Н.К. Иванова, Ю.Л. Малкова

ОБУЧЕНИЕ ПРОФЕССИОНАЛЬНО-ОРИЕНТИРОВАННОМУ ЧТЕНИЮ

Иваново 2013

Министерство образования и науки Российской Федерации
Ивановский государственный химико-технологический университет

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Учебное пособие

Иваново 2013

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Обучение профессионально-ориентированному чтению: учебное пособие / Н.К. Иванова, Ю.Л. Малкова; Иван. гос. хим.-технол. ун-т. – Иваново, 2013. –140 с.

ISBN 978-5-9616-0471-9

Учебное пособие предназначено для аудиторных занятий со студентами 2 курса механического факультета, изучающими английский язык. Цель пособия — подготовить студентов к работе с оригинальной литературой, обучить необходимым лексико-грамматическим навыкам для извлечения информации из профессионально-ориентированных текстов.

Тексты и упражнения каждого урока позволяют осуществить работу по обучению различным видам чтения, закрепить полученные навыки работы с иноязычным текстом. Послетекстовые упражнения (в том числе аудиоприложения) направлены на развитие навыков разговорной речи и передачи полученной информации.

Завершается пособие текстами для дополнительного чтения, предназначенными для повторения пройденного лексико-грамматического материала.

Печатается по решению редакционно-издательского совета Ивановского государственного химико-технологического университета

Рецензенты:

кандидат филологических наук, доцент И.В. Куликова
(Ивановский государственный университет);
кандидат филологических наук, доцент А.А. Абызов
(Ивановский государственный политехнический университет)

ISBN 978-5-9616-0471-9

Lesson 1

Grammar: It, that

Text: Iron and Steel

Предтекстовые упражнения

1. Запомните произношение следующих слов и уточните по словарю их значения:

earth	/' ɜ:θ/
useful	/'u:sfəl/
iron	/'aɪən/
ore	/ɔ:/
considerable	/kən' sɪdərəbl/
either ... or	/' aɪðə ɔ: /
quantity	/'kwɒntɪtɪ/
certain	/' sɜ:tən/
majority	/ mə'dʒɒrətɪ/
engineering	/ˌendʒɪ' nɪərɪŋ /
moreover	/' mɔ:r əʊvə/
blast furnace	/'blɑ:st fɜ:nɪs /
constituent	/kənsˈtɪtjənt/
behaviour	/bɪ'heɪɪvɪə /

2. Переведите предложения, обращая внимание на значение выделенных слов и сочетаний

number of — ряд
There are a large number of metals which are useful to man.
Cast iron possesses a number of useful properties.

either ... or — или …или
Modern industry needs many metals — either in the form of iron or in the form of steel.
by means of — посредством, при помощи
The impurities in the iron ore are removed by means of smelting**.**

3. Переведите следующие слова, не пользуясь словарем:

Industry, modern, form, product, magnetic, electrical, combine, carbon, machinary, manufacture, complex, sulphur.

TEXT A. IRON AND STEEL

It is known that the earth contains a large number of metals which are useful to man. One of the most important of these is **iron** /'aɪən/**.** Modern industry needs con-

siderable quantities of this metal, either in the form of iron or in the form of steel. A certain number of non-ferrous metals, including aluminium and zinc are also important, but even today the most part of our engineering products are of iron and steel. It is necessary to note that iron possesses magnetic properties, which have made the development of electrical power possible. Iron is less reactive than carbon. To extract iron from iron (III) oxide, the oxygen must be removed. This reaction is called **reduction.**

The iron ore, which we find in the earth, is not pure. An **ore** is a rock that contains metals in such high concentration that is economically worthwhile to extract the metal from the rock. It contains some impurities that must be removed by means of smelting. The process of **smelting** consists of heating the ore in a blast furnace from the bottom and provide the oxygen which is necessary for the reduction of the ore. The ore becomes molten and its oxides combine with carbon from the coke. The non-metallic constituents of the ore combine with the limestone and form a liquid slag. This slag floats on the top of the molten iron and passes out of the furnace through a tap. The metal which remains is **pig-iron.** We can melt this down again in another furnace — a cupola— with more coke and limestone. This is **cast-iron**. It contains 96 % pure iron. Cast iron doesn't have the strength of steel. It is brittle and can fracture under tension. But it possesses a number of properties which make it very useful in manufacture of machinery. In the molten state it is very fluid, and therefore it is easy to cast it into

complex shapes. Also it is easy to machine it.

Cast-iron contains small proportions of other substances. These non-metallic constituents of cast-iron contain carbon, silicon and sulphur, and the presence of these substances affects the behavior of the metal. Iron, which contains a small quantity of carbon, for example, **wrought-iron**, behaves differently from the iron which contains a lot of carbon. It is very pure. Unfortunately, it can be too soft for many uses. Most iron is used to make steels**. Steels** are alloys of iron because they are mixtures of iron with carbon and other elements. **Low-carbon** steels are easily shaped and **high-carbon** steels are hard. Some steels, such as **stainless steels**, contain lager quantities of other metals.

Notes

smelting	плавка металла
ore	руда
blast furnace	доменная печь
coke	кокс
limestone	известняк
slag	шлак
tap	край
pig iron	чугун
cupola	вагранка
cast iron	серый чугун
to cast	отливать
shape	литейная форма
to machine	подвергать машинной обработке

wrought-iron	сварочная сталь (железо)
fricture	образовывать трещину
tension	напряжение

Послетекстовые упражнения

1.Найдите в тексте и проанализируйте функции слов **it, that**

2. Переведете слова, обращая внимание на суффиксы и префиксы

to use – use – useful
industry – industrial
to develop – development
electricity – electrical
pure – impure – impurity
to reduce – reduction (найдите в словаре все значения глагола)
to heat – heating
to melt – melting

3.Найдите в тексте следующие словосочетания

1. Большое количество металлов
2. Современная промышленность
3. Определённый ряд металлов
4. Цветные металлы
5. Магнитные свойства
6. Обладать рядом свойств

7. В расплавленном состоянии
8. Отливать в сложные формы

4. Найдите в тексте и переведите

Electric power, engineering products, non-metallic constituents, liquid slag, cast-iron, cupola (furnace), small portions, magnetic properties, a lot of carbon, in the molten state, strength of steel.

5. Запомните следующие слова и переведите предложения

to melt — плавиться
molten — расплавленный
mould — литейная форма, пресс-форма

At certain temperature metals melt.
They become molten.
The molten iron passes out of the furnace into moulds.

to smelt — плавить
smelting — плавка
pig-iron — чугун
ore — руда
blast furnace — доменная печь

We smelt iron ore by heat, and change the ore into its metal state.
When the ore is smelted, it becomes pig-iron.

This process of smelting consists of heating the ore in a blast furnace.

6. Запомните синонимы. Замените подчеркнутые в предложениях слова синонимичными, переведите их

quantity, amount — количество
property, characteristic, quality — свойство, качество
to have, to possess — иметь, обладать
component, constituent — составная часть, компонент
fluid, liquid — жидкий

Every metal possesses certain properties, which we can find by experiments.
Non-metallic components of cast iron contain a certain amount of carbon.
The heating makes steel liquid.

7. Запомните антонимы. Переведите предложения:

pure	чистый
impure	с примесью
impurity	примесь
heating	нагревание
cooling	охлаждение
reduction	восстановление
oxidation	окисление
top	верхняя часть
bottom	дно

remain	оставаться
remove	удалять
brittle	хрупкий
hard	твердый

1) By cooling the substance we can lower the temperature to freezing point; by heating the substance we can raise the temperature to boiling point.
2) The reaction opposite (противоположная) to that of oxidation is reduction.
3) They remain the pure metal in the furnace.
4) The most common impurities of iron ore are silica-titanium and phosphorus.

8. Заполните пропуски соответствующими словами:

1. Modern industry needs considerable ... of iron.
2. The process of smelting consists of heating ore in a ...
3. Iron possesses magnetic ...
4. The ore becomes molten and its oxides combine with carbon from the ...
5. The non-metallic ... of the ore combine with the lime-stone.
6. ... does not have the strength of steel, as it is brittle and may fracture under tension.
7. In the molten state it is ...
8. Cast-iron ... small proportions of other substances.

(свойства, компонент, количество, кокс, серый чугун, содержать, жидкий, доменная печь.)

9. Найдите в тексте ответы на следующие вопросы:

1. What is one of the most important metals useful to man?
2. What metals does modern industry need?
3. How is it possible to remove impurities containing in the iron ore?
4. What does the process of smelting consist of?
5. What kind of furnace is used for smelting of pig-iron?
6. What are the main characteristics of cast iron?
7. What constituents does the cast iron contain and how do they affect the behaviour of the metal?

10. Назовите перечисленные в тексте вещества, металлы и элементы. Их должно быть 11.

11.Сократите текст, сохранив его основное содержание.

12.Передайте содержание текста по-русски, по-английски, сохранив последовательность подачи информации в нём.

WRITTEN PRACTICE

Use the words from the text to complete the table

Name	**Description**
a)	The name of very pure iron
b)	An alloy containing iron and carbon, which is easy to shape
c)	A material produced when iron from blast furnace is allowed to cool down and solidify
d)	the compound found in iron ore

13. Изучите правила перевода и функции it и that. Переведите предложения.

1. The processes that were discussed are of great importance for the country's industry.
2. It is very important to find suitable engineering materials for every part of a machine or structure.
3. It was this engine that H. Diesel patented in 1892.
4. The efficiency (мощность) of the diesel engine is higher than that of the other engines.
5. The viscosity of water is 30 times greater than that of air.
6. It is known that the charge of the proton is equal in size but opposite in sign to the charge of the electron.

7. Thorium possesses properties similar to that of uranium.
8. These data can be classified into two groups.
9. He said that applications of electricity are quite numerous. It is impossible to consider them in this book.
10. This particle is very small. It cannot be seen.
11. It is impossible to formulate this idea precisely.
12. The molecular theory states that molecules are in a state of permanent motion.
13. It was periodic table of elements that D. Mendeleyev discovered in 1869.
14. That there are different ways of producing an electric current is a well-known fact.
15. It was Yablokov who was the first to understand the advantage of a transformer.
16. The fact is that it is the Soviet scientist Chernov who found «critical points».
17. That the earth turns round the sun is known to everybody.
18. Uranium is a very heavy silvery-white metal, hard, it is reactive, it burns on air on warming, it takes fire in fluorine, and sulfur combines with it at 500°.
19. The properties of those compounds are quite different.
20. Crystalline silicon has a structure similar to that of diamond.
21. It was not until 1930 that the third type of particles, that make up atoms was discovered.
22. That water is a compound was found at the end of the I8th century.
23. The metals that alloy freely with aluminium are cop-

per, zinc and iron.
24. The nature of non-ferrous alloys differs greatly from that of ferrous group.
25. Engineering materials are such materials that have large industrial applications.

14. Проверьте, знаете ли Вы следующие слова:

Industry, modern, ore, to smelt, smelting, amount, non-ferrous metals, iron, ore, coke, blast furnace, pig iron, cast iron, mould (shape), wrought iron, molten state, quality, quantity, to possess, fluid, to remove, reduction, impurity, constituent, brittle, to machine, cupola.

15. Подберите соответствующие английские эквиваленты.

1. твердый	1. brittle
2. количество	2. quality
3. восстановление	3. ore
4. серый чугун	4. fluid
5. доменная печь	5. characteristic
6. руда	6. to smelt
7. плавить	7. reduction
8. примесь	8. quantity
9. свойство	9. cast iron
10. хрупкий	10. to possess
11. жидкий	11. hard
12. обладать, иметь	12. impurity

16. Прочитайте и переведите текст B. Задайте к его содержанию 5 вопросов разных типов.

TEXT B. PRODUCTION OF CASTINGS

Production of castings made from different metals requires different types of melting furnaces. The cupola furnace is usually used for melting grey iron. The air cupola, and electric furnaces are used to melt the metal for making malleable iron castings. For melting steel, the open-hearth, crucible or electric furnaces are used. Non-ferrous metals are generally melted in crucibles or electric furnaces. The fuels mostly used for melting metals are coke, coal, oil and gas. Besides the different types of furnaces, different kinds of moulding sand are also required for making the moulds for different metals. In many cases, it is necessary as well to treat either the metals or the castings in some special way before the castings can be used.

17. Прочитайте, переведите и перескажите текст C.

TEXT C. THE BLAST FURNACE

The first blast furnaces were probably very similar to those that could be seen in some parts of India and Africa in 1960s of the 20th century. These

were usually small chimneys about 18 in. in diameter and about 4 ft high, built of clay. A crude bellows operated by hand or foot was used to blow air through holes in the side of the furnace near the base. The furnace was filled with a mixture of charcoal and iron ore. It was not operated continuously like the modern blast furnace, but was blown until all the charcoal had burnt away and part of the ore had been reduced to metal. The furnace was then pulled down and the frozen metal removed.

Notes

in.	inch (дюйм)
ft.	foot (фут)
bellows	воздуходувные мехи

Oral practice

Metallic issues

There are social, economic and environmental issues associated with exploiting metal ores. Recycling save energy and limited resources. There are drawbacks as well as benefits from the use of metals in structures. Some examples are shown in the table below.

Benefits	Drawbacks
- they are strong - they can be bent into shape	- obtaining metals from ores causes pollution and uses up limited recourses

- they can be made into flexible wires - they are good electrical conductors	- metals are more expensive than other materials such as concrete - iron and steel can rust

Use the information in this chapter to explain the benefits and drawbacks of using steel for girders in buildings.

Lesson 2

Grammar: the word **"one"**

Text: The Kinetic Theory of Heat

Предтекстовые упражнения

1. Запомните произношение следующих слов. Уточните значение по словарю:

kinetic	/kaɪ'netɪk/
equilibrium	/ˌi:kwˌɪ'lɪbriəm/
fundamental	/ˌfʌndə'mentəl/
equal	/'i:kwəl/
liquid	/'lɪkwɪd/
average	/'ævrɪdʒ/
gaseous	/'gæsɪəs/
sufficiently	/sə'fɪʃəntlɪ/

evaporate	/ɪ'væpəreɪt/
thermal	/'θɜ:məl/
degree	/dɪ'gri:/
cohesive	/kəʊ'hi:sɪv/

2. Переведите, не пользуясь словарём.

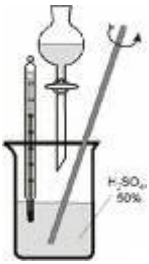
Solid, liquid, gaseous, iron, thermal, transform, transformation, permanent, normal temperature, kinetic energy, absolute zero, intermolecular, unlimited expansion.

3. Переведите предложения, обращая внимание на подчеркнутые словосочетания.

According to — согласно, в соответствии
According to the molecular theory of matter, a hot body differs from a cold one only in the state of motion of its particles.
The + прил. в сравнит. ст., the +прил. в ср. ст. — чем..., тем (the ... the)
The faster the molecules move, the hotter the body seems.

Sooner or later — рано или поздно
No longer — больше не
There come sooner or later the stage when the cohesive forces are no longer able to keep the molecules rigidly (неподвижно) in their places.

TEXT A. THE KINETIC THEORY OF HEAT



There are three fundamental states — the solid, the liquid and the gaseous. We know that any substance in nature can be brought into each of these three states. Even iron evaporates at several thousand degrees and even air freezes into a solid block at sufficiently low temperatures. Thus, the difference between the solid, liquid and gaseous states of a given body depends upon its thermal condition. By adding heat to a solid body one transforms it into a liquid. By adding still more heat one may transform the liquid into a gas. But what is heat?

According to the molecular theory of matter, a hot body differs from a cold one only in the state of motion of its particles. The molecules of every material body at normal temperature are in a state of permanent motion; and the faster they move, the hotter the body seems. If we bring a hot body into contact with a colder one, the fast moving molecules of the first will collide, on their common boundary, with the slower moving molecules of the second and transfer to them a part of their kinetic energy. Thus, the fast molecules will gradually slow down, and the slow ones speed up, until a state of equilibrium is reached, in which the molecules in both bodies have equal average energies. One says that both bodies possess the same temperature, and that the "flow of heat" from one into the other has stopped.

Thus, it follows that there should exist a lowest

possible temperature, or an absolute zero, at which the molecules of all material bodies are completely at rest. At this temperature the constituent particles of any substance will stick together, because of intermolecular cohesive forces, and demonstrate the properties of a solid.

As the temperature rises, and the molecules begin to move, there comes, sooner or later, a stage when the cohesive forces are no longer able to keep the molecules rigidly in their places, though still strong enough to prevent them from flying apart. The body is not solid any longer, but still keeps its finite volume and one then has matter in the liquid state. At still higher temperatures, the molecules move so fast that they tear apart from each other and fly off in all directions, thus forming a gas with a tendency toward unlimited expansion.

Notes

to bring into	приводить в состояние
to collide	сталкиваться
boundary	граница
at rest	в состоянии покоя
to stick together	зд. примыкать друг к другу
to fly apart	зд. отлетать друг от друга
finite	ограниченный
to tear apart	отрываться
flow	поток
cohesive	связующий

Послетекстовые упражнения

1. Переведите, обращая внимание на суффиксы, префиксы:

sufficient-	sufficient**ly**
gas-	gase**ous**
add-	add**ing**, addi**tion**
transform-	transforma**tion**
move- motion-	move**ment**
slow-	slow**er**, slow**est**
hot-	hotter, hottest
complete-	complete**ly**
rigid-	rigid**ly**
expand-	expan**sion**

2. Найдите в тексте следующие словосочетания

1. Низкие температуры
2. Газообразное состояние
3. Молекулярная теория
4. Быстродвижущиеся молекулы
5. Общие границы
6. Кинетическая энергия
7. Одинаковая температура
8. Составные части
9. Силы сцепления
10. Безграничное расширение

3. Заполните пропуски подходящими по смыслу словами:

1. There are three ... states.
2. Even iron ... at several thousand degree.
3. Air ... into a solid block at sufficiently low temperature.
4. By adding heat to a solid body one can ... it into liquid.
5. The molecules of every material body ... at normal temperature.

(двигаться, превращать, замерзать, основной, испаряться)

4. Запомните синонимы. Переведите на русский язык:

To transform, to change, to convert — превращать
State, condition — состояние

Metal which is hardened by cold-working may be brought back to its original state (condition) by annealing. (отжиг).
This furnace converts the chemical energy in the fuel into heat.
The gas engine transforms heat into mechanical energy.

5. Сгруппируйте антонимы. Переведите предложения:

Low, liquid, cold, high, slow, strong, fast, weak, to slow down, solid, to speed up, hot.

1. Aluminium has high corrosion resistant qualities.
2. After melting any solid begins to expand.
3. Aluminium is too soft for making castings.
4. By varying the properties of non-ferrous metals, alloy that are hard or soft, weak or strong, can be produced.
5. The density of any substance in the solid state is higher than in the liquid.

6. Ответьте на вопросы:

1. How many fundamental states are there in nature?
2. What are these states?
3. What does the difference between the solid, liquid and gaseous states depend on?
4. How is it possible to transform a solid body into a liquid one?
5. How is it possible to convert a liquid into a gas?
6. What is the difference between a hot and a cold body according to the molecular theory of matter?
7. What is an absolute zero?
8. What happens to a substance as the temperature rises?

7. Письменно сократите текст, сохранив его основное содержание.

8. Передайте содержание текста по-русски, по-английски.

9. Проверьте, знаете ли Вы следующие слова:

State, nature, evaporate, low, to depend on, to transform, to convert, according to, matter, motion, particle, fast, boundary, slow, equilibrium, equal, average, at rest, cohesive force, unlimited, strong, condition, solid, liquid state, expansion.

10. Изучите функции "one", переведите предложения.

1. To determine the density of a body one must know its mass and volume.
2. Copper is one of the metals used in the prehistoric (доисторическое) time.
3. An elementary substance is the one which consists of only one kind of atoms.
4. One has to remember that this reaction is followed by an explosion.
5. Ductile (эластичные) materials have greater strength than brittle ones.
6. One has to know that all objects are acted upon by gravitation forces.
7. If one knows the acceleration of a body, one can easily define its speed at any time after it has started its motion.

8. One can say that there are unlimited sources of energy in the world.
9. While making the experiment, one has to keep the temperature constant.
10. One can determine the specific gravity of the substance if one knows its weight and volume.
11. These machines are inefficient and that is why it is necessary to replace them by new ones.
12. In order to learn the properties of a substance one must have it in its pure form.
13. Observing the arrangement (расположение) of atoms in a solid, one can better understand its properties.
14. One of the ways of obtaining oxygen is to decompose water by the electric current.
15. One knows that the heavier the nucleus (ядро), the denser the energy levels.
16. One thinks this hypothesis is doubtful.
17. One is to remember that as a wire becomes thicker, its resistance is less.
18. One way of classifying a solid is according to its electrical properties.
19. One may convert potential energy into kinetic one.
20. It was known that elements could unite with one another in more than one proportions but one should know that Dalton was the first to discover a simple relation between the different proportions in which the elements combine.

11. Прочитайте и переведите текст, пользуясь словарем:

TEXT B. HEAT

One must know that heat is the transfer of thermal energy between two bodies which are at different temperatures.

Heat is to thermal energy as work is to mechanical energy. Heat flows between regions that are not in thermal equilibrium; in particular, it flows from areas of high temperature to ones of low temperature. All objects (matter) have a certain amount of internal energy that is related to the random motion of their atoms or molecules. This internal energy is directly proportional to the temperature of the object. When two bodies of different temperature come into thermal contact, they will exchange internal energy until the temperature is equalized. The amount of energy transferred is the amount of heat exchanged. Sometimes one confuses heat with internal energy, but it is a common misconception and there is a difference: heat is related to the change in internal energy and the work performed by the system. The term "heat" is used to describe the *flow* of energy, while the term "internal energy" is used to describe the energy itself.

Heat transfer mechanisms. Heat tends to move from a high temperature region to a low temperature one.

This heat transfer may occur by the mechanisms conduction, and radiation. The term "convection" is used to describe the combined effects of conduction and fluid flow. In the past, this has been regarded as a third mechanism of heat transfer, but, logically, it is not a mechanism of its own.

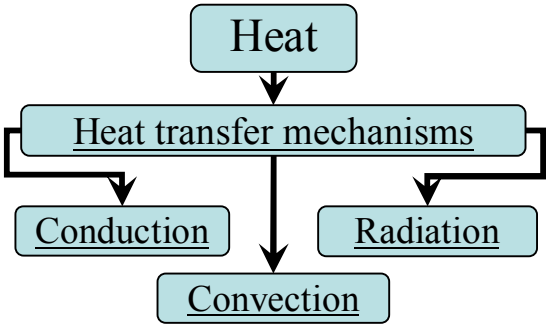
Conduction is the most common means of heat transfer in a solid. On a microscopic scale, conduction occurs as hot, rapidly moving or vibrating atoms and molecules interact with neighbouring ones, transferring some of their energy (heat) to these neighbouring atoms.

Convection is usually the dominant form of heat transfer in liquids and gases. This is a term used to characterize the combined effects of conduction and fluid flow. In convection, enthalpy transfer occurs by the movement of hot or cold portions of the fluid together with heat transfer by conduction. For example, when water is heated on a stove, hot water from the bottom of the pan rises, heating the water at the top of the pan.

Radiation is a means of heat transfer. Radioactive heat transfer is the one form of heat transfer which can occur in the absence of any form of medium and as such is the only means of heat transfer through a vacuum. Thermal radiation is a direct result of the movements of atoms and molecules in a material. Since these atoms and molecules are composed of charged particles (protons and electrons), their movements result in the emission of electromagnetic radiation, which carries energy away from the surface. At the same time, the surface is constantly bombarded by radiation from the

environment, resulting in the transfer of energy to the surface. Since the amount of emitted radiation increases with increasing temperature, a net transfer of energy from higher temperatures to lower ones results.

12. Кратко изложите содержание текста на английском языке, располагая информацию в соответствии со следующей схемой:



13. Дайте определение следующим терминам: *heat, convection, conduction, radiation.*

TEXT C. FUEL ISSUES

Fossil fuels are non-renewable and they cause pollution. The need to develop alternative fuels is becoming more urgent. Hydrogen has advantages as a fuel. It burns easily and realizes a large amount of energy per gram. It produces no carbon dioxide when it is burnt, only water. Hydrogen can be burnt in combustion engines or can be used in fuel cells to power vehicles. Hydrogen can be

produced from renewable sources. The disadvantages of using hydrogen include supply, storage and safety problems. Vehicles that use fuel cells need to much the performance, convenience and costs of petrol and diesel vehicles.

Ответьте на вопросы

1. Why are cars fuelled with hydrogen being developed?
2. Suggest three problems that need to be overcome to make hydrogen suitable fuel for cars.

For you to know.

James Joule /dʒu:l/ (1818-1889), was the first scientist to realize that there are many different types of energy, for example…

Light energy
Sound energy
Kinetic (movement) energy
Gravitational potential energy
Thermal (heat) energy
Chemical energy
Electrical energy

Energy is measured in units called Joules, named after James Joule.

Energy can't be created or destroyed, but it can be changed from one form to another, or transferred

from one place to another. Energy changers are devices that can change or transfer energy. Some energy-changing devices are given in this table.

Device	**Energy change**
Kettle	Electrical energy into thermal energy. For example, it takes 500 kJ to boil a kettleful of water.
Car engine	Chemical energy (in fuel) into kinetic energy. For example, it takes 100 kJ to accelerate to 30 mph.
Human	Chemical energy (in food) into kinetic energy (to move) and thermal energy to keep warm. An average person uses 11 000 kJ a day.
Microphone	Sound energy into electrical energy.
Loudspeaker	Electrical energy into sound energy.
Torch	Chemical energy (in batteries) into light and thermal energy. (The thermal energy heats up the bulb. It is not useful, so it's called wasted energy).
Diver	Gravitational potential energy into kinetic energy. As a diver falls from a diving board, his speed increases as more energy is changed into kinetic energy.

What do energy changers do?
What types of energy do you know? Give the definition of each of them.

Listen to the text about James Joule. Retell it.

Lesson 3

Grammar: general revision of "it, that, one"

TEXT A: HEAT TREATMENT OF STEEL

It is possible to change the characteristics of steel in various ways. Steel which contains very little carbon will be milder than that which contains a higher percentage of carbon up to the limit about 1,5%. One can heat the steel above a certain critical temperature, and then allow it to cool at different rates.

At this critical temperature changes take place in the molecular structure of the atom. In the process known as annealing, we heat the steel above the critical temperature and allow it to cool very slowly. The metal becomes softer than before, and its machining becomes easier.

One can make steel harder by rapid cooling. We heat it up beyond the critical temperature and drop it in water or some other liquid. Then we heat it again to the temperature below the critical one, and cool it slowly. This treatment is called tempering. It makes the steel less brittle. The properties of temperatured steel allow us to use it in the manufacture of tool which need a rather hard steel. High carbon steel is harder than the temperatured that, but it is much difficult to work. These heat treatments take place during various shaping operations.

Notes

annealing	отжиг
to drop	погружать
tempering	отпуск /стали/
treatment	обработка

1. Answer the following questions:

1. How is it possible to change the characteristics of steel?
2. What is annealing?
3. How can one make steel harder?
4. Describe the process of tempering.
5. Where is the tempered steel used?
6. When do the heat treatments take place?

TEXT B. ACCELERATION

It is known that the simplest kind of motion is such motion in which a body moves along a straight line with a constant velocity, the word "velocity" meaning both size and direction of the motion. When interested only in the size of the motion, we use the word "speed". If the velocity is not constant we have an acceleration, the latter being defined as the time rate of change of velocity; it is used in order to denote either an increase or a decrease of speed. It is im-

portant to understand that an acceleration is not fully determined when we do not know the time required to change the speed.

The simplest case of accelerated motion occurs when the velocity of a body moving in a straight line changes by equal amounts in equal intervals of time. It is in this case that the acceleration is called "constant" and the motion "uniformly accelerated".

When a body is acted upon by an "unbalanced" force, it has an acceleration in the direction in which the force acts. In this case, the acceleration is proportional to the force applied. By an "unbalanced" force we mean each push or pull which acts in one direction with a greater strength than in the other. For example, a locomotive is pulling a train at a constant speed of 50 miles an hour. The engine is exerting a force on the train. It is known that there are other forces, due to friction and air resistance, which act in the opposite direction. It is these forces that balance the pull of the engine.

2. Answer the following questions:

1. What is the simplest kind of motion?
2. What does the word "velocity" mean?
3. If we are interested only in the size of the motion, what word do we use?
4. What is acceleration?
5. Give an example of acceleration.

TEXT C. MECHANICS

That the object of physics is the study of the things surrounding us in nature is known to everybody. It is in physics that we deal with the phenomena and processes in the world of nature, which are similar with those dealt with in chemistry.

The fact is that physics is divided into five divisions: mechanics, heat, electricity, sound and light. We'll have to deal with mechanics rather than with other branches of physics and it is for this reason that we should have a precise and clear ideas of this subjects. Mechanics is that branch of physics which studies the motion of bodies. Kinematics is that part of mechanics which deals with motion, and does not deal with the body that is moved or with the forces causing motion. It is dynamics that deals with the action of forces that cause motion.

That statics and kinetics are parts of dynamics is known to everybody; the former studying forces that keep a body in equilibrium, and the latter studies how a body will move when it is acted on by a given set of forces. It is also studies what set of forces may cause a given type of motion. The matter is that statics is simpler than kinetics.

Notes

the former	первый из упомянутых
the latter	второй из упомянутых

3. Answer the following questions:

1. What is the object of physics?
2. What do we deal with in physics?
3. What branch of physics is mechanics?
4. What is kinematics (dynamics)?
5. Is there any difference between statics and kinetics? What is the difference?

4. Analyse the sentences with it, one, that. Define the functions of these words.

TEXT D. KINDS OF FORCES

Force is usually defined as a push or pull which tends to cause a body to change its state of rest or of uniform motion in a straight line. Our aim is to consider two kinds of forces. When a body that is in motion and therefore possesses kinetic energy, is acted upon by a force, it loses its kinetic energy. When thrown vertically upwards, a body is acted upon by the forces of gravity, but this force continues to act and pulls the body back to its starting points. It is at this staring point that the body recovers its kinetic energy. The same is true when a moving body is arrested by the stretching or bending forces, due to the gravity and elasticity, respectively, which depend only on the position of the body or the relative position of the parts of a system of bodies at any moment, but not the direction or magnitude of the motion at that moment. It is

these forces that are called positional.

That the case is very different when the arresting force is friction is quite evident, this force depending on the action of the body. In this case, one sees that the body, for example, a train or an automobile, simply comes to rest, and the force does not help it to recover its kinetic energy expended. Friction opposes the motion of the body in whatever direction the body may be moving. A force depending on the state of motion of a body is called a motional forces.

5. Answer the following questions:

1. When does a body in motion lose its kinetic energy?
2. What force acts on a body thrown vertically upwards?
3. Does the body recover its kinetic energy if it has returned to its starting point?
4. What forces are called positional ones?
5. What forces do positional forces depend on?
6. What force is called a motional force?

6. Retell the text.

Listening practice

New words and expressions

Gantry – портальный (кран на платформе)

Beams – зд. балка

To bolt - скреплять болтами

Core - насквозь

To adjust – регулировать, выверять

play	pause	stop

Victor, an engineer from German company that makes and installs industrial gantry cranes, is phoning Rajesh, the construction manager of a manufacturing plant currently being built near New Delhi, India.

They are discussing the gantry crane due to be installed at the plant. Listen to the conversation and answer the questions.

1. Why are holes needed in the concrete walls?
2. What are core drilled holes and what are preformed holes?
3. In this context, what is meant by play?
4. What impact will the lack of the play around the bolts have (on the construction)?
5. Apart from technical questions, what two issues will determine the most feasible way of forming the holes?

Lesson 4

Grammar: Would, Conditional clauses.
Text: Expansion

Предтекстовые упражнения

1. Запомните произношение следующих слов и уточните по словарю их значение:

expand	/ɪks'pænd/
zinc	/'zɪŋk/
expansion	/ɪks'pænʃn/
metre	/'mi:tə/
special	/'speʃəl/
millimetre	ˌmɪlɪ'mi:tə/
precise	/prɪ'saɪs/
breadth	/'bredθ/
aluminium	ˌælə'mɪniəm/
cubic	/kju:bɪk/
for instance	/fər 'ɪnstəns/
increase, v	/ɪn'kri:z/
increase, n	/'ɪnkri:s/
platinum	/'plætɪnəm/
wire	/'waɪə/
liquid	/'lɪkwɪd/

2. Переведите следующие слова, не пользуясь словарем:

Special, instrument, metal, aluminium, metre, millimetre, steel, cubic, litre, platinum.

3. Переведите предложения, обращая внимание на степени сравнения прилагательных:

1. Almost all solids expand more or less when heated.
2. Aluminium expands less and zinc more than other common metals.
3. A steel metre rod would be 1.3 millimetres longer, if we raise the temperature from 0° to 100°.
4. Liquids expand more than solids.
5. Some liquids expand even more than water.

TEXT A. EXPANSION

Almost all solids expand more or less when heated, but this expansion is very small. In order to see it, the special instruments are used. Very precise instruments show that different metals expand at different rates. Aluminium, for instance, expands less and zinc more than other common metals. If we made a platinum wire one meter long at 0º C, it would be one metre and nine millimetres long at I00°C. Similarly, a steel metre rod would be 1.3 millimetres longer if we raise the temperature from 0º to I00°C.

On determining how much a given object, such as steel rod, will expand, it is necessary to know three things about it: namely, its length, the rise of temperature and the rate of the expansion of the substance used.

A metal wire, if heated, expands not only in length but also in breadth and thickness, in other words, its volume increases, such expansion being called cubic expansion. Liquids expand more than solids. For instance, if you heat a litre of water from 0° to 100°, it will increase in volume about 40 c. If you heated a piece of steel of the same volume, it would expand only 3.9 c. Some liquids expand even more than water.

Notes

precise	точный
similarly	подобным образом
rod	стержень
object	предмет
breadth	ширина
namely	а именно

Послетекстовые упражнения

1. Проанализируйте функции слов «it», «that» и “would”, встречающиеся в предложениях данного текста.

2. Переведите слова, обращая внимание на суффиксы и префиксы.

to expand – expansion
to differ – different – difference
similar – similarly
special – specially – speciality
precise – precisely
thick – thickness
long – longer – length
broad – breadth

3. Найдите в тексте следующие сочетания:

Точные инструменты, различные металлы, с различной скоростью, обычные металлы, платиновая проволока, стальной метровый стержень, повышение температуры, скорость расширения, кусок стали, одинаковый объем.

4. Переведите на русский язык следующие сочетания:

Metal wire, in other words, its volume increases, cubic expansion, special instruments, it is necessary to use, a given object, in length, in breadth, in thickness, for instance, the same, even more than H_2O.

5. Запомните следующие синонимы. Замените подчёркнутые слова синонимичными. Переведите предложения.

instruments, tools — инструменты
to use, to employ, to apply — применять

For the temperature rise control the special instruments will be employed.
The applied tools will allow to analyse this complex phenomena very precisely.
For this purpose one must use tool steel number 66 and 94.

6. Запомните следующие антонимы. Переведите предложения.

expand, contract — расширять, сжимать
1. Many substances will expand if we heat them — they will become bigger or longer.
2. Many substances will contract if we cool them — they will become smaller or shorter.

increase, v	/in'kri:s/	увеличивать
decrease, v	/dɪ'kri:s/	уменьшать
increase, n	/'i:nkrɪs/	увеличение

1. The heat of vaporization decreases with 'increase in molecular weight.

2. Nickel increases strength and hardness of steel.

7. Заполните пропуски подходящими по смыслу словами:

1. Almost all ... expand more or less when heated.
2. Aluminium ... less and zinc more than other common metals.
3. When the volume increases such expansion is called ...
4. Liquids ... more than solids.
5. Some liquids expand more than ...

(кубическое, вещество, вода, жидкости, расширяться)

8. Скажите, соответствуют ли данные утверждения содержанию прочитанного. Пользуйтесь формулой:

It is right	Sorry, you are mistaken
It is wrong	Quite correct

1. Almost all solids expand when heated and this expansion is very great.
2. Different metals expand at the same rate.
3. 1n order to see expansion it is necessary to use special instruments.
4. Aluminium expands more and zinc less than other common metals.
5. A metal wire if heated expands only in the length.
6. Some liquids expand more than water.

9. Ответьте на следующие вопросы.

1. What happens when bodies are heated?
2. Do metals expand at the same or different rate?
3. How long would a platinum wire of one metre long be at 100°C?
4. What is the expansion in volume called?
5. Are there any liquids that expand more than water?

10. Передайте содержание текста по-русски, по-английски, сохранив последовательность подачи информации в нём.

11. Изучите правила перевода условных предложений.

12. Переведите следующие предложения, обращая внимание на функции "would" и типы условных предложений.

1. Charged particles cannot be used for nuclear experiments if they are not accelerated.
2. Gas becomes ionized if exposed to ultraviolet light.
3. Iron rusts slowly when exposed to the air unless it is heated to a high temperature in contact with oxygen.
4. If we want to know the size of a body, we have to measure it.
5. If there were no electricity, industry would not develop so rapidly.
6. If the temperature remained con-

stant, no expansion would take place.
7. Were the temperature raised, the physical properties of iron would change.
8. Glass, when it is hot, conducts current much better than it would were it cold.
9. If he experimentally tested his data, he would publish them.
10.If high-energy protons hit a molecule, ionization will result.
11.If two or more pure metals are mixed in molten state (расплавленное состояние), we shall have an alloy after cooling.
12.If the two elements form a solid solution, the alloy will be harder and stronger.
13.If air-cooled engines were used, the plane would have greater reliability (надежность) in operation.
14.If some air were allowed to mix with hydrogen, the reaction would take place with a characteristic sound.
15.Were the resistance to flow increased, the volume of gas would be decreased.
16.Had not enough air been admitted to the fire, a part of the fire would have been converted into carbon monoxide.
17.If phosphorus tin is used and alloyed with copper, better results will be obtained than if the phosphorus is mixed with the copper.
18.We were told that the experiment would be completed in the shortest time.
19.Had he finished his experiment last week, he would have got the necessary results.

20.Professor Roentgen proved that the rays would pass through solid substances.

13. Раскройте скобки, употребляя соответствующую форму глагола. Определите тип условного предложения. Переведите предложения.

1. If we (to heat) a solid body or a liquid, they will usually expand.
2. The motor car (to move) very quickly, provided it had had a powerful motor.
3. If we (to know) the dimensions of the body we would calculate its volume.

14. Переведите предложения на английский язык.

1. Мы бы получили лучшие результаты, если бы использовали другой материал.
2. Это вещество можно было бы определить, если бы мы знали свойства, которыми оно обладает.

15. Проверьте, знаете ли вы следующие слова:

Solid, to expand, expansion, to contract, contraction, special, tool, to show, wire, rod, platinum, similar, steel, to raise, necessary, length, breadth, thickness, volume, cubic, ratio, to apply, instrument, to employ, precise.

16. Подберите соответствующие английские эквиваленты:

1 расширение	1 similar
2 применять	2 to rise
3 скорость	3 contraction
4 сжатие	4 tool
5 проволока	5 thickness
6 длина	6 expansion
7 точный	7 velocity
8 похожий	8 precise
9 инструмент	9 length
10 толщина	10 wire
11 повышать	11 to apply
12 твердое вещество	12 volume
13 объем	13 solid

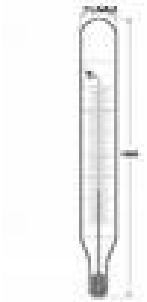
17. Повторите основные модели условных предложений. Раскройте скобки, употребляя соответствующую форму глагола. Переведите текст письменно.

Example:

1. The body will expand if you heat it.
2. The body would expand if it were heated.
3. The body would have expanded if it had been heated.

TEXT B. WHAT IS TEMPERATURE?

In a qualitative manner, we can describe the temperature of an object as that which (**to determine**) the sensation of warmth or coldness felt from contact with it.



If two objects of the same material **(to place)** together (physicists say when they are put in thermal contact), the object with the higher temperature **(to cool)** while the cooler object (**to become**) warmer until a point is reached after which no more change occurs, and to our senses, they **(to feel)** the same. When the thermal changes have stopped, we (**to say**) that the two objects (physicists define them more rigorously as systems) **(to be)** in thermal equilibrium. We can then (**to define**) the temperature of the system by saying that the temperature is that quantity which is the same for both systems when they **(to be)** in thermal equilibrium.

If we **(to experiment)** further with more than two systems, we (**to find**) that many systems can be brought into thermal equilibrium with each other. Thermal equilibrium does not depend on the kind of object used, i.e. if two systems **(to be)** separately in thermal equilibrium with a third, then they must also be in thermal equilibrium with each other, and they all (**to have**) the same temperature regardless of the kind of systems they are.

If three or more systems are in thermal contact with each other, and all in equilibrium together, then any two taken separately **(to be)** in equilibrium with one an-

other (the zeroth law of thermodynamics).

Now one of the three systems could be an instrument calibrated to measure the temperature — i.e. a thermometer. When a calibrated thermometer (**to be put**) in thermal contact with a system and it (**to reach**) thermal equilibrium, we then have a quantitative measure of the temperature of the system.

18. Прочитайте текст. Дайте следующие определения на английском языке: Temperature, The quantity of heat и **Specific heat**

TEXT C. HEAT

It is very important not to confuse quantity of heat and temperature. Temperature is the intensity or degree of heat while the quantity of heat is the actual amount of kinetic energy that a certain body contains. For example, if we have two blocks of the same substance, one exactly twice as large as the other, but both at the same temperature, the larger block will contain twice as much energy as the smaller block because it contains twice as many molecules. Each molecule has the same vibrations and therefore the same kinetic energy at any one temperature. This consideration leads to a property of substances known as specific heat. It is defined as the amount of heat necessary to rise the temperature of one gram of the substance at one degree Centigrade (C). Specific heat is

expressed in calories per gram per degree centigrade, one calorie being the amount of heat necessary to rise 1 g. of water from 14.5° to 15.5°C. The specific heat or heat capacities of materials are of great importance in calculations involving the heating of furnaces, the drying of materials, the distillation of petroleum and the melting operations.

Notes

twice as much energy	вдвое больше энергии
in calculations involving	в расчетах, включающих

Reading practice

HEAT LOSS IN THE HOME

Energy is used to heat your home, but some energy will be lost in various ways. In a cold day a badly insulated house can lose up to 10 000 J per second. This is wasted energy. Wasted energy that has been generated in thermal power stations means that more fuel is burned than necessary and more polluted gases are released into the environment. Polluted gases can contribute to **global warming and** could cause problems for humans, plants and animals. You can reduce the amount heat energy lost in a building by improving the insulation.

Efficiency is a measure of how much energy is used compared with how much energy is wasted in a given situation.

Questions:

1. Give one way to reduce energy loss in the home.
2. What formula is used to calculate efficiency?

Lesson 5

Grammar: Subordinate Clauses

Text: Early Methods of Iron Making

Предтекстовые упражнения

1. Запомните произношение следующих слов и уточните по словарю их значения

ornament	/'ɔ:nəmənt/
archaeologist	ˌɑkɪ'ɒlədʒɪst/
ancient	/'eɪnʃənt/
corrodibility	/kə'rəʊdɪbɪlɪtɪ/
implement	/'ɪmplɪmənt/
weapon	/'wepən/
wipe out	/'waɪp 'aʊt/
charcoal	/'tʃɑ:kəʊl/
shallow pit	/'ʃæləʊ pɪt/
spongy	/'spɒndʒi/
alternate	/'ɔ:ltəneɪt/
bamboo	ˌbæm'bu:/
clay	/kleɪ/
wax	/wæks/

2. Переведите следующие слова, не пользуясь словарем:

Gold, silver, copper, to smelt, charcoal, slag, mixture, bottom, top, furnace, steel, cast iron, industry.

3.Переведите предложения, обращая внимание на выделенные слова.

According to — в соответствии с, согласно
According to some archeologists, the use of bronze followed the use of the native metals by the ancients.

Because of — из-за
Many modern metallurgists disagree with this because of the difficulties involved in smelting copper-alloys.

Until — до тех пор пока, до
The new method spread rapidly although the old direct methods of making iron persisted until comparatively recent times.

TEXT A. EARIY METHODS OF IRON MAKING

Probably the first metals used by man were gold, silver and copper, which were found in the native or metallic state and used principally as ornaments. According to some archaeologists, the use of bronze followed the use of the native metals by the ancients.

Many modern metallurgists disagree with this because of the difficulties involved in smelting copper-alloys. Their belief is that iron antedated the use of bronze by a considerable period of time, but the easy corrodibility of iron implements and weapons has wiped out all traces of its early use and left bronze as the earliest remains of smelted metals. Although this idea has not been proved, it is quite probable that it is true since iron can be reduced from its ores much more readily and by cruder methods than copper or tin. Also the ores of iron are considerably more widely spread than those of other metals, particularly tin.

Easily reducible iron ore, mixed with charcoal, was smelted in shallow pits made in the ground. The blast was furnished by a crude bellows and was introduced through an underground tube. The product was an impure mixture of spongy iron, slag, and unreduced ore. This was again mixed with charcoal and resmelted, and the hot waxy mixture of iron and slag was hammered into various shapes.

A very old method of iron production was practised in India. The furnace was round and of open construction, built of clay, was 2 to 4 ft. high, about 9 in. in diameter at the bottom and 6 in. at the top. It had two openings near the bottom, one for working the furnace and the other for inserting a bamboo blast pipe which was connected to a goat-skin bellows. The ore was fed in alternate layers with charcoal, and after several hours of blowing a pasty mass of iron was withdrawn and pounded to free it partly from slag.

A very good steel was produced in India from this type of iron. After repeated smelting and cutting it into small pieces the iron was mixed with a particular wood and fused in a clay crucible which was placed in a shallow pit and fired by charcoal.

The increased furnace temperature, which resulted from introducing water power to work the bellows, melted the iron, and it ran from the furnace in fluid form for the first time. This was the beginning of the cast iron industry. The new method spread rapidly although the old direct methods of making iron persisted until comparatively recent times.

Notes

in the native state	в самородном состоянии
involved in smelting	связанных с выплавкой
corrodibility	способность подвергаться коррозии, окисляемость
left bronze as the earliest remains of smelted metals	оставила бронзовые изделия в качестве наиболее древних памятников металлов, выплавленных из руд
for working the furnace	для управления работой печи
in shallow pits	в небольших (выплавленных из руд) углублениях
was withdrawn	извлекалась
was fired by charcoal	нагревалась пламенем древесного угля
cast iron industry	чугунно-литейная промышленность

Послетекстовые упражнения

1. Найдите в тексте придаточные предложении и определите их вид

2. Переведите слова, обращая внимание на суффиксы и префиксы.

metal	metallic
principal	principally
corrode	corrodibility
wide	widely
pure	impure
mix	mixture
smelt	resmelt
compare	comparatively
wide - width	widely

3. Найдите в тексте следующие словосочетания.

Легко воспламеняемая железная руда, подземная труба, простые кожаные меха, невосстановленная руда, различные формы, около 9 футов в диаметре, губчатое железо, чередующиеся слои, глиняный тигель, тестообразная масса.

4. Заполните пропуски подходящими по смыслу словами.

1. Probably the first metals used by man were found ... or metallic state.
2. The blast … by a crude bellows.
3. The hot waxy mixture of iron and slag was hammered into …
4. The increased furnace temperature melted the iron and it ran from the furnace in … for the first time.

(various shape, was furnished, fluid form, in the native state)

5. Переведите предложения на английский язык.

1. Легко восстанавливаемая железная руда смешивалась с древесным углем.
2. Простые кожаные меха нагнетали воздух через подземную трубу.
3. После повторной переплавки мягкое железо ковалось в различные формы.

6. Ответьте на вопросы:

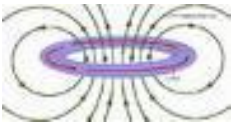
1. What were the first metals used by man?
2. What enables us to think that the use of iron antedated the use of bronze?
3. Which metal is more corrodible: iron or bronze?
4. Which of the three metals — iron, tin, copper — is the most widespread?

7. Сократите текст, сохранив его основное содержание.

8. Передайте содержание текста по-русски, по-английски.

9. Изучите правила перевода придаточных предложений. Переведите следующие предложения и проанализируйте их структуру.

1. Since almost no iron exists free in nature, it came into general use somewhat later.
2. This definition is used by us as it is rather precise.
3. The temperature fell to zero as the fire stopped burning.
4. Man's next use of iron was to fashion tools so that he could make life easier for himself.
5. Mechanics is the science concerning forces and the resulting motion of material bodies that are subjected to various kinds of forces.



6. Force is a quantity with which everyone is familiar.
7. In order to be measured, forces must be compared by means of a basic unit.
8. Weight is a force, whereas mass is a measure of how great an effect a force may have on the object.
9. A mechanical system is defined as anything that is composed of matter.

10. That heat is a form of energy is well known.
11. Whether this reaction will take place is unknown.
12. The decision of the commission was that the discovery was of great importance to industry.
13. Whether an element exists at room temperature as a gas, liquid, or solid depends upon the nature of the forces or bonds holding the various units of the elements together.
14. That solids are made up of atoms and molecules is known to every student.
15. The question is whether the pressure is high enough to continue our experiments.
16. We know that solids materials are composed of crystals, fibers, grains, or similar units arranged in some geometrical pattern.
17. It has been noted that the addition of a neutron produces isotopes (such as heavy hydrogen which is an isotope of hydrogen).
18. We know elements of the same atomic number but different atomic weights are called isotopes.
19. Germanium belongs to the class of materials we know as semiconductors.
20. The sand which is used for making moulds should be refractory (огнеупорный).

10. Проверьте, знаете ли вы следующие слова

Native state, to involve, belief, to antedate, corrodibility, implements, to wipe out, trace, to reduce, shallow pits, crude bellows, underground tube, spongy iron,

unreduced ore, various shapes, alternate layers, pasty mass, fluid form, cast iron industry, comparatively.

11. Найдите определительные придаточные предложения и поставьте в начале их союзное слово с относящимся к нему предлогом. Предложения переведите на русский язык.

1. The Academy, M. V. Lomonosov worked in, was established by Peter I.
2. Any mineral, a metal can be obtained from, is called ore.
3. Water is one of the things man cannot live without.
4. Chemistry deals with the properties, composition and structures of the materials our world and all that it contains, are composed of.
5. The laboratory, we work in, is equipped with modern apparatus.

12. Прочитайте и переведите текст, пользуясь словарем. Кратко расскажите об истории золота и серебра на английском языке.

TEXT B. A SHORT HISTORY OF METALS

Currently there are 86 known metals. Before the 19th century only 24 of these metals had been discovered and, of these 24 metals, 12 were discovered in the 18th century. Therefore, from the discovery of the first met-

als — gold and copper until the end of the 17th century, some 7700 years, only 12 metals were known. Four of these metals, arsenic, antimony, zinc and bismuth, were discovered in the 13th and 14th centuries, while platinum was discovered in the 16th century. The other seven metals, known as the Metals of Antiquity, were the metals upon which civilization was based. These seven metals were: gold, copper, silver, lead, tin, iron, mercury.

These metals were known to the Mesopotamians, Egyptians, Greeks and the Romans.

Gold. Gold articles are found extensively in antiquity mainly as jewelry e.g. bracelets, rings, etc. Early gold artifacts are rarely pure and most contain significant silver contents. This led to the ancients naming another metal — electrum, which was an alloy of gold and silver, pale yellow and similar in colour to amber. Therefore, early gold varied from pure through electrum to white gold. The symbol for gold is Au from the Latin "aurum" meaning shining dawn.

Stone age man learned to fashion gold into jewelry and ornaments, learning that it could be formed into sheets and wires easily. However, its malleability, which allows it to be formed into very thin sheet (0.000005 inches), ensures that it has no utilitarian value and early uses were only decorative. As gold is a noble metal, being virtually noncorrosive and tarnish free, it served this purpose admirably.

Gold is widely dispersed through the earth's crust and is found in various types of deposits. Since gold is found uncom-

bined in nature, early goldsmiths would collect small nuggets of gold from stream beds etc., and then weld them together by hammering.

Silver. Although silver was found freely in nature, its occurrence was rare. Silver is the most chemically active of the noble metals, is harder than gold but softer than copper. It ranks second in ductility and malleability to gold. It is normally stable in pure air and water but tarnishes when exposed to ozone, hydrogen sulfide or sulfur. Due to its softness, pure silver was used for ornaments, jewelry and as a measure of wealth. In a manner similar to gold, native silver can easily be formed. Silver's symbol is Ag from the Latin “argentum”.

Galena always contains a small amount of silver and it was found that if the lead was oxidized into a powdery ash a droplet of silver was left behind. Another development in this process was the discovery that if bone ash was added to the lead oxide, the lead oxide would be adsorbed and a large amount of material could be processed. By 2500 BC the cupellation process was the normal mode of silver manufacture.

13. Прочитайте текст. Соотнесите названия оставшихся из 7 металлов и их характеристики.

TEXT C. IRON, COPPER, TIN, LEAD, MERCURY

The use of this metal in antiquity is more significant than gold as the first tools, implements and weapons were made from it. The symbol for this metal is Cu and

comes from the Latin “cuprum” meaning from the island of Cyprus.

Malachite, a green friable stone, was the source of this metal in the early smelters. Although this metal can be found free in nature, the most important sources are the minerals cuprite, malachite, azurite, chalcopyrite and bornite. It is reddish coloured, malleable, ductile and a good conductor of heat and electricity.

This metal is not found free in nature but Galena (its sulfide) was used as an eye paint by the ancient Egyptians. The production of metallic form of this metal from its ore is relatively easy. At first it was not used widely because it was too ductile and the first uses of this metal were around 3500 B.C.

The ability of the metal to flow and collect at the bottom of the campfire is an important concept in process metallurgy.

Smelted copper was rarely pure, in fact, it is clear that by 2500 BC the Sumerians had recognized that if different ores were blended together in the smelting process, a different type of copper, which flowed more easily, was stronger after forming and was easy to cast, could be made.

It is not found in nature in its native state. Tin was reduced by charcoal and at first was thought to be a form of lead. It is highly malleable and ductile and has two allotropic forms. It is highly crystalline. It is also quite resistant to corrosion.

It was also known to the ancients

and has been found in tombs dating back to 1500 and 1600 BC. It, also known as quicksilver, is the only metal which is liquid at room temperature. Although it can be found in its native state, it is more commonly found in such ores as calomel, livingstonite, corderite and its sulfide cinnabar.

It was widely used because of its ability to dissolve silver and gold (amalgamation) and was the basis of many plating technologies.

It was available to the ancients in small amounts from meteors. This native metal is easily distinguishable because it contains 6-8% nickel. Wrought form of this metal was the first one known to man. The product of reaction was a spongy mass of this metal intermixed with slag. In the early days it was 5 times more expensive then gold and its first uses were as ornaments.

These seven metals: gold, silver, copper, lead, tin, mercury and iron, and the alloys bronze and electrum were the starting point of metallurgy and even in this simple, historic account we find some of the basic problems of process metallurgy.

1. Прочитайте текст и ответьте на вопросы.

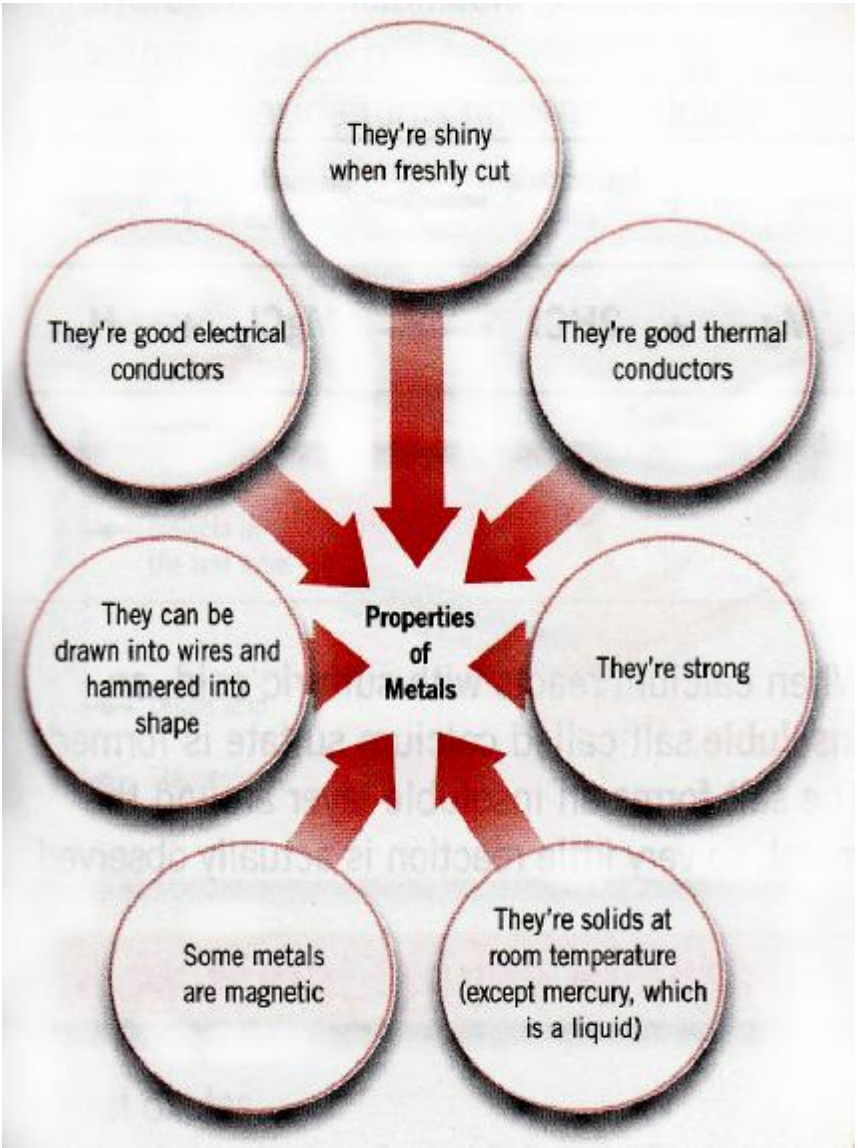
1. Why is it expensive to extract aluminium from its ores?
2. Why is titanium a very useful metal for making aircraft engines?

Aluminium has a low density and, although it is quite high in the reactivity series, it is resistant to corrosion. Aluminium is more reactive than carbon and so its oxide cannot be reduced using carbon. It has to be ex-

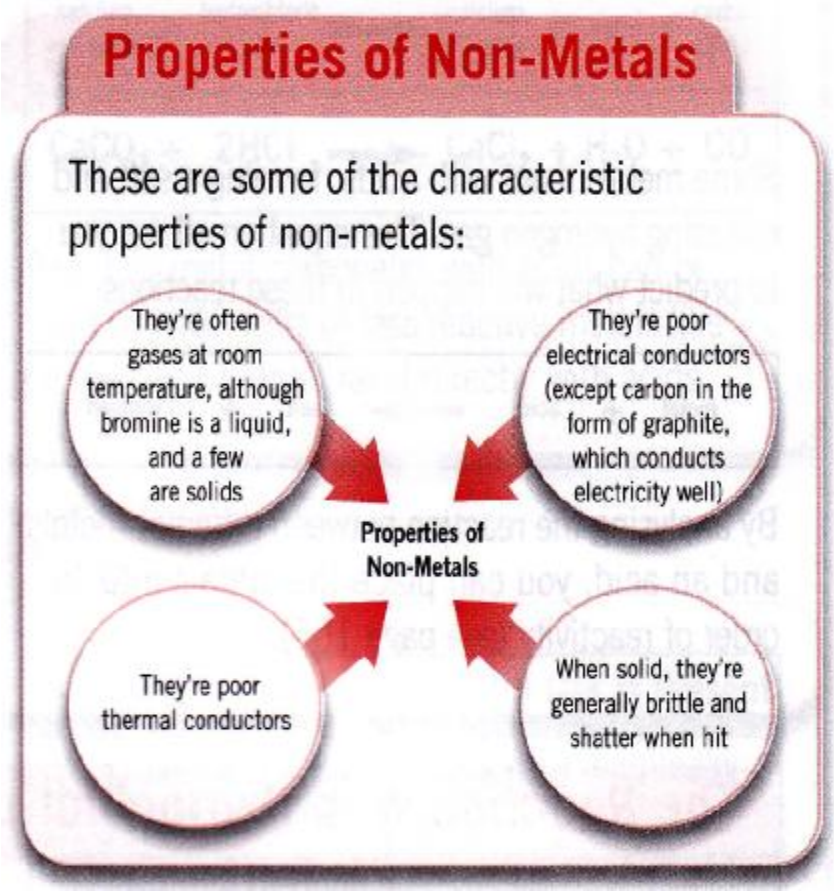
tracted by electrolyses of molten alumunium oxide. The process requires high temperature and a lot of electricity. This makes aluminium expensive to extract. Pure alumunium is not very strong, but aluminiun alloys are stronger and harder. They have many uses.

Titanium is resistant to corrosion and is very string. It also ahs a low density compared with other string metals. Titanium oxide can be reduced by carbon, but the metals reacts with carbon making it brittle. Titanium is extracted from its ore by a process that involves several stages and large amounts of energy. The high costs of the process make titanium expansive.

Describe the properties of metals using the information below.



What are the characteristic properties of non-metals?



Lesson 6
Grammar: Infinitive.
Text: Metals

Предтекстовые упражнения

1. Запомните произношение следующих слов:

characteristics	ˌkærəktə'rɪstɪk/
electrolysis	/ɪˌlek'tˌrɒləsɪs /
charge	/tʃɑ:dʒ/
conductivity	ˌkɒndək'tɪvɪti/
malleability	ˌmælɪə'bɪlɪti/
iron	/'aɪən/
crystal	/'krɪstəl/
mercury	/'mɜ:kjʊəurɪ/
magnesium	/mæg'ni:zɪəm/
single	/'sɪŋgl/
alloy	/'ælɔɪ/
bronze	/'brəʊnz/
constituent	/kən'stɪtjʊənt/
metallurgy	/me'tælədʒi/

2. Переведите следующие слова, не пользуясь словарем.

Natural, metallic, electrolysis, positive, cathode, nature, electricity, zinc, aluminium, electrochemical process, production, metallic substance, non-metal, bronze, component, atmosphere, metallurgy, crystal structure.

3. Переведите предложения, обращая внимание на значение выделенных слов.

aim — цель
The aim of this article is to examine the properties of some metallic substances.

to depend on (upon) — зависеть от
The quality of metal depends on its nature.

widely used — широко использовать
Iron and steel are widely used in modern industry.

due to — вследствие, по причине
Aluminium and sodium are widely employed due to the application of electrochemical process for their production.

when exposed — при подтверждении действию
fail + Inf.' — не + глагол
"Noble metals" fail to tarnish when exposed to the atmosphere.

TEXT A. METALS

The aim of the article is to discuss some characteristics of metals. One is to remember that metals are very important: out of the 92 natural chemical elements about 70 are metals.

Metal working was not the first craft known to man. Man learned to make fire and later to build furnaces in order to liquefy the metals. This liquefying process is called casting. A metal can be defined as a chemical element that possess metallic luster and which in electrolysis carries a positive charge and is liberated at the cathode. The applications of metals depend on their physical and chemical properties. It is necessary to note that metals vary in density, hardness, heat and electrical conductivity, strength, malleability, ductility and weight. The hardness of metals depends upon the presence of other substances in them and the nature of metal itself. Everyone knows that metals are the best conductors of heat and electricity.

The most widely used metals are: iron, copper, zinc, tin, lead, mercury, silver and gold. The most important metal is iron. Men used to call gold and silver "noble

metals" because they fail to tarnish when exposed to the atmosphere for a long time and because they could be melted again without much loss of weight. All the other metals are called "base metals". Nowadays aluminium, magnesium and sodium are widely employed due to the development of

electrochemical process for their production.

Copper is a very good conductor of heat and does not react with water. It can be bent but it is hard enough to keep its shape. These properties make it useful for making pipes and tanks in water and heating systems. It is a very good conductor of electricity as well and so it is used for electrical wiring.

Men learned to mix different metals together to form an alloy. An alloy is a metallic substance but it is not a single chemical element. It is formed by the union or mixture of two or more metals, or metals or non-metals. Probably the first alloy that was made was bronze, made of copper mixed with tin (I:10). Each constituent of an alloy is called a component. The ability of various metals to form alloys differs greatly.

The craft of metal working developed into the science metallurgy. The scientists began to examine the properties of metals: their melting points, crystal structure, strength, hardness, etc. It has become possible to improve the properties of some metals and to form the new ones.

Notes

craft	ремесло
malleability	ковкость
ductility	эластичность
single	один, отдельный
loss	потеря
to loose, v	терять
used to call	обычно называют

Послетекстовые упражнения

1. Найдите в тексте и проанализируйте функции инфинитива.

2. Переведите слова, обращая внимание на суффиксы и префиксы

metal – metallic
to liquefy – liquid – liquefaction
conduct – conductivity – conductor
nature – natural
electric – electricity
to develop – development
to differ – different – difference
to expose – exposure
to melt – melting (point)
hard – hardness
to vary – various – variety

3. Найдите в тексте следующие сочетания:

Характерные свойства, процесс сжижения, химический элемент, металлический блеск, нести положительный заряд, выделяться на катоде, физические и химические свойства, тепло- и электропроводимость, природа самого металла, электрохимический процесс, отдельный химический элемент, благородные металлы, улучшать свойства.

4. **Переведите следующие определения. Запомните выделенные слова**

1. Density is the measurement of mass per volume unit.
2. To tarnish means to form oxides on the surface.
3. To liquefy means to change substance into a liquid.
4. Metallurgy is the science of making metals, of mixing metals to form alloys, of treating metals with heat.
5. Casting is the process of melting the metals and pouring them into the form.

5. **Запомните следующие синонимы. Переведите предложения. Замените подчеркнутые слова синонимичными.**

to vary, to differ — отличаться, различаться
1. The metals differ in their physical and mechanical properties.
2. The metals vary greatly in density; the heaviest is osmium.
3. We must cut different metals at various speeds.

to define, to determine — определять
1. To determine the volume of a gas one must know the volume of the vessel (сосуд) which contains it.
2. The solids obtained when two or more metals are mixed in the molten condition and allowed to solidify can be defined as alloys.

6. Запомните антонимы. Переведите.

positive — положительный
negative — отрицательный
1. Negative charge of the electron neutralizes the positive charge of the nucleus (ядро).
2. The atom consists of a positive nucleus surrounded (окружать) by negative charges of electricity, called electron.

hardness – softness, n
hard – твердый
soft – мягкий
1. Zinc is a hard bluish-white metal.
2. Lead is a very heavy bluish-grey metal which is very soft.
3. Chromium is so hard that will cut glass, potassium is so soft that can be moulded like wax (воск).

7. Заполните пропуски соответствующими словами.

1. It is known that out of 92 ... elements about 70 are metals.
2. Man learned to build furnaces in order to ... the metals.
3. The process of liquefying the metal is called ...
4. The use of metal ... on their physical and chemical properties.
5. The ... of metals depends on the presence of other substances in them.

6. Metals are the best ... of heat and electricity.
7. To the noble metals belong ... and ...
8. An ... is formed by the union or mixture of two or more metals.
9. The science of metal working is called ...
10. The scientists learned to ... the properties of metals.

(to depend on, metallurgy, chemical, casting, hardness, gold, alloy, silver, to improve, to liquefy).

8. Найдите существительные, которые описывают свойства металлов.

9. Ответьте на следующие вопросы.

1. What is the aim of this article?
2. How many metals are there among natural chemical elements?
3. How is it possible to liquefy metal?
4. What is a metal?
5. What do the metal properties depend on?
6. What are the main properties of metals?
7. What are the mostly widely used metals?
8. What metal is the most important?
9. What metals are called "noble"?
10. How is it possible to form an alloy?
11. What is called every constituent of an alloy? Name the constituents of bronze and brass (латунь).
12. What is metallurgy?

10. Сократите текст, сохранив его основное содержание.

11. Передайте содержание текста по-русски, по-английски, сохранив последовательность подачи информации в нём.

For you to know

Elements from the central block of the Periodic table are known as the **transition metals.** They are all metals and have similar properties. They are good conductors of heat and electricity. Many of them are strong, but can be bent or hammered into shape. These properties make them useful s materials for buildings, vehicles, containers, pipes and wires.

What properties make transition metals useful materials for making things?

12. Изучите функции инфинитива и переведите предложения.

1. To form a homogeneous liquid, the metal alloys are melted together.
2. Copper is the metal to be found in nature.
3. Copper was one of the first metals to be used by man.
4. The first to prove it experimentally was the Englishman Cavendish.
5. Steel undergoes that treatment to improve its structure.

6. The new ways to prepare diamonds commercially (в промышленности) will be discovered in the near future.
7. To synthesize water he had to combine oxygen and hydrogen.
8. To observe is the principle rule of any experiment.
9. Today scientists in order to describe mass and length use the metric system of units in all countries of the world.
10. The metals to be employed resemble one another in their chemical properties.
11. There are many problems to be solved in order to understand these phenomena.
12. The mechanical systems are often too simple to be of any practical interest.
13. The aim of my work is to study the characteristics of engineering materials.
14. They will have to separate iron from sulfur with a magnet.
15. Different kinds of steel will have to be used in making blades (лопасти).
16. In this part of work you will have to deal with different kinds of motion.
17. Scientists began to examine the magnetic properties of many metals.
18. Using fire bricks (огнеупорный кирпич) is possible to minimize heat losses in the boiler.
19. One of the best methods of joining pieces of metal together is to weld (сварить) them.
20. To carry out this experiment will be very difficult.
21. To recognize a substance it is not necessary to examine all its properties.

22.To obtain good results in the experiment, one must work hard.
23.The reason for using insulation was to decrease fuel costs.
24.To increase the output of metal it is necessary to apply new methods of melting.
25.In order to determine the density of a body, one must know its mass and its volume.

13. Переведите на английский язык.

1. Чтобы изменить свойства какого-либо материала, вводят специальные элементы или примеси.
2. Чтобы изучить распределение электронов в твердых телах, были использованы мягкие рентгеновские лучи.
3. Для того чтобы сделать железо коррозиеустойчивым, его можно покрыть никелем.
4. С помощью полупроводников можно превратить тепловую энергию в электрическую.
5. Щелочные металлы хранятся в масле, чтобы исключить влияние воздуха.

14. Проверьте, знаете ли вы следующие слова:

To discuss, furnace, to liquefy, casting, to define, luster, positive, to determine, charge, negative, to vary, density, to depend on, hard, hardness, conductivity, strength, malleability, conductor, electricity, tin, lead, mercury, gold, silver, to tarnish, due to, alloy, to differ, to examine, to improve, to tarnish.

15. Подберите эквиваленты к следующим словам:

1. furnace	1. отрицательный
2. alloy	2. свинец
3. to differ	3. улучшать
4. lead	4. олово
5. to tarnish	5. различаться
6. tin	6. сплав
7. negative	7. печь
8. luster	8. положительный
9. positive	9. твердый
10. conductor	10. заряд
11. density	11. ковкость
12. to improve	12. сжижать
13. to liquefy	13. тускнеть
14. charge	14. блеск
15. malleability	15. плотность
16. to vary	16. определять
17. hard	17. проводник
18. to determine	18. различаться

16. Прочитайте и переведите текст. Найдите инфинитив и проанализируйте его функции.

TEXT B. CORROSION

Corrosion is deterioration of useful properties in a material due to reactions with its environment. Weakening of steel due to oxidation of the iron atoms is a well-known example of electrochemical corrosion. This type of damage usually affects metallic materials, and

typically produces oxide(s) and/or salt(s) of the original metal. Corrosion also includes the dissolution of ceramic materials and can refer to discolouration and weakening of polymers by the sun's ultraviolet light.

Some metals are more resistant to corrosion than others, either due to the fundamental nature of the electrochemical processes involved, or due to the details of how reaction products form.

The materials most resistant to corrosion are those for which corrosion is thermodynamically unfavourable. Corrosion products of gold or platinum tend to decompose spontaneously into pure metal that is why these elements can be found in metallic form on Earth. More common "base" metals can only be protected by more temporary means.

Some metals have naturally slow reaction kinetics, even though their corrosion is thermodynamically favourable. These include such metals as zinc, magnesium and cadmium. While corrosion of these metals is continuous and ongoing, it happens at an acceptably slow rate. An extreme example is graphite, which releases large amounts of energy upon oxidation but has such slow kinetics that it is effectively immune to electrochemical corrosion under normal conditions.

17. **Найдите в тексте слова, образованные от следующих слов:**

Use, oxide, metal, colour, favourable, weak, corrode.

18. Запомните выражения и найдите их употребление в тексте:

Due to – из-за, вследствие, по причине
Either ... or – или … или

19. Ответьте на вопросы:

1. What is corrosion?
2. What materials are influenced by corrosion?
3. What materials are the most resistant to corrosion?
4. Why can gold and platinum be found in metallic form on Earth?
5. What material is effectively immune to electrochemical corrosion under normal conditions and why?

20. Прочитайте текст.

THE CHANGING APPEARANCE OF METALS

Over time many metals are affected by air and water. Different metals are affected in different ways and some examples are shown in Table 1. Gold objects don't react at all; gold is described s being unreactive. Most metals are hard, but a few, like lithium (Li), sodium (Na) and potassium (K), are much softer and can be cut with a sharp knife. These three metals re found in group 1 of the periodic table. This group is known s the alkali metals.

Alkali metals…

- are shiny when freshly cut

- tarnish (become dull) very quickly when exposed to air.

Table 1.

Metal	Example Object	How the Object Changes Over Time
Iron	Nail	It **rusts** 
Silver	Ring	It becomes dull 
Copper	Water pipe	It gets darker 
Aluminium	Aluminium can	It goes grey 

Give your own examples of object changing. Remember the adjectives rust, dull, dark, light, grey

TEXT C. RUST

Rust is the substance formed when iron compounds corrode in the presence of water and oxygen. It is a mixture of iron oxides and hydroxides. Rusting is a common term for corrosion, and usually corrosion of steel.

Iron is found naturally in the ore hematite as iron oxide, and metallic iron tends to return to a similar state when exposed to air, (hydrogen, oxygen, nitrogen, etc) and water. This corrosion is due to the oxidation reaction when iron metal returns to an energetically favourable state. Energy is given off when rust forms. The process of rusting can be summarised as three basic stages: The formation of iron(II) ions from the metal; the formation of hydroxide ions; and their reaction together, with the addition of oxygen, to create rust.

Iron is the main component of steel and the corrosion of steel is observed more frequently, since iron is nearly never used without alloying.

When steel contacts water, an electrochemical process starts. On the surface of the metal, iron is oxidised to iron(II):

$$Fe \rightarrow Fe^{2+} + 2e^{-}$$

The electrons released travel to the edges of the water droplet, where there is plenty of dissolved oxygen. They reduce the oxygen and water to hydroxide ions:

$$4e^{-} + O_2 + 2H_2O \rightarrow 4OH^{-}$$

The hydroxide ions react with the iron(II) ions and more dissolved oxygen to form iron oxide. The hydration

is variable, however in its most general form:

$$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$$

$$4Fe(OH)_2 + O_2 \rightarrow 2(Fe_2O_3.xH_2O) + 2H_2O$$

Hence, rust is hydrated iron(III) oxide. Corrosion tends to progress faster in seawater than in fresh water due to higher concentration of sodium chloride ions, making the solution more conductive. Rusting is also accelerated in the presence of acids, but is inhibited by alkalis. Rust can often be removed through electrolysis, however the base metal object can not be restored through this method.

Hydrated iron oxide is permeable to air and water, meaning that the metal continues to corrode after rust has formed. The iron mass eventually converts entirely to rust, and disintegrates.

There are several methods available to control corrosion and prevent the formation of rust. Cathodic protection is a method to control corrosion and the formation of rust using electrochemical techniques. Galvanizing consists of coating metal with a thin layer of another metal, such as zinc. The electrochemical potential of zinc is more negative than steel (or iron) and will provide cathodic protection to the underlying steel. Typically, zinc is applied by either hot-dipgalvanizing or electrogalvanizing. A good thing about galvanizing is that a scratch on a galvanized piece of iron will not lead to rust at the scratch. The zinc layer acts as a galvanic anode.

Corrosion control can be done using a coating to isolate the metal from the environment. Covering steel

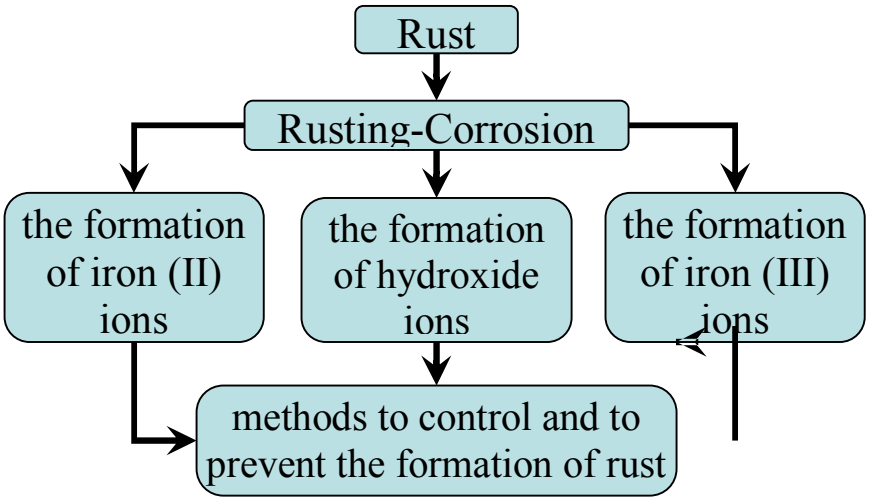
with concrete provides protection to steel by the high pH environment at the steel-concrete interface. However, if concrete covered steel does corrode, the rust formed can cause the concrete to spall and fall apart. This will create structural problems.

Corrosion of aluminium is different from steel or iron, in that aluminium oxide formed on the surface of aluminum metal forms a protective, corrosion resistant coating.

Notes

permeable	проницаемый
to spall	разбивать, дробить
concrete	бетон

21. Расположите информацию текста в соответствии со схемой, перескажите текст.



Key word exercise

Match each key word with its meaning

Alkaline	A material that electricity can pass through easily
Displaces	A solution that has a pH greater than 7
Electrical conductor	Quickly
Molten	A list that places that metals in order from the most reactive to the least reactive
Reactivity series	A compound formed when iron reacts with oxygen and water
Rust	Liquid
Tarnish	Become dull
Thermal conductor	A material that heat can pass through easily
Vigorously	Takes the place of

Comprehension

Read the passage about rusting, then answer the following questions.

1. What is an alloy?
2. Why do different steels have different properties?
3. **a)** Why is stainless steel a very useful alloy?
   b) How is stainless steel used?
4. What is the chemical name for rust?
5. Why does a layer of paint prevent iron from rusting?

Iron is usually turned into an alloy. Alloys are mixtures of metals. The most common alloy of iron is called steel. Different types of steel can be made by using different types of metals in different proportions. The different steels have different properties.

The type of steel selected for a particular application will depend on the properties required. Stainless steel is made by mixing iron and chromium. It's very resistant to corrosion and is widely used to make cutlery and saucepans.

If iron or iron alloys are exposed to water and oxygen, they will eventually react to form hydrated iron oxide (rust). Even stainless steel will eventually rust. Many other metals also react to form metal oxides, but these metal oxides aren't referred to as rust.

Iron can be protected from rusting by coating the metal with a layer of plastic, paint or oil. This stops the oxygen and water from reaching the metal. But if the coating is scratched, the iron will start to rust. Iron can also be protected from rusting by placing it in contact with a more reactive metal, such as magnesium. The more reactive metal reacts, leaving the iron intact.

play	pause	stop

Listening practice

Roland, a mechanical and electrical services (M&E) engineer, is talking to Saskia, an architect, about the design of a new building. Listen to the conversation and answer the following questions.

1. What is a key characteristic of the client company?
2. How will this characteristic affect the building design?
3. What do you think is meant by *presence detectors?*
4. What does Roland say about design options and does he describe option one?

Lesson 7

Grammar: Nominative with the Infinitive.
Text: How to Generate Electric Current

Предтекстовые упражнения

1. Запомните произношение следующих слов, уточните их значения по словарю.

current	/'kʌrənt/
voltaic	/ˌvɒl'teɪɪk/
denote	/dɪ'nəʊt/

circuit	/'sɜ:kɪt/
generate	/'dʒenereɪt/
couple	/kʌpl/
electricity	/ˌɪlek'trɪsɪti/
thermal	/'θɜ:məl/
through	/'θru:/
machinery	/mə'ʃɪ:nərɪ/
device	/dɪ'vaɪs/

2. Переведите следующие слова, не пользуясь словарем.

Electricity, conductor, to generate, thermal, magnetic, alkali, metal, to form, thermoelectric, negatively, electron, phenomenon, photoelectric, permanent, dynamo-machine, principal, machinery.

3. Переведите предложения, обратите внимание на значение выделенных слов и словосочетаний.

By means of — при помощи, посредством
Direct current (постоянный ток) may be generated by means of four principal methods.
Owing to — благодаря, вследствие.
Electricity can be generated owing to chemical reaction.

In this way — таким образом, таким путем.
Light falls on a special kind of ce11 (элемент) and in this way the electric current is produced.

TEXT A. HOW TO GENERATE ELECTRIC CURRENT

The term "electric current" is used to denote "electricity in motion", i.e. electricity which flows through a metal or liquid conductor, a direct current being such a current which is sure to flow through a conductor in one direction only. There are known to exist at least four principal methods by which a direct current is likely to be generated, namely, by means of:

1. chemical reaction;
2. thermal or heat action;
3. light action;
4. magnetic action.

To produce a current by chemical reaction, an alkali or acid is made to react with a metal. The device that is used in such cases is known to be a voltaic or an electric cell, a group of two or more cells being connected together to form a battery. The voltaic cell is so named after Volta, its inventor who was the first to show that electricity could be generated owing to chemical reaction.

To produce a current by thermal action heat is applied to two unlike metals, soldered together in two points. The apparatus which causes such a current is regarded to be a thermo-electric couple or thermocouple for short. The reason the thermocouple generates a current is due to the fact that the heat makes the electrons tear off of the negatively charged metal at the point of joint. It is

these electrons that form the current flowing through the circuit**.** Now there exist semi-conductor thermoelements which without any machinery allow thermal energy to be converted into electrical energy. Falling on a special kind of cell, light is sure to produce an electric current. The device making use of this phenomenon so as to produce electricity is known to be a photoelectric cell.

In order to generate a current by magnetic action, a wire is made to pass through a magnetic field, the latter being set up either by a permanent magnet. The devices which are certain to generate the electric current in this way are regarded to be "magneto" and "dynamo" machines.

Notes

device	зд. устройство
cell	элемент
voltaic cell	гальванический элемент
battery	батарея, состоящая из нескольких гальванических элементов
to solder	паять
point of joint	точка соединения

Послетекстовые упражнения

1. Найдите в тексте и проанализируйте предложения с инфинитивом и инфинитивной конструкцией «именительный падеж с инфинитивом».

2. Переведите слова, обращая внимание на суффиксы и префиксы.

electric – electrici**ty**
to conduct – conduct**or** – semiconduct**or** – conductivi**ty**
to exist – exist**ence**
to act – ac**tion**
to invent – invent**or**
to produce – produc**tion** – productivi**ty**
negative – negative**ly**
direct – direct**ly** – indirectly – direc**tion**

3. Найдите в тексте следующие сочетания:

Электрический ток, «электричество в движении», жидкий проводник, только в одном направлении, четыре основных метода, тепловое действие, термопара, полупроводник, термоэлемент, особый вид элемента, фотоэлемент, магнитное поле, гальванический элемент.

4. Запомните, что слово *"current"* имеет два основных значения: 1. ток; 2. поток.

а) Переведите следующие сочетания, в которых "current" употребляется в первом значении:

Electron current, galvanic current, line current, photoelectric current, photoemissive current, polarization

current, reaction current, magnetic current, thermal current, three-phase emission current.

б) Запомните перевод следующих сочетаний.

direct current — постоянный ток (D. C.)
alternating current — переменный ток (A.C.)
conduction current — ток проводимости
charging current — зарядный ток
discharged current — разрядный ток
heavy current — сильный ток
light current — слабый ток
gas current — ионный ток
voltaic current — гальванический ток

в) Переведите следующие сочетания, в которых слово “current” употребляется в значении “поток”
Energy current, heat current, current of electrons, air current, atmospheric current, zero heat current.

Запомните: current events — **текущие события**

5. Запомните следующие синонимы. Замените подчёркнутые слова синонимичными. Переведите предложения.

principal – main – basic: главный, основной
Four main methods for a direct current generation are known to exist.
There are two basic types of semiconductors.

The principal industrial method of preparing the gas is fractional distillation of liquid air.

kind – type – sort: вид, тип.
Reactions of three types are supposed to be employed in this process.
Energy can be classified into several kinds: mechanical, heat and chemical.
There exist some sorts of electron microscopes.
Besides the different types of furnaces different kinds of moulding sand are also employed.

to convert – to transform: превращать
Electrical energy can be converted into a number of forms. Heat energy is transformed into a mechanical energy by means of steam engine.
The gas engine converts heat to mechanical energy.

6. Запомните следующие антонимы. Переведите предложения:
Conductor – insulator: проводник – диэлектрик
To increase – to decrease: увеличивать – уменьшать
The conductivity of a conductor decreases as its temperature increases while that of an insulator varies slightly (but does not increases with increasing temperature).

You are to remember:
Electric conductor having a conductivity intermediate between that of an insulator and that of a metal is *semiconductor*

.7. **Заполните пропуски подходящими по смыслу словами:**

1. A direct current is each current which flows through a conductor in one ... only.
2. ... cell is a group of two or more cells being connected together to form a battery.
3. Volta was the first to show that electricity could be ... owing to chemical reaction.
4. To produce a current by thermal action heat is ... to two unlike metals.
5. Semiconductor thermoelements allow thermal energy to be ... into electrical energy without any machinery.
6. For generating a current by magnetic action**,** a wire is made to pass through a magnetic.

(Гальванический элемент, направление, производить, превращать, применять, поле)

8. Ответьте на вопросы:

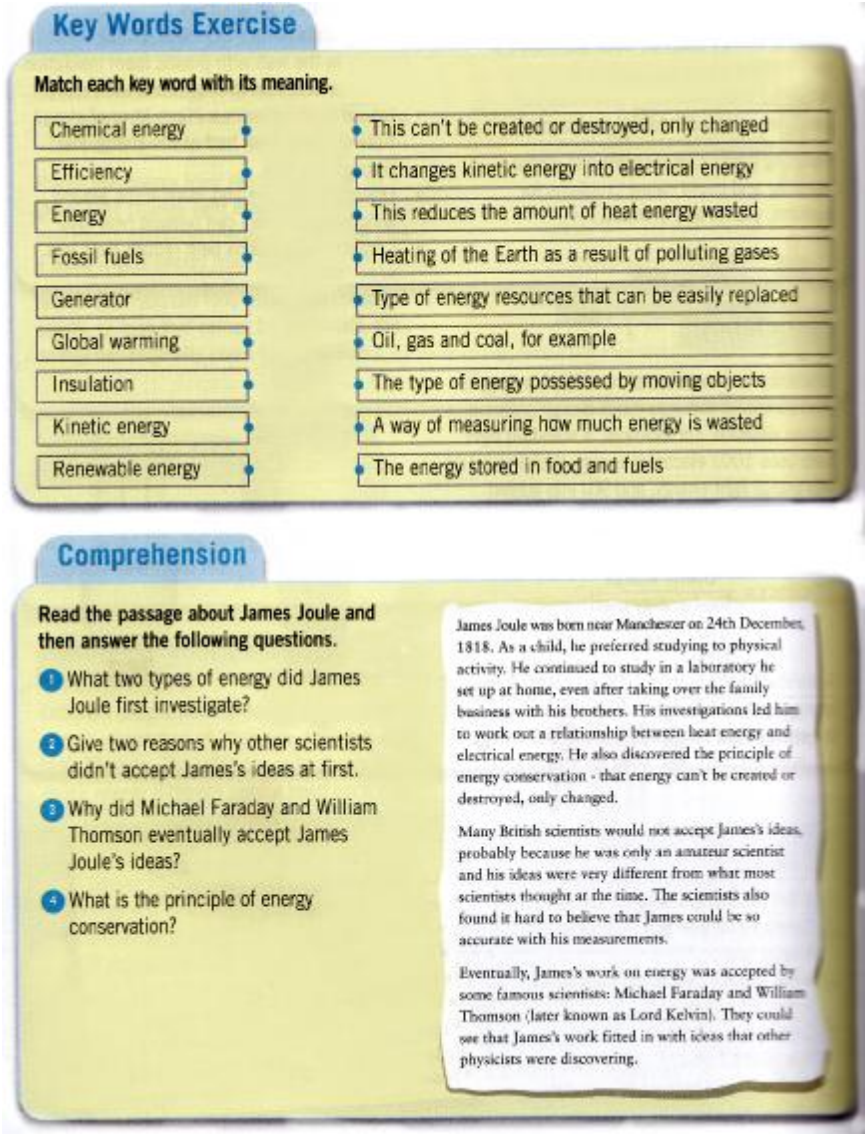
1. What is a direct current?
2. How many methods of generating a direct current exist?
3. What device is used to produce a current by chemical reaction?
4. Who was the first to show that electricity could be generated by chemical reaction?
5. How can one produce a current by thermal action?
6. By what method is electricity generated in a photoelectrical cell?
7. What is a dynamo machine?

9. Сократите текст, сохранив его основное содержание.

10. Передайте содержание текста по-русски, по-английски, сохранив последовательность передачи информации в нем.

11. Проверьте, знаете ли вы следующие слова:

To generate, to denote, to flow, direct current, alternating current, thermal, device, voltaic cell, to connect, battery, inventor, owing to, thermocouple, negative, positive, heavy current, light current, principal, to convert, circuit, machinery, field, in this way, to regard, heat current, cell.



Key Words Exercise

Match each key word with its meaning.

Chemical energy	This can't be created or destroyed, only changed
Efficiency	It changes kinetic energy into electrical energy
Energy	This reduces the amount of heat energy wasted
Fossil fuels	Heating of the Earth as a result of polluting gases
Generator	Type of energy resources that can be easily replaced
Global warming	Oil, gas and coal, for example
Insulation	The type of energy possessed by moving objects
Kinetic energy	A way of measuring how much energy is wasted
Renewable energy	The energy stored in food and fuels

Comprehension

Read the passage about James Joule and then answer the following questions.

1. What two types of energy did James Joule first investigate?
2. Give two reasons why other scientists didn't accept James's ideas at first.
3. Why did Michael Faraday and William Thomson eventually accept James Joule's ideas?
4. What is the principle of energy conservation?

James Joule was born near Manchester on 24th December, 1818. As a child, he preferred studying to physical activity. He continued to study in a laboratory he set up at home, even after taking over the family business with his brothers. His investigations led him to work out a relationship between heat energy and electrical energy. He also discovered the principle of energy conservation - that energy can't be created or destroyed, only changed.

Many British scientists would not accept James's ideas, probably because he was only an amateur scientist and his ideas were very different from what most scientists thought at the time. The scientists also found it hard to believe that James could be so accurate with his measurements.

Eventually, James's work on energy was accepted by some famous scientists: Michael Faraday and William Thomson (later known as Lord Kelvin). They could see that James's work fitted in with ideas that other physicists were discovering.

12. Изучите правила перевода конструкции «Именительный падеж с инфинитивом». Переведите следующие предложения.

1. Air was considered formerly to be an element.
2. Sound is known to transmit faster in solids than in liquids.
3. The relativity theory (теория относительности) appeared to become a turning point in physics.

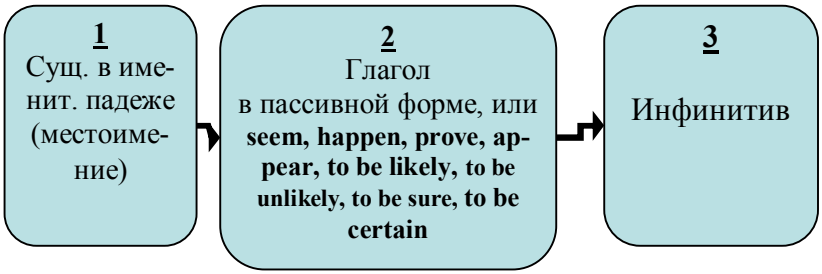
4. Some liquids prove to be good conductors.
5. This metal is likely to be brittle at the temperature mentioned above.
6. Salt water appears to conduct electricity well.
7. An electric current is considered to be a stream of electrons in motion.
8. The thermocouple proved to be useful for our tests.
9. Jablochkov is known to be the inventor of the electrical candle.
10. This vacuum tube seems to be in operation for a long time.
11. The four best conducting metals proved to be silver, gold, copper and aluminium.
12. The resistance of the conductor is known to depend not only on the material it is made of and its temperature but on its diameter and length as well.
13. Direct current is known to flow in one direction only.
14. Pure air is supposed to be a good insulator.
15. When an electric force is applied to a metal and a stream of electrons seems to migrate from one part of the metal to another, there is said to flow an electric current through a conductor.

16.An electric current is known to be a stream of electrons passing through a conductor.
17.The electrons are said to pass from one atom to another.
18.Different substances are known to differ in electrical conductivity.
19.Every student is supposed to know such fundamental terms as intensity of the current, voltage, electromotive force (e.m.f.) and resistance.

13. Переведите следующие предложения на английский язык. Пользуйтесь схемой.

1. Известно, что железо, титан, тантал и хром – хрупкие металлы.
2. Известно, что металлы подвергаются коррозии.
3. Обнаружено, что железо, помещенное в соленую воду, ржавеет.
4. Считают, что название «коррозия» относится к тем изменениям, при которых металл превращается из элемента в соединение.
5. По-видимому, некоторые минералы содержат азот.
6. Считают, что постоянный ток получают четырьмя основными способами.
7. Полагают, что Вольта первым получил электрический ток при помощи химической реакции.
8. По-видимому, можно получить электрический ток с помощью фотоэлемента и магнита.
9. Считают, что серебро является лучшим проводни-

ком электричества.
10.Оказывается, некоторые жидкости также проводят электричество.



14. Прочитайте и переведите текст. Измените предложения при помощи построения конструкции Nominative-with-the-Infinitive, используя слова, данные в скобках.

TEXT B. ELECTROMAGNETISM

Electromagnetism (to consider, to be) the physics of electromagnetic fields: a field, encompassing

all of space, comprised of electrical and magnetic fields. The electric field can be produced by stationary electric charges, and gives rise to the electric force, which **(to know, to cause)** static electricity and drive the flow of electric current in electrical conductors. The magnetic field can be produced by the motion of electric charges,

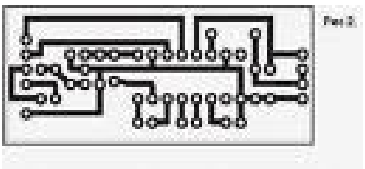
such as an electric current flowing along a wire, and gives rise to the magnetic force one associates with magnets. The term "electromagnetism" **(to know, to come)** from the fact that the electric and magnetic fields are closely intertwined, and, under many circumstances, it is impossible to consider the two separately. For instance, a changing magnetic field **(to find, to give)** rise to an electric field; this is the phenomenon of electromagnetic induction, which underlies the operation of electrical generators, induction motors, and transformers.

15. Передайте содержание текста на английском языке.

TEXT C. ELECTROMOTIVE FORCE

Electromotive force (e.m.f.) is a measure of the strength of a source of electrical energy. The unit of e.m.f. is known to be the volt (energy per unit electric charge) and so the term 'force' is misleading.

The term "electromotive force" originally referred to the strength with which positive and negative charges could be separated (i.e. moved, hence "electromotive"), and was also called "electromotive power" (although it is not a power in the modern sense).



E.m.f. was found to be generated by chemical reaction (e.g., a battery or a fuel cell), absorption of

radiant or thermal energy (e.g., a solar cell or a thermocouple), or electromagnetic induction (e.g., a generator or an alternator). Electromagnetic induction is known to be a means of converting mechanical energy, i.e., energy of motion into electrical energy. The e.m.f. generated in this way is often referred to as motional e.m.f.

Motional e.m.f. is ultimately due to the electrical effect of a changing magnetic field. In the presence of a changing magnetic field, the electric potential and hence the potential difference (commonly known as voltage) is undefined (see the former) — hence the need for distinct concepts of emf and potential difference.

Lesson 8

Grammar: Objective with the Infinitive
Text: The Heating Effect of Electric Current

Предтекстовые упражнения

1. Запомните произношение следующих слов и уточните их значения по словарю:

through	/θru:/
opposition	ˌɒpə'zɪʃn/
generation	ˌdʒenə'reɪʃn/
wire	/'waɪə/
energy	/'enədʒi/

generally	/'dʒenərəli/
flowing	/'fləʊɪŋ/
recognize	/'rekəgnaɪz/

2. Переведите без словаря и прочитайте:
Con'ductor, e'lectron, electro'lytic, ther'mometer, 'energy, 'generator, 'physical, ion.

3. Запомните перевод подчёркнутых слов, переведите предложения.

Because of — из-за, вследствие
Because of the partial decomposition of the carbide, grey-cast-iron is softer than white-cast iron.
As well as — так же, как и ...
Aluminium as well as copper are the best conductors of electricity.
Be due to — обуславливать (due to — если, по причине)
Conductivity is mainly due to free electrons.
Both … and — как и … , так и …
We consider the heat produced per second to depend both upon, the resistance of the conductor and upon the amount of current flowing through it.

TEXT A. THE HEATING EFFECT OF AN ELECTRIC CURRENT

When a current is flowing through a conductor, there is always some opposition to its flow because of the fact that electrons, if the conductor is electrolytic, are sure to collide with each other as well as with the ions or molecules of the conductor. The energy supplied by the generator or battery in order to overcome this opposition is known to be transformed into heat within the conductor.

We consider the heat produced per second to depend both upon, the resistance of the conductor and upon the amount of current flowing through it.

If some current flows through a thin wire and then the same amount of current is sent through a thicker one, we may expect a different amount of heat to develop in both these wires. When the current is passed through the wire which is too thin to carry it freely, that is the wire which resistance would offer greater opposition to its flow, more electric energy would be converted into heat than in the case of the thick wire carrying a small current.

A wire through which an electric current passes usually looks exactly like the one that does not carry current. As it is impossible to recognize electricity by any of our physical senses, we generally detects its presence owing to its various effect, one of which being heat set up in the wire due to the current flowing through it.

If the wire is a large one and the current is a small one, the only way to detect the developed heat is to use a sensitive thermometer, the heating being too slight to be felt by other means. When the wire is very thin and the current is large, the amount of heat generated is great enough to be felt by hand.

Notes

opposition -	зд. сопротивление
to supply -	подавать (энергию)
per second -	в секунду
to develop -	выделять
physical senses -	органы чувств

Запомните:
to develop a theory (method, device) – разрабатывать теорию (метод, устройство),
to develop industry – развивать промышленность,
to develop gas (heat) – выделять газ (тепло).

Послетекстовые упражнения

1. Найдите в тексте и проанализируйте функции инфинитива и конструкции «объектный падеж с инфинитивом».

2. Переведите, обращая внимание на суффиксы, префиксы.

Opposite – opposition
to conduct – conductor – non-conductor – conductivity
to generate – generator
to resist – resistance
thick – thicker
to differ – different – difference
free – freely
great – greater
possible – impossible
sense – sensitive
to vary – various – variety

3. Найдите в тексте следующие сочетания:

Энергия, подаваемая генератором; сопротивление проводника, тонкая проволока, различное количество теплоты, слабый ток, органы чувств, чувствительный термометр.

4. Сгруппируйте синонимы и переведите предложения.

To transform, different, exact, to apply, quantity, to convert, amount, various, precise, to use, kind, to employ, type,

1. For melting steel crucible or electric furnaces are used.

2. For this purpose non-ferrous metals are mixed in various proportions to form different alloys.
3. People can use heat, electricity and light for many purposes.
4. Exact analysis help to classify these metals into some types.
5. Their task was to convert potential energy into a kinetic one.

5. Запомните синонимы. Переведите предложения.

Means – средство, способ
Way – средство, способ
Method – способ, метод

1. One way of classifying a solid is according to its electrical properties.
2. The molecular formulas of compounds are determined by chemical means.
3. There are some methods of machining the metals.
4. For our experiment we must find the means of several temperature measurements.

6. Запомните антонимы. Переведите предложения.

Thin / thick тонкий / толстый
The alternating current is passed through a thick wire to a receiver, in which a thin metal plate vibrates.
If thin wires are used, they get hot or melt. Large currents need very thick wires.

The small current is cheaper because the wires need not be thick.

7. Заполните пропуски соответствующими словами.

1. Electrons are sure to ... with each other.
2. The energy supplied by a ... or ... is known to be transformed into heat within the conductor.
3. We consider the ... produced per second depend both upon the resistance of a conductor and upon the amount of current flowing through it.
4. We can ... the presence of electricity owing to its various effects.
5. When the wire is very ... and the current is ... , the amount of generated heat can be felt by hand.

(Тонкий, обнаруживать, толстый, тепло, гальваническая батарея, сталкиваться, генератор)

8. Ответьте на следующие вопросы:

1. Is there any opposition to the flow of the current when it is flowing through a conductor?
2. What is the energy overcoming this opposition transformed into within a conductor?
3. What does the heat produced per second depend on?
4. Is there any difference between the wire carrying a current and the one that does not carry any?
5. By what means can we detect the developed heat?

9. Сократите текст, сохранив его основное содержание.

10. Передайте содержание текста по-русски, по-английски, сохранив последовательность передачи в нем информации.

11. Проверьте, знаете ли Вы следующие слова:

To conduct, conductivity, semiconductor, conductor, insulator, electron, electrolytic, to collide, to supply, to overcome, to transform, to consider, resistance, thin, thick, to develop, to pass, to carry, to detect, the only, thermometer, means, to recognize, wire, as well as, because of, to generate, way.

12. Подберите эквиваленты к следующим английским глаголам

1. to generate	1. считать, рассматривать
2. to pass	2. преодолевать
3. to detect	3. превращать
4. to transform	4. пропускать
5. to conduct	5. выделять
6. to overcome	6. производить
7. to develop	7. проводить
8. to recognize	8. подавать (ток)

9. to consider 9. узнавать
10. to supply 10. находить, обнаруживать

13. **Изучите правила перевода конструкции «Объектный падеж с инфинитивом». Переведите предложения.**

1. We know the electric current to flow in metal parts.
2. Many years ago, scientists believed an electric current to be a stream of tiny electrical particles.
3. We know electric current to be surrounded by a magnetic field.
4. We know the strength of a current to depend upon the resistance of the circuit.
5. Joule and other scientists proved heat to be a form of energy.
6. The engineer wants the new device to be tested in the laboratory.
7. He has found the temperature to be a determining factor.
8. We know him to have started a series of new laboratory experiments .
9. Ampere supposed the current to flow from the positive pole of the source of the current to the negative one.
10. We may suppose the alpha particles within the nucleus to by in motion.
11. We assume a substance to be a number of small particles called atoms.
12. On close examination of a piece of granite we find it to be composed of several kinds of minerals having dif-

ferent colours, different degrees of hardness and different properties in general.
13. We know the velocity of a particle to be continuously changing if this particle has a nonuniform motion.
14. Mendeleyev found the properties of the elements to repeat themselves after a definite number of steps.
15. In liquids the atmospheric pressure at any given point is equal in all directions but we know it to decrease as altitude increases.
16. We know very few objects to be made of pure tin, but it is used to make bronze, babbit (баббит) and other alloy metals.
17. This scientist states laser light to be different from ordinary light.
18. The kinetic theory of gases assumes a gas to be made up of particles moving about with random motion.
19. We know gases as nitrogen, helium and argon to make up much as 26 % of pitchblende (уранит).

14. Переведите предложения на английский язык. Пользуйтесь схемой:

- *подлежащее;*
- *сказуемое*;
- *личное местоимение в объектном падеже или существительное в общем падеже;*
- *инфинитив.*

1. Мы хотим, чтобы вы приняли участие в этом исследовании.
2. Мы полагаем, что опыт был проведен успешно.

3. Мы знаем, что луч лазера широко используется в медицине.
4. Мы считаем, что эти легкие металлы будут использованы во многих отраслях промышленности в будущем.
5. Они знали, что опыты были завершены, и результаты были удовлетворительными.

15. Измените следующие предложения по указанному образцу и переведите их на русский язык.

We know that he is the best student. – We know him to be the best student.
1. We know that red phosphorus is a more stable form than white phosphorus.
2. They discovered that ground water contained a great deal of impurities.
3. The experiment proved that air consisted of nitrogen and oxygen with small amounts of other gases.

16. Прочитайте и переведите текст.

17. Найдите в тексте инфинитивные обороты и определите их тип.

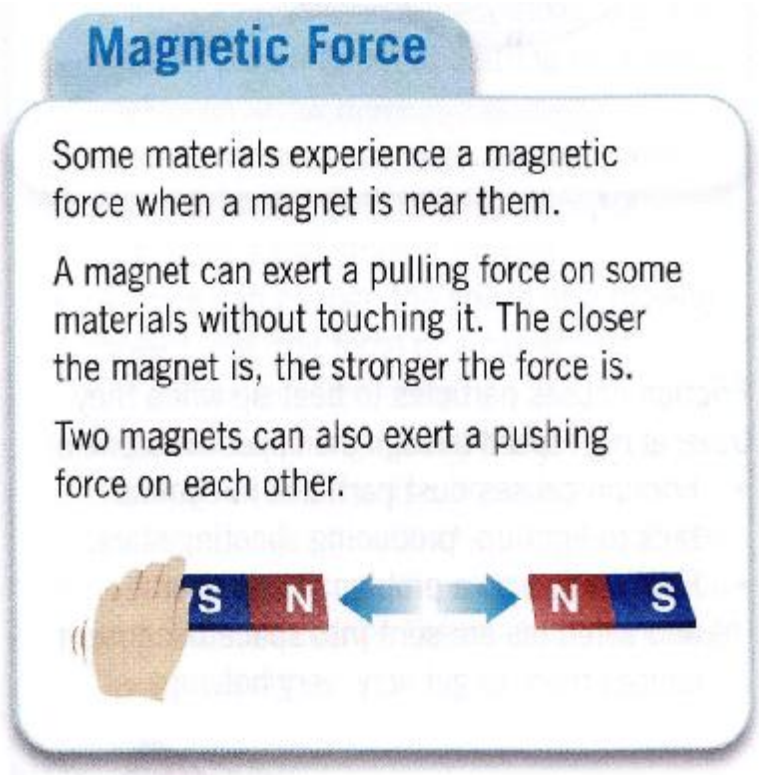
18. Задайте к тексту 5 вопросов.

TEXT B. ELECTROMAGNETIC FORCE

The force that the electromagnetic field exerts on electrically charged particles, called the electromagnetic force, is one of the four fundamental forces. The other fundamental forces are the strong nuclear force (which holds atomic nuclei together), the weak nuclear force (which causes certain forms of radioactive decay), and the gravitational force. All other forces are ultimately known to be derived from these fundamental forces. However, the electromagnetic force turns out to be the one responsible for practically all the phenomena one encounters in daily life, with the exception of gravity. Roughly speaking, we may assume all the forces involved in interactions between atoms to be traced to the electromagnetic force acting on the electrically charged protons and electrons inside the atoms. This includes the forces we experience in "pushing" or "pulling" ordinary material objects, which come from the intermolecular forces between the individual molecules in our bodies and those in the objects. It also includes all forms of chemical phenomena, which arise from interactions between electron orbitals.

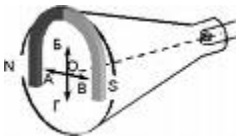
Furthermore, we know light to be a kind of traveling disturbance in the electromagnetic field (i.e. electromagnetic waves.) Therefore, all optical phenomena are actually electromagnetic phenomena.

An accurate theory of electromagnetism, known as classical electromagnetism, was developed by various physicists over the course of the 19th century. It is known to be culminated in the work of James Clerk Maxwell, who unified the preceding developments into a single theory and discovered the electromagnetic nature of light. In classical electromagnetism, the electromagnetic field obeys a set of equations known as Maxwell's equations. We know the electromagnetic force to be given by the Lorentz force law.



19. Раскройте скобки.

TEXT C. ELECTRIC FIELD



In physics, an electric field or E-field is an effect produced by an electric charge that (to exert) a force on charged objects in its vicinity. The units of the electric field (to be) newtons per coulomb or volts per meter (both are equivalent). Electric fields (to compose) of photons and contain electrical energy with energy density proportional to the square of the field intensity. In the static case, an electric field (to compose) of virtual photons being exchanged by the charged particle(s) creating the field. In the dynamic case the electric field (to accompany) by a magnetic field, by a flow of energy, and by real photons.

Non-Contact Forces

Non-contact forces act without touching an object. The region in which a non-contact force acts is called a **field**.

Magnetic force, electrostatic force and gravitational force are examples of non-contact forces.

Lesson 9

General Revision of Infinitives and Infinitive Constructions

TEXT A: CONDUCTORS AND INSULATORS

As it is well known, to conduct an electric current is the same as to transmit electrons. All substances have some ability to transmit electrons but are known to differ greatly in the ease with which electrons pass through them. For instance, we know a copper wire to conduct electricity readily, glass seems to conduct so little current that it is difficult to measure it. Substances through which currents are easily pass are known to be conductors. Substances strongly resisting the current flow are considered to be insulators, the latter also being called dielectrics.

There being no sharp distinction between conductors and insulators, no substance should be considered to be a perfect conductor or a perfect non-conductor under ordinary conditions. For example, paper though a poor conductor cannot be regarded to be a perfect insulator.

Almost all metals are known to conduct electricity, but silver is believed to be the best conductor of all. Copper appears to come next, followed by aluminium. Some liquids are likely to conduct electricity. They even prove to be good conductors of electricity, water with salt being an example. On the other hand, distilled water is sure to have high resistivity.

Most gases are supposed to conduct current under proper conditions of pressure and temperature. Among the non-metals some forms of carbon are very good conductors. On the other hand, the diamond which we consider to be crystallized carbon greatly resists the passage of electrical current and could be used as a good insulator if it were not so expensive. As a rule, most of the non-metals are found to transmit only a negligible current and that is why they are to be considered insulators.

Notes

perfect	идеальный
condition	условие
proper	соответствующий
diamond	алмаз
expensive	дорогой
negligible	незначительный

1. Ответьте на вопросы:

1. What ability do all substances possess?
2. Is there a sharp distinction between conductors and insulators?
3. What metal is believed to be the best conductor?
4. Does water conduct electricity?
5. Under what conditions do most gases conduct current?
6. Why do not we use diamond as an insulator?

2. **Выразите свое согласие или несогласие со следующими утверждениями. Пользуйтесь клише:**

I think it's right.	Думаю, это верно.
It seems to be wrong.	Кажется, это неверно.
I can't agree with it.	Я не могу с этим согласиться.
As far as I know …	Насколько я знаю …
To my mind …	По-моему …
On the contrary …	Наоборот …

1. To conduct an electric current is the same as to transmit electrons.
2. There is no sharp distinction between conductors and insulators.
3. Some liquids are unlikely to conduct electricity.
4. Among non-metals some forms of carbon are very good conductors.
5. Copper is the best conductor.

3. **Complete the following sentences using *from, with or of.***

1. Bronze contains significant amounts _____ copper.
2. Galvanised steel is coated _____ zinc.
3. Steel is an alloy derived _____ iron.
4. Pyre metals can usually be recovered _____ alloys.

5. To produce stainless steel, iron is mixed _____ other metals.
6. Stainless steel contains quantities _____ chromium and nickel.
7. Glass tableware contains traces _____ metals, such as lead.
8. When new method is extracted _____ ore, the costs can be high.

play	pause	stop

Listening practice

Claudia, an engineer, is asking Kevin and Dave, the manager of a fun park, about their requirements for a proposed space module simulator called *Mars Lander*. Listen to the conversation and note the three main areas Claudia asks about.

How do Claudia and Kevin focus on specific subjects? Complete the following phrases from the conversation using the words in the box. Listen again and check your answers.

concerned	regard	regarding	regards	terms

1. … with_____ to the capacity.
2. … in _____ of the number of people.

3. … as far as size is _____ .
4. … and as _____ the graphics …
5. … _____ the schedule …

Тексты для контроля навыков чтения, перевода и аннотирования

Electrical conduction

Electrical conduction is known to be the movement of electrically charged particles through matter. The movement can form an electric current in response to an electric field. The underlying mechanism for this movement depends on the material. Conduction is well-described by Ohm's Law, which assumes the current to be proportional to the applied electric field.

Solids (including insulating solids). In crystalline solids, atoms interact with their neighbours, and the energy levels of the electrons in isolated atoms turn into bands. Whether a material conducts or not is determined by its band structure. Electrons, being fermions, follow the Pauli exclusion principle, meaning that two electrons cannot occupy the same state. Thus electrons in a solid fill up the energy bands up to a certain level, called the Fermi energy. Bands which are completely full of electrons cannot conduct electricity, because there is no state of nearby energy to which the electrons can jump.

Materials in which all bands are full (i.e. the Fermi energy is between two bands) are known to be insulators.

Metals are known to be good conductors because they have unfilled space in the valence energy band. In the absence of an electric field, there exist electrons traveling in all directions and many different velocities up to the Fermi velocity (the velocity of electrons at the Fermi energy). When an electric field is applied, a slight imbalance develops and mobile electrons flow. Electrons in this band can be accelerated by the field because there are plenty of nearby unfilled states in the band. Resistance comes about in a metal because of scattering of the electrons from defects in the lattice or by phonons.

In **semiconductors,** impurities greatly affect the concentration and type of charge carriers. Donor (n-type) impurities have extra valence electrons with energies very close to the conduction band which can be easily thermally excited to the conduction band. Acceptor (p-type) impurities capture electrons from the valence band, allowing the easy formation of holes. If an insulator is doped with enough impurities, the insulator turns into a conductor.

Electrolytes. We know electric currents in electrolytes to be flows of electrically charged atoms (ions). For example, if an electric field is placed across a solution of Na^+ and Cl^-, the sodium ions will move constantly towards the negative electrode (cathode), while the chlorine ions will move towards the positive electrode (anode). If the conditions are right, redox

reactions will take place at the electrode surfaces, releasing electrons from the chlorine, and allow electrons to be absorbed into the sodium.

Water-ice and certain solid electrolytes called proton conductors contain positive hydrogen ions which are free to move. In these materials, currents of electricity are composed of moving protons.

In certain electrolyte mixtures, populations of brightly-coloured ions form the moving electric charges. The slow migration of these ions during an electric current is one example of a situation where a current is directly visible to human eyes.

In neutral **gases**, electrical conductivity is known to be very low. They act as a dielectric or insulator, up until the electric field reaches a breakdown value, freeing the electrons from the atoms in an avalanche process thus forming a plasma. This plasma provides mobile electrons and positive ions, acting as a conductor which supports electric currents and forms a spark, arc or lightning. In ordinary air below the breakdown field, the dominant source of electrical conduction is via mobile ions produced by radioactive gases and cosmic rays.

Plasma is known to be the state of matter where some of the electrons in a gas are stripped or "ionized" from their molecules or atoms. We know a plasma can be formed by high temperature, or by application of an electric field. Due to their lower mass, the electrons in a plasma accelerate more quickly in response to an electric field than the heavier positive ions, and hence carry the bulk of the current.

Since a **vacuum** normally contains no charged particles, vacuums normally behave as good insulators. However, any metal electrode surfaces to be present in a vacuum can make a vacuum into a conductor by providing a cloud of free electrons through the process of thermoionic emission. Externally heated electrodes can generate an electron cloud, or electrodes themselves can produce an electron cloud via spontaneous heating, for example, during a vacuum arc. Vacuum tubes are some of the electronic switching and amplifying devices based on vacuum conductivity.

A Dielectric

A dielectric, or electrical insulator, is known to be a substance that is highly resistant to flow of electric current. Layers of such substances are commonly inserted into capacitors to improve their performance, and the term dielectric refers specifically to this application.

The use of a dielectric in a capacitor presents several advantages. The simplest of these is that the conducting plates can be placed very close to one another without risk of contact. Also, if subjected to a very high electric field, any substance will ionize and become a conductor. Dielectrics are more resistant to ionization than air, so a capacitor containing a dielectric can be subjected to a higher voltage.

Also, dielectrics increase the capacitance of the capacitor. An electric field polarizes the molecules of the dielectric, producing concentrations of charge on its

surfaces that create an electric field opposed (antiparallel) to that of the capacitor. Thus, a given amount of charge produces a weaker field between the plates than it would without the dielectric, which reduces the electric potential. Considered in reverse, this argument means that, with a dielectric, a given electric potential causes the capacitor to accumulate a larger charge.

<u>Texts for extra-curricular reading</u>

Mechanics in Science and Engineering

Mechanics can be seen as the prime, and even as the original, discipline of physics. It is a huge body of knowledge about the natural world. It also constitutes a central part of technology. That is, how to apply this knowledge for humanly defined purposes. Briefly stated, mechanics is concerned with the motion of physical bodies, and with the forces that cause, or limits, these motions, as well as with forces which such bodies may, in turn, give rise to. Due to the wide scope of the subject, one may well find topics that would not fit easily into even this general characterization. Thus the term "body“ needs to stand for a wide assortment of objects, including particles, projectiles, spacecraft, stars, parts of machinery, parts of solids, parts of fluids (gases and liquids), etc.

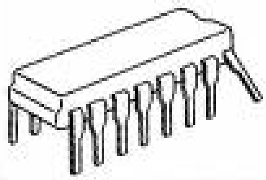


Рис. 6.4 Микросхема с согнутой ножкой

The major division of the mechanics discipline separates classical mechanics from quantum mechanics. Historically, classical mechanics came first, while quantum mechanics is a comparatively recent invention. Classical mechanics is older than written history, while quantum mechanics (in 2005) is 105 years old. Both are commonly held to constitute the most certain knowledge that exists about physical nature. Especially classical mechanics has therefore often been viewed as a model for other so-called exact sciences. Essential in this respect is the relentless use of mathematics in theories, as well as the decisive role played by experiment in generating and testing them.

Quantum mechanics is, formally at least, of the widest scope, and can be seen as encompassing classical mechanics, as a sub-discipline which applies under certain restricted circumstances. If properly interpreted, there is no contradiction, or conflict between the two subjects, each simply pertains to specific situations. While it is true that, historically, quantum mechanics has been seen as having superseded classical mechanics, this is only true on the abstract, or fundamental, level. In practice, classical mechanics remains as useful as ever.

In a somewhat analogous way, relativity has expanded the scope of mechanics. This is true for classical as well as quantum mechanics. Again, there are no contradictions, or conflicts, so long as the specific circumstances are carefully kept in mind. Just as one could, in the loosest possible sense, characterize classical mechanics as dealing with "large" bodies (such as engine

parts), and quantum mechanics with "small" ones (such as particles), it could be said that relativistic mechanics deals with "fast" bodies, and non-relativistic mechanics with "slow" ones. However, "fast" and "slow" are relative concepts, depending on the state of motion of the observer. This means that all mechanics, whether classical or quantum, potentially needs to be described relativistically. On the other hand, as an observer, one may frequently arrange the situation in such a way that this is not really required.

Other distinctions between the various sub-disciplines of mechanics, concern the nature of the bodies being described. Particles are bodies with little (known) internal structure, treated as mathematical points in classical mechanics. Rigid bodies have extension, but retain a simplicity close to that of the particle, adding just a few so-called degrees of freedom, such as orientation in space. Otherwise, bodies may be semi-rigid, i.e. elastic, or non-rigid, i.e. fluid. These subjects have both classical and quantum divisions of study. For instance, the motion of a spacecraft is described by classical mechanics, regarding its orbit and attitude (i.e. by rotation with respect to the fixed stars). While an atomic nucleus is described by quantum mechanics in analogous situations.

Formally, "fields" constitute a separate discipline in physics, distinct from mechanics, whether classical fields or quantum fields. In actual practice, however, subjects belonging to mechanics and fields are closely interwoven. Thus, for instance, forces that act on particles are frequently derived from fields

(electromagnetic or gravitational), and particles generate fields by acting as sources. In fact, in quantum mechanics, particles themselves are fields, as described theoretically by the wave function.

Classical Mechanics

In physics, classical mechanics is one of the two major sub-fields of study in the science of mechanics, which is concerned with the motions of bodies, and the forces that cause them. The other sub-field is quantum mechanics. Roughly speaking, classical mechanics was developed in the 400 years since the groundbreaking works of Brahe, Kepler, and Galilei, while quantum mechanics developed within the last 100 years, starting with similarly decisive discoveries by Planck, Einstein, and Bohr.

The notion of “classical” may be somewhat confusing, insofar as this term usually refers to the era of classical antiquity in European history. While many discoveries within the mathematics of that period remain in full force today, and of the greatest use, the same cannot be said about its "science". This in no way belittles the many important developments, especially within technology, which took place in antiquity and during the Middle Ages in Europe and elsewhere.

However, the emergence of classical mechanics was a decisive stage in the development of science, in the

modern sense of the term. What characterizes it, above all, is its insistence on mathematics (rather than speculation), and its reliance on experiment (rather than observation). With classical mechanics it was established how to formulate quantitative predictions in theory, and how to test them by carefully designed measurement. The emerging globally cooperative endeavor increasingly provided for much closer scrutiny and testing, both of theory and experiment. This was, and remains, a key factor in establishing certain knowledge, and in bringing it to the service of society. History shows how closely the health and wealth of a society depends on nurturing this investigative and critical approach.

The initial stage in the development of classical mechanics is often referred to as Newtonian mechanics, and is characterized by the mathematical methods invented by Newton himself, in parallel with Leibniz, and others. More abstract, and general methods include Lagrangean mechanics and Hamiltonian mechanics.

Classical mechanics produces very accurate results within the domain of everyday experience. It is enhanced by special relativity for objects moving with large velocity, near the speed of light. Classical mechanics is used to describe the motion of human-sized objects, from projectiles to parts of machinery, as well as astronomical objects, such as spacecraft, planets, stars, and galaxies, and even microscopic objects such as large molecules. Besides this, many specialties exist, dealing with gases, liquids, and solids, and so on. It is one of the largest subjects in science and technology.

Although classical mechanics is largely compatible with other "classical" theories such as classical electrodynamics and thermodynamics, some difficulties were discovered in the late 19th century that can only be resolved by more modern physics. When combined with classical thermodynamics, classical mechanics leads to the Gibbs paradox in which entropy is not a well-defined quantity and to the ultraviolet catastrophe in which a black body is predicted to emit infinite amounts of energy. The effort at resolving these problems led to the development of quantum mechanics.

Energy

Energy is a fundamental quantity that every physical system possesses; it allows us to predict how much work the system could be made to do, or how much heat it can produce or absorb. In the past, energy was discussed in terms of easily observable effects it has on the properties of objects or changes in state of various systems. Basically, if something changes, some sort of energy was involved in that change. As it was realized that energy could be stored in objects, the concept of energy came to embrace the idea of the potential for change as well as change itself. Such effects (both potential and realized) come in many different forms; examples are the electrical energy stored in a battery, the chemical energy stored in a piece of food, the thermal energy of a hot water heater, or the kinetic energy of a moving train. To simply say, energy is "change or the

potential for change", however, misses many important examples of energy as it exists in the physical world.

Energy can be used not only to produce observable change, it also is used to prevent change in which case unaided observation of this kind of energy can be difficult. For example, looking at a statue holding a 50 pound weight, the presence of energy needed to do so may not be observable. However, if you are holding up the fifty pound weight instead of the statue the need for energy to accomplish this becomes apparent. You can feel the gravitational force on you both when you are moving the weight up and when you are not moving it.

Energy can be readily transformed from one form into another; for instance, using a battery to power an electrical heater converts chemical energy into electrical energy, which is then converted into thermal energy. In the previous example of holding the fifty pound weight, the work you perform to raise the weight is observed as kinetic energy of motion which is converted to potential energy. Letting go of the weight once again transforms this stored potential energy back into kinetic energy as the weight falls under the force of gravity. The law of conservation of energy states that the total amount of energy, corresponding to the sum of a system's constituent energy components, remains constant. This law is not always applicable within the realm of quantum mechanics. Scientists have also defined several forms of energy that are not easily measured by the unaided observer.

A Machine

A machine is any mechanical or organic device that transmits or modifies energy to perform or assist in the performance of tasks. It normally requires an input as a trigger, and transmits the modified energy to an output, which performs the desired task.

Humans have used mechanisms and machines to amplify their abilities. The primary difference between simple tools and simple mechanisms or machines is a power source and a somewhat independent operation. The term machine generally applies to an assembly of parts operating together to perform work. Generally these devices decrease the intensity of an applied force, altering the direction of the force or transforming one form of motion or energy into another.

The mechanical advantage of a machine is the ratio between the resistance or load, and the force required to overcome it, although this ratio is not entirely accurate as force is required to overcome friction, as well. To compensate for this, mechanical advantage is calculated as the ratio between the distance moved by the force applied, and the distance moved by the force not applied. The mechanical efficiency of a machine is the ratio of the actual mechanical advantage (AMA) to the ideal mechanical advantage (IMA). Functioning physical machines are always less than 100% efficient.

Inefficiency of a machine is the degree or percentage to which a machine does not accomplish the work it could do without the restrictions of friction.

Modern power tools, automated machine tools, and human-operated power machinery complicate this definition greatly. Machines used to transform heat or other energy into mechanical energy are known as engines.

Gasoline Engine

Gasoline engine (also referred to as petrol engine or Otto engine) invented at the end of the 19th century by German engineer Nikolaus Otto is a type of internal combustion engine which is often used for automobiles, aircraft, small mobile vehicles such as lawnmowers or motorcycles, and outboard motors for boats.

The most common engine of this type is a four-stroke cycle internal combustion engine that burns gasoline (in American English) or petrol (British English). Burning is initiated by an ignition system that fires a high voltage spark through a sparkplug, in contrast to the Diesel engine which ignites the fuel through high compression. The two-stroke cycle type of engine is often used for smaller, lighter and cheaper applications but it is less fuel efficient and, partly as a result, produces more hydrocarbon exhaust emissions.

Wankel engines can also use gasoline as their fuel. One

component in older engines is the carburator, which mixes the gasoline with air. In later engines the carburetor is replaced with fuel injection.

With minor modifications, the gasoline engine can be made to run on other fuels. Use of natural gas, for instance, is easy, since it is already a gas and mixes readily with air; many automobiles have been modified to run on natural gas, or to be able to switch back and forth from natural gas to gasoline. Alcohol is another fuel often used, although the fuel delivery system has to be modified to deliver a greater volume of fuel. Applications such as drag racing where peak power output is more important than engine longetivity add nitrogen-containing fuels like nitromethane for this purpose.

Diesel Engine

The diesel engine is a type of internal combustion engine; more specifically, it is a compression ignition engine, in which the fuel is ignited by being suddenly exposed to the high temperature and pressure of a compressed gas containing oxygen (usually atmospheric air), rather than a separate source of ignition energy (such as a spark plug), as is the case in the gasoline engine.

This is known as the diesel cycle, after Rudolf Diesel, who invented it in 1892 and received the patent on February 23, 1893. Diesel intended the engine to use a variety of fuels including coal dust. He demonstrated it in

the 1900 Exposition Universelle (World's Fair) using peanut oil. It was later refined and perfected by Charles F. Kettering.

Isaac Newton

Sir Isaac Newton (25 December 1642 – 20 March 1727 by the Julian calendar in use in England at the time; or 4 January 1643 – 31 March 1727 by the Gregorian calendar) was an English physicist, mathematician, astronomer, philosopher, and alchemist who wrote the Philosophiae Naturalis Principia Mathematica (published 5 July 1687), where he described universal gravitation and, via his laws of motion, laid the groundwork for classical mechanics. Newton also shares credit with Gottfried Wilhelm Leibniz for the development of differential calculus. While they both discovered calculus nearly contemporaneously, their work was not a collaboration.

Newton was the first to promulgate a set of natural laws that could govern both terrestrial motion and celestial motion. He is associated with the scientific revolution and the advancement of heliocentrism. Newton is also credited with providing mathematical substantiation for Kepler's laws of planetary motion. He would expand these laws by arguing that orbits (such as those of comets) were not only elliptic, but could also be hyperbolic and parabolic. He is also notable for his

arguments that light was composed of particles (see wave-particle duality). He was the first to realise that the spectrum of colours observed when white light passed through a prism was inherent in the white light and not added by the prism as Roger Bacon had claimed in the 13th century.

Newton also developed a law of cooling, describing the rate of cooling of objects when exposed to air; the binomial theorem in its entirety; and the principles of conservation of momentum and angular momentum. Finally, he studied the speed of sound in air, and voiced a theory of the origin of stars.

Quotations about Newton

"The Principia is preeminent above any other production of human genius." — Pierre-Simon Laplace

"Taking mathematics from the beginning of the world to the time when Newton lived, what he has done is much the better part." — Gottfried Leibniz

"All that has been accomplished in mathematics since his day has been a deductive, formal, and mathematical development of mechanics on the basis of Newton's laws." — Ernst Mach

"Nature and Nature's laws lay hid in night: God said, Let Newton be! and all was light." — poem, Alexander Pope

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Учебное издание

Иванова Наталья Кирилловна,
Малкова Юлия Леонидовна

ОБУЧЕНИЕ ПРОФЕССИОНАЛЬНО-ОРИЕНТИРОВАННОМУ ЧТЕНИЮ

Учебное пособие

Технический редактор Г.В. Куликова

Подписано в печать 05. 09. 2013. Формат 60×84 1/16.
Бумага писчая. Усл. печ. л. 6,28. Уч.- изд. л. 6,97.
Тираж 150 экз. Заказ

ФГБОУ ВПО «Ивановский государственный химико-технологический университет»

Отпечатано на полиграфическом оборудовании кафедры экономики и финансов
ФГБОУ ВПО «ИГХТУ»

153000, г. Иваново, Шереметевский пр., 7