АНГЛИЙСКИЙ ЯЗЫК

для инженеров:
ЭЛЕКТРОЭНЕРГЕТИКА

Учебное пособие

Рекомендовано УМО РАЕ по классическому университетскому и техническому образованию в качестве учебного пособия для студентов высших учебных заведений, обучающихся по направлениям подготовки: 13.03.02 – «Электроэнергетика и электротехника» (Профиль подготовки: «Электроснабжение»), 35.03.06 – «Агроинженерия» (Профиль подготовки: «Электрооборудование и электротехнологии в сельском хозяйстве»).

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Пособие предназначено для обучения студентов специальной лексике, формирования навыков работы с иноязычным профессионально-ориентированным текстом, а также навыков коммуникации в профессиональной сфере. Разработано в соответствии с требованиями ФГОС ВО по направлениям подготовки 13.03.02 «Электроэнергетика и электротехника», 35.03.06 «Агроинженерия».

Для студентов высших учебных заведений (уровень бакалавриата).

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FOREWORD

Учебное пособие предназначено прежде всего для студентов вузов электроэнергетических направлений подготовки, изучающих иностранный язык на уровне бакалавриата. Рекомендовано для студентов, изучавших английский язык в средней школе или средних профессиональных учебных заведениях и имеющих базовые знания английского языка.

Цель учебного пособия заключается в формировании навыков чтения специальной литературы с целью получения информации, реферирования и перевода литературы по специальности, а также совершенствовании навыков и умений устной и письменной иноязычной речи на базе профессиональной лексики.

Пособие состоит из шести тематических разделов: «Ток и электрические цепи», «Принципиальные схемы и элементы цепи», «Производство электроэнергии», «Передача электроэнергии», «Потребление электроэнергии», «Современные технологии в электроэнергетике». Каждый раздел включает в себя тексты, словарный минимум, упражнения, направленные на совершенствование лексико-грамматических и коммуникативных навыков, а также навыков чтения и перевода.

В конце пособия приведены клише для реферирования текстов и контрольные задания по темам и разделам пособия, которые могут быть использованы студентами самостоятельно с целью самоконтроля, а также аудиторно преподавателем для проведения словарных диктантов.

Пособие рекомендовано для студентов очной и заочной форм обучения.

PART 1.
CURRENT AND CIRCUITS

Unit 1. Electricity

Vocabulary

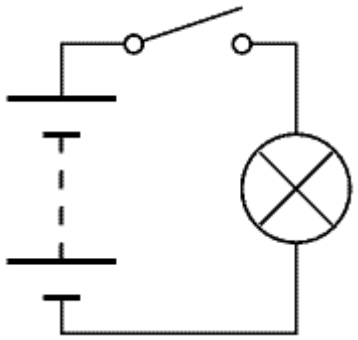
battery	батарея
to break	размыкать
break	обрыв, разрыв (цепи)
broken	разомкнутый
broken circuit	разомкнутая цепь
to burn out	перегорать
cell	гальванический элемент, батарейка
charge	заряд
complete circuit	замкнутая цепь
component	элемент цепи
connection	соединение
current	(электрический) ток; сила тока
diagram	схема, чертеж
(electric) circuit	электрическая цепь
electricity	электричество
energy	энергия
flow	поток, протекание (тока)
lead	вывод (детали)
power supply	источник (электро)питания; электро-снабжение
short	короткое замыкание
switch	выключатель, переключатель
voltage	напряжение
voltage source	источник напряжения
wire	проволока, провод
wrong connection	ошибочное соединение

Text

Electricity is the flow of charge around a circuit carrying energy from the battery (or power supply) to components such as lamps and motors.

Electric current can flow only if a circuit is complete. Electric current flows through wires from the battery to circuit components and back to the battery again.

The diagram shows a simple circuit. The components of the circuit are a battery, wires, a switch and a lamp. The switch works by breaking the circuit.



When the switch is open the circuit is broken, electricity cannot flow and the lamp is off. With the switch closed the circuit is complete allowing electricity to flow and the lamp is on.

What is "open circuit"?

We say "open circuit" when there is no connection. "Open circuit" is a break in some part of a circuit (for example a switch in the open or off position) or a fault (for example a broken wire or burnt out component).

What is "short circuit"?

A "short circuit" is a connection with very low resistance such as a wire which provides a very easy way for current. A short circuit is a fault or wrong connection.

For example, if the battery leads contact one another they create a connection with very low resistance and make a short circuit. Current will flow though this short circuit instead through the circuit. This stops the circuit working. Short circuit can be the cause of a fire, because large current flows through the leads and the battery, and they will become very hot.

Voltage and current (complete circuit)

Current can flow when the switch is closed and the circuit is complete. The lamp is glowing.

Voltage but no current (open circuit)

Current cannot flow because the switch is open and the circuit is broken. The lamp is not glowing.

No voltage and no current (open circuit, no voltage source)

Current cannot flow because without the cell there is no source of voltage. The lamp is not glowing.

Exercise 1. Answer the questions

1. What is electricity?
2. What circuit is called complete?
3. What happens if a short circuit takes place in an electric circuit?
4. What are the basic components of any electric circuit?
5. In which circuit can there be voltage but no current?

Exercise 2. Translate into English

1. Когда переключатель выключен, цепь разомкнута и лампа не горит.
2. Когда переключатель включен, электричество течет по цепи и лампа горит.
3. Если лампа перегорает, цепь размыкается.
4. Электрический ток течет через провода от батареи к элементам цепи и назад к батарее.
5. Короткое замыкание может быть причиной пожара.

Unit 2. Types of current

Vocabulary

alternating	переменный (ток)
to apply	применять, прилагать
to consider	рассматривать, обсуждать
cycle	цикл
direct	постоянный (ток)
direction	направление
frequency	частота
mains electricity	сетевое электричество
necessary	необходимый, нужный
provided (that)	при условии, что

sine wave	синусоидальная волна
single-phase	однофазный
three-phase	трехфазный
to use	использовать

Text

Current is flow of electricity through a circuit. Let us consider two main types of current: direct and alternating. Direct current (DC) flows through a conducting circuit in one direction only. It flows provided a direct voltage source is applied to the circuit. The current from a cell is direct current.

Alternating current (AC) is current that changes its direction of flow through a circuit. It flows provided an alternating voltage source is applied to the circuit. The electricity supplied to homes and other buildings – called mains electricity – is alternating current. Alternating current flows in cycles. The number of cycles per second is called the frequency of the current. For example, in the UK, AC supply is 50 Hz – it alternates 50 times per second.

The current supplied to most homes is single-phase – it forms one sine wave. In factories and large buildings, which have powerful electrical equipment, the supply if often three-phase – effectively three currents, each with a different phase (timing). This provides a smoother supply as it reduces the gaps between the voltage peaks.

It is easy to transform AC power from one voltage to another using a transformer. Transformers are also used to step down the voltage at the receiving point of the line to the low values that are necessary for use.

AC can be changed into DC but this is seldom necessary.

Exercise 1. Answer the questions

1. What is current?
2. What types of current do you know?
3. What type of current is called alternating current?
4. What type of current is called direct current?
5. What is the frequency of the current?

6. What device is used to transform AC power from one voltage to another?

7. Is it often necessary to change AC into DC?

Exercise 2. Choose the correct answer

1. DC is current that …	a) changes its direction of flow b) flows in one direction
2. AC flows provided …	a) a direct voltage source is applied b) an alternating voltage source is applied
3. The 50 Hz alternating current …	a) flows in one direction 50 times per second b) flows in one direction 50 times and in the other direction 50 times per second
4. AC …	a) can be changed into DC b) cannot be changed into DC

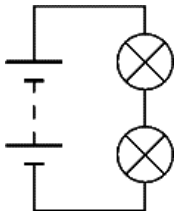
Unit 3. Parallel and series circuits

Vocabulary

to add up	складываться, суммироваться
to blow	перегорать (об электроприборах)
to complete circuit	замыкать цепь
to connect	соединять
to go out	погаснуть
identical	одинаковый, идентичный
milliampere, mA	миллиампер
mixed connection	смешанное соединение
parallel connection	параллельное соединение
series connection	последовательное соединение
supply voltage	напряжение питания
volt, V	вольт (единица измерения напряжения, э.д.с.)

Text

There are two ways of connecting circuit components:

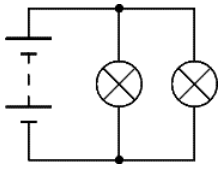


1. Connection in series

When components are connected in series each component has the same current.

The battery voltage is divided between the two lamps. Each lamp will have half the battery voltage if the lamps are identical.

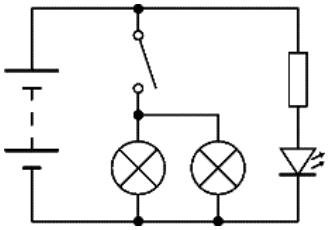
2. Connection in parallel



When components are connected in parallel each component has the same voltage.

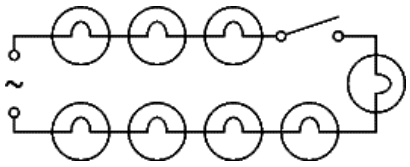
Both lamps have the full battery voltage across them. The battery current is divided between the two lamps.

Most circuits contain a mixture of series and parallel connections. The terms series circuit and parallel circuit are sometimes used, but only the simplest of circuits are entirely one type or the other. It is better to refer to specific components and say they are connected in series or connected in parallel.



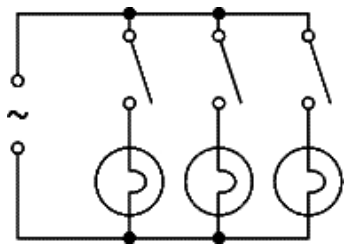
For example, the circuit shows a mixed connection: a resistor and LED are connected in series (on the right) and two lamps are connected in parallel (in the centre). The switch is connected in series with the two lamps.

Lamps in series



If several lamps are connected in series they will all be switched on and off together by a switch connected anywhere in the circuit. The supply voltage is divided equally between the lamps (if they are all identical). If one lamp blows, all the lamps will go out because the circuit is broken.

Lamps in parallel

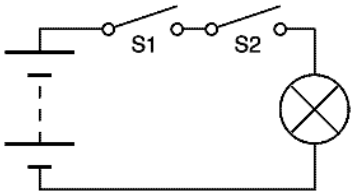


If several lamps are connected in parallel each one has the full supply voltage across it. The lamps may be switched on and off independently by connecting a switch in series with each lamp as shown in the circuit diagram. This arrangement is

used to control the lamps in buildings. This type of circuit is often called a parallel circuit but the switches are in series with the lamps, and it is these switch and lamp pairs that are connected in parallel.

Switches in series

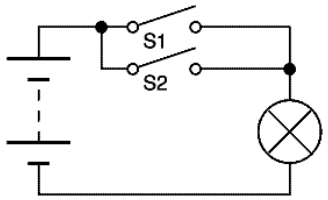
If several on-off switches are connected in series they must all be closed (on) to complete the circuit.



The diagram shows a simple circuit with two switches connected in series to control a lamp. Switch S1 and switch S2 must be closed to light the lamp.

Switches in parallel

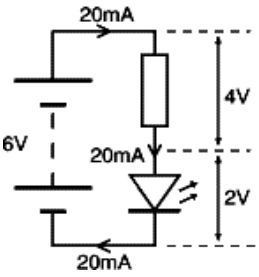
If several on-off switches are connected in parallel only one needs to be closed (on) to complete the circuit.



The diagram shows a simple circuit with two switches connected in parallel to control a lamp. Switch S1 or switch S2 (or both of them) must be closed to light the lamp.

Voltage and current for components in series

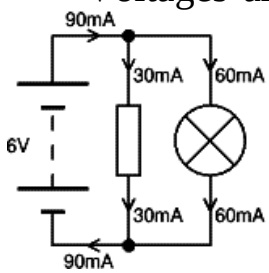
Voltages add up for components connected in series. Currents are the same through all components connected in series.



For example, in this circuit the 4V across the resistor and the 2V across the LED add up to the battery voltage: 2V + 4V = 6V. The current through all parts (battery, resistor and LED) is 20mA.

Voltage and current for components in parallel

Voltages are the same across all components connected in parallel. Currents add up for components connected in parallel.



For example, in this circuit the battery, resistor and lamp all have 6V across them. The 30mA current through the resistor and the 60mA current through the lamp add up to the 90mA current through the battery.

Exercise 1. Answer the questions

1. What ways of connecting circuit components are there?

2. What type of connection is used more frequently?

3. What happens if one of the lamps connected in series blows?

4. What type of connection should be used for lamps to be switched on and off independently?

5. In which type of connection do components have the same voltage across them?

Exercise 2. Find in the text above the English equivalents of the following word combinations

1. простейшие цепи; 2. делить поровну; 3. замыкать цепь; 4. двухпозиционный выключатель; 5. зажечь лампу; 6. пара «переключатель – лампа»; 7. половина напряжения батареи.

Unit 4. Conductors and insulators

Vocabulary

cheap	дешевый
common	общий, распространенный
conductor	проводник
copper	медь
to decrease	уменьшаться
difficulty	трудность
to increase	возрастать, увеличиваться
insulator	изолятор
load	нагрузка
load resistance	сопротивление нагрузки
make smb do smth	заставить кого-л. сделать что-л.
resistance	сопротивление
resistance material	резистивный материал
rubber	резина
since	так как
thus	так, таким образом
voltage drop	падение напряжения

Text

Conductors are materials having a low resistance so that current easily passes through them. The lower the resistance of the material, the more current can pass through it.

The most common conductors are metals. Silver and copper are the best of them. The advantage of copper is that it is much cheaper than silver. Thus, copper is widely used to produce wire conductors. One of the common functions of wire conductors is to connect a voltage source to a load resistance. Since copper wire conductors have a very low resistance, a minimum voltage drop is produced in them. Thus, all of the applied voltage can produce current in the load resistance.

It should be taken into consideration that most materials change the value of resistance when their temperature changes.

Metals increase their resistance when the temperature increases while carbon decreases its resistance when the temperature increases. Thus, metals have a positive temperature coefficient of resistance while carbon has a negative temperature coefficient. The smaller is the temperature coefficient or the less the change of resistance with the change of temperature, the more perfect is the resistance material.

Materials having a very high resistance are called insulators. Current passes through insulators with great difficulty. The most common insulators are air, paper, rubber, plastics.

Any insulator can conduct current when a high enough voltage is applied to it. Current of great value must be applied to insulators in order to make them conduct. The higher the resistance of an insulator, the greater the applied voltage must be.

When an insulator is connected to a voltage source, it stores electric charge and a potential is produced on the insulator. Thus, insulators have two main functions: to isolate conducting wires and thus to prevent a short between them; to store electric charge when a voltage source is applied.

Exercise 1. Answer the questions

1. What materials are called conductors?
2. What is the advantage of copper as compared to silver?

3. What is the most common function of wire conductors?

4. Why is a minimum voltage drop produced in copper conductors?

5. What is the relation between the value of resistance and the temperature in carbon?

6. What materials are called insulators?

7. What are the most common insulators?

8. What are the main functions of insulators?

Exercise 2. Choose the correct answer

1. Insulators are materials having …	a) low resistance b) high resistance
2. Current passes through conductors …	a) easily b) with great difficulty
3. Copper and silver are …	a) common insulators b) common conductors
4. Air, paper and plastics are …	a) common insulators b) common conductors
5. In case a high voltage is applied to an insulator …	a) it does not conduct current b) it conducts current
6. Insulators are used …	a) to reduce voltage b) to store electric charge
7. Metals have …	a) a positive temperature coefficient of resistance b) a negative temperature coefficient of resistance
8. Metals increase their resistance …	a) when the temperature decreases b) when the temperature increases

Unit 5. Electromotive force and resistance

Vocabulary

to consist (of)	состоять (из)
to depend (on)	зависеть (от)

electromotive force	электродвижущая сила
excess	избыток, излишнее количество
to influence	влиять
to measure	измерять, мерить
movement	движение
to offer resistance	оказывать сопротивление
on the other hand	с другой стороны
photocell	фотоэлемент
potential difference	разность потенциалов
to provide	предоставлять; обеспечивать; снабжать

Text

There is always a disorderly movement of free electrons within all substances, especially metals. Let us suppose that there is a movement of electrons through the wire, say, from point A to point B. What does it mean? It means that there is excess of electrons at point A. Unless there were a flow of electric current between A and B in any direction, it would mean that both the former and the latter were at the same potential. Of course, the greater the potential difference, the greater is the electron flow.

The electromotive force (EMF) is the very force that moves the electrons from one point in an electric circuit towards another. In case this EMF is direct, the current is direct. On the other hand, were the electromotive force alternating, the current would be alternating, too. The EMF is measurable and it is the volt that is the unit used for measuring it.

Current is unable to flow in a circuit consisting of metallic wires alone. A source of an EMF should be provided as well. The source under consideration may be a cell or a battery, a generator, a photocell, etc.

In addition to the electromotive force and the potential difference reference should be made here to another important factor that greatly influences electrical flow, namely, resistance. All substances offer a certain amount of opposition, that is to say, resistance to the flow of current. This resistance may be high or low depending on the type of circuit and the material employed. Take glass or rubber as an example. The offer a very high resistance and, hence, they are considered as good insulators. Nevertheless,

one must not forget that all substances do allow the passage of some current provided the potential difference is high enough.

Certain factors can greatly influence the resistance of an electric circuit. Among them there are the size of the wire, its length and type. The thinner or longer the wire, the greater is the resistance offered. Besides, silver wire would offer less resistance than an iron one.

Exercise 1. Put all possible questions to the following sentences

1. The excess electrons will flow towards the point of deficiency.
2. The parallel circuit provides two or more paths for current flow.

Exercise 2. Find in the text above the English equivalents of the following word combinations

1. тем не менее; 2. беспорядочное движение электронов; 3. оказывать сопротивление; 4. как первый, так и последний; 5. в случае, если; 6. используемый материал; 7. прохождение тока; 8. определенные факторы.

Unit 6. Inductance and mutual inductance

Vocabulary

ampere, A	ампер (единица измерения силы тока)
to bring	приносить
coil	катушка, обмотка
definite	определенный
fast	быстрый
high-frequency	высокочастотный
to induce	индуцировать
induced voltage	индуцированное напряжение
inductance	индуктивность
low-frequency	низкочастотный
mutual	взаимный
result from	происходить в результате, быть следствием

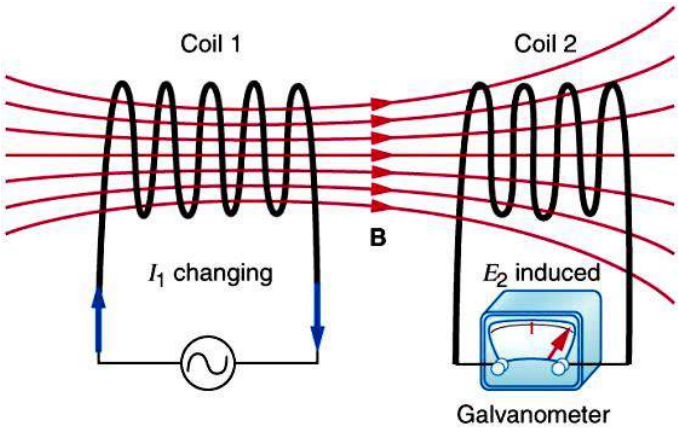
size	размер
terminal	клемма; ввод, вывод
that is	то есть
to touch	касаться, трогать
unit	единица
value	значение, величина

Text

Any conductor has some definite value of inductance. The inductance of a conductor shows how well it can provide induced voltage.

Elements of a circuit with a definite value of inductance are coils of wire called inductors. The inductance of a coil depends on its size and material. The greater the number of turns of a coil, the higher is its inductance. An iron core also increases the value of inductance. Coils of this type are used for low-frequency currents while coils with an air core are used for high-frequency currents.

The coils 1 and 2 are brought close together and a source of alternating current is applied to coil 1. If a measuring device is connected across the terminals of coil 2 it will be found that voltage is induced in this coil though the two coils do not touch. The secondary voltage, that is the voltage in coil 2, is called induced voltage and energy from one coil to the other transfers by induction. The coil across which the current is applied is called the primary, that in which voltage is induced is called the secondary. The primary and the secondary coils have mutual inductance. Mutual inductance is measured in the same unit as inductance, that is in henries.



Thus, when a rate of change of one ampere per second in the primary coil will produce one volt in the secondary coil, the two coils have one henry of mutual inductance.

It should be taken into consideration that induction by alternating current results from the change in current, not in the current value. The faster the current changes, the higher the induced voltage.

Exercise 1. Answer the questions

1. What are elements with a definite value of inductance called?
2. What does the inductance of a coil depend on?
3. What units is the value of mutual inductance measured in?
4. Do conductors have any value of inductance?
5. What does the inductance of a conductor show?
6. What type of coils is used for low-frequency currents?

Exercise 2. Choose the correct answer

1. Any conductor has …	a) some definite value of resistance b) some definite value of inductance
2. Any conductor can provide …	a) induced voltage b) electric power
3. Elements with a definite value of inductance are called …	a) inductors b) coils
4. The inductance of a coil depends on its …	a) size and material b) size, material, core, number of turns
5. An iron core …	a) increases the value of inductance b) decreases the value of inductance
6. The value of mutual inductance is measured in …	a) watts b) henries

PART 2.
CIRCUIT DIAGRAMS AND CIRCUIT COMPONENTS

Unit 1. Circuit diagrams and component layouts

Vocabulary

actual	фактический, реальный
to arrange	располагать, размещать
blob	маленький шарик
capacitance	емкость
circuit diagram	принципиальная схема
controls	элементы управления
to draw	чертить, рисовать
drawing	рисунок, чертеж
input	вход, ввод
junction	соединение
to label	помечать, обозначать
layout	расположение, компоновка
to make sure	убедиться, обеспечить
to omit	пропускать, не включать
output	выход, вывод
variable	переменный

Text

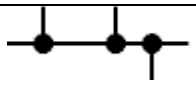
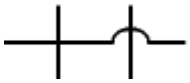
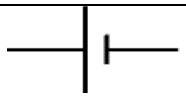
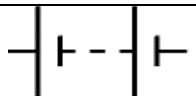
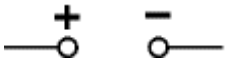
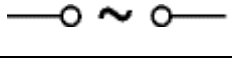
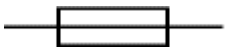
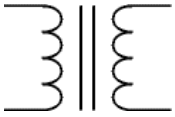
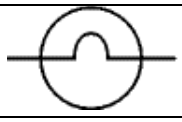
Circuit diagrams show how circuit components are connected together. Each component is represented by a symbol. All wires are shown as straight lines. The actual layout of the components is usually quite different from the circuit diagram. A circuit diagram is useful when testing a circuit and for understanding how it works. When drawing circuit diagrams:

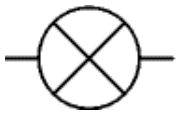
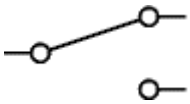
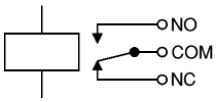
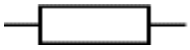
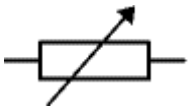
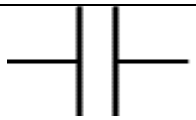
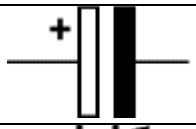
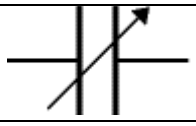
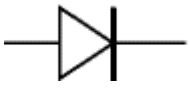
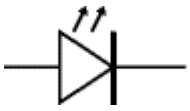
- Make sure you use the correct symbol for each component.
- Draw connecting wires as straight lines (use a ruler).
- Put a “blob” (•) at each junction between wires.

- Label components such as resistors and capacitors with their values.
- The positive (+) supply should be at the top and the negative (-) supply at the bottom. The negative supply is usually labeled 0V, zero volts.
- Try to arrange the diagram so that signals flow from left to right: inputs and controls should be on the left, outputs on the right.
- You may omit the battery or power supply symbols, but you must include (and label) the supply lines at the top and bottom.

In the table below you will find some circuit components, their symbols and their functions in circuits.

Table of circuit components

Component		Circuit symbol	Component function
Wires joined	провода соединены		Wires connect components and pass current from one part of a circuit to another.
Wires not joined	провода не соединены		
Cell	гальванический элемент, батарея		A cell supplies electrical energy.
Battery	батарея		A battery is two or more cells joined together.
DC supply	источник постоянного тока		Supplies electrical energy (direct current).
AC supply	источник переменного тока		Supplies electrical energy (alternating current).
Fuse	плавкий предохранитель		A safety device which will melt if the current flowing through it exceeds a specified value.
Transformer	трансформатор		Transformers are used to step up (increase) and step down (decrease) AC voltages.
Lamp (lighting)	лампа освещения		A lamp providing illumination.

Lamp (indicator)	сигнальная лампа		A lamp which is an indicator, for example a warning light on a car dashboard.
Motor	мотор		A motor converts electrical energy to kinetic energy (motion).
Coil	катушка		A coil of wire creates a magnetic field when current passes through it.
On-off switch	двухпозиционный переключатель (включено-выключено)		Current flows only when the switch is closed (on).
2-way switch	переключатель на два направления		A 2-way switch directs the flow of current to one of two routes according to its position.
Relay	реле		An electrically operated switch. NO = Normally Open COM = Common NC = Normally Closed
Resistor	резистор		Resistors limit the flow of current.
Variable resistor	переменный резистор		Variable resistors with two contacts are used to control current.
Capacitor (unpolarized)	неполярный конденсатор		Capacitors store electric charge.
Capacitor (polarized)	полярный конденсатор		These capacitors have large capacitance.
Variable capacitor	конденсатор переменной емкости		A variable capacitor is used in a radio tuner.
Diode	диод		Diodes allow current to flow in one direction only.
LED (Light Emitting Diode)	светодиод		LEDs convert electrical energy to light.

Exercise 1. Find in the text above the English equivalents of the following words and word combinations

1. преобразовывать энергию; 2. ограничивать течение тока; 3. сигнальная лампа; 4. приборная панель; 5. освещение; 6. предохранительное устройство; 7. превышать заданное значение; 8. чертить принципиальную схему; 9. прямая линия; 10. слева направо; 11. линия питания; 12. переключатель с электрическим приводом; 13. направлять ток; 14. соединенные провода; 15. повышать напряжение.

Exercise 2. Draw a circuit diagram of an electric circuit containing a cell and a variable resistor of 5Ω in series with a combination of two lighting lamps in parallel

Unit 2. Electric cells

Vocabulary

alkaline	щелочной
cell phone	сотовый телефон
charging	зарядка, подзарядка
chemical	химикат
consumer electronics	бытовая электроника
discharged	разряженный
electrolyte	электролит
energy capacity	энергоемкость
energy-to-weight ratio	удельная энергия по массе
to go flat	садиться (о батарейках, аккумуляторах)
laptop (computer)	ноутбук
lead-acid battery	свинцово-кислотная батарея
lead dioxide	диоксид свинца
lithium-ion battery	ионно-литиевая батарея
manganese oxide	оксид марганца
mercuric oxide	оксид ртути

mercury	ртуть
nickel-cadmium battery	никель-кадмиевая батарея
nickel-iron battery	никель-железная батарея
portable	портативный, переносной
potassium hydroxide	гидроксид калия
primary cell	первичный (гальванический) элемент
to react	реагировать
to recharge	перезаряжать
rechargeable	перезаряжаемый
to release	освобождать, высвобождать
remote control	пульт дистанционного управления
reverse direction	обратное направление
secondary cell	вторичный (аккумуляторный) элемент
solution	раствор
to start an engine	запустить двигатель
storage cell	аккумулятор
sulfuric acid	серная кислота
torch	фонарь(рик)
useful life	срок службы
vehicle	транспортное средство
wristwatch	наручные часы

Text

Electric cell is a device that stores electric energy in the form of chemical energy. All cells consist of an electrolyte (solution containing ions), positive electrode and negative electrode. Electricity is generated when the negative electrode (cathode) reacts with the electrolyte. During the reaction electrons are released. They move to the positive electrode (anode). The electric energy is released when a conductor is connected between the terminals of the cell. When the cell has no power to release electricity (when electrolyte has reacted fully), the cell is said to be discharged. Some types of cells can be recharged by passing current in reverse direction. This type of rechargeable cells is also called storage cell or secondary cell. Primary cells cannot be recharged.

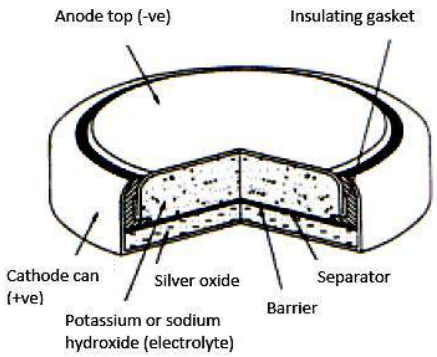
Let’s consider some basic types of electric cells.

Alkaline dry cells

One of the oldest types of primary cell used today is alkaline dry cell. This type of cell consists of a positive electrode made of manganese oxide (MnO) and a negative electrode made of zinc. The electrolyte is potassium hydroxide (KOH). Alkaline cells are widely used in radios, remote controls and torches. They can supply quite large currents for long periods.

Mercury cells

Mercury cells are made in the shape of a small disc to be used in small portable electronic devices. They can be used in wristwatches, calculators, etc. In these cells the negative electrode consists of zinc, while the positive electrode is made of mercuric oxide (HgO). The electrolyte is a solution of potassium hydroxide (KOH).



Silver oxide primary cells

Silver oxide positive electrode in the cell gives better voltage than mercury cells. They are also often made in the shape of a small disc.

Lead-acid battery

This is a secondary cell because it can be recharged. It generally consists of three or six cells connected in series. The electrolyte used is a solution of sulfuric acid (H_2SO_4), the negative electrode consists of lead (Pb) and the positive electrode is made of lead dioxide (PbO_2). This type of battery is used mostly in cars, trucks, air planes and other vehicles. Its major advantage is that it can give a very large electric current for starting an engine.

A lead-acid storage cell goes flat when sulfuric acid is gradually converted into water and the electrodes are converted into lead sulfate (PbO_4). When the lead-acid battery is recharged, these chemical reactions are reversed until the chemicals have been re-

stored to their original condition. A lead-acid battery has a useful life of about two to three years and they produce about 2V per cell.

Nickel-iron battery

A secondary cell widely used in heavy industry is nickel-iron battery. The principle of operation is the same as in the lead-acid cell. The only exception is that the negative electrode consists of iron and the positive electrode is made of nickel oxide (Ni_2O_3). The electrolyte is a solution of potassium hydroxide (KOH). The nickel-iron cell has the disadvantage of emitting hydrogen gas during charging.

Cadmium battery (nickel-cadmium cell)

This is also very similar to nickel-ion battery. Here negative iron electrode is replaced by cadmium electrode. The positive electrode is nickel oxide. Some nickel-cadmium batteries gradually lose their maximum energy capacity if they are repeatedly recharged after being only partially discharged – this phenomenon of losing energy capacity is called “memory effect”.

Lithium-ion battery

This is a rechargeable type of battery in which a lithium ion moves between the anode and the cathode. This type of battery is very commonly used in consumer electronics, laptop computers, cell phones, video games, etc. Because of the best energy-to-weight ratios, no memory effect and a slow loss of charge when not in use, they are one of the most popular types of battery for portable electronics.

Exercise 1. Match the battery types with their applications

1. Lithium-ion battery …	a) is used in vehicles
2. Mercury cell …	b) is used in cell phones and laptop computers
3. Alkaline dry cell …	c) is used in wristwatches and calculators
4. Lead-acid battery …	d) is used in remote controls and torches

Exercise 2. Translate into English

1. Батарейка дает электричество, когда отрицательный электрод (катод) реагирует с электролитом.

2. Когда электролит прореагировал полностью, говорят, что элемент питания разряжен.

3. Некоторые типы гальванических элементов могут перезаряжаться, если пропускать ток в обратном направлении.

4. Щелочные батарейки широко используются в радиоприемниках, пультах дистанционного управления и фонариках.

5. Ртутные батарейки сделаны в форме маленького диска, чтобы использоваться в портативных электронных устройствах – наручных часах, калькуляторах и т.д.

6. Свинцово-кислотный аккумулятор для автомобиля обычно состоит из шести элементов, соединенных последовательно, и может давать очень большой ток для запуска двигателя.

7. Ионно-литиевые батареи обычно используются в бытовой электронике, ноутбуках, сотовых телефонах и т.д.

Unit 3. Capacitors

Vocabulary

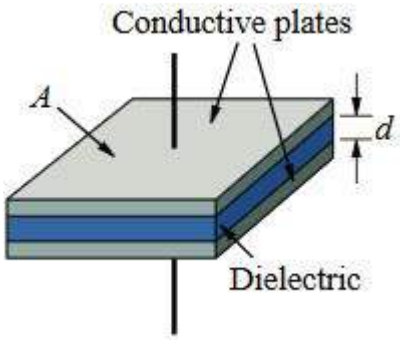
advantage	преимущество
besides	кроме того
capacitor	конденсатор
disadvantage	недостаток
distance	расстояние
fixed capacitor	конденсатор постоянной емкости
for this reason	по этой причине
to move	двигать(ся), перемещать(ся)
open	обрыв, разрыв
part	часть
plate	анод

to prevent	предотвращать
reason	причина
to smooth	сглаживать
to store charge	накапливать заряд
variable capacitor	конденсатор переменной емкости

Text

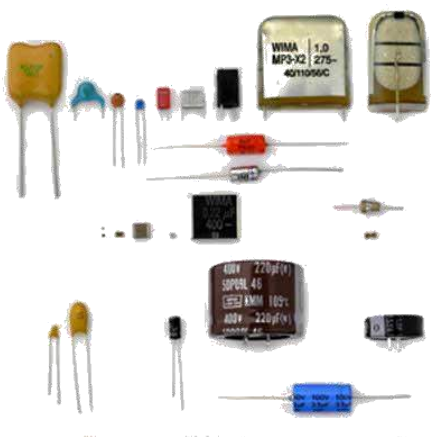
A capacitor is one of the main elements of a circuit. It stores electric charge. A capacitor stores electric energy provided that a voltage source is applied to it. Capacitors are used to smooth varying DC supplies by acting as a reservoir of charge. They are also used in filter circuits because capacitors easily pass AC signals but they block DC signals.

Capacitance is a measure of a capacitor's ability to store charge. Large capacitance means that more charge can be stored. Capacitance is measured in farads.



The main parts of a capacitor are metal plates and insulators. The function of insulators is to isolate the metal plates and in this way to prevent a short.

Two common types of capacitors in use nowadays are a fixed capacitor and a variable one. The plates of a fixed capacitor cannot be moved; for this reason its capacitance does not change. The plates of a variable capacitor move; its capacitance changes. The greater the distance between the plates, the less is the capacitance of a capacitor. Variable capacitors are commonly used by radiomen; their function is to vary the frequency in the circuit. Fixed capacitors are used in telephone and radio work.



Fixed capacitors have insulators produced of paper, ceramics and other materials; variable capacitors have air insulators. Paper capacitors are commonly used in radio and electronics; their advantage is their high capacitance, it may be higher than 1,000 picofarad.

Besides, electrolyte capacitors are highly in use. They also have a very high capacitance; it varies from 0.5 to 2,000 microfarad. Their disadvantage is that they change their capacitance when the temperature changes. They can operate without a change only at temperatures not lower than -40° C.

Common troubles in capacitors are an open and a short. A capacitor stops operating and does not store energy in case it has a trouble. A capacitor with a trouble should be substituted by a new one.

Exercise 1. Answer the questions

1. What is a capacitor used for?
2. What are the main parts of a capacitor?
3. What is the function of insulators?
4. What is the difference between a fixed capacitor and a variable one?
5. What type of insulators do fixed capacitors have?

Exercise 2. Choose the correct answer

1. A capacitor is used …	a) to supply voltage b) to store energy
2. A capacitor includes …	a) insulators b) conducting wires
3. The function of insulators is …	a) to store energy b) to prevent a short between metal plates
4. The capacitance of a fixed capacitor is …	a) constant b) varied
5. The plates of a variable capacitor …	a) can be moved b) cannot be moved
6. The greater the distance between the plates, …	a) the greater is the capacitance b) the less is the capacitance
7. Fixed capacitors have …	a) air insulators b) paper insulators

Unit 4. Resistors

Vocabulary

to adjust	регулировать (настраивать)
cermet	металлокерамика
circuit board	печатная схема, плата
fixed resistor	постоянный резистор
IR drop	активное (омическое) падение напряжения; падение напряжения на внутреннем активном сопротивлении
to mount	устанавливать, монтировать
potentiometer	потенциометр
preset	предварительная установка
resistance track	резистивная дорожка
rheostat	реостат
variable resistor	переменный резистор
wiper	ползунок

Text

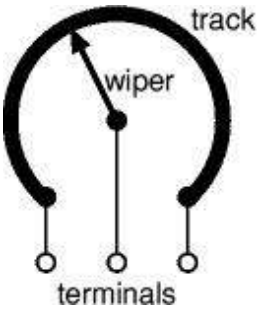
A resistor is one of the most common elements of any circuit. Resistance is the property of a resistor which restricts the flow of charge. Resistors are used 1) to reduce the value of current in the circuit; 2) to produce IR voltage drop and in this way to change the value of the voltage.

When current is passing through a resistor its temperature rises high. The higher the value of current, the higher is the temperature of a resistor. Each resistor has a maximum temperature to which it may be heated without a trouble. If the temperature rises higher the resistor fails in an open configuration and opens the circuit.

Resistors are rated in watts. The watt is the rate at which electric energy is supplied when current of one ampere is passing at a potential difference of one volt.

Some resistors have a constant value – these are fixed resistors, the value of other resistors may be varied – these are variable resistors.

Variable resistors consist of a resistance track with connections at both ends and a wiper which moves along the track. The track may be made of carbon, cermet (ceramic and metal mixture) or a coil of wire (for low resistances).



Variable resistors may be used as a rheostat with two connections (the wiper and just one end of the track) or as a potentiometer with all three connections in use. Miniature versions called presets are made for setting up circuits which will not require regular adjustment.

In a ***rheostat*** two terminals are used: one connected to an end of the track, the other to the moveable wiper. The resistance changes between the two terminals from zero up to the maximum resistance. Rheostats are often used to vary current, for example to control the brightness of a lamp or the rate of charging a capacitor.

Potentiometers have all three terminals connected. This arrangement is normally used to vary voltage, for example to control the volume (loudness) in radio or TV.

Presets are miniature versions of standard variable resistors. They are designed to be mounted directly onto circuit boards and adjusted only when the circuit is built. For example, they may be used to set the frequency of an alarm tone or the sensitivity of a light-sensitive circuit. A small screwdriver or similar tool is usually required to adjust presets.

Exercise 1. Answer the questions

1. What is a resistor used for?
2. When does the temperature of a resistor rise?
3. What element is used to change the value of voltage?
4. How are resistors rated?
5. What types of resistors are there?
6. When does a resistor get open?

7. What does an open resistor result in?

8. What is the difference between a fixed resistor and a variable resistor?

Exercise 2. Translate into English

1. Резисторы используются для уменьшения тока в цепи.

2. Когда ток проходит через резистор, его температура повышается.

3. Постоянные резисторы имеют постоянное значение сопротивления.

4. Если величина сопротивления может быть изменена, то это переменный резистор.

5. Переменные резисторы состоят из резистивной дорожки и ползунка.

Unit 5. Relays

Vocabulary

to allow	позволять, разрешать
lever	рычаг
magnetic field	магнитное поле
relay coil	катушка реле
separate	отдельный; обособленный
set	набор (совокупность)

Text

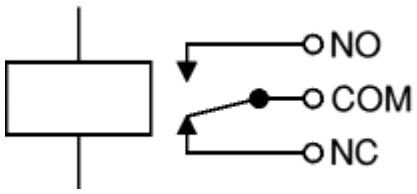
A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and connects or disconnects the switch contacts. The coil current can be on or off so relays have two switch positions.

Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example, a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages.

Relays can have many sets of switch contacts. The relay's switch connections are usually labeled COM, NC and NO:

- COM = Common, always connect to this; it is the moving part of the switch.
- NC = Normally Closed, COM is connected to this when the relay coil is off.
- NO = Normally Open, COM is connected to this when the relay coil is on.



Connect to COM and NO if you want the switched circuit to be on when the relay coil is on.

Connect to COM and NC if you want the switched circuit to be on when the relay coil is off.

Exercise 1. Translate into English

1. Ток, проходящий через катушку реле, создает магнитное поле, которое притягивает рычаг и замыкает или размыкает контакты выключателя.

2. Внутри реле нет электрического соединения между двумя цепями.

3. Все реле имеют два положения переключателя.

4. Реле могут иметь много контактных групп переключения.

Exercise 2. Pair work. Make up a dialogue about principles of relay operation

Unit 6. Electron tubes

Vocabulary

amplification	усиление
anode	анод
carrier	носитель (заряда)
cathode	катод
diode	диод
electrode	электрод
electron tube	электронная лампа
to emit	испускать, излучать
envelope	баллон, колба
evacuated	вакуумный, разреженный
field emission	автоэлектронная эмиссия
filament	нить накала
filament voltage	напряжение накала
gas-filled	газонаполненный
grid	сетка
to heat	нагревать(ся)
heater	нагреватель
operation	работа
photoelectric emission	фотоэлектронная эмиссия
plate current	ток анода, анодный ток
rectifier	выпрямитель
to repel	отталкивать
secondary emission	вторичная эмиссия
thermionic emission	термоэлектронная эмиссия
triode	триод
velocity	скорость

Text

A good high vacuum is practically a perfect nonconductor, since in it no carriers of electricity are present. If two metal plates or electrodes are

enclosed in a vacuum by a glass envelope, we have an open circuit and no current will flow.

However, if one of the electrodes is heated to a high temperature, the velocity of some of the electrons in the metal becomes high enough for these electrons to escape. This process is called emission.

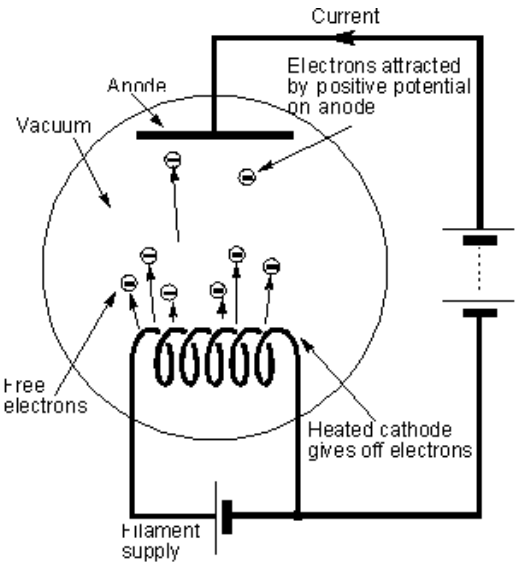
There are some methods of obtaining emission. They are thermionic, photoelectric, field and secondary. The operation of electron tubes or vacuum tubes is based on the thermionic emission.

The electrode which emits the electrons is called a cathode. The electrode which acts as a collector of the electrons (positive potential) is called a plate or anode. The electrodes are mounted in an evacuated or gas-filled envelope. So any electron tube is a metal, glass or ceramic envelope containing electrodes.

Electron tubes are classified by the number of electrodes they contain. A tube with two electrodes is known as a diode, a tube with three electrodes is a triode, etc.

Diodes

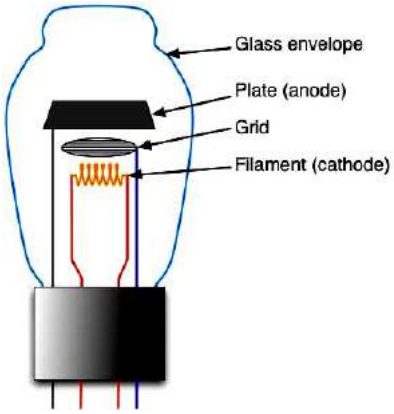
The diode design is simple. It has a cathode with a heater and a plate. When the filament voltage is turned on, the cathode emits electrons. Negative voltage on the cathode repels the electrons. Positive voltage on the plate attracts the electrons. Then the electrons return through the external circuit to the cathode. The electric field is established within the tube. The current flows through the tube. This flow of electrons is known as the plate current. If negative voltage is applied to the plate, the current does not flow. The plate current flows only during the time when the plate is positive. Thus, the diode conducts the current in one direction only.



Diodes are used as rectifiers of alternating voltages, as detectors of radio signals, as switching devices, etc. So the only function of a diode is to convert alternating current voltage into direct current voltage.

Triodes

In a triode there are three electrodes: a cathode, a plate and a grid. When heated the cathode emits electrons. The electrons flow from the cathode to the plate. The grid is placed between the cathode and the plate. It controls the flow of electrons. The closer the grid is to the cathode, the more influence it has on the electron flow. Even if small negative voltage is applied to the grid, a large plate current flows. If large negative voltage is applied to the grid, the plate current decreases. Due to this property of a triode, it can be used for amplification.



Exercise 1. Translate the words in brackets into English

1. (Работа электронных ламп) is based on the thermionic emission.
2. The electrode which (излучает) electrons is called a cathode.
3. The electrode which acts as (собиратель электронов) is called a plate.
4. An electron tube is an evacuated or gas-filled envelope (содержащий электроды).
5. The diode (устройство) is simple.
6. The cathode is used as an (излучатель) of the electrons.
7. The diode (проводит) current in one direction only.
8. All the triodes have the following electrodes: a cathode, a plate and the third element called (сетка).
9. The grid (управляет) the flow of electrons.
10. (Чем ближе) the grid to the cathode, (тем больше влияния) it has on the electron flow.

Exercise 2. Match the questions with the answers

a) 1. Are electron tubes classified by the number of electrodes they contain? — a) No, it isn’t.

2. Is a tube with three electrodes called a diode? — b) Yes, there are.

3. Are there four methods of obtaining emission? — c) Yes, it is.

	4. The operation of electron tubes is based on the thermionic emission, isn't it?	d) Yes, they are.
b)	1. The diode design isn't complex, is it?	a) Yes, it does.
	2. Does the diode conduct the current in one direction only?	b) No, it doesn't.
	3. Is the diode used as a rectifier?	c) No, it isn't.
	4. Does the triode convert AC voltage into DC voltage?	d) Yes, it is.
c)	1. Is the triode used as a rectifier?	a) No, there aren't.
	2. Are there four electrodes in a triode?	b) Yes, it is.
	3. Does the plate control the flow of electrons?	c) No, it isn't.
	4. Is the grid placed between the plate and the cathode?	d) No, it doesn't.

PART 3.
ELECTRIC POWER GENERATION

Unit 1. Power plant

Vocabulary

alternator	генератор переменного тока
beam	луч
boiler	паровой котел, бойлер
chain reaction	цепная реакция
to condense	конденсировать
convenient	удобный
dam	дамба, плотина
equipment	оборудование
fissile	расщепляющийся; подвергающийся расщеплению, ядерному делению
fission	расщепление, деление (атомного ядра при цепной реакции)
fossil fuel	ископаемое топливо
to generate	вырабатывать (энергию и т.п.), производить, генерировать
geothermal energy	геотермальная энергия
hydroelectric power plant	гидроэлектростанция
industrial enterprise	промышленное предприятие
nuclear energy	ядерная, атомная энергия
petroleum	нефть
photovoltaic power plant	фотоэлектрическая станция
power plant	электростанция
renewable energy	возобновляемая энергия
solar array	солнечная панель
solar power plant	солнечная электростанция
steam	пар

steam power plant	паротурбинная электростанция
turbine	турбина
wind farm	ветровая электростанция
working fluid	рабочая жидкость

Text

Energy exists in various forms but electrical energy is the most convenient form of energy. It can be transported with ease, generated in different ways, and can be converted into mechanical work or heat energy. A power plant (also known as power station) is basically an industrial enterprise for the generation of electrical energy. The basic purpose of a power plant is to convert other types of energy such as chemical energy, nuclear energy, geothermal energy, falling water energy (hydroelectric dams) into electric power. The electric equipment used inside a power plant converts mechanical energy into electrical energy using turbines and alternators.

Thermal power plants convert heat energy into electrical energy. Heat is generated by burning fossil fuels like coal, petroleum or natural gas. These power plants are also called the fossil fuel power plants. The working fluid of these plants is mostly steam.

A steam power plant consists of a boiler which is used to generate the steam from water, a steam turbine rotating the alternator to produce electricity. The steam is again condensed in the condenser and led back to the boiler.

Hydroelectric power plants use the kinetic energy of flowing water to produce electrical energy. Hydroelectric power plants store water in large reservoirs. The water in these reservoirs flows down the dam and rotates a turbine. As the blades of the turbine turn, so do the magnets inside the generator which is connected to the turbine. These magnets rotate past copper coils and with each rotation, electricity is produced. The major drawback of hydroelectric power plants is that they are highly dependent on the hydrological cycle of the area where they are built.

Nuclear power plants work on the chemical process of fission. Fission is a nuclear reaction in which atoms of certain elements called nuclear fuels absorb free neutrons. Then they split into two or more smaller nuclei and some free neutrons. In this process, large amount of energy is released.

The free neutrons further strike the atoms of other fissile materials, thus beginning a chain reaction. The energy released from this chain reaction is used to generate electricity. Nuclear power plants have ways to control or stop these reactions when they go out of control. A lot of radioactive material is created in the process of fission. These substances remain radioactive for long time, so there exists the problem of managing nuclear waste.

Solar power plants concentrate the rays of the sun into a single beam using lenses and mirrors. The beam then heats a working fluid that is used to generate power. Besides, the concentrating solar power plants, multi-megawatt photovoltaic power plants have also been built in recent times. In these plants, sun rays are concentrated on photovoltaic solar arrays which convert the Sun's energy into electrical energy using the photoelectric effect.

Wind farms are renewable energy converters. The energy generated by a wind farm can be fed directly into the general energy grid after passing through transformers. Wind farms are a large source of renewable energy. Once installed, a wind farm can operate for a long time.

Exercise 1. Complete the sentences using information from the text

1. An industrial enterprise for the generation of electrical energy is called …
2. Conversion of other energy types into electric power is …
3. In thermal power plants, … is converted into electrical energy.
4. The kinetic energy of flowing water is used to produce electrical energy in …
5. The working principle of nuclear power plants is based on …
6. … are used in solar power plants to concentrate the rays of the Sun into a single beam.
7. A wind farm is a …

Exercise 2. Translate into English

1. Электростанция – это промышленное предприятие для генерирования электроэнергии.
2. Электрооборудование на электростанции преобразует механическую энергию, используя турбины и генераторы.

3. Паровая электростанция состоит из котла для получения пара из воды и паровой турбины, вращающей генератор.

4. Главный недостаток гидроэлектростанций состоит в том, что они очень зависят от гидрологического цикла того района, где они построены.

5. На солнечных электростанциях лучи солнца концентрируются на солнечных панелях, которые преобразуют энергию солнца в электрическую энергию.

6. Энергия, произведенная ветровой электростанцией, может подаваться непосредственно в общую сеть после прохождения через трансформаторы.

Unit 2. Hydroelectric power plant

Vocabulary

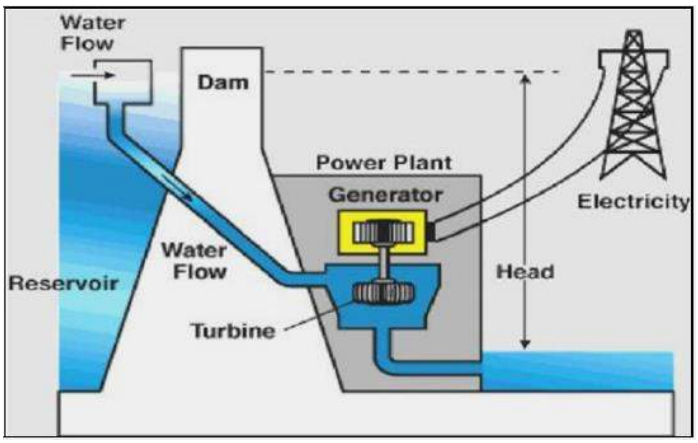
blade	лопасть
to fluctuate	меняться; колебаться
water head	напор воды; водяной столб
level	уровень
magnitude	величина
power capacity	мощность
to rotate	вращать(ся)
runner	ротор
shaft	вал; ось

Text

Hydroelectric power plants are built on rivers. Large-capacity hydroelectric power plants are commonly located at considerable distances from the consumers of electric power.

The production process at these plants is rather simple: the water flows into the hydroturbine runner, acts upon the runner blades and rotates the runner and the turbine shaft.

The generator shaft is connected to the turbine runner shaft. The difference in the water level influences the power capacity of a plant, i.e. the magnitude of the water head and the daily inflow of water fluctuate considerably according to the season.



The production process is different at power plants of different constructions and of different kinds. In atomic power plants, for example, it is not so simple as in hydroelectric plants.

Exercise 1. Find in the text above the English equivalents of the following word combinations

1. значительное расстояние; 2. производственный процесс; 3. вал генератора; 4. гидроэлектростанция большой емкости; 5. влиять на мощность; 6. суточный приток воды; 7. потребители электроэнергии; 8. ротор турбины.

Exercise 2. Choose the correct answer

1. Hydroelectric power plants are built on …	a) rivers b) waterfalls
2. Large-capacity power plants are located …	a) at a short distance from consumers of power b) at a considerable distance from power consumers
3. The production process at hydroelectric power plants is …	a) very complex b) rather simple
4. The power capacity of a plant …	a) remains constant b) changes depending on the difference in the water level
5. The daily inflow of water fluctuates according to …	a) the consumption b) the season

6. The production process …	a) depends on the construction of a plant b) is the same at power plants of different constructions

Unit 3. Atomic power plant

Vocabulary

attending personnel	обслуживающий персонал
to deliver	поставлять; доставлять
dust	пыль
to feed	подавать; подводить
heat exchanger	теплообменник
to include	включать в себя
to install	устанавливать
to pollute	загрязнять
to shield	защищать
tube	труба

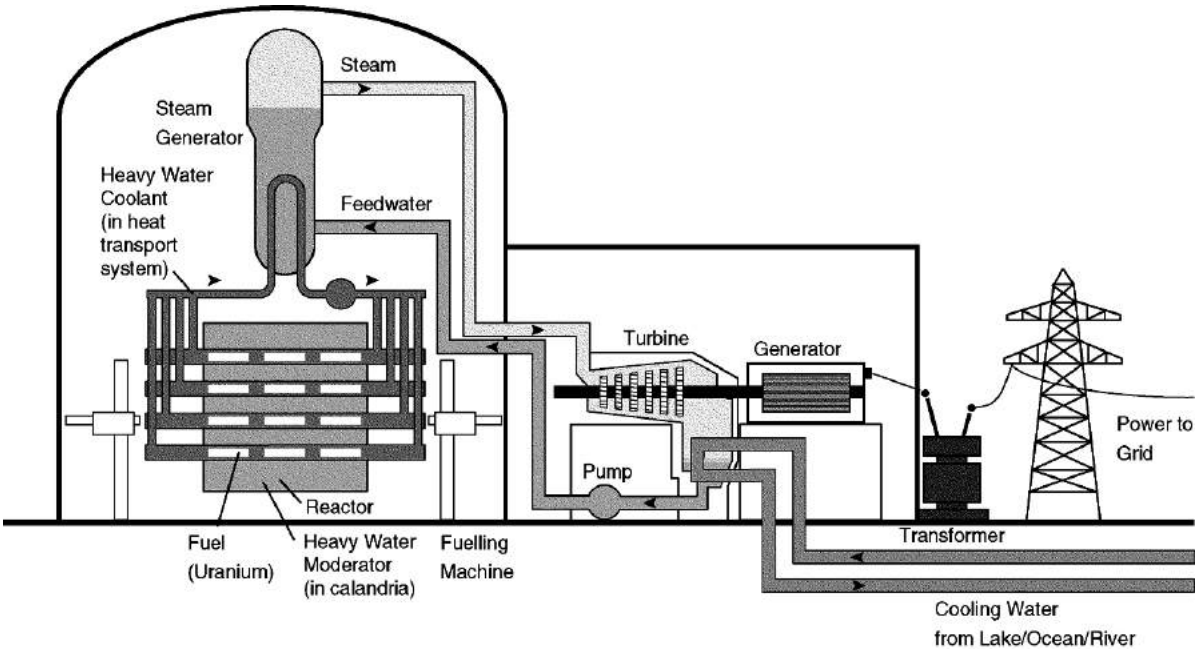
Text

Atomic power plants are modern installations. They consist of several main units and a great number of auxiliary ones.

In a nuclear reactor uranium is utilized as fuel. During operation process powerful heat and radioactive radiation are produced. The nuclear reactor is cooled by water circulation. Cooling water circulates through a system of tubes, in which the water is heated to a temperature of 250-300°C. In order to prevent boiling of water, it passes into the reactor at a pressure up to 150 atmospheres.

A steam generator includes a series of heat exchangers comprising tubes. The water heated in the reactor is delivered into the heat exchanger tubes. The water to be converted into steam flows outside these tubes. The steam produced is fed into the turbogenerator.

Besides, an atomic power plant comprises a common turbogenerator, a steam condenser with circulating water and a switchboard.



Atomic power plants have both advantages and disadvantages. The reactors and steam generators operate in them noiselessly; the atmosphere is not polluted with dust and smoke. As to the fuel consumption, it is of no special importance and there is no problem of fuel transportation.

The disadvantage of power plants utilizing nuclear fuel is their radiation. Radioactive radiation produced in the reactors is dangerous for attending personnel. Therefore, the reactors and steam generators are installed underground. They are also shielded by thick (up to 1.5 m) concrete walls. All their controls are operated by means of automatic devices. These measures serve to protect people from radioactive radiation.

Exercise 1. Answer the questions

1. What are the main units of an atomic power plant?
2. How is the nuclear reactor cooled?
3. At what pressure does the water pass into the reactor?
4. Why is it necessary to protect atomic power plant personnel?
5. What measures are taken to protect the personnel from radioactive radiation?

Exercise 2. Complete the text with the words below. Entitle the text

a) designed *b) contaminated* *c) accident*
d) cooling *e) explosions*

The earthquake and tsunami that struck eastern Japan on March 11, 2011, caused a serious _____ at the Fukushima Dai-ichi nuclear power plant on the northeastern coast of Japan.

The earthquake cut off external power to the reactors. Tsunami, which reached levels more than twice as high as the plant was _____ to withstand, disabled backup diesel generators, crippling the reactor _____ systems. Battery power was quickly exhausted, and overheating fuel in the plant's operating reactor cores led to hydrogen _____ that severely damaged three of the reactor buildings. Fuel in three of the reactor cores melted, and radiation releases from the damaged reactors _____ a wide area surrounding the plant and forced the evacuation of nearly half a million residents.

PART 4.
ELECTRIC POWER TRANSMISSION

Unit 1. Transmission lines

Vocabulary

air circuit breaker	воздушный выключатель
alternate route	альтернативный, обходной путь
bus bar	собирательная шина
bus support insulator	опорный шинный изолятор
capacitor bank	конденсаторная батарея
cross arm	поперечная балка
cross sectional area	площадь поперечного сечения
demand	спрос
to energize	подавать питание; включать напряжение
interconnected power system	объединенная энергосистема
leakage current	ток утечки
line conductor	линейный провод
network	сеть
oil circuit breaker	масляный выключатель
overhead power line	воздушная линия электропередачи
pole	столб
pothead	концевая кабельная муфта
(power) grid	электроэнергетическая система; электрическая сеть
to quench the arc	гасить дугу
to reinforce	укреплять, усиливать
shut down	отключить (электричество); остановить
strand	жила, прядь (кабеля)
substation	подстанция
subtransmission line	распределительная линия, отходящая от оконечной подстанции электропередачи
suspension insulator string	гирлянда подвесных изоляторов
supply	снабжение, поставка; предложение
tower	вышка; мачта; опора (ЛЭП)
to transmit	передавать
transmission line	линия передачи
underground power line	подземная линия электропередачи

Text

Electrical energy from power plants is transferred to substations located near cities. Transmission lines are high-voltage transmission networks. They are usually called “power grids” or simply “grids”. Transmission lines use three-phase alternating current (AC). Railway electrification systems sometimes use single phase AC. It is more economical to transmit electricity at high voltages (110 kV or above) to reduce the energy loss in long distance transmission. Electric power is usually transmitted through overhead power lines. Underground power transmission lines through cables are more expensive but are often used in cities.

Electrical energy cannot be stored and therefore must be generated when it is needed. Electrical energy supply must be equal to the demand. If supply and demand are not equal, generation plants and transmission equipment can shut down. That is why electric transmission networks are interconnected into regional, national or continental wide networks. This interconnected power system provides alternate routes for electric power to another part of the network.

Subtransmission lines carry voltages reduced from the major transmission line system (typically, 34.5 kV to 69 kV). This power is sent to regional distribution substations.

Overhead AC transmission lines usually carry three-phase current. The voltages can be different according to the particular grid system they belong to. Transmission voltages vary from 69 kV up to 765 kV.

The DC voltage transmission tower has lines in pairs rather than in threes (for three-phase current) as in AC voltage lines. One line is the positive current line and the other is the negative current line.

High-voltage overhead lines are made of aluminum wires not covered by insulation. Wires have several strands and are often reinforced with steel strands. Copper was sometimes used before for overhead transmission

but aluminum weighs less and is cheaper. Overhead conductors can have cross sectional area from 12 mm^2 to 750 mm^2. Transmission voltages are usually 110 kV and above. Voltages 66 kV and 33 kV are sometimes used on long lines with small loads. Voltages less than 33 kV are usually used for distribution.

Insulators are usually made of porcelain or glass and can be stacked in a suspension insulator string. They hang from a cross arm on a tower or pole and support the line conductor. Suspension insulators are used for very high voltage systems.

A pothead is a type of insulator with a bell- or pot-like shape used to connect underground electrical cables to overhead lines. It separates the conductors from one another in the cable. It also seals the cable end from the weather. Potheads are mounted on a distribution pole.

Air circuit breakers are used to break circuits while current flows through them. Compressed air is used to quench the arc when the connection is broken.

Bus support insulators are porcelain or fibreglass insulators that serve to isolate the bus bar switches and other support structures and to prevent leakage current from flowing through the structure or to ground. These insulators are similar in function to other insulators used in substations and transmission poles and towers.

Capacitors are used to control the level of the voltage supplied. Oil circuit breakers are used to switch circuits and equipment in and out of a system in a substation. They are oil filled to provide cooling and to prevent arching when the switch is activated.

Circuit switches provide equipment protection for transformers, lines, cables and capacitor banks. They are also used to energize and reenergize capacitor banks and other circuits.

Exercise 1. Answer the questions

1. What is the usual way of transmitting electric power?
2. Can electrical energy be stored?
3. What types of transmission lines are there?
4. Why is electricity transmitted at high voltages?
5. Why are electric transmission networks interconnected into wider networks?
6. Which type of insulator is used to connect underground cables to overhead lines?
7. What is used to control the voltage level supplied?

Exercise 2. Translate into English

1. Линии электропередачи используют трехфазный переменный ток.
2. Линии электропередачи связаны в региональные, национальные или континентальные сети.
3. Высоковольтные воздушные линии электропередачи используют алюминиевые провода, не покрытые изоляцией.
4. Подземные линии электропередачи более дорогие, но часто используются в городах.
5. Гирлянда подвесных изоляторов висит на поперечине вышки или на столбе и поддерживает линейный провод.
6. Воздушные выключатели используются для прерывания цепи, когда в них течет ток.

Unit 2. Transformers

Vocabulary

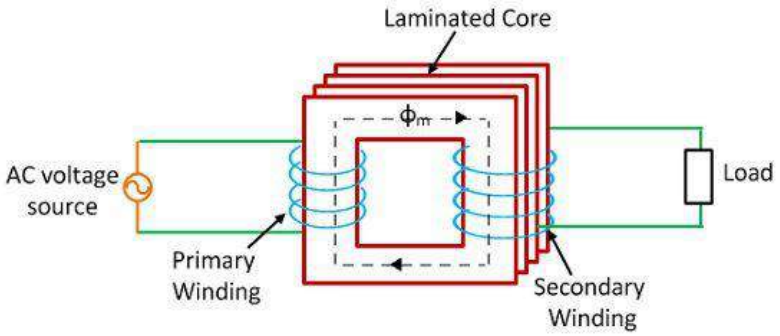
to convert	преобразовывать
core	сердечник
due to	благодаря; из-за
electric power	электроэнергия
primary winding	первичная обмотка

regulator	стабилизатор
secondary winding	вторичная обмотка
smoothing	сглаживающая фильтрация
to step down	понижать
step-down transformer	понижающий трансформатор
to step up	повышать
step-up transformer	повышающий трансформатор
to supply	снабжать; поставлять; подавать; питать
to transfer	передавать, переносить
two-winding transformer	двухобмоточный трансформатор
turn	виток
while	тогда как
winding	обмотка

Text

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronics circuits and other devices. A power supply can be broken down into a series of blocks (e.g. transformer, rectifier, smoothing, regulator), each of which performs a particular function.

A transformer is a static device which transfers AC electrical power from one circuit to the other at the same frequency, but the voltage level is usually changed. For economical reasons, electric power is required to be transmitted at high voltage while it has to be utilized at low voltage from a safety point of view. Due to the transformer electric power may be transferred at a high voltage and reduced at the point where it must be used to any value.



A two-winding transformer consists of a closed core and two coils (windings). The primary winding is connected to the voltage source. It receives energy. The secondary winding is connected to the load resistance and supplies energy to the load.

The value of voltage across the secondary winding depends on the number of turns in it. In case it is equal to the number of turns in the primary winding, the voltage in the secondary winding is the same as in the primary. In case the secondary has more turns than the primary, the output voltage is greater than the input voltage. The voltage in the secondary is greater than the voltage in the primary by as many times as the number of turns in the secondary is greater than the number of turns in the primary. A transformer of this type increases or steps up the voltage and is called a step-up transformer. In case the secondary has fewer turns than the primary, the output voltage is lower than the input. Such a transformer decreases or steps down the voltage; it is called a step-down transformer.

Common troubles in transformers are an open in the winding, a short between the primary and the secondary, and a short between turns. In case a transformer has a trouble it stops operating or operates badly. A transformer with a trouble should be substituted.

Exercise 1. Choose the correct answer

1. A transformer is used …	a) to change the frequency in a circuit b) to change the voltage in a circuit
2. Electric power is transferred at a high voltage and reduced to any value due to …	a) transformers b) rectifiers
3. A transformer consists of …	a) a core and windings b) primary and secondary windings
4. The function of the primary is …	a) to receive energy b) to supply energy
5. The function of the secondary is …	a) to receive energy b) to supply energy

6. A step-up transformer increases the voltage …	a) on its primary winding with respect to the secondary b) on its secondary winding with respect to the primary
7. In a step-down transformer …	a) the number of turns of the secondary winding is greater than the number of turns of the primary b) the number of turns of the primary winding is greater than the number of turns of the secondary

Exercise 2. Complete the sentences using *while*

1. The secondary winding of a transformer is connected to the load resistance …

2. The primary winding receives energy …

3. A step-down transformer decreases the voltage …

4. In a step-up transformer the number of turns of the secondary winding is greater than the number of turns of the primary winding …

Unit 3. Substation

Vocabulary

bus	шина
control house	диспетчерский пункт
distribution substation	распределительная подстанция
emergency	авария; непредвиденный случай
end-user	конечный пользователь
grounded neutral	заземленная нейтраль
power blackout	отключение электроэнергии
power line carrier	высокочастотная связь по проводам ЛЭП
power transformer	силовой трансформатор
residential customer	бытовой потребитель электроэнергии
supervisory control	диспетчерское управление

switchboard panel	распределительный щит
switching point	переключательная подстанция
transmission substation	передающая подстанция

Text

A substation is a high-voltage electric system facility. It is used to switch on and off generators, equipment and circuits or lines in a system. It is also used to change AC voltages from one level to another or change alternating current to direct current or vice versa. Some substations are small; they have a transformer and switches. Other substations are very large with several transformers and dozens of switches and other equipment.

The substation control house contains switchboard panels, batteries, battery chargers, supervisory control, power-line carrier, meters and relays. The control house provides all weather protection and security for the control equipment.

Batteries are used in the substation control house to power the control systems in case of a power blackout. Control panels contain meters, control switches and recorders located in the control building, also called a doghouse. These are used to control the substation equipment, to send power from one circuit to another or to open or to shut down circuits when needed.

There are three main types of substations.

A step-up transmission substation receives electric power from a nearby power plant and uses a large power transformer to increase the voltage for transmission to distant places. A transmission bus is used to distribute electric power to one or more transmission lines.

A substation can have circuit breakers that are used to switch generation and transmission circuits in and out of service. This is made in case of emergencies requiring shut-down of power to a circuit or redirection of power.

The voltages from a step-up transmission substation are determined by the customer needs in regional grids. Direct current voltage is either positive or negative. A DC line has two conductors, so one would be positive and the other negative.

Step-down transmission substations are located at switching points in an electrical grid. They connect different parts of a grid and are a source for subtransmission lines or distribution lines. The step-down substation can change the transmission voltage to a subtransmission voltage, usually 69 kV. The subtransmission voltage lines can then serve as a source to distribution substations. The power goes to a distribution substation.

Distribution substations are located near the end-users. Distribution substation transformers change the transmission voltage to lower levels for end-user consumption. Typical distribution voltages vary from 34,500Y/19,920 volts to 4,160Y/2,400 volts.

34,500Y/19,920 volts means a three-phase circuit with a grounded neutral source. This would have three high-voltage conductors or wires and one grounded neutral conductor, a total of four wires. The voltage between the three-phase conductors would be 34,500 volts and the voltage between one-phase conductor and the neutral ground would be 19,920 volts.

From distribution substation the power is distributed to industrial, commercial and residential customers.

Exercise 1. Put the words in the correct order

1. A step-up transformer, places, is, to increase, for, to, transmission, the voltage, distant, used.

2. Are, of, three, there, types, substations, main.

3. A source, step-down transmission substations, distribution lines, are, for.

4. Determined, the voltage, needs, by, is, the customer.

Exercise 2. Translate into English

1. Подстанция используется для того, чтобы включать и выключать генераторы, оборудование и линии в системе.

2. Подстанции могут быть очень большие с несколькими трансформаторами и множеством выключателей и другого оборудования.

3. Повышающая передающая подстанция получает электроэнергию от близлежащей электростанции и использует трансформатор большой мощности, чтобы увеличить напряжение.

4. Понижающие передающие подстанции расположены при переключательных подстанциях в электрической сети и являются источником для распределительных линий.

5. Распределительные подстанции изменяют передаваемое напряжение до более низкого уровня для потребления конечными пользователями.

Exercise 3. Choose the correct words from the brackets to complete the descriptions of different stages of AC generation and supply. Put the stages in the correct order

a. After the step-up transformer, the current enters a (distribution / transmission) line.

b. Current is produced at sites called (power / electric) stations.

c. The current goes from the step-down transformer to a (distribution / transmission) line.

d. The current leaves the power (grid / station) and enters homes.

e. Amperage is reduced and voltage is increased by a (step-up / step-down) transformer.

PART 5.
ELECTRIC POWER CONSUMPTION

Unit 1. Plug and socket types

Vocabulary

earthing	заземление
grounded	заземленный
grounding	заземление
hot	под напряжением
to insert	вставлять
outlet	штепсельная розетка
pin	штырь; штифт
plug	штепсельная вилка
prong	зубец; штырь
recessed	установленный заподлицо; утопленный
socket	штепсельная розетка
spring	пружина

Text

Type A

· mainly used in the USA, Canada, Mexico & Japan
· 2 pins
· not grounded
· 15 A
· almost always 100–127 V
· socket compatible with plug type A

There are currently 15 types of electrical plugs in use today, each of which has been assigned a letter by the US Department of Commerce International Trade Administration (ITA), starting with A and moving through the alphabet. Let's consider some most widely spread of them.

Type A

This class II ungrounded plug with two flat parallel prongs is pretty much standard in most of North and Central America. It is known as NEMA 1-15 and was invented in 1904 by Harvey Hubbell II. The plug has two flat 1.5 mm thick blades, measuring 15.9–18.3 mm in length and spaced 12.7 mm

apart. Type A plugs are generally polarized and can only be inserted one way because the two blades do not have the same width. The blade connected to neutral is 7.9 mm wide and the hot blade is 6.3 mm wide. This plug is rated at 15 amps.

Type B

This class I plug is designated as American standard NEMA 5-15. It has two flat 1.5 mm thick blades, spaced 12.7 mm apart, measuring 15.9–18.3 mm in length and 6.3 mm in width. It also has a 4.8 mm diameter round or U-shaped earth pin, which is 3.2 mm longer than the two flat blades, so the device is grounded before the power is connected. The centre-to-centre distance between the grounding pin and the middle of the imaginary line connecting the two power blades is 11.9 mm. The plug is rated at 15 amps.

Type B

· mainly used in the USA, Canada, Mexico & Japan
· 3 pins
· grounded
· 15 A
· almost always 100–127 V
· socket compatible with plug types A & B

Type A and B plugs have two flat prongs with (often, but not always) a hole near the tip. These holes aren't there without a reason. If you were to take apart a type A or B socket and look at the contact wipers that the prongs slide into, you would find that in some cases they have bumps on them. These bumps fit into the holes so that the outlet can grip the plug's prongs more firmly. This prevents the plug from slipping out of the socket due to the weight of the plug and cord. It also improves the contact between the plug and the outlet. Some sockets, however, do not have those bumps but just two spring-action blades that grip the sides of the plug pin, in which case the holes are not necessary.

Type A and B plugs are not insulated (i.e. the pin shanks do not have a black covering towards the plug body) and the outlets are not recessed into the wall, which means that if a plug is pulled halfway out, its prongs are still connected to the socket. Type A and B sockets are potentially dangerous, since the distance between the socket and a partially pulled-out

plug is big enough to touch the pins with your fingers or with a metal object such as a teaspoon.

Type C

Type C is probably the single most widely used international plug. This two-wire plug is ungrounded and has two round prongs. It is popularly known as the Europlug which is described in CEE 7/16. The plug has two 4 mm round pins, measuring 19 mm in length on centers spaced 18.6 mm apart at the base and 17.5 mm apart at the tip. The two pins have 10 mm long insulated sleeves. They converge slightly, but they are relatively flexible, which allows the plug to mate with any socket that accepts 4.0–4.8 mm round contacts on 17.5–19 mm centers. The plug is generally limited for use in class II applications that require 2.5 amps or less. It is, of course, unpolarized. It is commonly used in all countries of Europe except in the United Kingdom, Ireland, Cyprus and Malta. It is also used in various parts of the developing world.

Type C

· commonly used in Europe, South America & Asia
· 2 pins
· not grounded
· 2.5 A
· almost always 220–240 V
· socket compatible with plug type C

Whereas type C plugs are very commonly used, this is not the case for type C sockets. This kind of socket is the older and ungrounded variant of socket types E, F, J, K or N. Nowadays most countries demand grounded sockets to be installed in new buildings. Since type C sockets are ungrounded, they are being replaced by type E, F, J, K or N (depending on the country).

Type F

Type F

· used almost everywhere in Europe & Russia, except for the UK & Ireland
· 2 pins
· grounded
· 16 A
· 220–240 V
· socket compatible with plug types C, E & F

Plug F is known as CEE 7/4 and commonly called “Schuko plug”, which is the acronym of “**Schu**tz**ko**ntakt”, a German word meaning “protection contact” or “safety contact”. The plug was designed in Germany shortly after the First World War. It goes back to a patent (DE 370538) granted in 1926 to Albert Büttner, a Bavarian manufacturer of electrical accessories.

Type F is similar to C except that it is round and has the addition of two grounding clips on the side of the plug. The plug has two 4.8 mm round pins, measuring 19 mm in length on centers spaced 19 mm apart. The distance between either of the two earthing clips and the middle of the imaginary line connecting the centers of the two power pins is 16 mm.

Because the CEE 7/4 plug can be inserted in either direction into the socket, the Schuko connection system is unpolarized (i.e. line and neutral are connected at random). It is used in applications up to 16 amps.

Exercise 1. Choose the correct answer

1. Type A plugs are …	a) ungrounded, generally polarized, insulated
	b) ungrounded, polarized, not insulated
2. The most widely used international plug is …	a) type B
	b) type C
3. Type F socket is similar to …	a) type C
	b) type A
4. In 1904 Harvey Hubbell II invented …	a) type A plug
	b) type F plug
5. Type … plug has a grounding pin.	a) B
	b) F
6. Type C plug is popularly known as …	a) Europlug
	b) Schuko plug

Exercise 2. Answer the questions

1. How many types of plugs are there nowadays?
2. Which plug type is used in Russia?
3. Why are type A and B plugs potentially dangerous?
4. Why is type F plug called Schuko?

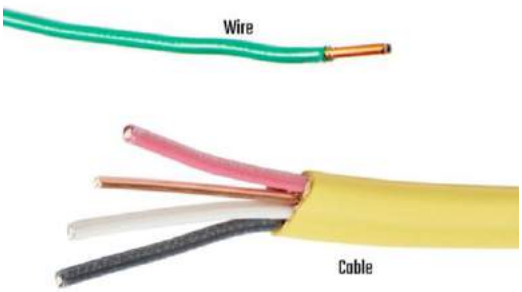
5. Why are type C sockets not commonly used in new buildings?
6. Which plug type is safer: C or F? Why?

Unit 2. Types and characteristics of electrical wires

Vocabulary

bare wire	голый провод
circuit breaker panel	панель прерывателей цепи
conduit	труба для электропроводки
cord	шнур
flame-resistant	огнестойкий
gauge	калибр, сортамент
ground wire	заземляющий провод
hardwired	соединенный проводами
heat resistance	теплостойкость
hot wire	провод под напряжением
main feed	магистральная линия (питания)
junction box	распределительная коробка
service drop	ответвление к потребителю
sheathing	оболочка
single strand wire	одножильный провод
smoke detector	датчик дыма
solid wire	одножильный провод
stranded wire	многожильный провод
wiring	прокладка электрических проводов; электропроводка

Text



The terms wire and cable are often used to describe the same thing, but they are actually quite different. Wire is a single electrical conductor, whereas a cable is a group of wires swathed in sheathing.

Size of wires

Each application requires a certain wire size for installation, and the right size for a specific application is determined by the wire gauge. Common wire sizes are 10, 12 and 14 – a higher number means a smaller wire size, and affects the amount of power it can carry. For example, a low-voltage lamp cord with 10 Amps will require 18-gauge wire, while service panels or subpanels with 100 Amps will require 2-gauge wire.

Wire lettering

The letters THHN, THWN, THW and XHHN represent the main insulation types of individual wires. These letters depict the following NEC (National Electric Code) requirements:

- T – Thermoplastic insulation
- H – Heat resistance
- HH – High heat resistance (up to 194°F)
- W – Suitable for wet locations
- N – Nylon coating, resistant to damage by oil or gas
- X – Synthetic polymer that is flame-resistant

Types of wires

There are mainly 5 types of wire:

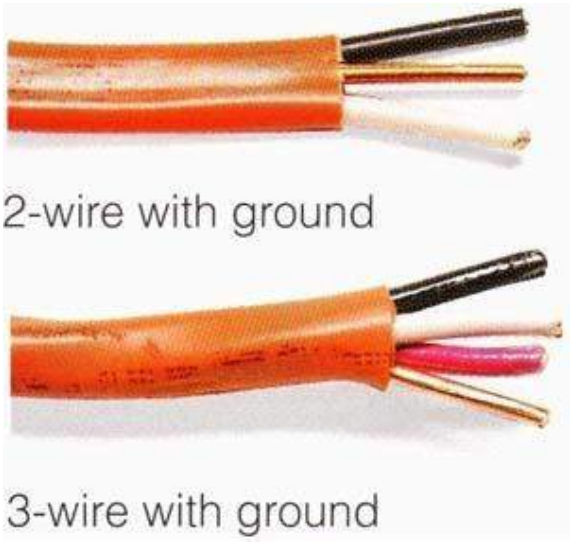
Weatherhead

- Triplex wires: Triplex wires are usually used in single-phase service drop conductors, between the power pole and weatherheads. They are composed of two insulated aluminum wires wrapped with a third bare wire which is used as a common neutral. The neutral is usually of a smaller gauge and grounded at both the electric meter and the transformer.

- Main feeder wires: Main power feeder wires are the wires that connect the service weatherhead to the house. They're made with stranded or solid THHN wire and the cable installed is 25% more than the load required.
- Panel feed wires: Panel feed cables are generally black insulated THHN wire. These are used to power the main junc-

tion box and the circuit breaker panels. Just like main power feeder wires, the cables should be rated for 25% more than the actual load.

- Non-metallic sheathed wires: Non-metallic sheath wire, or Romex, is used in most homes and has 2-3 conductors, each with plastic insulation, and a bare ground wire. The individual wires are covered with another layer of non-metallic sheathing. Since it's relatively cheaper and available in ratings for 15, 20 and 20 amps, this type is preferred for in-house wiring.



- Single strand wires: Single strand wire also uses THHN wire, though there are other variants. Each wire is separate and multiple wires can be drawn together through a pipe easily. Single strand wires are the most popular choice for layouts that use pipes to contain wires.

Color codes

Different color wires serve different purposes, like:

- Black: Hot wire, for switches or outlets.
- Red: Hot wire, for switch legs and for connecting wire between two hardwired smoke detectors.
- Blue and Yellow: Hot wires, pulled in conduit. Blue for 3-4 way switch application, and yellow for switch legs to control fan, lights etc.
- White: Always neutral.
- Green and Bare Copper: Only for grounding.

Exercise 1. Answer the questions

1. What is the difference between wire and cable?
2. What is the wire gauge?
3. What does wire lettering represent?
4. What wire type is used in service drop conductors?
5. Why are non-metallic sheath wires preferred for in-house wiring?
6. What insulation is used in non-metallic sheath wires?
7. What color is the ground wire?

Exercise 2. Match the words with their definitions

1. wire	a) a wire which comes from the bottom terminal of the switch and becomes hot when the switch is turned on; it is used to turn the load on and off
2. cable	b) a flexible insulated electric cable, used especially to connect appliances to mains
3. cord	c) an overhead electrical line running from a utility pole, to a customer's building or other premises
4. service drop	d) a flexible metallic conductor, usually insulated, used to carry electric current in a circuit
5. weatherhead	e) a grouping of two or more independent electrical wires
6. switch leg	f) a weatherproof receptacle at the service drop entry point where overhead conductors enter a building

Unit 3. Watt hour meters

Vocabulary

accuracy	точность
automatic meter reading system	система автоматизированного снятия показаний счетчика
counter mechanism	счетный механизм
current coil	обмотка тока
dial	циферблат; круговая шкала
eddy current	вихревой ток
electromagnet	электромагнит
electromechanical induction meter	электромеханический индукционный счетчик
to exert force	прилагать силу
flux	поток
gear train	зубчатая передача
high end processor	высокопроизводительный процессор

instantaneous voltage	мгновенное напряжение
to lag	отставать
meter	счетчик
metering point	место измерения
phase angle	угол сдвига фаз, фазовый угол
power line communication	ВЧ-связь по ЛЭП
pressure coil	обмотка напряжения
product	произведение, результат умножения
pulse rate	частота повторения импульсов
smart energy meter	интеллектуальный счетчик электроэнергии
spindle	ось, вал
utilities	коммунальные предприятия

Text

Watt hour meter or energy meter is an instrument which measures amount of electrical energy used by the consumers.

Energy meters are classified in accordance with several factors such as:

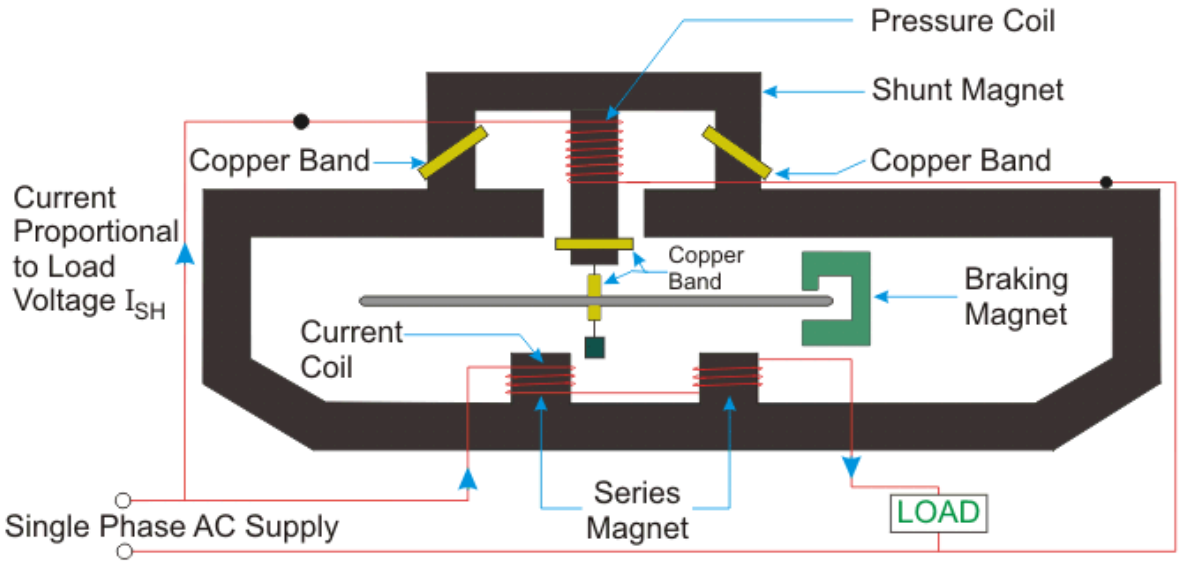
- type of display like analog or digital electric meter;
- type of metering point like grid, secondary transmission, primary and local distribution;
- end applications like domestic, commercial and industrial;
- technical like three phases, single phase, HT (High Tension), LT (Low Tension) and accuracy class meters.

Electromechanical induction type energy meter

It is the popularly known and most common type of age old watt hour meter. It consists of rotating aluminum disc mounted on a spindle between two electromagnets. Speed of rotation of disc is proportional to the power and this power is integrated by the use of counter mechanism and gear trains. It comprises two silicon steel laminated electromagnets, i.e., series and shunt magnets.

Series magnet carries a coil which is of few turns of thick wire (current coil) whereas shunt magnet carries a coil with many turns of thin wire (pressure coil).

Braking magnet is a permanent magnet which applies the force opposite to normal disc rotation to move that disc at balanced position and to stop the disc while power is off.



Series magnet produces the flux which is proportional to the current flowing and shunt magnet produces the flux proportional to the voltage. These two fluxes lag by 90 degrees due to inductive nature. The interaction of these two fields produces eddy current in the disk, exerting a force, which is proportional to product of instantaneous voltage, current and phase angle between them.

Vertical spindle or shaft of the aluminum disc is connected to gear arrangement which records a number, proportional to the number of revolutions of the disc. This gear arrangement sets the number in a series of dials and indicates energy consumed over a time. This type of meter is simple in construction and accuracy is somewhat less due to creeping and other external fields. A major problem with these types of meters is their easy prone to tampering, leading to a requirement of an electrical energy monitoring system. These are very commonly used in domestic and industrial applications.

Electronic energy meters

These meters are accurate and reliable types of measuring instruments as compared to conventional mechanical meters. They consume less power and start measuring instantaneously when connected to load. These meters might be analog or digital. In analog meter, power is converted to proportional frequency or pulse rate and it is integrated by counters placed inside it. In digital electric meter, power is directly measured by high end processor. The power is integrated by logic circuits to get the energy and also for testing and calibration purpose. It is then converted to frequency or pulse rate.

Smart energy meters

It is an advanced metering technology involving placing intelligent meters to read, process and feedback the data to customers. It measures energy consumption, remotely switches the supply to customers and remotely controls the maximum electricity consumption. Smart metering system uses the advanced metering infrastructure system technology for better performance.

These meters are capable of communicating in both directions. They can transmit the data to the utilities like energy consumption, parameter values, alarms, etc. and also can receive information from utilities such as automatic meter reading system, reconnect / disconnect instructions, upgrading of meter software and other important messages. These meters reduce the need to visit while taking or reading monthly bill. Modems are used in these smart meters to facilitate communication systems such as telephone, wireless, fiber cable, power line communications. Another advantage of smart metering is complete avoidance of tampering of energy meter where there is scope of using power in an illegal way.

Exercise 1. Answer the questions

1. What is the most common type of electricity meter?
2. What physical principle is at work in electromechanical meters?

3. How many magnets are there in electromechanical meters? What are their functions?

4. What types of electronic energy meters are there?

5. Is there a meter which can help get accurate bills and save energy?

Exercise 2. Find in the text above the English equivalents of the following word combinations

1. установленный на оси; 2. счетный механизм; 3. сбалансированное положение; 4. взаимодействие двух полей; 5. число оборотов диска; 6. подключать к нагрузке; 7. логическая схема; 8. максимальное потребление электроэнергии; 9. обновление программного обеспечения; 10. ежемесячный счет.

Exercise 3. Pair work. Talk to your partner about advantages and disadvantages of electromechanical induction meter and smart energy meter. Compare the following characteristics: accuracy, tampering possibilities, communication technology, data management, etc.

PART 6.
LATEST TECHNOLOGY
IN ELECTRICAL ENGINEERING INDUSTRY

Unit 1. Innovations in electric power generation

Vocabulary

containment	защитная оболочка (ядерного реактора)
drive train	цепь привода
electric service	электроснабжение
heat rod	нагревательный стержень
outdoor lighting	наружное освещение
photovoltaic cell	фотогальванический элемент
semiconductor	полупроводник
solar cell	солнечный элемент
wind turbine	ветряная турбина

Text

Science and industry researchers are constantly finding ways to provide electric power more easily and inexpensively. As a result, innovations in electric power have made the industry cleaner and more efficient throughout its history, and made electric service available to millions of homes.

Wind turbines

With our lives centered around electricity, modern scientists have found innovative ways to convert the kinetic energy from the wind into electric power.

A wind turbine typically consists of a large, three-bladed propeller, called a rotor, atop a tower that's high enough that

nothing blocks it from the wind. The turbine has a drive train similar to a car's engine that includes an electric generator. The electricity generated gets added to the electric grid, which powers hundreds of homes and businesses in a geographic location. Wind farms are becoming increasingly common in large open spaces.

Solar cells

The sun provides a significant amount of energy in the forms of heat and light. Solar cell technology, called photovoltaic (PV) cells, converts that light into electricity. These PV cells contain semiconductor materials such as silicon. Electrons in the semiconductor move when the material absorbs the light.

Solar cells are versatile in size and portability. Large solar panels with hundreds of cells can be built in a factory and then sold to stretch out across land or mount on a rooftop. These large panels are used to power homes and businesses and must be replaced after about 30 years. Small solar panels with only a few cells gather enough energy to power standalone devices, like calculators and outdoor lighting.

Despite being a clean, renewable energy source, sunlight alone isn't sufficient for those who want to use electricity at night or on cloudy days. In most cases, solar panels are a supplemental power source for a building that's already attached to the electric grid.

Nuclear reactors

Nuclear fission is the process of breaking apart an atom, releasing the energy that holds the atom together. In the 1950s, nuclear fission of the radioactive isotope uranium-235 made energy cheaper and more efficient to produce. A nuclear reactor is a structure that produces this fission process from uranium-235. Nuclear power plants include one or more reactors along with large and complex mechanisms for cooling and containment.

The nuclear reactor itself is the key innovation here. The reactor controls the fission process from a very small amount of uranium-235 and

channels the energy to heat rods which, in turn, heat water to produce steam. The steam moves a turbine and turns an electric generator, similar to the way wind and water turbines work. So, in essence, a nuclear plant is just a steam plant powered by nuclear energy.

By using nuclear power, the world uses less of other resources, like coal and oil, to heat the water and produce steam. Despite this advantage, concerns still plague the minds of skeptics. Concerns include the safety of people who live and work in and around nuclear plants and the potential hazards of nuclear waste disposal. In addition, several notorious nuclear reactor disasters around the world have tainted the reputation of this energy source.

Exercise 1. Find in the text above the English equivalents of the following word combinations

1. доступный миллионам; 2. значительное количество; 3. поглощать свет; 4. автономное устройство; 5. дополнительный источник энергии; 6. механизм для охлаждения; 7. приводить в движение турбину; 8. в сущности; 9. тревожить умы; 10. утилизация ядерных отходов.

Exercise 2. Find in the text above synonyms for the following words

1. advanced; 2. diversified; 3. to install; 4. gadget; 5. to rotate; 6. alternative energy; 7. additional; 8. enough; 9. danger; 10. infamous.

Exercise 3. Put the verbs in the correct form

1. Scientists constantly (to look for) ways to provide electric power more easily and inexpensively.

2. Electric power industry (to become) cleaner and more efficient throughout its history.

3. The amount of electricity generated from wind (to grow) significantly since 2000.

4. The first wind turbine used for the production of electricity (to build) in Scotland in 1887.

5. Wind and solar power generation (to grow) quickly around the world.

6. Photovoltaic cells (to use) the light of the sun to produce electricity.

7. Sunlight (to be) a clean, renewable energy source.

8. In the nuclear fission reaction, a large amount of energy (to release).

9. Nuclear reactors (to use) for generating electricity, moving aircraft carriers and submarines.

10. The nuclear power industry (to improve) the safety and performance of reactors.

Unit 2. Electric vehicle

Vocabulary

AC motor	двигатель переменного тока
accelerator pedal	педаль газа
all-electric range	запас хода на электротяге
all-electric vehicle	полностью электрифицированный автомобиль
battery electric vehicle	чистый электромобиль (работающий исключительно на батареях)
braking	торможение
charger	зарядное устройство
DC motor	двигатель постоянного тока
to deplete	истощать, исчерпывать
drive mechanism	приводной механизм
electric vehicle	электромобиль
fuel cell electric vehicle	электромобиль на топливных элементах
internal combustion engine	двигатель внутреннего сгорания
motor controller	контроллер; регулятор частоты вращения двигателя
nickel metal hydride (NiMH) battery	никель-металлогидридный аккумулятор
to plug in	включать в сеть

plug-in hybrid electric vehicle	плагин-гибридный автомобиль (электромобиль-гибрид с подзарядкой от сети)
regenerative braking	рекуперативное торможение
tailpipe	выхлопная труба
tailpipe emissions	выброс выхлопных газов

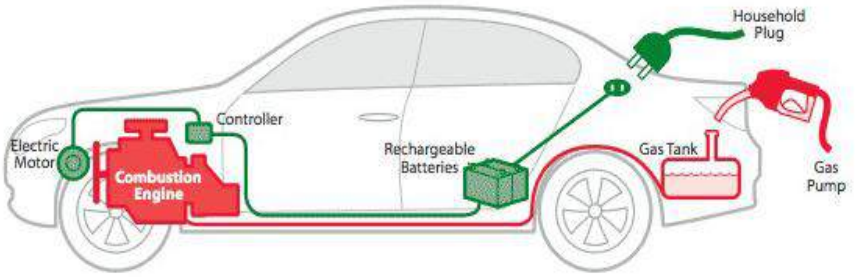
Text

Electric vehicles (or “EVs”) run at least partially on electricity. There are two basic types of EVs: all-electric vehicles (AEVs) and plug-in hybrid electric vehicles (PHEVs).

All-electric vehicles (AEVs) run only on electricity. They receive electricity by plugging into the grid and store it in batteries. They consume no petroleum-based fuel and produce no tailpipe emissions. AEVs include Battery Electric Vehicles (BEVs) and Fuel Cell Electric Vehicles (FCEVs). In addition to charging from the electrical grid, both types are charged in part by regenerative braking, which generates electricity from some of the energy normally lost when braking.

Most AEVs have all-electric ranges of 80 to 100 miles, while a few luxury models have ranges up to 250 miles. When the battery is depleted, it can take from 30 minutes (with fast charging) up to nearly a full day (with Level 1 charging) to recharge it, depending on the type of charger and battery.

Plug-in hybrid electric vehicles (PHEVs) offer both a gasoline or diesel engine and an electric motor. PHEVs run on electricity for shorter ranges (6 to 40 miles), then switch over to an



internal combustion engine running on gasoline when the battery is depleted. The flexibility of PHEVs allows drivers to use electricity as often as possible while also being able to fuel up with gasoline if needed. Powering the vehicle with electricity from the grid reduces fuel costs, cuts petroleum consumption, and reduces tailpipe emissions compared to conventional vehicles.

An electric vehicle's drive mechanism is mainly constituted of the following three parts: car motor, motor controller, car batteries.

Basically, all cars run on the principle of conversion of energy from one form to another. In a traditional gasoline car, the chemical energy stored in the fuel is converted into kinetic energy by the internal combustion engine, releasing byproducts in the form of combustion emissions. Whereas in an electric car, the electromechanical energy from the batteries is converted first into electrical energy and then into kinetic energy required for driving the car.

Car motor: The accelerator pedal in these cars is connected to a potentiometer (variable resistor). The potentiometer sends an appropriate electric signal to the motor controller corresponding to the amount by which the pedal is pressed. If the pedal is not pressed, no signal is transmitted. If the pedal is grounded or fully pressed, maximum signal is transmitted. Thus, the motor will deliver maximum power. The car motor may be a DC or an AC motor. DC motors are easy to maintain, more efficient and also allow greater acceleration. The motor can deliver between 20,000 watts to 30,000 watts of power.

Motor controller: This device is a link between the car batteries and the actual motor. It receives the controlling signal from the potentiometer connected to the accelerator pedal. It will transmit the battery voltage to the motor depending on this input signal.

Car batteries: Car batteries can be simple lead-acid batteries or the more sophisticated and long lasting NiMH batteries. These batteries will be between 96 to 192 volts for a typical DC motor. The battery charging mechanism in an electric car is of prime importance. It monitors the voltage, amperage and battery temperatures to avoid battery damage by overheating. A typical battery can be fully charged in 3-4 hours via hard wired charging docks built specially for this purpose.

Exercise 1. Answer the questions

1. What is an electric vehicle?
2. What types of EVs are there?
3. Which EV type is more environmentally friendly: AEV or PHEV? Why?
4. Are AEVs suitable for long-distance travel?
5. Do EVs run on the principle of energy conversion?
6. What are the main parts of the EV drive mechanism?
7. What is the function of the potentiometer in the EV motor?
8. Why is the battery charging mechanism of prime importance in EVs?

Exercise 2. Complete the sentences with the words below

a) tailpipe emissions b) regenerative braking c) all-electric range d) accelerator pedal e) motor controller

1. _____ is unique to EVs and enables the vehicle's kinetic energy to be converted back to electrical energy during braking.
2. A _____ can include automatic or manual means for starting / stopping the motor, choosing forward / reverse rotation, selecting and controlling the speed, etc.
3. A PHEV often has a larger battery than a hybrid and provides a longer _____.
4. _____ result from fuel combustion in a vehicle's engine.
5. According to the regulations, the _____ is "the only means by which the driver may control acceleration torque to the driven wheels."

Exercise 3. Pair work. Talk to your partner about advantages and disadvantages of electric vehicles as compared to gasoline vehicles. Make use of the information provided below

Electric	Gasoline
Environmental impact	
No tailpipe emissions	Greenhouse gases / Pollution
Recharge or refuel time	
About 6-7 hours	Less than 5 minutes
Costs	
About 2 cents per mile	More than 12 cents per mile
Purchase price	
Higher price	Lower price
Driving range	
62-294 miles	240-703 miles

SUMMARY WRITING

How to write a summary of a text

1. Определите название текста

The title of the text is "..." (The text is entitled "...")

2. Определите автора текста

The author of the text is ... (The text is written by ...)

3. Определите источник публикации

The text is taken from ... (The text is published in ..., number ..., on page ...)

4. Определите основную идею текста

The text is about ... (The main idea of the text is ...; The text is devoted to ...; The purpose of the text is to give the reader some information on ...)

5. Кратко передайте содержание текста (10-15 предложений)

The author starts by telling the reader that ...
The author stresses ...
It is reported that ...
It is found out that ...
It is assumed that ...
It is pointed out that ...
It is claimed that ...
Particular emphasis is placed on the fact, that ...
The text discusses...
The text considers...
The text analyzes...
The text reports on ...
Further the author reports that ...
According to the text, ...
Much (little) attention is given to the fact, that ...
A careful account is given to ...

A detailed (brief) description is given to the fact, that …
Of particular interest is the fact, that …
The author cites … (the words of…, who says, that …)

6. Определите выводы, к которым приходит автор в конце текста
In conclusion the author wants to add that …
It is recognized that …

7. Выразите свое мнение по обсуждаемой проблеме
The text is expressive/very emotional
The text contains very important facts
The text contains the most up-to-date information on …
The text is of (great) interest for …
The text is (highly) recommended to …
The information is of value for …
The text contains a lot of key (important) words (terms), such as …