give my love to Mike.

Love, Sue.

Verb Tense Review

Ex.4. Put the verbs in brackets into the correct form (Present Simple, Present Continuous, Present Perfect, Present Perfect Continuous, Past Simple, Past Continuous, Past Perfect Continuous, Future Continuous, Future Perfect).

1. When Carol … (call) last night, I … (watch) my favorite show on television.
2. I … (work) for this company for more than thirty years, and I intend to stay here until I retire!
3. Sharon … (love) to travel. She … (go) abroad almost every summer. Next year, she plans to go to Peru.
4. Thomas is an author. He … (write) mystery novels and travel memoirs. He … (write) since he was twenty-eight. Altogether, he … (write) seven novels, three collections of short stories and a book of poetry.

5. We were late because we had some car problems. By the time we … (get) to the train station, Susan … (wait) for us for more than two hours.
6. Sam … (try) to change a light bulb when he … (slip) and …(fall).
7. Right now, Jim … (read) the newspaper and Kathy … (make) dinner. Last night at this time, they … (do) the same thing. She … (cook) and he … (read) the newspaper. Tomorrow at this time, they … (do, also) the same thing. She … (prepare) dinner and he … (read). They are very predictable people!
8. By this time next summer, you … (complete) your studies and … (find) a job. I, on the other hand, … (accomplish, not) anything. I … (study, still) and you … (work) in some new high paying job.

Ex.5. Read the set of sentences and answer the questions below each set. Explain the meaning of all tenses used in these sentences.

1. Jane talks on the phone.
   Bob has been talking on the phone for an hour.
   Mary is talking on the phone.
   Who is not necessarily on the phone now?
2. I'm going to make dinner for Frank.
   I'm making dinner for Judy.
   I'll make dinner for Mary.
   I make dinner for Ted.
   I will be making dinner for Tony.
   Who are you offering to make dinner for?
3. Jane left when Tim arrived.
   Bob left when Tim had arrived.
   Tim arrived when Mary was leaving.
   John had left when Tim arrived.
   After Tim arrived, Frank left.
   Who did not run into Tim?
4. Jane is talking in class.
   Bob always talks in class.
   Mary is always talking in class.
   Whose action bothers you?
5. Jane never left Jamestown.
   Bob has never left Jamestown.
   Who is still alive?

Reading and Speaking

Before you read

In small groups, discuss these questions.

1. What do you know about alternative sources of energy that are common for Ukraine?

2. From the renewables that you are aware of choose those which, you think, are economically most acceptable and profitable for Donetsk region?

Tidal and Ocean Energy

Renewable energy flows involve natural phenomena such as sunlight, wind, tides, plant growth, and geothermal heat, as the International Energy Agency explains.

Tidal power

Tides are basically big bulges of water created by the gravity of the sun and the moon. These bulges move around our planet, back and forth, creating currents and causing water levels to rise and drop. Since we know where the moon is at all times, we can predict the rise or fall of water levels and at which location it occurs. Usually it takes about twelve hours for water to rise and twelve hours to fall. We can take advantage of this rise/fall phenomenon by harnessing renewable energy from it. By installing barrages (small damns), we can generate electricity from passing water by using turbines. Because the rise/fall phenomenon is always there, tidal power is a clean, non-polluting, renewable source of energy.

Advantages

• *Reliability.* Tidal power/energy is more predictable than solar or wind energies. Rise and fall of tides is more cyclic than random weather patterns.

• *Truly renewable.* Tidal energy will not run out very soon (something like 2 billion years, when all of the oceans will boil, because our planet's orbit will get too close to the sun). Tidal energy is free, non-polluting, no waste is produced.

• *Economical.* Startup costs to build a tidal energy plant are high, but the maintenance costs are very low. This means that you will not see profits for a few years, causing some investors to back out of the project. This can be seen as both an advantage and disadvantage, depending upon desired profit returns.

• *Security.* Barrages or small dams in general, can protect nearby cities or ship ports from dangerous tides during a storm, or at least reduce the damage done.

• *Efficiency.* Tidal turbines are up to 80% efficient in converting tidal energy to usable electricity. This is much higher than solar or wind energy generators.

Compare this to your car engine, which is about 30% efficient at converting fuel in your tank to actual energy applied to the road.

Disadvantages

• *Environmental Damage.* There is considerable effect on the ecosystem. The exchange of water volume between a basin and the sea is reduced, this leads to the potential for increased pollution, because pollution is left accumulating in the basin. Also, because the exchange of volume is reduced, salinity of the basin decreases and sediment accumulation increases. Basically, anything we place in the water can and does affect the ecosystem.

• *Fish population.* Even with the best barrage designs, fish mortality rate per pass through the barrage is about 15%. Solutions to resolve this problem either have failed or are too impractical and too expensive.

• *Time of day.* Tides are predictable, but power stations only generate power when the tide is flowing in or out of the basin, which only happens during certain times of the day.

Underwater tidal power

Some people just don't like the look of windmills or wind turbines outside their window. A number of companies are working on solving this problem. A company called Verdant Power came up with an idea of placing "wind" turbines underwater. This new free-flow hydropower technology converts kinetic energy of deep water into usable electricity. Check out the advantages and disadvantages of this system.

Advantages

• *Energy is clean and non-polluting.* Like the surface wind turbines, underwater turbines are also very clean and non-polluting.

• *Economic.* Underwater tidal power is cheaper than its relative tidal power. This is because it is expensive to build damns.

• *Integration.* These systems can be placed virtually anywhere underwater, they do not require special dams or channels or underwater pathways to be constructed.

• *Safe.* Systems appear to be safe for fish, as the rotors are slow turning. Also, they should be safe for submarines, as submarines have complex radar navigation and don't easily run into things underwater.

Disadvantages

• *In development.* This type of energy generation is still relatively new and in development, so we don't know what are the possible side effects to the environment due to placement of turbines underwater. It's hard to predict how this will affect ocean/river currents.

Ocean energy

Systems to harvest utility-scale electrical power from ocean waves have recently been gaining momentum as a viable technology. The potential for this technology is considered promising, especially on west-facing coasts with latitudes between 40 and 60 degrees.

In the United Kingdom, for example, the Carbon Trust recently estimated the extent of the economically viable offshore resource at 55 TWh per year, about 14% of current national demand. Across Europe, the technologically achievable resource has been estimated to be at least 280 TWh per year. In 2003, the U.S. Electric Power Research Institute (EPRI) estimated the viable resource in the United States at 255 TWh per year (6% of demand).

The world's first commercial tidal power station was installed in 2007 in the narrows of Strangford Lough in Ireland. The 1.2 megawatt underwater tidal electricity generator, part of Northern Ireland's Environment & Renewable Energy Fund scheme, takes advantage of the fast tidal flow in the Lough. Although the generator is powerful enough to power a thousand homes, the turbine has minimal environmental impact, as it is almost entirely submerged, and the rotor poses no danger to wildlife as it turns quite slowly.

Reading comprehension

Ex.1. From the information in the text, match the phrases a – l below with the ocean energy source, tidal and underwater tidal power. Note that there are more phrases than answers, so you will not need to use all of them.

a) the rotors pose no danger to wildlife
b) bulges of water move around our planet
c) free-flow hydropower technology
d) considerable effect on the ecosystem
e) the main source of nuclear energy
f) relatively new and in development
g) more predictable than solar or wind energies
h) 14% of current national demand
i) has minimal environmental impact
j) the potential to generate geothermal energy
k) up to 80% efficient
l) do not require special dams or channels

Tidal power	Ocean energy	Underwater tidal power

Ex.2. Choose the best answer for each question, a), b) or c).

1. Rise / fall phenomenon of the world ocean water is raised
   a) by wind.
   b) by gravity of earth.
   c) by gravity of sun and moon.
2. Why is a tidal energy plant economical?
   a) Because startup costs are low.
   b) Because maintenance costs are low.
   c) Because electricity supply costs are low.
3. Rise and fall of tides are more cyclic than
   a) weather relied green power resources.
   b) greenhouse gas emissions.
   c) heat resources.
4. The reduced exchange of water volume between a basin and the sea leads to
   a) the potential for increased pollution.
   b) the growing of the share of renewables.
   c) the potential to generate energy from hot dry rocks.
5. Underwater turbines can be placed anywhere because
   a) mini grids serve many areas.
   b) they operate at high wind speed.
   c) they don't need special dams or channels.
6. It's hard to predict how underwater tidal energy generation will affect
   a) ocean / river current.
   b) transformation and expansion of wind farms.
   c) location of the shallow depths.

Ex.3. Complete the following statements, based on the information in the reading text.

1. Ocean power technology is considered ....
2. Across Europe, the technologically achievable resource has been ....
3. Tides are predictable, but power stations generate power ....
4. Tidal energy is ....

5. Underwater tidal power is cheaper than its relative tidal power because ....

6. This new underwater tidal power systems appear to be safe for submarines because ....

Ex.4. What do the highlighted words refer to in the reading text?

1. ... harnessing renewable energy from it.
2. This can be seen as both advantage and disadvantage.
3. This is much higher than solar or wind energy generators.
4. ... is cheaper than its relative tidal power.
5. They should be safe for submarines.
6. ... it is almost entirely submerged.

***Speaking**

Ex.1. In pairs, discuss "green" energy resources.

Ex.2. In class, make a comparative description of solar, tidal, underwater and ocean power.

Ex.3. In the text (Tidal and Ocean Energy) the authors say that it's hard to predict how exploitation of tidal power will affect ocean / river currents. Imagine you are a serious scientist by now and put forward your ideas on the issue. Extend the discussion covering other problems (economical, political and national).

Ex.4. Prepare a conference on the topic "Green energy. Pros and cons."

***Writing**

Make a project on the energy of future.

APPENDIX. WORD LIST

UNIT 1

a number of		целый ряд, несколько
advanced technique	tek'nı:k	передовая технология
ancient	'eınʃ(ə)nt	древний
angle		угол
appropriate symbol		подходящий символ
authentic record	ɔ:'θentık	подлинная, достоверная запись
based on		основанный на …
be unlike		отличаться от
become familiar with	fə'mılıə	приобщаться, ознакомиться
consume		потреблять
decimal ~ point recurring ~		десятичная дробь; десятичный десятичная точка периодическая десятичная дробь
denominator common denominator		знаменатель дроби общий знаменатель
derive from	dı'raıv	происходить от…
entire new principle	ın'taıə	абсолютно новый принцип
ever-expanding		постоянно расширяющийся, непрерывно растущий
evidence	'evıd(ə)ns	доказательство
flourish in various directions	'flΛrıʃ 'vɛərıəs	процветать (развиваться) в различных направлениях
fraction improper ~ proper ~ vulgar ~	'vΛlgə	дробь неправильная ~ правильная ~ простая ~
have experience in		иметь опыт в
in fact		фактически, на самом деле
influence smth, smb (v)		влиять на что-то, кого-то
integer	'ıntıʤə	целое число
lack of		недостаток
match the duality	dju'ælıtı	соответствовать двойственности
mathematical solution to		математическое решение

multiply smth ten-fold		умножать в 10 раз
need for		потребность в
number abstract ~ cardinal ~ complex ~ concrete ~ conjugate ~ decimal ~ even ~ mixed ~ odd ~ ordinal ~ prime ~ whole ~	'kɔŋkrıːt 'kɔndʒugət	число отвлечённое ~ количественное числительное комплексное ~ именованное ~ (с размерностью) сопряженное ~ десятичное ~, десятичная дробь чётное ~ смешанное ~ нечётное ~ порядковое числительное простое ~ целое ~
numeral system		числовая система
numeral		число, цифра
numerator		числитель
proceed	prə'sıːd	продолжать, продвигаться
provide smb with smth		обеспечивать кого-либо чем-либо
revolve round		вращаться вокруг
serve mankind		служить человечеству
source of difficulty		источник сложностей
strongly support		решительно поддерживать
surface		поверхность
undergo changes		претерпевать изменения
universal symbol		универсальный символ
value	'vǽljuː	величина, значение

UNIT 2

addend		второе и последующее слагаемое
addition associative law of ~ commutative law of ~		сложение сочетательный закон сложения переместительный закон сложения
advanced science calculations		усложненные научные подсчеты

be regarded as		рассматриваться как
component	kəm'pəunənt	слагаемое
day-to-day counting		повседневные, обыденные подсчеты
decimal place notation for numbers		представление чисел в виде десятичной дроби
difference (remainder)		разность
dividend	'dıvıdend	делимое
division	dı'vıʒ(ə)n	деление
divisor	dı'vaısə	делитель
factor	'fǽktə	множитель, коэффициент
identity element of addition = additive identity		нулевой (нейтральный) элемент аддитивного закона
in common use		повсеместно принятый
index of power	'ındeks	показатель степени
inverse element of addition = additive inverse	'ın'vəːs	инверсия относительно сложения
item	'aıtəm	слагаемое
minuend	'mınjuend	уменьшаемое
multiplicand	ˌmʌltıplı'kǽnd	множимое
multiplication (multiplying)	ˌmʌltıplı'keıʃ(ə)n	умножение
multiplier	'mʌltıplaıə	множитель, коэффициент
obsolete	'ɔbs(ə)lıːt	устаревший; вышедший из употребления
product	'prɔdʌkt	произведение
quotient	'kwəuʃ(ə)nt	частное
remain		оставаться
remainder		остаток
sign division ~ equals ~ minus ~ multiplication ~ plus ~ root ~	saın 'maınəs	знак ~ деления ~ равенства ~ вычитания ~ умножения ~ сложения ~ корня
subtraction (subtracting)		вычитание
subtrahend	'sʌbtrəhend	вычитаемое

UNIT 3

advanced		продвинутый
array entry		элемент массива
auxiliary determinant	⊃:g'zɪljerɪ	вспомогательный определитель
be aware of		быть осведомлённым
behaviour		поведение
borrow		заимствовать
boundary conditions		граничные условия
charge		заряд
constitutive		основополагающий, неотъемлемый
derivative	dɪ'rɪvətɪv	производная
displacement		смещение
domain	dəu'mein	зона, область
environment	ɪn'vaɪər(ə)ment	окружение, окружающая среда
exhaust	ɪg'z⊃:st	истощать
field intensity		напряжённость поля
flux density		плотность потока
harmful		вредный
headline		заголовок
identity	aɪ'dentətɪ	тождество
infinitesimal	,ɪnfɪnɪ'tesɪm(ə)l	бесконечно малая величина
inverse matrix	'meɪtrɪks	обратная матрица
noxious fumes	'n⊃kʃəs	вредные газы
obey	ə'beɪ	подчиняться
partial differential equation	pɑ:ʃ(ə)l	частное дифференциальное уравнение
participant	pɑ:'tɪsɪpənt	участник
permittivity	,pə:mɪ'tɪvɪtɪ	диэлектрическая проницаемость
Pythagorean theorem	pəɪ,θægə'rɪən	теорема Пифагора
raising to a power	'reɪzɪŋ	возведение в степень
relate		относиться
relationship		взаимоотношение
satisfy		удовлетворять
skim		поверхностно знакомиться
strictly		точно, без отклонений
subset		подмножество
substitute		заменять
sufficient		достаточный
suite		комплект, набор
through	θru:	через
transposed matrix		транспонированная матрица
via	'vaɪə	через, посредством
volume		объём
yield	jɪ:ld	давать результат

UNIT 4

be parallel to		быть параллельным
be (un)equal to		быть (не)равным
be perpendicular to	,pə:p(ə)n'dɪkjulə	быть перпендикулярным чему-либо
be similar to		быть подобным
brackets		скобки
circumference	sə'kΛmf(ə)r(ə)ns	окружность
compare smth with		сравнивать что-либо с…
congruent	'k ⊃ ŋgruənt	совпадающий
conjunction	kən'ʤΛŋkʃ(ə)n	пересечение
deceive smb about smth	dɪ'sɪ:v	обманывать кого – либо в чем - либо
degree ~ of accuracy	'ækjurəsɪ	градус, степень степень точности
derive from		произойти из
despite smth	dɪ'spaɪt	несмотря на
distort		искажать
express		выразить
greater than		больше чем
in terms of		посредством; при помощи
in the ratio of ten		в отношении к 10
include		включать, предполагать
infinity	ɪn'fɪnətɪ	бесконечность
intersection		пересечение
length		длина
less than		меньше чем
magnitudes for measurements		величины для измерения

proportionality		пропорциональность
remain in use		по-прежнему применяться
remove		удалять, снимать
scales		весы
second order character	'kǽrəktə	знак, символ второго порядка
set		множество
sign ~ of identity ~ of parallelism ~ of similarity congruent ~ coincidence ~ conjunction ~ double ~ disjunction ~ empty set ~ proportionality ~	kəu'ınsıd(ə)ns	знак знак тождества знак параллельности знак подобия знак конгруэнтности знак конгруэнтности знак конъюнкции двойной знак (±) знак дизъюнкции знак пустого множества знак пропорциональности
symbol		знак (символ)
tend to		быть склонным, иметь тенденцию к
triangle	'traıǽngl	треугольник
union		объединение
units ~ of measurement base ~ derived ~ compound ~		единицы измерения единицы измерения основная единица измерения производная единица измерения единица измерения со сложной размерностью
wavelength		длина волны
weight		вес
width		ширина

UNIT 5

be affected by		подвергаться влиянию, подвергаться воздействию
be suitable for		быть подходящим для

change resistance in small steps		изменять сопротивление на небольшие величины
consistency of a measurement		стабильность, однородность показаний
convert smth into…		преобразовывать что-то в…
damped oscillations		затухающие колебания
damper		демпфер
damping factor		коэффициент ослабления
degrade with time	dı'greıd	ухудшаться со временем
delay		запаздывание, задержка
depend on		зависеть от
direction of approach		направление подхода к точке измерения
engineering units		инженерные единицы измерения
error band		интервал значений погрешностей
first-order lag		запаздывание первого порядка, линейное запаздывание
full scale		полная шкала (показаний)
give a fast response		иметь малое время отклика
make reading		снимать показание
measuring point		точка измерения
measuring span		диапазон измерений
mechanical backlash	mı'kǽnık(ə)l	механический люфт
occur	ə'kə:	происходить, иметь место
operate under specified conditions		работать, функционировать в заданных условиях эксплуатации
overshoot		выход за установленные пределы; заход за шкалу;
percentage	pə'sentıʤ	процент, процентное содержание
physical quantity		физическая величина
resolution		разрешение
second order response		отклик второго порядка
sensitivity		чувствительность (прибора)
sensor		датчик
span error		погрешность диапазона, ошибка шкалы

specified accuracy		нормативная точность
speed of response		скорость срабатывания, быстродействие
stiction		статическое трение
tolerate		допускать (значение) параметра
transducer	tŕænz'djusə	первичный измерительный преобразователь
transmitter		датчик
turndown		диапазон изменения (параметра)
value measured ~		числовое значение (переменной) измеренное значение
variable measured ~ process ~	'vɛərɪəbl	переменная (величина) измеряемая переменная регулируемая переменная
wire wound potentiometer	'waɪə	проволочный потенциометр
zero shift		смещение нуля; уход нуля

UNIT 6

angle acute ~ adjacent ~ alternate ~ angular point arms of ~ complementary ~ obtuse ~ reflex ~ right ~ straight ~ supplementary ~	 ə'kju:t ə'ʤeɪs(ə)nt 'æŋgjulə ,kɔmplɪ'mentərɪ əb'tju:s ,sʌplɪ'mentərɪ	угол острый ~ смежный ~ накрест лежащий ~ вершина угла лучи угла дополнительный до 90° ~ тупой ~ угол отражения прямой ~ развёрнутый ~ дополнительный до 180° ~
bisector	baɪ'səktə	биссектриса
convex	'kɔn'veks	выпуклый
curvature centre of ~ radius of ~	'kə:veʧə 'reɪdjəs	кривизна центр кривизны радиус кривизны
finite element analysis	'faɪnaɪt ə'næləsɪs	метод конечных элементов

line curved ~ straight ~		линия кривая ~ прямая ~
numerical method		численный метод
point of contact		точка касания
polygon	'pɔlɪgən	многоугольник
prompt		подсказка
ray pencil of rays		луч пучок лучей
symmetry axial (line) ~ axis of ~ central (point) ~ point of ~ symmetrical figure	 'ǽksɪəl sɪ'metrɪk(ə)l	симметрия осевая ~ ось ~ центральная ~ точка ~ симметричная фигура
tangent to curve	'tǽnʤ(ə)nt	касательная к кривой
triangle acute-angled ~ altitude base cathetus (pl. catheti) equilateral ~ exterior angle hypotenuse interior angle isosceles ~ obtuse-angled ~ median right-angled ~ sides (legs)	 'ǽltɪtju:d 'ɪkwɪ'lǽt(ə)r(ə)l ɪk'stərɪə haɪ'pɔt(ə)nju:s ai's⊃s(ə)lı:z əb'tju:s 'mɪdɪən	треугольник остроугольный ~ высота основание катет (катеты) равносторонний ~ внешний угол гипотенуза внутренний угол равнобедренный ~ тупоугольный ~ медиана прямоугольный ~ стороны
vertex (pl. vertices)	'və:teks	вершина (вершины)

UNIT 7

ancient	'eɪnʃ(ə)nt	древний
brick		кирпич
cone truncated ~	 'trʌnkeɪtɪd	конус усечённый ~

cylinder	'sılındə	цилиндр
edge		ребро
face lateral ~		грань боковая ~
hollow		полый, пустотелый
prism oblique ~ rectangular ~ right ~	 ə'blı:k rek'tæŋgjulə	призма наклонная ~ прямоугольная ~ прямая ~
pyramid regular ~ quadrilateral ~	'pırəmıd ˌkw⊃drı'læt(ə)r(ə)l	пирамида правильная ~ четырёхугольная ~
rectifier	'rektıfaıə	выпрямитель
section		сечение
solid	's⊃lıd	сплошной, тело

UNIT 8

aerial	'ɛəгıəl	антенна
although	⊃:l'əʊəu	хотя
amount		величина, количество
application		применение
at least		по крайней мере
continuous		длительный
former		прежний, предыдущий
hence		следовательно
however		однако
in spite of		вопреки
inventor		изобретатель
involve		вовлекать
link		соединять, связывать
liquid	'lıkwıd	жидкость
melt		плавиться
minute	maı'nju:t	крошечный
nevertheless		тем нее менее
particle		частица
push	puʃ	толкать

share		доля, делить, распределять
similar		подобный
since		с тех пор
solid		твёрдое тело
statement		утверждение
suppose		предполагать
switch		выключатель
terminal		зажим, вывод
vice versa		наоборот
while		в то время как; наряду с тем, что

UNIT 9

actuating cylinder		силовой цилиндр
actuating mechanism		исполнительный механизм
actuating pressure		рабочее давление
armature		якорь
brush	brΛʃ	щётка
detecting element		чувствительный элемент
damp		затухать
diffused light		рассеянный свет
efforts exerted		приложенные усилия
estimated performance		расчётная характеристика
flat-topped wave form		волна с уплощённой формой
forced cooling		принудительное охлаждение
hazardous		опасный
gradually		постепенно
grinding machine		дробилка
purify	'pjuərıfaı	очищать
reacting region		область взаимодействия
recording mechanism		записывающий механизм
ripple		колебания
roast	rəust	жарить
substance	'sΛbst(ə)ns	вещество
succession		последовательность
thermionic valve	vǽlv	термоэлектронный диод
turn round		вращаться

unidirectional		однонаправленный
uniformly	'ju:nıfɔ:mlı	однородно
upgrade		переводить в более высокую категорию
variety	və'raıətı	разнообразие

UNIT 10

apply to signals		применять к сигналам
as well as		тоже, также
at any rate		по крайней мере, во всяком случае
be essential for		быть важным для
break a circuit		разрывать цепь
by means of		посредством, при помощи
carry out		выполнять , осуществлять
carry the current		передавать ток
cause		причина
change in magnitude		изменять значение
circuit diagram	'sə:kıt 'daıəgrǽm	принципиальная схема; электрическая схема;
common reference point		общая начальная точка
complete circuit	kəm'plı:t	замкнутая цепь; замкнутый контур
compute		вычислять, подсчитывать
conducting circuit		токопроводящая цепь
consistent	kən'sıst(ə)nt	последовательный,
consumer	kən'sju:mə	потребитель
cross-section		поперечного сечения
effect	ı'fekt	результат
electric charge		электрический заряд
enable smth / smb to do smth		позволять (давать возможность) чему-либо/кому-либо делать что-либо
essential definition		основополагающие определения
flow through		протекать по
high-voltage cable		высоковольтный кабель
magnitude of the charge		величина заряда

move along current path		перемещаться по токовой цепи
power supply		источник питания
reach smth		достигать чего-либо
readings		показания (прибора)
reduce the number of wires		уменьшить количество проводников
relationship between		отношение между
require		требовать
reverse in direction	rı'və:s	изменять направление
sparking		искрение; проскакивание искр
strictly speaking		строго говоря
supply		поставлять, обеспечивать
terminal of the device		клеммы устройства
utilization	,ju:tılaı'zeıʃ(ə)n	применение, использование
voltage average ~ instantaneous ~ various ~	,ınstən'teınıəs	напряжение среднее ~ мгновенное ~ различное ~
with respect to (wrt)		по отношению к

UNIT 11

attain	ə'teın	достигать
basic properties		основные свойства
be ahead in phase		опережать по фазе
be associated with		быть связанным с
be in quadrature	'kwɔdrətʃə	со сдвигом фаз на 90 град.
by contrast		в отличие от этого, напротив
change in amplitude		изменять амплитуду
chemicals in the battery		химические вещества в элементе (электрической батарее)
coincide with	,kəuın'saıd	совпадать с…
complete one cycle		завершить один цикл
comprise		составлять
consider		считать, полагать. рассматривать
consider simultaneously		рассматривать одновременно

distinguish smth from smth		отличить, разграничить
duration		длительность, продолжительность
elapse	ɪ'læps	истекать (о времени)
electrical quantity		электрическая величина; электрический параметр
form a sine wave		образовывать, формировать синусоиду
graphical depiction of		графическое представление, изображение
in addition to		в дополнение к
in order to		для того, чтобы
lag behind		отставать по фазе
measurable value		измеряемая величина
obtain steady conditions		достигать устойчивого состояния
particular instant of time		определенный момент времени
pass through one complete cycle		проходить, претерпевать один полный цикл
plot against time		изображать зависимость от времени
power a load		подавать питание на нагрузку
power source		источник питания
reciprocal of frequency	rɪ'sɪprək(ə)l	величина, обратная частоте
recur	rɪ'kə:	возвращаться (к прежним величинам)
refer to		иметь в виду
regular waveform		(колебательный) сигнал правильной формы
remain		оставаться, пребывать в прежнем состоянии
rotate		вращаться
same direction		одно и то же направление
same instantaneous value		одинаковые, те же самые мгновенные значения
smooth changes		плавные изменения
succession of identical cycles		последовательность идентичных циклов
vary in a periodic manner		изменяться периодически

voltage		напряжение
~ amplitude		амплитуда ~
decay of ~		понижение ~
develop ~		вырабатывать ~
effective ~		действующее ~
growth of ~		рост, увеличение ~
output a constant ~		вырабатывать постоянное ~
root mean square (rms) ~		среднеквадратичное ~

UNIT 12

allow		позволять
decay		затухание
dissipate	'dɪsɪpeɪt	рассеивать
exceed		превышать
expect		ожидать
evince	ɪ'vɪns	ясно показывать
flux-linkage		потокосцепление
frequent		частый
hyphen	'haɪf(ə)n	дефис
immediately		немедленно
neighbourhood		окружение
negligible	'neglɪʤəbl	пренебрежимый, незначительный
ordinary		обычный
origin		начало, происхождение
oscillate		колебаться
oscillator		вибратор
possess		обладать
profound effect		чрезвычайный/сильный эффект
property		свойство
rely		полагаться
respectively		соответственно
suppress		подавлять
tape		измерительная лента
tend		иметь тенденцию
therefore		следовательно
tune		настраивать

UNIT 13

approach		подход, подходить
band		диапазон
compare		сравнивать
constitute		составлять, основывать
deafen	'def(ə)n	заглушать
deepen		углублять
digital	'dɪʤɪt(ə)l	цифровой
moderate		умеренный
noise		шум
occur		случаться
pivot	'pɪ:vət	штырь, вертеться вокруг оси
reason		причина, обосновывать
spark		искра
spread		распространяться
specimen	'spesɪmɪn	образец
traverse	'trǽvə:s	препятствие, пересекать
variety	və'raɪətɪ	разнообразие
waste		растрата, потеря, терять даром

UNIT 14

a set of contacts		набор контактов
amount of current		количество тока
as a matter of fact		на самом деле
as for		что касается
at last		наконец-то
at least		по крайней мере
be at rest		быть в состоянии покоя
be familiar among		быть известным среди
be of great practical importance		представлять большую практическую ценность
be provided with		быть обеспеченным
cannot do without		нельзя обойтись без
circumference		окружность

conducting metal lead		концевые выводы из токопроводящего металла
conduction		теплопроводность
dangerous		опасный
decrease efficiency		понижать производительность
depend on (upon)		зависеть от
detect current		обнаруживать, выявлять ток
expand	ɪk'spǽnd	расширяться
fixed to		прикрепленный к
flow along the wire		протекать по проводнику
give off		излучать, выделять
heat develop /generate/ produce ~ give up ~		тепло вырабатывать тепло отдавать тепло
in the case of		в случае с
manifestation of	ˌmǽnɪfes'teɪʃ(ə)n	проявление
marked difference in		заметная разность в
meet industrial requirements		удовлетворять требованиям промышленности
minute		очень маленький
needless to say		нет необходимости говорить
on the contrary		наоборот
overloaded wire		перегруженный провод
owing to		благодаря
principal effect of current		основное воздействие (влияние) тока
project	'prɔʤekt	выступать наружу
provided /providing (that)		при условии, что
remove		удалять
resistor composition ~ film ~ fixed ~		резистор композиционный ~ постоянный ~ плёночный ~
rotor winding		обмотка ротора
spring-loaded carbon brush		угольная щётка, прижимаемая

		пружиной
stationary part of the machine		неподвижная часть машины
undesirable		нежелательный
vice versa		наоборот
waste of useful energy		потери полезной энергии
wiper of the pot	'waɪpə	подвижный контакт; движок (потенциометра)

UNIT 15

allow to		позволять
bias	'baɪəs	подавать напряжение смещения; подавать электрическое смещение
block diagram		блок-схема; блочная диаграмма
bridge rectifier		выпрямитель по схеме моста
carrying capacity of the wire		допускаемая сила тока для провода; предельно допустимая нагрузка на провод
cause smth		явиться причиной чего-либо, вызывать что-либо,
circuit break /open ~ close ~ parallel ~ series ~ short ~ smoothing ~ stabilizing ~	'steɪbɪlaɪzɪŋ	цепь; контур; разорвать, разомкнуть ~ замкнуть ~ разветвлённая ~ последовательная ~ короткозамкнутая ~ сглаживающая схема (контур) стабилизирующий контур (цепь)
connect ~ in parallel with ~ in series with		соединять ~ параллельно ~ последовательно
danger of		опасность
discrete component	dɪ'skrɪ:t	дискретный компонент
double-pole switch		двухпозиционный (двухполюсный) переключатель
fault		неисправность, обрыв

cable ~ wire ~		повреждение в кабеле обрыв провода
fuse ~ blows ~ melts		предохранитель перегорать (о предохранителе) расплавляться (о предохранителе)
generally speaking		в сущности говоря, в общем случае
gratuitous		неуместный, неприемлемый
heatsink		теплоотвод
in turn		по очереди, последовательно
insulation		изоляция
internal resistance		внутреннее сопротивление источника
live side of the supply		сторона источника питания, находящаяся под напряжением
load		нагрузка
maintain a constant voltage		поддерживать постоянное напряжение
mount on		устанавливать, монтировать на
otherwise		в противном случае, иначе
portable equipment	'pɔ:təbl	переносное, портативное оборудование
purpose of		цель
remove the fluctuations	ˌflʌktʃu'eɪʃ(ə)n	устранять колебания
restrict sth to	rɪs'trɪkt	ограничивать что-либо до
result from		происходить из-за
safety device		устройство защиты; предохранитель
set fire to		поджигать, зажигать
turn attention to		обратить внимание на
under such conditions		в таких условиях
zener diode	'daɪəud	диод Зенера; стабилитрон

UNIT 16

acquired qualities	ə'kwaɪəd	приобретенные свойства
alloy	'ǽlɔɪ	сплав
arrange in an orderly way	ə'reɪnʤ	располагаться организованно, упорядоченно
attracting power		притягивающая сила
be confined to		сводиться к чем-л.; ограничиваться чем-л.
carry out experiments on		проводить опыты по
coercivity		коэрцитивность
compound with useful properties		элемент с полезными свойствами
curve knee of the ~ slope of the ~		кривая, график кривая намагничивания излом, изгиб кривой наклон кривой
density flux ~		плотность магнитная индукция; плотность магнитного потока
divide into		делить на
eddy currents		вихревые токи
electric conductivity	,kɔndʌk'tɪvɪtɪ	удельная электропроводность
ferrites		ферриты
garnet	'ga:nɪt	гранат (камень)
have difficulty in		иметь сложности с
hysteresis ~ loop ~ loss exhibit magnetic ~		гистерезиса петля гистерезиса потери на гистерезис проявлять магнитный гистерезис
imposed field		наложенное поле
in order to		для того, чтобы
increase	ɪn'kri:s	повышать, увеличивать
instead of		вместо
level off		выравниваться, достигать равновесия
namely		а именно

peak		достигать высшей точки развития
permeability initial ~ relative ~	,pə:mjə'bɪlɪtɪ	магнитная проницаемость; проникающая способность начальная магн. проницаемость относительная магн. прон-сть
plummet	'plʌmɪt	резко падать, резко уменьшаться
practical application of		практическое применение (использование)
prove		доказать
pull away	pul	отрывать, оттаскивать
recover		восстанавливаться, возвращаться к первоначальному состоянию или значению
relation between smth and smb		отношение между
remanence		остаточная магнитная индукция; остаточная намагниченность;
retain	rɪ'teɪn	сохранять, удерживать
saturation	,sǽʧə'reɪʃ(ə)n	насыщение магнитного материала
sense		направление, ориентация
step forward in		шаг вперед в
substitute smth with		заменить что-то на
surface tension		поверхностное натяжение
take interest in		заинтересоваться
trace out a loop		чертить, вычерчивать петлю
treatment of oversaturated solutions with		обработка перенасыщенных растворов
under the influence of		под влиянием
various	'vɛərɪəs	различный
wide range of		широкий набор
withdraw from the magnetic field	wɪð'drɔ:	извлекать из магнитного поля

UNIT 17

adapt		принимать
attached		соединённый

attic	'ætık	чердак
pie chart	'paı'ʧɑ:t	гистограмма
convenient		удобный
deflect		отклонять
indicating instrument		стрелочный прибор
look for		искать
mixture		смесь
majority		большинство
particularly		особенно
permanently mounted		смонтированный навсегда
pointer	'pɔıntə	стрелка
portable	'pɔ:təbl	переносной
rarely		редко
renewable energy		возобновляемая энергия
restrain	rıs'treın	сдерживать, обуздывать
ribbon	'rıben	лента
similarity	sımı'lærıtı	подобие
sliding contact	'slaıdıŋ	скользящий контакт (ползун)
thermocouple		термопара
tiny	'taını	крошечный
wave shape		форма волны

UNIT 18

bar chart		гистограмма
decline	dı'klaın	падение, идти к концу
eliminate	ı'lımıneıt	устранять, ликвидировать
fraction		дробь, часть
improve		улучшать
sensitivity	,sensı'tıvıtı	чувствительность
sink		колодец
shunt	ʃʌnt	шунт
spike	spaık	выброс
temporary		временный
twisted	'twıstıd	скрученный
vane	veın	крыло

UNIT 19

at a steady rate		постоянно
be detriment to	'detrımənt	наносить ущерб
be in development		находиться на стадии развития
contain the greenhouse gases		удерживать парниковые газы
crude oil	kru:d	сырая, неочищенная нефть
emission give off ~ harmful ~		выброс загрязняющих веществ в атмосферу выбрасывать в атмосферу вредные выбросы
energy source nonrenewable ~ renewable ~ well-established ~		источник энергии невозобновляемый ~ возобновляемый ~ установившийся, (традиционный) ~
environmental law		закон по охране окружающей среды
fossil fuels	'fɔs(ə)l	ископаемое топливо
keep from		удерживать, препятствовать попаданию
primarily	'praım(ə)rılı	главным образом
process smth into smth		перерабатывать что-то в
put into practice		вводить что-л. в силу; проводить что-л. в жизнь
radioactive waste		радиоактивные отходы
reduce		уменьшить, сократить
refine		очищать
release energy	rı'lı:s	высвобождать энергию
result in		повлечь за собой; приводить к
run smoothly	'smu:ðlı	работать безотказно
seek after		стремиться к чему-либо
split		расщеплять (атом)
store energy		накапливать энергию
use up		израсходовать

UNIT 20

affect smth	ə'fekt	оказывать влияние на
avoid doing smth		избежать выполнения чего-либо
back-up		резервная установка
be derived from		полученный, извлеченный из
be suitable for		быть подходящим для
by-product		побочный продукт
calorific value	ˌkælə'rɪfɪk	энергетическая ценность, удельная теплота сгорания
capacity factor		коэффициент использования мощности
charcoal	'ʧa:kəul	древесный уголь
come up with an idea		предложить идею
commercial use	kə'mə:ʃ(ə)l	промышленное применение
concern over		беспокойство из-за, по поводу
consider smth as		рассматривать что-либо в качестве
contribute		вырабатывать
contribute to		способствовать чему-либо
create the possibility		создавать возможность
current electricity demand		потребности в электроэнергии
dovetail with	'dʌvteɪl	сочетаться с
estimated cost of		оценочная стоимость; расчётная стоимость
exhaust	ɪg'zɔ:st	истощать, исчерпывать
experience		претерпевать, испытывать на себе воздействие чего-либо
fail		выходить из строя
five times		в 5 раз больше
float above the ground		парить над землей
gain attention		привлекать внимание
get energy from		получать, извлекать энергии из
harvest energy		получать электроэнергию
high energy fuel		высокоэнергетическое топливо
in terms of		с точки зрения
involve smth / doing smth		предполагать что-либо,

		выполнение чего-либо
lightning bolt	'laɪtnɪŋ bəult	вспышка молнии
location for		место расположения для
maintain properly		обслуживать должным образом, поддерживать в рабочем порядке
mean wind speed		средняя скорость ветра
offshore resources	ˌɔfˈʃɔ:	ресурсы, находящиеся в открытом море
particulate pollution		загрязнение мелкими частицами
pose a risk for		быть угрозой для
rated power		номинальная мощность
relatively		относительно
require		потребовать
residential supply line	ˌrezɪ'denʃ(ə)l	линия электропитания жилых массивов
residue from	'rezɪdju:	отходы, остатки
restoration of waste land	ˌrestə'reɪʃ(ə)n	восстановление бросовых земель
run wind turbine		приводить в движение ветряную турбину
solid biomass	'baɪəuməs	твердая биомасса
take up		занимать, поглощать
underwater current		подводное течение
utilize	'ju:tɪlaɪz	применять, использовать
windmill		ветроэнергетическая установка

UNIT 21

annually		ежегодно
bulge	bʌlʤ	выпуклость
clue	klu:	клубок, ключ
commitment	kə'mɪtmənt	вручение, обязательство
conventional		традиционный
derive		выводить
distinct	dɪs'tɪŋkt	отчётливый, ясный
dovetail	'dʌvteɪl	стыковаться
economically expedient		экономически целесообразный

entirely		полностью
essential		существенный
fail		неудача, провал
flexible		гибкий
fluctuation	ˌflʌkʧu'eɪʃ(ə)n	качание, колебание
forecast		предсказывать
harness	'hɑ:nɪs	запрягать, использовать
harvest		урожай, собирать урожай
latitude		широта
medium	'mɪdɪəm	среда
narrow		узкий, узкая часть
off-grid		вне сети
pollution		загрязнение
predict	prɪ'dɪkt	предвидеть
predictable	prɪ'dɪktəbl	предсказуемый
profit	'prɔfɪt	польза, выгода
recently		недавно
replenish	rɪ'plenɪʃ	пополнять
run out		выбегать, иссякать
rural	'ruər(ə)l	сельский
slightly	'slaɪtlɪ	слегка
submerge	səb'mə:ʤ	погружать
surpass	sə:'pɑ:s	превысить
tidal	'taɪdl	приливной
wild	waɪld	дикий