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АНГЛИЙСКИЙ ЯЗЫК В СФЕРЕ ТЕПЛОЭНЕРГЕТИКИ И ТЕПЛОТЕХНИКИ

Учебное пособие

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В учебном пособии содержится информация на английском языке об основных понятиях теплоэнергетики, а также теплоэнергетических предприятиях.

Предназначено для студентов бакалавриата (2–4-й курсы) и магистратуры всех форм обучения по направлению «Теплоэнергетика и теплотехника».

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ПРЕДИСЛОВИЕ

Теплоэнергетика – отрасль энергетики и теплотехники, занимающаяся преобразованием теплоты в другие виды энергии, главным образом в механическую и через неё в электрическую. Теплоэнергетика в мировом масштабе преобладает среди традиционных видов энергетики, на базе угля вырабатывается 46% всей электроэнергии, на базе газа – 18%, еще около 3% – за счет сжигания биомасс, нефть используется для 0,2%. Суммарно тепловые станции обеспечивают электроэнергией около 2/3 от общей выработки энергии всех электростанций мира.

Учитывая международное значение этой отрасли, профессиональное владение английским языком становится одной из ключевых компетенций будущего специалиста в сфере теплоэнергетики и теплотехники.

Учебное пособие состоит из пяти разделов и текстов для самостоятельного изучения. Каждый раздел сопровождается фонетическими, грамматическими, лексическими и словообразовательными упражнениями. Кроме того, пособие содержит задания, направленные на выход в речевую деятельность.

Авторы выражают благодарность Ларисе Михайловне Карповой и Софье Михайловне Богатовой за ценные замечания и предложения, сделанные при рецензировании рукописи учебного пособия.

INTRODUCTION

Task 1. Read the following international words, mind the stressed syllables and translate the words from English into Russian.

engineering [ˌendʒɪˈnɪərɪŋ]	energy [ˈenədʒɪ]	hydropower ['haɪdrə(u)'pauə]
engine [ˈendʒɪn]	electricity [ɪˌlekˈtrɪsətɪ]	geothermal ['ʤiːə(u)'θɜːm(ə)l]
kinetic [kɪˈnetɪk]	nuclear ['njuːklɪə]	industry ['ɪndəstrɪ]
potential [pəˈtenʃl]	atomic [ə'tɔmɪk]	chemical ['kemɪk(ə)l]
thermodynamics [ˌθɜːməʊdaɪˈnæmɪks]	physics [ˈfɪzɪks]	technology [tek'nɔləʤɪ]
liter/litre [ˈliːtə(r)]	machine [mə'ʃiːn]	technician [tek'nɪʃ(ə)n]
meter [ˈmiːtə(r)]	mechanic [mɪ'kænɪk]	economy [ɪ'kɔnəmɪ]
Joule [dʒuːl]	statistic [stə'tɪstɪk]	design [dɪ'zaɪn]
magnet ['mægnɪt]	deposit [dɪ'pɔzɪt]	manufacture ['mænju'fækʧə]
synchronize ['sɪŋkrənaɪz]	sequence ['siːkwəns]	universal ['juːnɪ'vɜːs(ə)l]
	nature ['neɪʧə]	radioactivity [ˌreɪdiəʊæk'tɪvəti]

Task 2. Form the nouns from the following verbs using the suffixes -tion, -ment, -ence:

to require; to equip; to apply; to restore; to differ; to act; to pay; to realize; to break; to enhance; to develop; to maintain; to regulate.

Task 3. Match English and Russian equivalents.

1. artificial	*a. экономичный*
2. natural	*b. управлять*
3. operate	*c. технический*
4. economical	*d. механический*
5. technical	*e. промышленный*
6. industrial	*f. искусственный*
7. statistically	*g. естественный*
8. application	*h. физический*
9. sequential	*i. химия*
10. chemistry	*j. применение*
11. physical	*k. статистически*
12. mechanical	*l. последовательный*

UNIT 1

WHAT IS ENERGY? THE FORMS OF ENERGY

Task 1. Discuss these questions with your teacher.

1. What is energy? How can you explain this?
2. Give some examples of energy seen in everyday life.
3. When we say about a person that he (she) is full of energy, what do we mean?

Task 2. Read and translate the following international words.

1. electricity [ɪˌlek'trɪsɪtɪ]
2. chemical ['kemɪk(ə)l
3. transformation [ˌtrænsfə'meɪʃ(ə)n]
4. kinetic [k(a)ɪ'netɪk]
5. biomass [ˈbaɪəʊmæs]
6. gravitational [ˌgrævɪ'teɪʃnəl]
7. geothermal [ˌdʒiːəʊˈθɜːml]
8. compression [kəm'preʃ(ə)n]
9. radioactive [ˌreɪdiəʊ'æktɪv]
10. technolology [tek'nɔləʤɪ]

Task 3. Match the terms with their definitions:

a) resources	d) molecule	g) renewable
b) consumption	e) environment	h) pollution
c) energy	f) industry	

1. a source of economic wealth, esp. of a country (mineral, land, labour, etc.) or business enterprise (capital, equipment, personnel, etc.).

2. that can be replaced naturally or controlled carefully and can therefore be used without the risk of finishing it.

3. the production of goods from raw materials, especially in factories.

4. the smallest unit, consisting of a group of atoms, into which a substance can be divided.

5. the process of making air, water, soil etc.

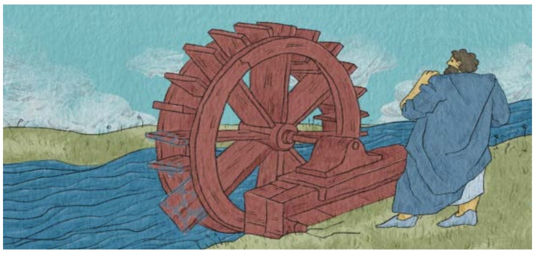
6. a source of power.

7. the natural world in which people, animals and plants live.

8. the process of using energy, food or materials.

Task 4. Read and translate the following text.

What Is Energy?



Scientists define energy as an ability to do work. We use energy to do work and make all movements. When we eat, our bodies transform the food into energy to do work. When we run or walk or do some work, we "burn" energy in our bodies. Cars, planes, trolleys, boats and machinery also transform energy into work. Modern civilization is possible because people have learned how to change energy from one form to another and then use it to do work. People use energy to walk and bicycle, to move cars along roads and boats through water, to cook food on stoves, to make ice in freezers, to light our homes and offices, to manufacture products, and to send astronauts into space. Work means moving or lifting something, warming or lighting something. There are many sources of energy that help to run various machines.

Task 5. Look through the passages. Put the parts of the text in the correct order. Fill in the table.

a	b	c	d	e	f	g
		1				

Some Facts from the History of Energy

a) In some respects, the global energy system has evolved in a cleaner direction in the last 25 years. The share of world primary energy derived from natural gas – the cleanest fossil fuel – has increased by more than 25%. So has the use and generation of renewable sources of energy. *Conserving* energy has become the need of the day in the transport, household, or industrial sectors.

b) As early as 4000–3500 BC, the first *sailing* ships and windmills were developed by *harnessing* wind energy. With the use of hydropower through watermills or irrigation systems, things began to move faster.

c) The discovery of fire by man led to the possibility of burning wood for cooking and heating thereby *using* energy. For several thousand years human energy demands were met only by renewable energy sources – sun, biomass (wood, leaves, twigs), hydel.

d) There has been an enormous increase in the demand for energy since the middle of the last century as a result of industrial development and population growth. World population grew 3.2 times between 1850 and 1970, per capita use of industrial energy increased about twentyfold, and total world use of industrial and traditional energy forms *combined* increased more than twelvefold.

e) Total commercial energy consumption has been growing tremendously since the last decade. Per capita commercial energy consumption in low-income countries have more than doubled.

f) About 15% of the world's population *living* in the wealthy industrialized counties consume over half the energy *used* in the world.

g) With the advent of the Industrial Revolution, the use of energy in the form of fossil fuels began growing as more and more industries were set up. This occurred in stages, from the exploitation of coal deposits to the exploitation of oil and natural gas fields.

Task 6. Answer the following questions.

1. Why did people need energy in prehistoric times?

2. What kind of energy sources did humans harness only for several thousand years?

3. When did people begin to use wind and water energy? Why?

4. What happened with an advent of Industrial Revolution?

5. Why did energy consumption increase greatly in the middle of the 20th century?

6. What problem of energy consumption has become the need of the day?

Task 7. Write out all the forms of energy mentioned in the text.

Task 8. Match the synonyms.

1. to grow	a) to derive
2. using	b) enormous
3. to extract	c) commercial

4. very big d) tremendously
5. trade e) consumption
6. spending f) to increase
7. greatly e) harnessing

***Task 9. Translate from Russian into English*:**

глобальная энергосистема, возобновляемый источник энергии, промышленный сектор, ветряные мельницы, гидроэлектрический (в сокращении), оросительная система, рост населения, двенадцатикратный, на душу населения, потреблять, страны с низким уровнем дохода, ископаемое топливо, залежи угля.

Task 10. Find out the Participle forms in italics in Task 5 and translate these sentences from English into Russian.

Task 11. What forms of energy do you know? Watch the video «Energy and different forms of energy with examples» on YouTUBE: https://www.youtube.com/watch?v=1JdvH_8cz-I
When watching the video answer the questions and make some notes in your copybook.

Task 12. Read the text and after name all the forms of energy you have remembered.

The Forms of Energy

Energy is found in different forms including *light, heat, chemical, and motion*. There are many forms of energy, but they can be put into two categories: *potential and kinetic*.

Kinetic energy is energy of motion, e. g. *molecules, waves, substances, objects.* There are different forms of kinetic energy :

• *Radiant Energy* is electromagnetic energy, travelling in transverse waves. The examples of radiant energy include visible light, x-rays, gamma rays and radio waves. Light is one type of radiant energy. Sunshine is also radiant energy, it provides the fuel and warmth, without it the life on the Earth is impossible.

• *Thermal Energy*, or heat, is the vibration and movement of the atoms and molecules within substances. When an object is heated, its atoms and molecules move faster. The thermal energy in the Earth is geothermal.

• *Motion Energy* is the energy stored in the movement of objects. The faster they move, the more energy is stored. It takes energy to get an object moving and energy is released when an object slows down. Wind is also an example of motion energy. In a car crash, when the car comes to a total stop it releases all its motion energy at once.

• *Sound* is the movement of energy through substances in longitudinal compression waves. Sound is produced when a force makes an object or substance vibrate – the energy is transferred through the substance in a wave. Usually the energy of sound is far less than other forms of energy.

Potential energy is a stored energy and the energy of position. There are several forms of potential energy:

• *Chemical Energy* is an energy stored in the bonds of atoms and molecules. The examples of stored chemical energy are: biomass, petroleum, natural gas, and coal. Chemical energy can be converted to thermal energy when we burn wood in a fireplace or gasoline in a car's engine.

• *Mechanical Energy* is an energy stored in objects by tension. Compressed springs and stretched rubber bands are examples of stored mechanical energy.

• *Nuclear Energy* is an energy stored in the nucleus of an atom the energy that holds the nucleus together. Very large amounts of energy can be released when the nuclei are combined or split apart.

• *Gravitational Energy* is energy stored in an object's height. The higher and heavier the object, the more gravitational energy is stored. When you ride a bicycle down a steep hill and pick up 12–speed, the gravitational energy is being converted to motion energy. Hydropower is another example of gravitational energy.

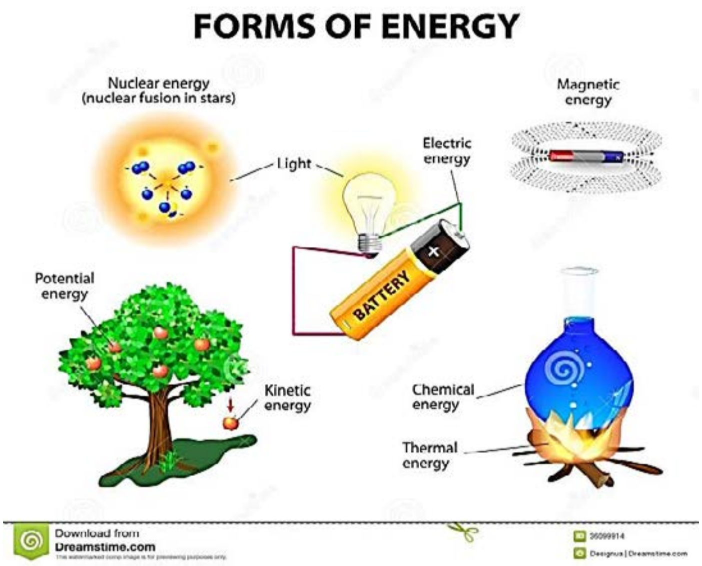
• *Electrical Energy* is what is stored in a battery, and can be used to power a cell phone or start a car. Electrical energy is delivered by tiny charged particles called electrons, typically moving through a wire. Lightning is an example of electrical energy in nature so powerful that it is not confined to a wire.

Task 13. Fill in the following table according to the types of energy:

form	kinetic/potential	sources	examples
gravitational			
electrical			
sound			
motion			
chemical			
mechanical			
nuclear			
radiant			
thermal			

Energy can be converted from one form to another. For example, the food a person eats contains chemical energy, and a person's body stores this energy until he or she uses it as kinetic energy during work or play. The stored chemical energy in coal or natural gas and the kinetic energy of water flowing in rivers can be converted to electrical energy, which in turn can be converted to light and heat.

Task 14. Study the picture «Forms of energy» and tell how different forms of energy can be converted into each other.



Task 15. Check yourself 1. Choose the right variant(s).

1. What is energy?

   a) everything that can be found in the environment

   b) an ability to make things of different materials

   c) to convert something from the original state

   d) an ability to work and make movements

2. The discovery of fire led to the possibility of … :

   a) riding a bicycle

   b) burning wood for cooking

   c) heating the dwelling

   d) driving a car

3. With the use of … through watermills or irrigation systems, things began to move faster:

   a) water

   b) kinetic energy

c) hydropower

d) natural gas

4. What forms of energy began growing as more and more industries were set up?

a) water

b) fossil fuels

c) sun

d) radiant

5. What kind of energy is stored in atoms or molecules?

a) mechanical

b) gravitational

c) chemical

d) nuclear

6. What kind of energy depends on heat?

a) electrical

b) thermal

c) radiant

d) potential

7. In what kind of energy does vibration appear?

a) chemical

b) motion

c) sound

d) radiant

8. Choose the variants of converting energy:

a) chemical – thermal

b) nuclear-magnetic

c) potential-kinetic

d) electric-light

UNIT 2
FUELS

ignition [ɪg'nɪʃ(ə)n] – возгорание, воспламенение	calorific value ['kælə'rɪfɪk 'vælju:] – теплотворная способность
kerosene ['kɛrəsiːn] – керосин	Joule [dʒuːl] (J) – Джоуль (Дж)
diesel ['di:z(ə)l] – дизель	to possesses [pə'zes] – обладать
to distinguish [dɪs'tɪŋgwɪʃ] – различать	liberate ['lɪbəreɪt] – высвобождать
cow dung cake [kau dʌŋ keɪk] – лепёшка коровьего навоза	undesirable ['ʌndɪ'zaɪ(ə)rəb(ə)l] – нежелательный
gaseous ['gæsɪəs] – газообразный	efficiency [ɪ'fɪʃ(ə)nsɪ] – эффективность
ethanol ['eθənɒl] – этанол	charcoal ['ʧɑ:kəul] – древесный уголь

Task 1. Read the text.

Substances which undergo combustion in air producing large amount of energy is called fuel. Petrol, diesel, LPG, wood, coal, charcoal are some fuels. Let’s consider the classification of fuels. Basically there are 3 types of fuels: solid fuel, liquid fuel, gaseous fuel. Solid fuels include such substances as coal, charcoal, firewood etc. Petrol, diesel, ethanol, kerosene are some of liquid fuels. LPG, CNG, hydrogen, biogas are some of gaseous fuels.

Let’s consider fuel efficiency. Not all fuels produce the same amount of energy. Some fuels like cow dung cake liberate very low energy. And LPG, for instance, liberates very high amount of energy. To distinguish between them we use the term “calorific value”. The amount of heat energy produced during complete combustion of 1 kg of a fuel is called *calorific value*. The higher the calorific value, the more heat will be produced by the fuel. As you see in the table, the calorific value of gaseous fuels is higher than the calorific value of liquid ones. And the calorific value of liquid fuels is higher than the calorific value of solid ones.

Indeed, there are a large number of fuels, however, we have to choose a "good fuel". A good fuel possesses some properties. It is cheap, readily available and it is easy to store and transport. It also catches fire easily, burns with a moderate rate and produces high amount of energy. Its ignition temperature must be moderate and its calorific value must be higher. During combustion, it must not produce undesirable and harmful products.

There is no ideal fuel that meets all these properties. However, we can choose a fuel which meets most of these properties. For instance, gaseous fuels are considered as good fuels because they meet most of these properties.

Task 2. Study the calorific value of different fuels given in the table.

Fuel	**Calorific Value (kJ/kg)**
Cow dung cake	6000–8000
Wood	17000–22000
Coal	45000
Petrol	45000
Kerosene	45000
Diesel	50000
CNG	50000
LPG	55000
Biomass	35000–40000
Hydrogen	150000

[https://world-nuclear.org/information-library/facts-and-figures/heat-values-of-various-fuels.aspx]

Task 3. Answer the questions.

1. What substances can be called fuels?
2. What types of fuels can you name?
3. What is fuel efficiency?
4. What does the term "calorific value" mean?
5. What determines calorific value?
6. Is the calorific value of solid fuels higher than the calorific value of liquid ones?
7. What are advantages and disadvantages of fuels?

Task 4. Read and translate the numbers and abbreviations:

14.5 km/h	0.57l	0.62 mi	220 V
–86.7 °C	248 K	0.5922 kcal/mol	16 Ω
300 MJ	12 lbs	2.476 kJ/mol	29 °F
150 cm^3	18 ft	23.4 mA	10.702 psi

2.1. Gas

to expand [ɪk'spænd] – расширять, расширяться	to redistribute ['ri:dɪ'strɪbju:t] – ерераспределять
to collide [kə'laɪd] – сталкиваться	gravity ['grævɪtɪ] – притяжение
ability [ə'bɪlɪtɪ] – способность	to squeeze [skwi:z] – сжимать
to flow [fləu] – течь	to compress ['kɔmpres] – сжимать
to breathe [bri:ð] – дышать	healthcare [ˈhelθkeə(r)] – здравоохранение

Task 1. Read the text.

A gas is a sample of matter that has no definite volume and no specific shape. In other words, gases can easily flow into and take the shape of a container and will expand redistributing themselves to evenly fill that container. Although there are many types of gases there are a few characteristics that they have in common.

First, particles in a gas have no real arrangement – they can move over and pass one another and the space between the molecules can increase or decrease. Molecules in a gas collide with one another and move more quickly or more slowly based on factors like temperature and pressure. But they will always spread out fairly equally to fill the space that they're in. All of this molecular movement means that gases hold a lot of kinetic energy caused by motion. Second, gases can be compressed because there is space between the molecules in a gas. It can be placed under pressure and squeezed so that the particles are forced to be close to one another. Third, gases can flow from one area to another. Although the direction of flow is not directly affected by gravity, this ability to flow means they are sometimes referred to as fluids. Last, gases have melting points and boiling points that are below room temperature. For the most part we are unable to see gases because of the space between their particles.

Scientists have to use characteristics like pressure volume, number of particles per unit area and temperature to discuss and identify them. Gases are commonly used in cooking, healthcare and scientific research and they even make up the air we breathe.

2.2. Natural Gas

methane ['mi:θeɪn] – метан	to undergo [ˌʌndə'gəu] – претерпевать
ethane ['i:θein] – этан	to bury ['berɪ] – захоронить
butane ['bju:teɪn] – бутан	reservoir ['rezəvwɑ:] – газоносный пласт

hydrocarbon ['haɪdrə(u)'kɑ:bən] – углеводород	refrigerant [rɪ'frɪʤ(ə)rənt] – охлаждающий реагент
compound [ˈkɒmpaund] – соединение	sulfur ['sʌlfə] – сера
carbon dioxide [ˌkɑːbəndaɪ'ɒksaɪd] – двуокись углерода	impermeable [ɪm'pɜ:mɪəb(ə)l] – непроницаемый
deposit [dɪ'pɔzɪt] – месторождение	to extract [ɪk'strækt] – извлекать
hydraulic [haɪ'drɔlɪk] – гидравлический	pure [pjuə] – чистый

Task 2. Read the text.

Natural gas is primarily methane or CH_4 with smaller quantities of other hydrocarbons. It was formed millions of years ago when dead organisms sank to the bottom of the ocean and were buried under deposits of sedimentary rock. Subject to intense heat and pressure these organisms underwent a transformation in which they were converted to gas over millions of years. Natural gas is found in underground rocks called reservoirs. The rocks have tiny spaces called pores that allow them to hold water and natural gas and sometimes oil. The natural gas is trapped underground by impermeable rock called a cap rock and stays there until it is extracted.

Natural gas can be categorized as dry or wet. Dry gas is essentially gas that contains mostly methane. Wet gas on the other hand contains compounds such as ethane and butane in addition to methane. These natural gas liquids, or NGLs for short, can be separated and sold individually for various uses such as in refrigerants and to produce products like plastics. Conventional natural gas can be extracted through drilling wells.

Natural gas leaks are also dangerous to nearby communities because it is a colorless odorless highly toxic and highly explosive gas.

Unconventional forms of natural gas like shale gas, tight gas, sour gas and coal bed methane have specific extraction techniques. Natural gas can also be found in reservoirs with oil and is sometimes extracted alongside oil. This type of natural gas is called associated gas. In the past associated gas was commonly flared or burned as a waste product but in most places today it is captured and used.

Once extracted natural gas is sent through small pipe lines called gathering lines to processing plants which separate various hydrocarbons and fluids from the pure natural gas to produce what is known as pipeline quality dry natural gas before it can be transported. Processing involves four main steps to remove various impurities: oil and condensate removal, water removal, separation of natural gas liquids, sulfur and carbon dioxide removal. Gas is then transported through pipelines called feeders to distribution centers or stored in underground reservoirs for later use. In some cases gas is liquefied for shipping in large tankers across oceans. This type of gas is called liquefied natural gas, or LNG.

Natural gas is mostly used for domestic or industrial heating and to generate electricity. It could also be compressed and used to fuel vehicles and as a feedstock for fertilizers, hydrogen fuel cells and other chemical processes. Natural gas development has increased as a result of technological advances in horizontal drilling and hydraulic fracturing. When natural gas is burned there are fewer greenhouse gas emissions and air pollutants when compared to other fossil fuels.

In fact, when used to produce electricity natural gas emits approximately half the carbon emissions. Despite fewer emissions natural gas is still a source of CO_2. In addition, methane is a potent greenhouse gas itself having nearly 24 times the impact of CO_2. During the extraction and transportation process natural gas can escape into the atmosphere and contribute to climate change.

Task 3. Answer the questions.

1. Is there methane in natural gas?
2. Where can natural gas be found?

3. How is natural gas formed?
4. What is the difference between dry and wet natural gas?
5. How is natural gas normally transported?
6. What unconventional forms of natural gas do you know?
7. Does natural gas come from crude oil?

Task 4. Translate the word combinations and abbreviations from English into Russian:

cap rock –	LNG –
impermeable rock –	LPG –
drilling well –	CO_2 –
processing plant	greenhouse gas –
sedimentary rock –	carbon emission –
waste product –	extraction technique –
explosive gas –	fuel cell –
associated gas –	hydraulic fracturing –

Task 5. Put down:

THREE THINGS I HAVE LEARNED:
TWO THINGS I FOUND INTERESTING:
ONE QUESTION I HAVE (i.e. one thing I would like to know):

2.3. SOLIDS

Task 1. Read the text.

Solids have a fixed shape. That is a shape that under normal circumstances does not change. Solids only change shape when an external force is applied to them. For example, solids change shape by heating, hammering, cutting, squashing, squeezing etc. Solids share other qualities: they do not move once placed. Solids cannot change volume. They take up the amount of space. For instance, a parachute changes shape when it is not in the air but the material will always fill the same amount of space.

Unlike a gas or a liquid, a solid has tightly packed molecules, so it cannot be compressed into a smaller space or volume. If you roll pizza dough it will get thinner but it will also get wider. You cannot change its volume. The only way to reduce the pizza's volume is to eat it. ☺

Task 2. Unjumble the words:

euvlom; ecreud; cenhag; yutaliq; pehas; cepas; matuno.

Task 3. Which of these objects and materials can be described as a solid?

a) rock
b) a gold bar
c) a china teacup
d) a pizza
e) tar
f) fuel oil
g) hydrocarbon
h) charcoal
j) a crankshaft
k) wood
l) a screwdriver
m) a screw nail
n) a lever
o) a pellet
p) a trigger
q) nitrogen
r) copper
s) brass
t) carbon dioxide
u) gasoline

Task 4. Answer the questions.

1. What differs solids from gasses and liquids?
2. How can the shape of solids be changed?
3. Why cannot solids change their volume?
4. What amount of space do solids always fill?
5. How are molecules packed in a solid?

Task 5. Listen to the song about solids and liquids by Peter Weatherall https://www.youtube.com/watch?v=1O0mdbYdIBs and put down: a) the characteristics of solids and liquids mentioned in it; b) the words similar to those in the text under study.

2.4. LIQUIDS

Task 1. Read the text.

Liquids are materials that have a definite volume but no specific shape. In other words, liquids can easily flow into and take the shape of the container that they're in but do not expand to fill that container. Although types of liquids vary widely there are a few characteristics that they have in common.

First, particles in a liquid are arranged so that they remain close together. Although the molecules in a liquid can move over and pass one another the space between the molecules remains small. This attraction is called intermolecular bonding. Second, liquids can't be compressed because there is not a lot of space between the atoms. They can't be squeezed together any closer than they already are. Sometimes scientists say that liquids are a condensed phase of matter. Third, they flow from one area to another generally from a higher to a lower point due to gravity. This ability to flow means they are sometimes called fluids.

Last, in general, liquids have melting boiling points that are higher than room temperature. Because of the way molecules and atoms are arranged in a liquid they produce a phenomenon called surface tension. Surface tension is the force that causes liquids to form droplets and beads on surfaces. It even enables very light objects to be born on the surface of the water such as in the case of water striders.

Although we're familiar with and dependent on the most common liquid on earth – water. Liquids are actually the rarest form of matter in the universe. This is because liquids can only exist with the narrow ranges of temperature and pressure which are uncommon outside of the Earth's atmosphere.

Task 2. Answer the questions.

1. What differs liquids from other forms of matter?
2. Are types of liquids numerous or few?
3. What is called intermolecular bonding?
4. Why do scientists consider liquids to be a condensed phase of matter?
5. How do liquids flow?
6. Why are liquids sometimes called fluids?
7. How are atoms arranged in a liquid?
8. What is surface tension?

Task 3. Complete the sentences using the words given in brackets:

1. Unlike gases, liquids … (container).
2. The space between molecules in a liquid is … (smaller).
3. Small space between the atoms in liquids prevents them from … (compress).
4. It is gravity that makes liquids … (to flow).
5. Droplets on the surface … (surface tension).
6. Liquids as a form of matter … (the earth, the universe).

Task 4. Put down:

THREE THINGS I HAVE LEARNED:
TWO THINGS I FOUND INTERESTING:
ONE QUESTION I HAVE (i.e. one thing I would like to know

Task 5. Check yourself 2. Give the right answer(s) to the questions.

1. What substances have a fixed shape?

a) gas

b) liquids

c) solids

2. Which substances can be fuels?

a) milk

b) kerosene

c) coal

d) metal

3. Why are natural gas leaks so dangerous?

a) because it is trapped underground by impermeable rock called a cap rock and stays there until it is extracted

b) because it has a strong smell which is dangerous for people’s health

c) because it is a colorless odorless highly toxic and explosive gasoline

4. In what substances can’t we change their volume?

a) solids

b) liquids

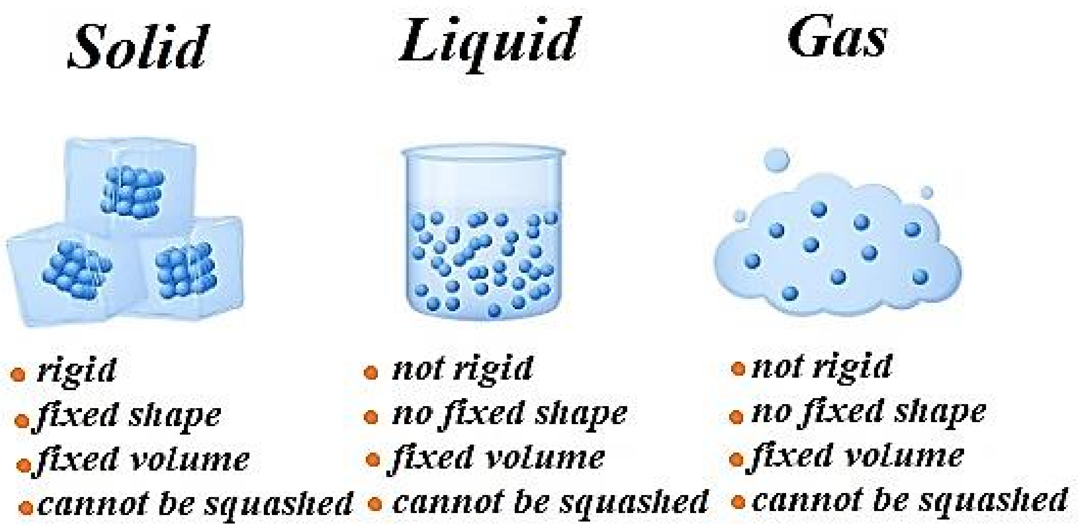
c) gas

5. What gas contains mostly methane?

a) wet

b) natural

c) dry



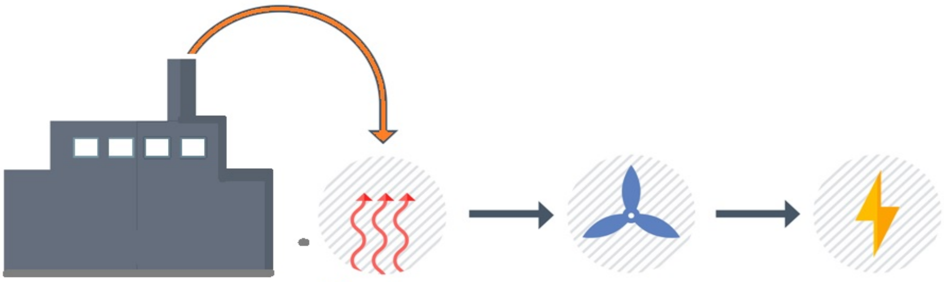
UNIT 3
HEAT

3.1. Converting Heat Into Electricity

by-product ['baɪ'prɔdʌkt] – побочный продукт	cost-effectively [ˌkɒstɪ'fektɪvlɪ] – экономически эффективно
photon ['fəutɔn] – фотон	efficiency [ɪ'fɪʃ(ə)nsɪ] – эффективность
to glow [gləu] – светиться, сиять	to emit [ɪ'mɪt] – испускать, излучать
furnace exhaust ['fɜ:nɪs ɪg'zɔ:st] – выпускная труба печи	interruption ['ɪntə'rʌpʃ(ə)n] – приостановка, перебой (в работе)
process ['prəuses] – процесс	technology [tek'nɔləʤɪ] – технология
co-generate [ˌkəʊ'ʤenəreɪt] – совместное производство	photovoltaic cell [ˌfəʊtəʊvɒl'teɪɪk sel] – фотоэлектрическая батарея
to absorb [əb'zɔ:b] – поглощать, впитывать (влагу)	usable ['ju:zəb(ə)l] – используемый, применимый

Task 1. Read the text.

Heat is a by-product of many industrial processes. Glass and metal production, cement factories, biomass facilities and much of it is released into the air. Converting that heat into electricity usually involves making steam which drives turbines which in turn drive electric power generators. But modern technology can convert heat directly into electricity. When you see something glowing red that's photons that are being emitted and if you take a photovoltaic cell you can actually take those photons and make electricity.



The efficiency of this invention comes from its two important features. First, the gap between the material that absorbs the heat and the photovoltaic cells which convert its glow into electricity is less than 1 micron or 50 times smaller than the width of a human hair, so the photons do not have to travel a great distance. Second, photovoltaic cells are actively cooled down to 30 ^{o}C while the photon generating elements on the other side may be at 900 ^{o}C. The temperature difference also contributes to the efficiency.

Photovoltaic cells can actually co-generate an enormous amount of power. They are very cost-effective: somewhere between 2 and 8 cents per kWh. Rods with photovoltaic elements can be inserted in holes that usually already exist in furnace exhausts. As most industrial furnaces work for years without interruption the energy production can be continuous. Some companies are working on the next generation of this technology capable of working at heat as low as 100 ^{o}C which will make it usable in cars, homes and even some consumer electronic devices.

Task 2. Answer the questions.

1. How is the term “by-product” defined?
2. How can electricity be generated by using photons?
3. What important features does the efficiency of photovoltaic cells come from?
4. Are photovoltaic cells small? Can you describe their size?

5. Does the temperature difference contribute to the efficiency?
6. Are photovoltaic cells cost-effective?
7. What new photovoltaic cell technology are some companies working on?

Task 3. Put down the full forms of the abbreviations:

30 ^{o}C, 900 ^{o}C, kWh.

Task 4. Match the verbs with their antonyms:

to exhaust	to freeze
to invent	to produce
to warm up	to detach
to insert	to copy
to heat	to replenish
to consume	to cool

Task 5. Make up sentences using the words given below.

1. take/ you/ and/ electricity/ the/ actually/ make/ can/ photons.
2. electricity/ technology/ can/ modern/ heat/ convert/ into/ directly.
3. move/ at/ photons/ the/ light/ always/ of /speed.
4. long/ of water / these/ distances / workers/ carry / heavy/ containers/ over.

Task 6. Match the words with their definitions.

device	a substance that is produced during the process of making or destroying something else
furnace	an object or a piece of equipment that has been designed to do a particular job
temperature	the quality of being hot

efficiency	a space surrounded on all sides by walls and a roof for heating metal or glass to very high temperatures
width	a photon is an elementary particle that is a quantum of the electromagnetic field
heat	the measurement in degrees of how hot or cold a thing or place is
photon	the measurement from one side of something to the other; how wide something is
by-product	the quality of doing something well with no waste of time or money etc.

Task 7. Translate the sentences from English into Russian.

1. One of the by-products of unemployment is an increase in crime.
2. Scientists are looking to develop more efficient ways of converting the energy from sunlight into electricity.
3. The embers glowed in the hearth.
4. The metal container began to emit a clicking sound.
5. Plants absorb carbon dioxide from the air.
6. There’s been an interruption in the power supply.
7. Unfortunately, the device cannot be fixed. I can’t detach this battery.

3.2. SOLAR PANELS

Earth [ɜ:θ] – Земля	layer ['leɪə] – слой
reliant [rɪ'laɪənt] – зависимый	light bulb [ˈlaɪtbʌlb] – лампочка
abundant [ə'bʌndənt] – имеющийся в избытке	dislodge [dɪs'lɔʤ] – выбивать (частицу)
aluminum [ə'lu:mɪnəm] – алюминий	unevenly ['ʌn'iːvənlɪ] – неровно

obvious ['ɒ(b)vɪəs] – очевидный	neighbour ['neɪbə] – сосед
current ['kʌrənt] – ток	kerosene ['kerəsiːn] – керосин
to examine [ɪg'zæmɪn] – исследовать	to require [rɪ'kwaɪə] – требовать
available [ə'veɪləb(ə)l] – доступный	reliable [rɪ'laɪəb(ə)l] – надёжный

Task 1. Read the text.

The Earth intercepts a lot of solar power – 173,000 terawatts. That's 10,000 times more power than the planet's population uses. So is it possible that one day the world could be completely reliant on solar energy? To answer that question we first need to examine how solar panels convert solar energy to electrical energy. [https://medium.com/the-pingo-blog/how-solar-panels-work-c6f93feeabab]

Let's find out how solar panels work. Solar panels are made up of smaller units called solar cells. The most common solar cells are made from silicon, a semiconductor that is the second most abundant element on Earth. In a solar cell, crystalline silicon is sandwiched between conductive layers. Each silicon atom is connected to its neighbours by 4 strong bonds which keep the electrons in place so no current can flow.

Here's the key: A silicon solar cell uses two different layers of silicon. An n-type silicon has extra electrons, and ap-type silicon has extra spaces for electrons called holes. Where the two types of silicon meet, electrons can wander across the p/n junction, leaving a positive charge on one side and creating negative charge on the other. You can think of light as the flow of tiny particles called photons shooting out from the Sun.

When one of these photons strikes the silicon cell with enough energy, it can knock an electron from its bond, leaving a hole. The negatively charged electron and location of the positively charged hole are now free to move around. But because of the electric field at the p/n junction, they'll only go one way. The electron is drawn to the n-side while the hole is drawn to the p-side.

The mobile electrons are collected by thin metal fingers at the top of the cell. From there, they flow through an external circuit, doing electrical work like powering a light bulb, before returning through the conductive aluminum sheet on the back. Each silicon cell only puts out half a volt, but you can string them together in modules to get more power. 12 photovoltaic cells are enough to charge a cellphone, while it takes many modules to power an entire house. Electrons are the only moving parts in a solar cell, and they all go back where they came from. There is nothing to get worn out or used up, so solar cells can last for decades.

So what's stopping us from being completely reliant on solar power? There are political factors at play not to mention businesses that lobby to maintain the status quo. But for now, let's focus on the physical and logistical challenges. And the most obvious of those is that solar energy is unevenly distributed across the planet. Some areas are sunnier than others. It's also inconsistent. Less solar energy is available on cloudy days or at night. So, a total reliance would require efficient ways to get electricity from sunny spots to cloudy ones, and effective storage of energy.

The efficiency of the cell itself is a challenge, too. If sunlight is reflected instead of absorbed or if dislodged electrons fall back into a hole before going through the circuit, that photons energy is lost. The most efficient solar cell yet still only converts about 40% of the available sunlight to electricity, and most commercial systems are currently 15–20% efficient.

In spite of these limitations, it actually would be possible to power the entire world with today's solar technology. We'd need the funding to build the infrastructure and a good deal of space. Estimates range from tens to hundreds of thousands of square miles, which seems a lot, but the Sahara Desert alone is over 3 mln square miles in area.

Meanwhile, solar cells are getting better, cheaper, and are competing with electricity from the grid. And innovations, like floating solar farms, may change the landscape entirely. Thought experiments aside, there's the fact that over a billion people don't have access to a reliable electric grid, especially in developing countries, many of which are sunny. So in places like that solar energy is already much cheaper and safer than available alternatives like kerosene. For say, Finland or Seattle, though, effective solar energy may still be a little way off.

Task 2. Answer the questions.

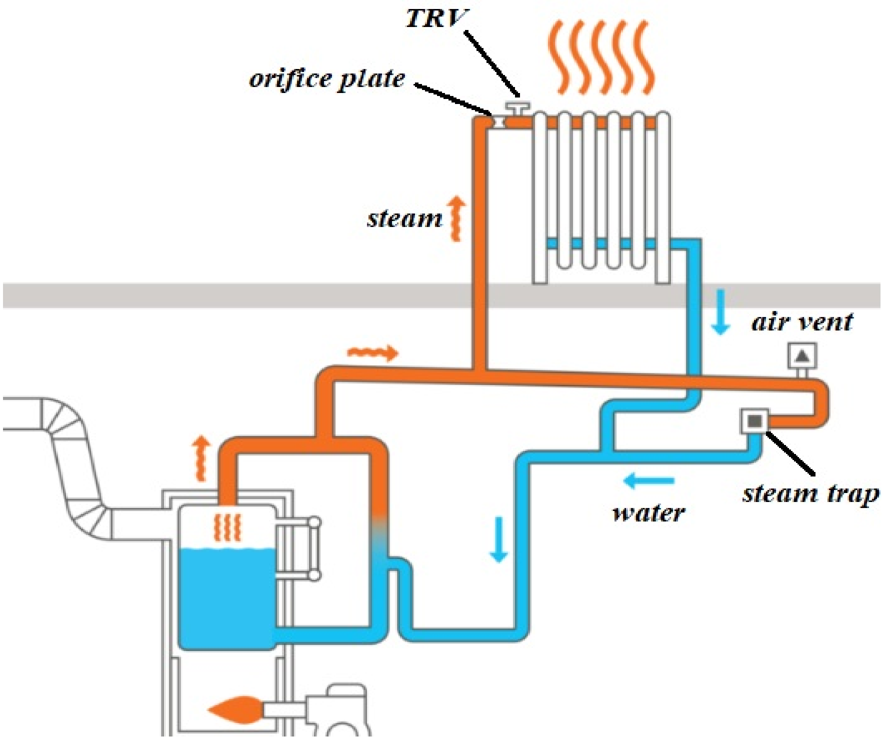
1. Are there any disadvantages of solar energy?
2. Is the initial cost of purchasing a solar system fairly high?
3. Is solar energy storage expensive?
4. Does a solar system use a lot of space?
5. Is dealing with solar energy associated with pollution?
6. What prevents us from being completely reliant on solar power?

Task 3. Put down:

THREE THINGS I HAVE LEARNED:
TWO THINGS I FOUND INTERESTING:
ONE QUESTION I HAVE (i.e. one thing I would like to know):

3.3. STEAM HEATING SYSTEMS

Celsius ['selsɪəs] – Цельсий	require [rɪ'kwaɪə] – требовать
Fahrenheit ['færənhaɪt] – Фаренгейт	pressure ['preʃə] – давление
although [ɔ:l'ðəu] – хотя	increase (n) ['ɪŋkri:s] – увеличение
steam [sti:m] – пар	increase (v) [ɪŋ'kri:s] – увеличиваться
molecule [ˈmɒlɪkjuːl] – молекула	tightly ['taɪtlɪ] – тесно, вплотную
vibrate [vaɪ'breɪt] – колебаться transfer [træns'fɜ:] – переносить	approximately [ə'prɔksɪmɪtlɪ] – приблизительно
excite [ɪk'saɪt] – возбуждать	boiler ['bɔɪlə] – котел
to create[krɪ'eɪt] – создавать	to avoid [ə'vɔɪd] – избегать



Task 1. Read the text.

Steam heating systems can be found in residential, commercial and even industrial sites. They are very common in large campuses especially larger older buildings. These systems do not require pumps – instead they use the steam itself to distribute the heat around the building. Although we might find a condensate pump on the return line. If we add thermal energy or heat to some water at standard atmospheric pressure its temperature rises until it reaches 100 ^{o}C or 212 ^{o}F. At this point it begins to boil and evaporate into steam. The thermal energy is carried away by the steam.

If we capture and contain the steam by placing a loosely fitting lid over the vessel we would see the lid rise up. If we fix the lid firmly to the vessel we would see the internal pressure increase. That's because the water molecules are expanding and taking up more space. In cool water the molecules are tightly packed together.

But as more thermal energy is added the water molecules become excited and they vibrate rapidly which increases their volume. It increases so much that one unit of water can expand into steam approximately 1,600 times its original volume. If the volume of the vessel is fixed and more thermal energy is added the water molecules are going to become excited and move faster. They will collide with the walls of the vessel more frequently and with more force. This increases the pressure inside the vessel. The pressure pushes the steam.

It naturally tries to reach a location of lower pressure. We can use that pushing force to distribute the thermal energy through pipes to radiators and then back to the boiler. In a typical two-pipe steam heating system the boiler is adding thermal energy and heating the water which turns it into steam. The pressure is pushing the steam along the pipe into the radiator. The radiator heats the ambient air of the room so thermal energy is transferred from the steam through the radiator wall and into the air of the room.

As the air is heated it rises up and the cooler air rushes up to take its place. This will repeat continuously. The steam is giving away its thermal energy. As it does so it condenses back into a liquid. The high pressure of the system is going to push this water back to the boiler where it will be reheated and repeat the cycle.

We only want to condensate liquid returning to the boiler. We don't want any steam getting into the return line. This would be a waste of energy as it will warm the condensate liquid and also lose heat on the way back. We've paid to create the steam so we don't want to waste it. Mixing the steam and the condensate will cause many problems which can be catastrophic for the system – so we must try to avoid them. One way to do that is through a thermostatic radiator trap.

Task 2. Answer the questions.

1. How can you describe thermal energy?
2. Why does hot air rise?
3. At what temperature does water begin to boil?
4. How do molecules behave in cold water?
5. How many times can one unit of water expand into steam?
6. What does the radiator do?
7. Does mixing the steam and the condensate cause any problems?

Task 3. Match the antonyms:

protection	advantage
inception	insecurity
absence	enemy
friend	presence
problem	end
justice	ignorance
separation	exit
entrance	success
failure	injustice
knowledge	connection

to return	to refuse
to demand	to free
to attack	to depart
to conceal	to defense
to accept	to offer
to borrow	to fail
to hasten	to contract
to imprison	to reveal
to expand	to slow down
to succeed	to lend

sour	*blunt*	*kind*	*strong*	*rigid*	*lazy*	*crucial*	*huge*
cruel	sweet	sharp	soft	tiny	weak	industrious	insignificant

Task 4. Put down:

THREE THINGS I HAVE LEARNED:
TWO THINGS I FOUND INTERESTING:
ONE QUESTION I HAVE (i.e. one thing I would like to know):

Task 5. Form sentences using the words given below. Model: sources/ new/ are/ scientists/ energy/ of/ finding/ → Scientists are finding new sources of energy.

1. central/ a/ system/ homes/ warmth/ heating/ to/ provides.
2. be/ energy/ primary/ sources/ fuels/may.
3. the/ heating/ ancient/ Greeks/ developed/ originally/ central.
4. goes/ warm/ everywhere/ air/ rises/ heat/ but.

UNIT 4
POWER PLANTS

4.1. THERMAL ENGINEERING

mechanical engineering [mɪ'kænɪk(ə)l 'enʤɪ'nɪ(ə)rɪŋ] – машиностроение	to design [dɪˈzaɪn] – проектировать, конструировать, рассчитывать
thermal engineer – инженер по теплотехнике	thermodynamics [ˌθɜːməʊdaɪˈnæmɪks] – термодинамика
air conditioning ['eə kən'dɪʃ(ə)nɪŋ] – кондиционирование воздуха	refrigeration system [rɪ'frɪʤə'reɪʃ(ə)n 'sɪstəm] – холодильная система
to depend on (something/somebody) – зависеть от (чего-либо/ кого-либо)	expert [ˈekspɜːt] – крупный специалист, эксперт
to convert (into) [kənˈvɜːt] – превратить, преобразовывать, трансформировать	manufacturing plant [ˌmænjuˈfæktʃərɪŋ 'plɑːnt] – промышленное предприятие, производство
sustainably [səˈsteɪnəblɪ] – устойчиво, стабильно	to ensure [ɪn'ʃuə] – обеспечивать, гарантировать, заверять
oil refinery ['ɔɪlrɪ'faɪn(ə)rɪ] – нефтеперерабатывающий завод	to disrupt [dɪs'rʌpt] – нарушать, прерывать
wisely – разумно; умно; грамотно	process [ˈprəʊses] – процесс

Task 1. Read the text.

Thermal engineering is a specialized sub-discipline of mechanical engineering that deals exclusively with heat energy and its transfer between not only different mediums but also into other usable forms of energy. A thermal engineer is a specialist who has deep knowledge of thermodynamics.

A thermal engineer designs systems for converting generated energy from various thermal sources into chemical, mechanical, or electrical energy, depending on the task given.

Obviously, all thermal engineers are experts in all aspects of heat transfer. At process plants some raw materials or resources are converted into something useful. For example, power plants, oil refineries, plastic manufacturing plants etc. contain countless components and systems which have to be designed in terms of heat transfer. It is particularly important to ensure that not too much heat is lost during the process of converting energy and the process itself is not disrupted. Conversely, some processes or systems are designed to use heat to their advantage and a thermal engineer must make sure enough that heat is generated and used wisely and sustainably.

Thermal engineers must also know about the economics of the components and systems designed. They make sure that they don't only provide the improvement of the existing solutions but don't lose the company money either. Thermal engineers are not limited in areas of specialization and can work in numerous fields. There are brief examples of some areas thermal engineers can work in: combustion engines, heating, ventilation and air conditioning (HVAC), cooling systems, refrigeration systems etc.

Thermal engineers are involved in the construction of commercial or industrial buildings. They create military and defense equipment, electronics and electrical components and systems. Common industries that regularly employ thermal engineers include power companies and the automotive industry and commercial construction. Thermal engineers generally spend most of their time working in an office but they often travel to the site of the current project. Job opportunities for a thermal engineer are very broad and promising.

from: https://en.wikipedia.org/wiki/Thermal_engineering

Task 2. Answer the questions.

1. What is thermal engineering?
2. Is it necessary for a thermal engineer to possess profound knowledge of thermodynamics?
3. What systems does a thermal engineer design?
4. What are some things thermal engineers should know about?
5. Why are thermal engineers in high demand?
6. What are the perspectives of thermal engineering?
7. What things would you like to improve in our live being a thermal engineer?

Task 3. Prepare a summary of the text (10–12 sentences).

Task 4. Match English and Russian equivalents:

heat transfer['hi:t 'trænsfɜ:]	оборудование
area ['e(ə)rɪə]	горение
advantage [ədˈvɑːntɪdʒ]	завод
source [sɔːs]	решение
combustion [kəm'bʌsʧ(ə)n]	преимущество
equipment [ɪˈkwɪpmənt]	область
solution [səˈluːʃ(ə)n]	источник
plant [plɑːnt]	теплопередача

Task 5. Match the words/word combinations with their definitions:

mechanical engineering	a person whose job involves designing and building engines, machines, roads, bridges, etc.
power plant	a chemical reaction between substances, usually accompanied by the generation of heat and light in the form of flame
thermodynamics	an industrial facility that generates electricity from primary energy
combustion	the study of how machines are designed, built and repaired
thermal engineering	the study of the relations between heat, work, temperature, and energy.
engineer	the branch of science and technology that studies electric currents in electronic equipment
electronics	a specialized sub-discipline that deals with the movement of heat energy and transfer

Task 6. Translate the characteristics of a successful engineer from English into Russian.

1. honesty **2.** curiosity **3.** lust for improving **4.** creativity and Innovation **5.** prioritising **6.** problem solving **7.** effective risk management	**8.** good soft skills including communication and leadership **9.** mathematical and analytical abilities plus logical thinking **10.** attention to details **11.** ability to embrace new technologies

Task 7. Fill in the table with the derivatives.

Noun	***Verb***	***Adjective***
		deep
		useful
production		
	classify	
combustion		
	remove	
	shorten	
reaction		
		simple
access		

Task 8. Use the correct form of the verb given in brackets.

1. Thermal engineers to use their expertise in the principles of thermodynamics to design heating and cooling systems.
2. Experts in thermodynamics to be needed in many industries.
3. Where energy to be converted, there is often waste heat.
4. Heat to be transferred from the object at higher temperature to the object at lower temperature.
5. The generator to convert the turbine's mechanical energy into electricity.

Task 9. Unjumble the words (Model: iosl → soil):

opewr; metas; thea; eryegn; aernstrf; ntalp; tmehlar.

4.2. THERMAL POWER PLANT

thermal power plant ['θɜ:m(ə)l 'pauə] plɑ:nt] – тепловая электростанция (ТЭС)	power demand ['pauə dɪ'mɑ:nd] – потребность в электроэнергии
environmental [ɪn'vaɪ(ə)rən'mentl] – относящийся к окружающей среде	environmental standards – экологические нормативы
outlet ['autlet] – выходное (выпускное) отверстие	Rankine cycle ['ræŋkin 'saɪk(ə)l] – цикл Рэнкина
to supply [sə'plaɪ] – подводить (электрическую энергию / давление)	high-capacity ['haɪ kə'pæsɪtɪ] – большой мощности, высокомощный
coal [kəul] – уголь	turbine ['tɜːbaɪn] – турбина
pressure ['preʃə] – давление	voltage ['vəultɪʤ] – напряжение
temperature ['temp(ə)rəʧə] – температура	intermediate [ˌɪntəˈmiːdiət] – средний, промежуточный
precipitator [prɪ'sɪpɪteɪtə] – пылеуловитель	to pulverize ['pʌlvəraɪz] – превращать в порошок

Task 1. Read the text.

Thermal power plants help meet almost half of the world's power demand. They use water as the working fluid. Today's thermal power plants are capable to run under green efficiency by conforming to stringent environmental standards.

Let's find out how a coal-based thermal power plant achieves this in a detailed step-by-step manner.

By turning the shaft of this generator we will be able to generate electricity. In order to turn steam turbine, you have to supply high pressure and high temperature steam at the inlet of the turbine. As the turbine absorbs energy from the high-energy fluid its pressure and temperature drop toward the outlet.

Let’s take a closer look at the uniquely shaped steam turbine rotor blades. High capacity power plants often use different stages of steam turbines such as high pressure turbines, intermediate pressure turbines and low pressure turbines. So now, after producing electricity from the generator, we have met our objective. If we can bring the low pressure and low temperature steam back to their original states which were of a much higher pressure and temperature we can repeat the process.

The first step is to raise the pressure. You can use a compressor for this purpose. But compressing steam is a highly energy intensive process and such a power plant will not be efficient at all. An easy way is to convert the steam into liquid and boost the pressure. For this purpose we’ll introduce condenser heat exchangers which sit beneath the low pressure turbine. In the condenser a stream of cold water flows through the tubes. The steam rejects heat to this liquid stream and becomes condensed. Now we can use the pump to increase the pressure of this feed water. Typically multistage pumping is used for this purpose. That way the pressure will revert to its original state. The next task is to bring the temperature back to its original value.

For this purpose heat is added to the exit of the pump with the help of a boiler. High capacity power plants generally use the type of boiler called a “water tube boiler”. Pulverized coal is then burnt inside the boiler. The incoming water initially passes through any economizer session. Here the water will capture energy from the flue gas. The water flows straight the down-comer and then through the water walls, where it transforms into steam. The pure steam is separated at a steam drum. Now the working fluid is back to its original state: high pressure and high temperature. This steam can be fed back into the steam turbine and the cycle can be repeated over and over again for continuous power production.

But a power plant working on this basic Rankine cycle will have a very low efficiency and a low capacity. We can increase the performance of the power plant considerably with the help of a few simple techniques.

In case of super heating even after the liquid has been converted into steam even more heat is added. And with that the steam becomes super-heated. The higher the temperature of the steam, the more efficient the cycle. Just remember the Carnot’s theorem of maximum thermal efficiency possible. But the steam turbine material will not withstand temperatures of more than 600 °C. So super heating is limited to the threshold. The temperature of the steam decreases as it flows along the rows of the blade. Consequently a good way to increase the efficiency of the power plant is to add more heat after the first turbine stage. This is known as reheating and it will increase the temperature of the steam again leading to a high power output and greater efficiency.

The low pressure sides of the power plant are prone to suck the atmospheric air even with sophisticated ceiling arrangements. The dissolved gases in the feed water will spoil the boiler material over time. To remove these dissolved gases an open feed water heater is introduced. Hot steam from the turbine is mixed into the feed water. Steam bubbles so generated will absorb the dissolved gases. The mixing also preheats the feed water which helps improve the efficiency of the power plant to an even greater extent. All these techniques make the modern power plant work under an efficiency range of 40–45%.

Now we’ll take a look at how heat addition and heat rejection are executed in an actual power plant. The cold liquid is supplied at the condenser with the help of a cooling tower. The heated up water from the condenser outlet is sprayed in the cooling tower which induces a natural air draft and the sprayed water loses heat. This is how a colder liquid is always provided at the condenser inlet. At a heat addition side the burning coal produces many pollutants.

We cannot release these pollutants directly into the atmosphere. So before transferring them to a stack the exhaust gases are cleaned in an electro static precipitator. The ESP uses plates with high voltage static electricity to absorb the pollutant particles.

Task 2. Answer the questions.

1. What is a thermal power plant?
2. How is electricity generated at a power plant?
3. What is the function of a condenser?
4. How does steam become superheated?
5. What temperatures can the steam turbine material withstand?

Task 3. Prepare a summary of the text (10–12 sentences).

Task 4. Match English and Russian equivalents:

intermediate pressure turbine	цель, замысел
pulverized coal	как следствие
purpose	турбина среднего давления
to separate	усложнять
to sophisticate	растирать, тонко измельчать
(to pulverize)	отделять
consequently	угольный порошок

Task 5. Put down the transcribed words:

[kə'pæsɪtɪ] –	['ækʧuəl] –	[θru:] –	[fləu] –
[hi:t] –	['bʌb(ə)l] –	['ækʧuəl] –	[ɪŋk'ri:s] –
['səulə] –	[drɑ:ft] –	[rɪ'ʤekʃ(ə)n] –	[pə'lu:t(ə)nt] –
[spreɪ] –	['næʧ(ə)rəl] –	['preʃə] –	['selsɪəs] –
[sə'plaɪ] –	[eə] –	['si:lɪŋ] –	[bɪ'ni:θ] –
['pɜ:pəs] –	[ˈsep(ə)rət] –	[sə'fɪstɪkeɪt] –	['kɔnsɪkwəntlɪ] –

Task 6. Match:

a) the synonyms

purpose	give
produce	build up
provide	take off
increase	blaze
remove	aim
burn	dematerialize
dissolve	enhance
improve	make

b) the antonyms

remove	decrease
produce	extinguish
dissolve	worsen
fall	consume
increase	rise
emerge	insert
improve	disappear
burn	condense

Task 7. Make up sentences using the following words.

1. disrupted/ the/ town's/ supply/ power/ the / storm.
2. many/ produces/ pollutants/ the/ coal/ burning.
3. property / of / charge/ a/ matter/ electric/ is.
4. electricity/ is/ what/ of/ example/ an/ static ?

Task 8. Unjumble the words (Model: tenaub→butane):

ltupolan; burtine; wproe; cficyfiene; emtsa; eolvatg.

Task 9. Put down:

THREE THINGS I HAVE LEARNED:
TWO THINGS I FOUND INTERESTING:
ONE QUESTION I HAVE (i.e. one thing I would like to know):

4.3. NATURAL GAS POWER PLANT

environment [ɪn'vaɪ(ə)rənmənt] – окружающая среда	consumption [kən'sʌmpʃ(ə)n] – потребление
natural ['næʧ(ə)rəl] – природный	current ['kʌrənt] – ток
exhaust heat [ɪg'zɔ:sthi:t] – тепло отработанных газов	combined [kəm'baɪnd] – комбинированный, смешанный
greenhouse warming ['wɔ:mɪŋ] – потепление, вызванное парниковым эффектом	supply [sə'plaɪ] – поставлять, снабжать, удовлетворять (нужду)
efficient [ɪ'fɪʃ(ə)nt] – эффективный efficiency [ɪ'fɪʃ(ə)nsɪ] – эффективность	in comparison [kəm'pærɪs(ə)n] – по сравнению
carbon dioxide ['kɑ:bən daɪ'ɔksaɪd] – двуокись углерода/углекислый газ	cycle ['saɪk(ə)l] – цикл turbine ['tɜːbaɪn] – турбина
affordability [əˌfɔːdə'bɪlɪtɪ] – доступность	renewables [rɪˈnjuːəblz] – возобновляемые источники энергии
combined cycle power plant – электростанция с комбинированным циклом	simple cycle gas turbine – газотурбинный двигатель простого цикла

Task 1. Read the text.

Many people use natural gas for heating their homes and cooking their food. Gas also produces electricity and the natural gas consumption is expected to grow because natural gas has become the number one choice for large new power plants in many countries of the world. Let’s find out how these natural gas power plants work.

They work much like the spinning turbine of a powerful jet engine. Burning natural gas at the power plant heats up the air needed to spin the hundreds of propeller-like blades in the turbine. The turbine is connected by a shaft to a generator that makes electric current. By spinning magnets through a wider coil it converts the mechanical energy at the turbine into electricity. That’s why it’s called a generator. This type of power plant is called a *simple cycle gas turbine* because it is really rather simple. There is only one turbine and one generator.

There is also a second type of natural gas power plant called a *combined cycle power plant*. It combines a gas turbine and a steam turbine used in a coal power plant. But instead of using coal or even more gas to create steam a combined cycle power plant uses the exhaust heat from the gas turbine to turn water into steam. The steam then drives a second turbine which spins the second generator producing even more electricity. This two-step combined cycle process is highly efficient converting as much as 50% of the energy contained in natural gas into electricity. In comparison coal fired steam turbines are only about 33% efficient. And this is one of main reasons why gas fired power plants are better for the environment.

Natural gas starts out with a lower carbon content than coal and with more efficient plants it can produce electricity with about 60% less carbon dioxide than coal fired power plants. Also natural gas power plants do not release many of toxic substances like mercury that comes from burning coal. Modern natural gas power plants can start operating in just 15 minutes that makes them ideal for backing up renewables since they can switch on and off faster than most other conventional plants and partner with wind and solar energy as the wind changes or clouds move across the sky.

Besides helping with the environment natural gas power plants also make financial sense. According to the Energy Information Administration when you consider the construction and fuel costs natural gas power plants are the cheapest kind of new power generation you can build right now. So, from efficiency to affordability to helping the environment it’s easy to see why natural gas is playing a bigger role in supplying our electricity needs.

Task 2. Find the synonyms of the verbs in the text:

to harness – … ;	to rotate – … ;	to construct – … ;
to let out – … ;	to turn into – … ;	to transform – … .

Task 3. Answer the questions.

1. Why is natural gas used for heating?
2. What is a turbine connected to?
3. What types of natural gas power plant can you name?
4. Does natural gas produce less CO_2/kWh comparing to coal?
5. How can we avoid natural gas leaks?
6. What are the pros and cons of natural gas power plants?

Task 4. Do you agree or disagree with the information given in the passage below? Give reasons for your answer.

Burning natural gas produces less CO_2/kWh compared to coal. However, studies show that 3,7% of the natural gas leaks into the atmosphere and natural gas (mainly methane) is 80% more powerful in terms of greenhouse warming potential compared to CO_2. Besides this gas needs to be compressed for transportation which takes extra energy and the gas exploration process (often fracking) is environmentally damaging. Making a long story short: gas power plants are not always the best idea.

Task 5. Match the word with its definition.

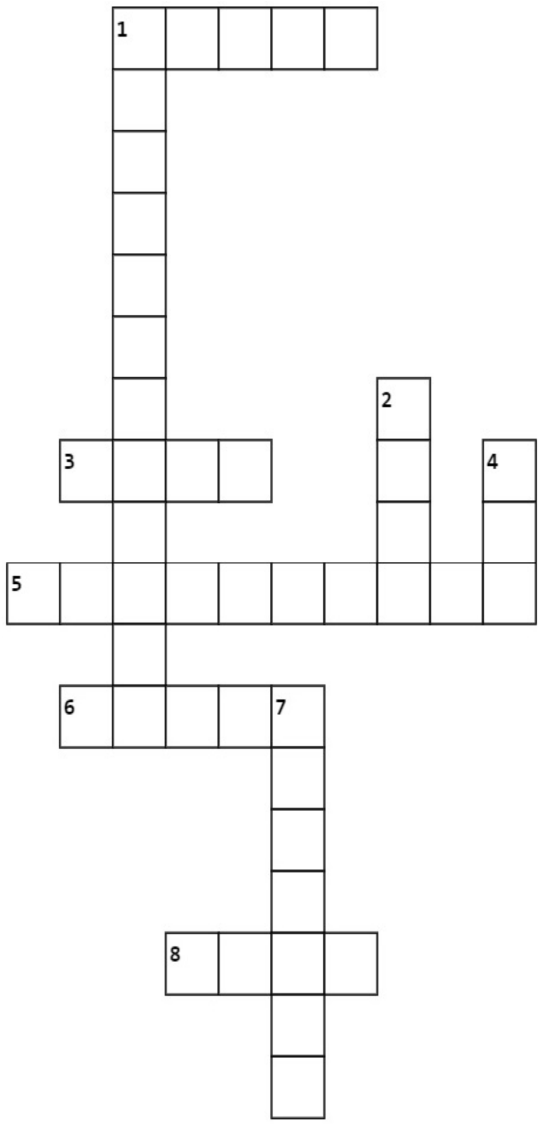
turbine	a chemical element; a poisonous silver liquid metal, used in thermometers
methane	the conditions in which a person, animal or plant lives or operates or in which an activity takes place
power plant	a gas without colour or smell, that burns easily and is used as fuel. Natural gas consists mainly of it.
steam	a machine or part of a machine that produces continuous turning power from a fast-moving flow of a liquid or gas, using a set of vanes attached to a wheel or rotor

environment	a building or group of buildings where electricity is produced
mercury	the hot gas that water changes into when it boils

Task 6. Fill in the crossword.

Across

1. grey or white mass that floats in the sky, made of very small drops of water.
3. air that moves quickly as a result of natural forces.
5. types of energy that can be replaced naturally such as energy produced from wind or water.
6. a factory or place where power is produced or an industrial process takes place.
8. to turn round and round quickly; to make something do this.



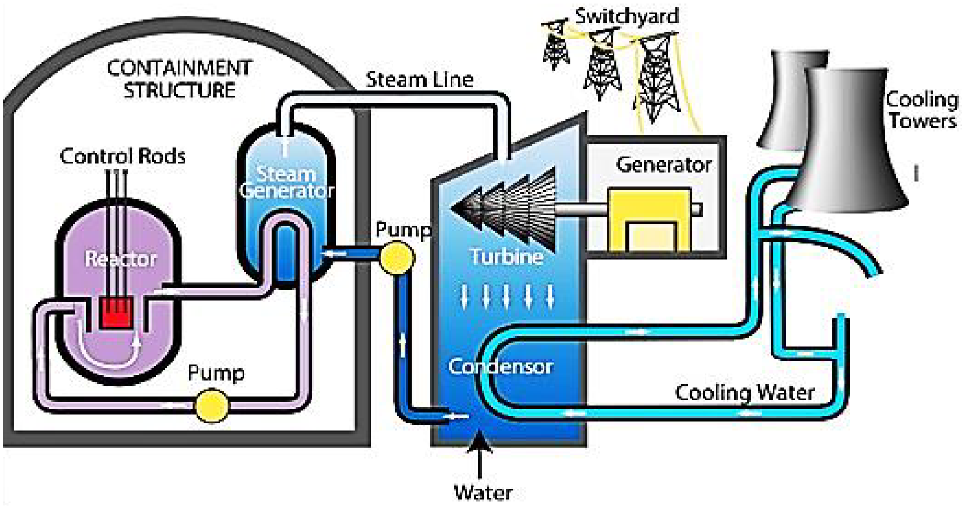
Down

1. tending to follow what is done or considered acceptable by society in general; normal and ordinary, and perhaps not very interesting.
2. a hard black mineral that is found below the ground and burnt to produce heat.
4. any substance like air that is neither a solid nor a liquid, for example.
7. a machine or part of a machine that produces continuous turning power from a fast-moving flow of a liquid or gas, using a set of vanes attached to a wheel or rotor.

4.4. NUCLEAR POWER PLANT

containment [kən'teɪnmənt] – защитная оболочка (ядерного реактора)	nuclear fission [ˌnjuːkliə ˈfɪʃn] – распад атомного ядра
calandria [kə'lændriə] – каландр	watt (W) [wɔt] – ватт (Вт)
approximately [ə'prɔksɪmɪtlɪ] – приблизительно	proceed [prə'si:d] – продолжиться, произойти
uranium [juə'reinjəm] – уран	allow [ə'lau] – позволять, разрешать
heavy water ['hevɪ 'wɔ:tə] – тяжелая вода	ensure [ɪn'ʃuə] – обеспечивать, гарантировать
deuterium [dju(:)'tɪərɪəm] – дейтерий	due to ['dju:tə] – в связи с
average ['æv(ə)rɪʤ] – средний	to house [haus] – размещать
operable ['ɔp(ə)rəb(ə)l] – действующий	moderator ['mɔdəreɪtə] – замедлитель

Task 1. Read the text.



A nuclear power plant is a thermal power station which generates electrical energy from heat. Basically, it is a factory for making much electricity enough to power a city of around 2 mln people. Nuclear energy is the world's second largest low-carbon source of electricity. Approximately 10% of the global electricity is generated by nuclear reactors. As of September 2022 there are 440 operable power reactors in the world with a combined electrical capacity of 390 gigawatts (GWs).

By far the largest nuclear electricity producers were the United States with 91.5 GWs in 2021. [https://www.power-technology.com/analysis/top-ten-nuclear-energy-producing-countries/]

The nuclear power plant consists of numerous buildings and facilities.

Let's consider the most important ones. The containment building is the building where the nuclear reactor is housed. It is made of two-meter-thick reinforced concrete. Inside the containment building there is a large tank called calandria which is the heart of the nuclear reactors. This is the turbine generator building housing the turbine and generator. This is the controlling building for monitoring and controlling the nuclear reactors. The fuel is naturally occurring uranium processed into small pellets and then the pellets are sealed into metal tubes which are welded to form a fuel bundle.

The fuel bundles are then inserted in a calandria. Typically more than 200 of these rods are bundled together to form a fuel assembly. A reactor core is typically made up of a couple of hundred assemblies in order to allow nuclear fission to proceed in a controlled manner of a rod.

The control rod can be moved up and down the fission rate of uranium. The nuclear power plant produces electricity using the heat that comes from splitting uranium atoms in a process called nuclear fission. Nuclear fission is a nuclear radioactive decay process in which the hitting neutrons on the uranium atoms then the uranium atoms split into two releasing 3 neutrons. Each process releases 2 uranium atoms and 3 neutrons. A chain reaction of atom splitting ensures that there is a constant source of heat meaning that it generates lots of heat.

This heat is used to convert electricity. The calandria vessel is a cylindrical vessel housing numerous of lattice tubes which are filled with the heavy water moderator that flows around the fuel bundles. Heavy water is found in all water, rivers and oceans. On average one out of every thousand drops of water is heavy water. It is 10% heavier than ordinary water because it incorporates a heavy form of hydrogen called deuterium.

During the nuclear fission process the heavy water flows around the fuel bundles. A chain reaction releases tremendous amount of heat into the heavy water. Then the heated heavy water flows through a closed loop system that is pumped through the reactor to a set of the steam generator where it transfers the heat to ordinary water. When that water boils it turns into steam.

The steam is transported at high pressure through pipes to a large turbine where it pushes the blade and turns a shaft connected to a rotor in the generator causing the rotor to spin. The spinning rotor is a large electromagnet producing rotating magnetic fields. Due to this process electricity is generated. Then it is transferred to the transmission line.

Task 2. Answer the questions.

1. How can electricity be produced from heat?
2. How can nuclear power be obtained?
3. What are the main dangers of nuclear power?
4. What are the advantages of nuclear power?
5. Where is nuclear energy used the most?
6. Is nuclear power reliable and cost-effective?
7. What country is one of the largest nuclear electricity producers?

Task 3. Read the statements and decide whether they are true or false.

a) Nuclear power generation causes one of the lowest levels of fatalities per unit of energy generated compared to other energy sources.

b) Nuclear power plants emit no greenhouse gases.

c) When a neutron hits the nucleus of a uranium-235 or plutonium atom, it can split the nucleus into two smaller nuclei, which is a nuclear fission reaction.

d) Nuclear power plants are thermal power stations that generate electricity by harnessing the thermal energy released from nuclear fission.

e) Protons, electrons and neutrons constitute the nuclei of atoms.

f) The free proton (a proton not bound to nucleons or electrons) is a stable particle.

g) The task of scientists is to use atomic energy for peaceful purposes.

Task 4. Make up sentences.

1. the/power plant / the/ nuclear/ 1950s/ was/ built/ first/ in.
2. is/ nuclear power/ nuclear/ reactions/ to/ electricity/ the use of/ produce.
3. to/ used/ electricity/ is/ generate/ heat.
4. during/ occurred/ the/ a/ accident/ test/ safety.
5. steam / turns/ water/ boils/ it/ into/ when.
6. to close/ the/ decided/ has/ the plant/ committee /.

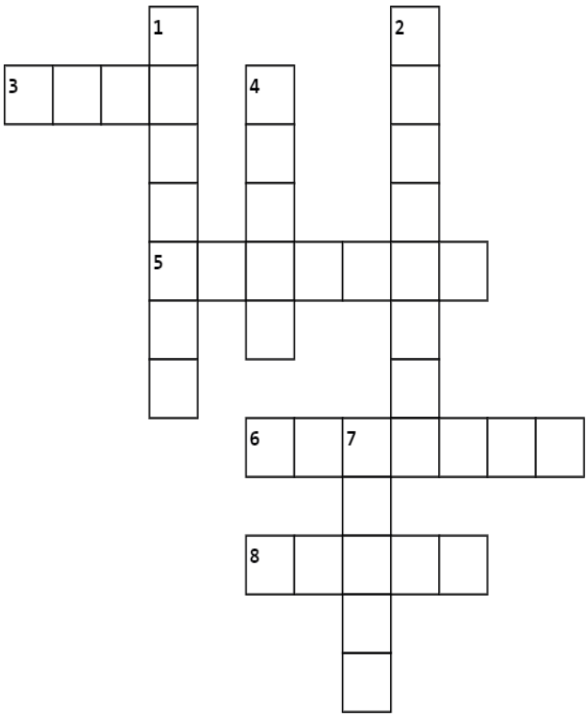
Task 5. Fill in the crossword.

Across

3. a tube through which liquids and gases can flow.
5. a large structure used to produce nuclear energy.
6. a chemical element. It is a heavy, silver-white, radioactive metal, used mainly in producing nuclear energy.
8. To divide, or to make something divide, into two or more parts.

Down

1. a very small piece of matter that carries no electric charge and that forms part of the nucleus of an atom.
2. a chemical element. A gas that is the lightest of all the elements. It combines with oxygen to form water.
4. the process or result of being destroyed by natural causes or by not being cared for.
7. to let somebody/something do something; to let something happen or be done.



Task 6. Translate the sentences from English into Russian.

1. The designers of that particular reactor had intentionally designed it so that you would vent the hydrogen outside of the containment building.
2. A new steel structure was built under the containment shield to support the decaying concrete sarcophagus in Chernobyl's reactor number four.
3. The company has been investing in a new plant and equipment.
4. The reactor converts the nuclear energy to heat.
5. Apparently, only industrialized countries need nuclear power.

Task 7. Match the equivalents:

containment building	цепная реакция
containment	технические требования
water moderator	оболочка реакторного бака
chain reaction	герметичная оболочка; защитная оболочка
technical requirements	водяной замедлитель
calandria vessel	колпак реактора; здание защитной оболочки ядерного реактора

4.5. Coal-Fired Power Plant

stacker ['stækə] – отвалообразователь угля	deaerator [diːəˈreɪtə] – деаэратор water-tube boiler – водотрубный котёл
silo ['saɪləu] – траншея (шахта, яма) для хранения запаса угля	feed water pump ['fi:d'wɔ:təpʌmp] – насос подачи воды
coalpulverizer [kəul 'pʌlvəraɪzə] – углеразмольная мельница	draft fan [drɑ:ft] [fæn] – дымосос

boiler ['bɔɪlə] – котел to require [rɪ'kwaɪə] – требовать to deliver [dɪ'lɪvə] – доставлять	storage area ['stɔ:rɪʤ 'e(ə)rɪə] – площадка для складирования и хранения
coal yard [kəul jɑ:d] – угольный склад	pneumatically [nju:'mætɪk(ə)lɪ] – пневматически

Task 1. Read the explanation of an expert in thermal engineering and answer the questions:

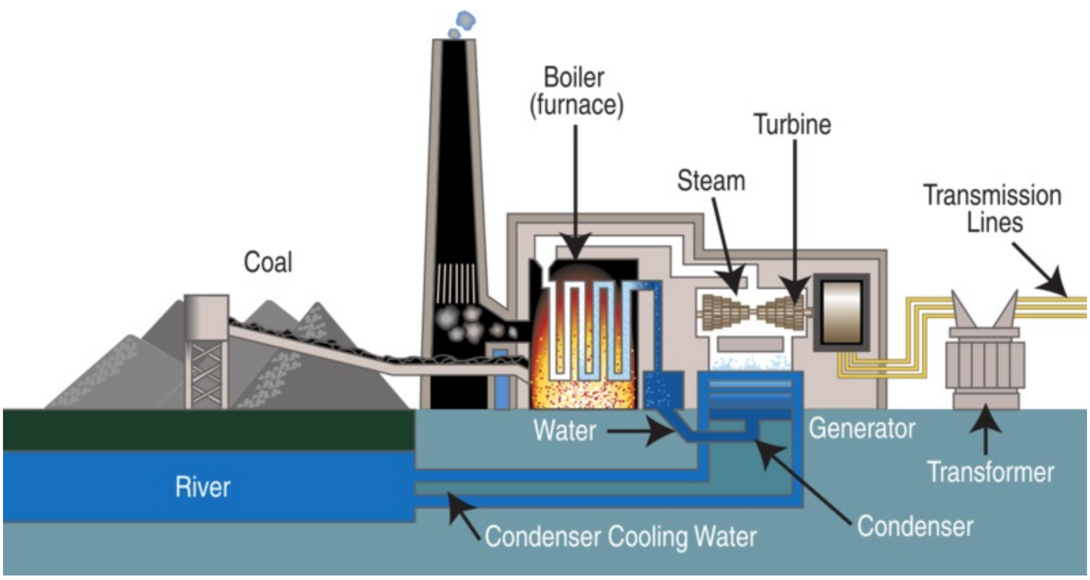
1. What are the systems that make up the coal-fired power station?

2. How do they work together? (give an example of how these systems work together to produce electricity and explain the principles of their working).

3. What major systems do we need for a coal-fired power station to function correctly?

4. What differs major systems from minor ones?

5. How is coal delivered to the power station?



When we build a coal-fired power station, the first thing we need is coal. The idea is that we burn fuel to release chemical energy that we can use to heat up water and create steam. Coal can be delivered by a ship. It can also be delivered by highway truck, rail, barge or coal slurry pipeline. In the beginning the coal must be unloaded from the ship.

And then we use a stacker to stack the coal up in a coal yard or perhaps a coal dome or generally just a storage area. Now, we're going to store thousands of tons of coal in this area. The coal yard or the storage area needs to be organized. We do not use up more space than we actually require. And that essentially means that whereas we drop the coal off before into the coal yard, we're now going to pick the coal up again and start feeding it towards the power station. The reason we have a coal yard in the first place is because sometimes we may not be able to get deliveries through to the power station. So, we will store a lot of coal, sometimes enough for three or four months and we'll gradually feed coal to the power station without worrying to run out of coal.

After we've reclaimed some of the coal from the coal yard, we'll send it to a silo, often termed a day silo and we'll feed the coal from the day silo to a coal pulverizer. The idea of the pulverizer is that we can pulverize the coal in order to get very fine coal dust. Inside the pulverizer, we're also going to dry the coal out using air, cooled primary air from a draft fan. We're going to take this air from a pre-heater so that the air is quite hot and then we'll force it into the pulverizer and as the coal is ground up into small molecules, we'll also dry it out using this air because it's going get blown into the boiler along with the coal.

So, we've got our coal dust leaving the pulverizer, it's been blown pneumatically from the pulverizer to the boiler. When we get to the boiler, we're going to ignite that coal and we're going to get combustion. So, that is our fuel system.

We may also use oil to fire the boiler, at least initially, or natural gas which is predominantly methane gas. It all depends on the design of the boiler itself. The type of the boiler we're using is a water tube boiler. Whenever you need a lot of steam at very high pressures, you're going to be using a water tube boiler.

Steam turbines require steam at very high pressures and that's why we use water tube boilers but water tube boilers also generate a lot of steam. They're very large. They can be greater than 40, 50, 60 meters in height. And these are the boilers that power stations in the power generation industry always use.

So, let's have a look at our water circuit now because it's water that gets fed to the boiler in order to generate steam. We've got a makeup water inlet. Makeup water feeds to a deaerator. We are essentially talking about the water that's added to the system and then treated before it becomes boiler feedwater. You can't just take water from a city grid or from a lake or a river and put it into a water tube boiler, that's not going to work. You're going to have a lot of corrosion and a lot of problems. This makeup water has to be treated, chemically and mechanically and we do that quite often in a deaerator. The deaerator is going to reduce the oxygen content and the CO_2 content of the water and before the water gets to the deaerator, it's going to be filtered to take out those particles that might be floating around in the water.

Then we'll go to a boiler feedwater pump. This is usually a multi-stage centrifugal pump. And we will increase the pressure of our boiler feedwaterand send it to our water tube boiler. The pressures involved here are actually quite high. You're looking at in excess of 200 bar which is in excess of around 3,000 psi. The water will be pumped to an economizer where we'll preheat the water a little bit before we send it to the main body of the water tube boiler. The economizer is a nice way of preheating the water before we send it into the main part of the boiler to really start heating it up a lot more. We don't want to feed cold water into the main part of the boiler or the furnace as we call it because if we do that then we will thermal shock the boiler and that could mean that we have cracked pipes etc.

We'll preheat it by sending it to the economizer. We'll then send the water around to the furnace and we'll put the water into the water tube boiler walls. They're called walls because the piping around the furnace makes up a square space similar to having four separate walls. This means we can get a lot of heat transfer, mostly via radiation to the furnace walls and then this heat is going to be absorbed via conduction into the water and our water is going to change to steam. We have different types of steam. We have wet steam and we have dry steam, superheated steam etc. But when we talk about wet and dry steam, we're referring to steam having water molecules in it or not. If the steam is totally dry then it will have no water molecules in it.

Steam is a colorless and odorless gas. And by the time this steam vapor has reached our steam drum which is at the top of the boiler, we're going to have wet steam. It's not going to be completely dry yet, there are particles of moisture in the steam. That is what we see normally when we think about steam. In the steam drum we will begin to separate that moisture from the steam, sometimes using steam separators or steam cyclones, sometimes using arrangement of baffles or a combination of both.

We'll then send our steam to a super heater where we will really heat that steam up and although we get a slight pressure drop, we're going to add more and more heat and the temperature of the steam is going to increase. We will then feed that steam from our super heaters into a high pressure turbine. As the steam passes through the turbine, it causes the turbine runner to rotate. So, we've taken the chemical energy of the fuel, turned it into heat, we've heated up the water. We've created high-pressure steam, we've fed it to a turbine and now we are converting that heat energy or heat into mechanical movement or kinetic energy.

Task 2. Change the sentences into those ones typical of instructions, dry and precise. E.g. When we build a coal-fired power station, the first thing we need is coal. → First of all coal is needed to build a coal-fired power station.

1. It's not going to be completely dry yet, there are particles of moisture in the steam.

2. We have different types of steam.

3. We don't want to feed cold water into the main part of the boiler or the furnace.

4. We're going to have wet steam.

5. The deaerator is going to reduce the oxygen content and the CO_2.

6. You're going to have a lot of corrosion and a lot of problems.

Task 3. Make up the sentences using the words and word-combinations below.

1. a / designed/ are/ to convert/ vapour/ liquid/ to/ boilers.
2. converted/ combustion/ is/ steam/ by the application of/ water/ under pressure/ into.
3. such as/ and air compressors/ steam engineers/ boilers/ equipment/ operate and maintain.
4. burns/ electricity/ a coal-fired power station/ a/ which/ coal/ to generate/ thermal power station/ is.
5. electric power/ coal/ used/ as/ fuel/ is/ to generate.

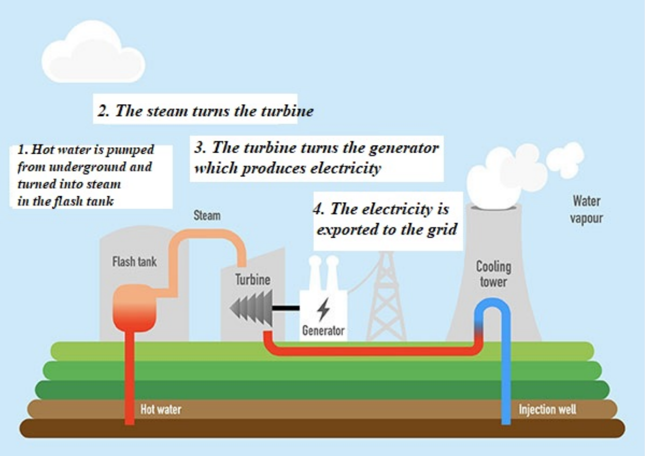
4.6. GEOTHERMAL POWER PLANT

geothermal ['ʤi:ə(u)'θɜ:m(ə)l] – геотермальный	crystallizer ['krɪstəlaɪzə] – кристал-лизатор
reservoir ['rezəvwɑ:] – резервуар	pressure ['preʃə] – давление
renewable [rɪ'nju:əb(ə)l] – возобновляемый	wellhead separator ['welhed 'sepəreɪtə] – устьевой сепаратор
to reduce [rɪ'dju:s] – уменьшать	to lessen – уменьшать

to vaporize ['veɪpəraɪz] – испаряться	shaft [ʃɑ:ft] – вал
surface['sɜ:fɪs] – поверхность	to consider [kən'sɪdə] – рассматривать
impact ['ɪmpækt] – воздействие	to flash into steam – обратиться в пар

Task 1. Translate the text from English into Russian in writing.

Geothermal energy gives us a steady supply of electrical power with minimal environmental impact. Let's consider a basic process. Water in underground reservoirs is heated to high temperatures by magma.



Production wells drilled up to 10,000 feet below the earth's surface, tap into this hot fluid. Under its own pressure the fluid flows through these wells toward the surface. As it travels the pressure lessens causing a small amount to become steam. Together the hot fluid and steam move through a surface pipeline to a wellhead separator where the pressure is reduced. Here most of the fluid vaporizes and flashes into high-pressure steam.

Any fluid not flashed into steam moves to a standard pressure crystallizer to produce standard pressure steam. Remaining fluid is then flashed at a lower pressure to create low-pressure steam. All steam created in the plant is sent to a turbine on site. The force of the steam spins the turbines' blades which turns the shaft connected to an electrical generator. An electrical charge is created and directed to a transformer where the voltage is increased and sent down power lines. Any fluids not flashed into steam return to the underground reservoir where in time they will be reheated and reused. Geothermal energy is a simple, clean and renewable energy source.

Task 2. Answer the following questions.

1. What is geothermal energy?
2. How deep are production wells drilled?
3. Why does the fluid flow through these wells?
4. What do the hot fluid and steam move through?
5. What spins the turbines’ blades?
6. What are the advantages and disadvantages of geothermal energy?

Task 3. Match the synonyms:

to tap into	to reduce
to use	to furnish
to connect	to harness
to turn off	to use
to lessen	to link
to provide	to switch off

Task 4. Make up sentences using the words given below.

1. heat/ within / geothermal energy/generated/ the Earth/ is/ that/ is.
2. the surface/ flows/ the Earth’s/ internal/ thermal/ energy/ to.
3. this/ thermal/ energy/ is/ stored/ in / rocks?
4. power/geothermal/ gives us/ of electrical/ supply/ energy/ a steady/.
5. or due to/ steam/ boiling/ occur/ may/ due to/ evaporation/.

Task 5. Unjumble the words (*Model: iosl→soil)****:***

woper; metas; thea; eryegn; aernstrf; ntalp; tmehlar.

Task 6. Read the sentences and make up questions.

1. Geothermal energy gives us a steady supply of electrical power. (General Question).

2. All steam created in the plant is sent to a turbine on site. (Special Question).

3. The force of the steam spins the turbines' blades which turns the shaft connected to an electrical generator. (Disjunctive Question).

4. Geothermal energy is clean. (Alternative Question).

Task 7. Specify the features of:

a) fuel system;

b) water system;

c) steam system;

d) electrical system;

e) exhaust gas system.

Task 8. Check yourself 3. Choose the right variant.

1. This power plant uses the world's second largest low-carbon source of electricity:

a) Natural Gas Power Plant;

b) Nuclear Power Plant;

c) Coal-Fired Power Plant;

d) Geothermal Power Plant.

2. This power plant has got a minimal environmental impact:

a) Natural Gas Power Plant;

b) Nuclear Power Plant;

c) Coal-Fired Power Plant;

d) Geothermal Power Plant.

3. This power plant can produce electricity with about 60 % less carbon dioxide than Coal-Fired Power Plant:

a) Natural Gas Power Plant;
b) Nuclear Power Plant;
c) Coal-Fired Power Plant;
d) Geothermal Power Plant.

4. Fuel for this plant can be delivered by trucks, rails, ships:

a) Natural Gas Power Plant;
b) Nuclear Power Plant;
c) Coal-Fired Power Plant;
d) Geothermal Power Plant.

Task 9. Translate from Russian into English:

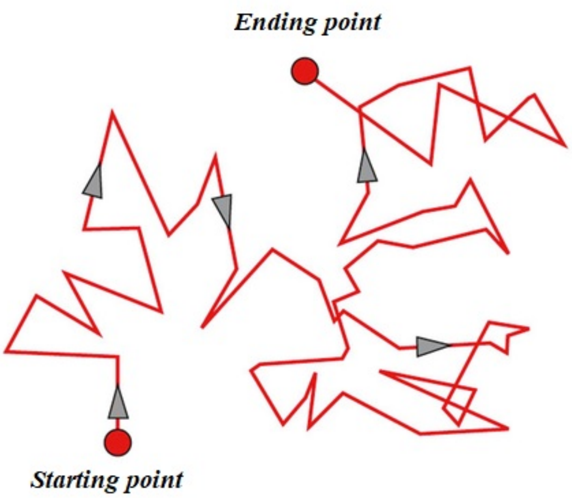
поглощать, тепло, преобразовывать, пар, фотоэлектрическая батарея, турбина, выхлоп, печь, окружающая среда, вращаться, уголь, ядерный реактор, расщеплять, хранить, распылять, вал, возобновляемый, распад.

UNIT 5
STUDYING BASIC LAWS

5.1. BROWNIAN MOTION

Brownian motion ['braʊniən ˈməʊʃn] – броуновское движение	available [əˈveɪləbl] – имеющийся в наличии, доступный
to exist [ɪg'zɪst] – существовать	to spread [spred] – распространяться
to surround [sə'raund] – окружать	to appear [əˈpɪə(r)] – появляться
particle [ˈpɑːtɪkl] – частица	mould [məʊld] – форма, шаблон
definite [ˈdefɪnət] – определенный	continually [kənˈtɪnjuəli] – постоянно
to vibrate [vaɪˈbreɪt] – вибрировать	to cause [kɔːz] – вызывать, быть причиной, обусловливать
to view [vjuː] – визуально наблюдать (в данном контексте)	to occur [əˈkɜː(r)] – случаться, возникать, происходить
instead [ɪn'sted] – вместо	to behave [bɪˈheɪv] – вести себя

Task 1. Read the text.



Water can exist in three different states: in the iceberg it's a solid, in the sea it's a liquid, in the surrounding air it's a gas. Solid, liquid and gas are the three states of matter. Solids, unlike liquid and gas, have a definite shape. A block of ice takes the shape of its mould; when it melts it changes. Water spreads out and fills up the container.

All liquids behave this way: they flow and find their own level. Gases spread out even more, filling any space available. The way solids, liquids and gases behave gives us clues about how their particles are arranged. In solids the particles are in a fixed framework. They are held close together and vibrate. In liquids the particles are still in contact but this time they are free to move around. The particles in a gas are far apart. They move quickly and randomly in any direction. But how do we know the particles in a gas behave this way?

Some of the evidence comes from looking at how smoke appears under a microscope. Let's do an experiment. First, let's burn a straw. Smoke from the straw is injected into a small container. A lid keeps it in place and a bright light enables it to be viewed under a microscope. It looks like tiny jittering points of light. When a straw burns the smoke produced is mostly bits of carbon which haven't combusted. Under a microscope they catch the light and appear to glimmer. But why do they randomly dance around?

The movement of the smoke is caused by collisions with invisible air particles. As the air particles move about they knock the smoke. Particles in a gas move randomly and quickly. Flowers produce pollen which is a very fine dust easily brushed off by a finger. Nearly 200 years ago it was this dust which first gave us clues about how particles behave in a liquid. In the 1820s the botanist Robert Brown was carrying out a study of pollen grains. He decided to crush the pollen and suspend the grains in water. But to his annoyance the pollen continually jittered around.

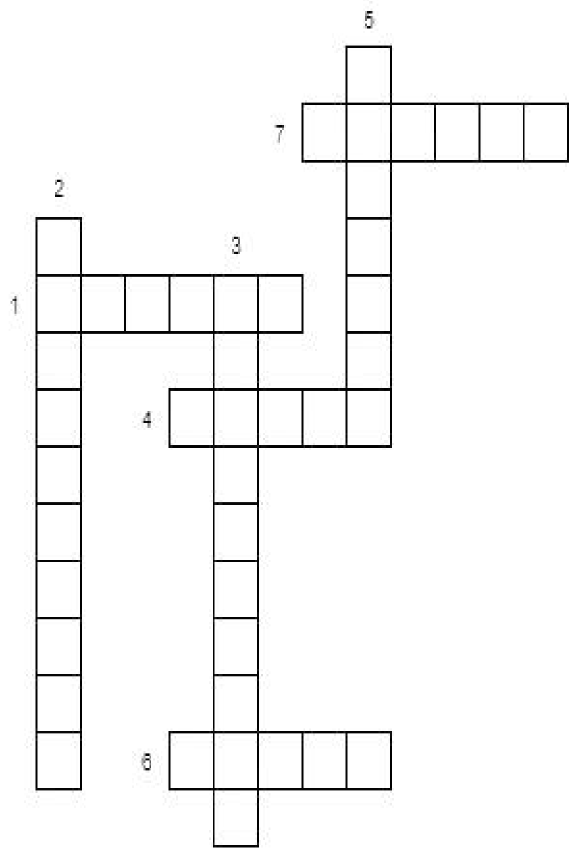
Today we can best see this effect by looking at tiny carbon particles instead. A drop of carbon powder suspended in oil is placed on the slide and viewed under a microscope. Just like the smoke the carbon is dancing around. Brown didn't know why this movement occurred. But we now believe it's caused by the motion of particles in the liquid. The carbon is being pushed around by collisions in the oil.

Task 2. Answer the questions.

1. What states can water exist in?
2. Why do solids, liquids and gases behave differently?
3. What is Robert Brown known for?
4. How is Brown's experiment carried out?
5. Why do we need to burn a straw when performing the experiment described in the text?
6. What is the name of the instrument used in scientific study for making very small things look larger so that you can examine them carefully?
7. How can you describe the motion of gas particles?
8. What is the cause of Brownian motion?

Task 3. Fill in the crossword.

1. to put a liquid or other substance into something using a syringe or similar instrument.
2. an instrument used in scientific study for making very small things look larger so that you can examine them carefully.
3. a chemical process in which substances combine with the oxygen in the air to produce heat and light.
4. the grey, white or black gas that is produced by something burning.
5. to move or make something move from side to side very quickly and with small movements.
6. a container that you pour a liquid or soft substance into, which then becomes solid in the same shape as the container, for example when it is cooled or cooked.
7. a substance that flows freely and is not a solid or a gas, for example water or oil.



Task 4. Form the nouns from the following verbs using suffixes:

to move – ; to collide – ; to exist – ; to arrange– ;

to contain – ; to examine – ; to inject – ;

to combine – ; to produce – ; to suspend – .

Task 5. Match the English and Russian equivalents:

solid	дым
powder	жидкий
framework	течь
produce	стучать, ударяться, натыкаться
motion	порошок
clue	структура
liquid	твердый
knock	производить
flow	ключ к разгадке, зацепка, намёк
smoke	движение

Task 6. Decide whether the following statements are true or false according to the text. Correct them if necessary.

1. Water can exist in two different states.
2. Liquid and gas have a definite shape.
3. Particles in a gas move randomly.
4. In solids the particles are not in a fixed framework.

Task 7. Unjumble the words (Model: utc→cut):

aocnbr; nbru; iluqdi; tuds; ilo; asuce; sepadr; udlom; werdpo.

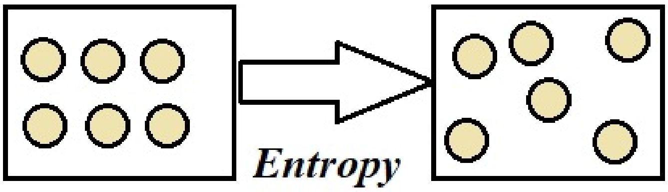
Task 8. Form sentences using the words given below. Model: sources/ new/ are/ scientists/ energy/ of/ finding → Scientists are finding new sources of energy.

1. flow/ all/ and/ own/ find/ level /liquids /their.
2. out/ fills/ container/ and/ water / up/ the/ spreads.
3. properties/ what/ of / are/ liquids/ physical (*a question*).

5.2. ENTROPY

entropy ['entrəpɪ] – энтропия	atomic [ə'tɔmɪk] – атомный
crucial ['kru:ʃ(ə)l] – принципиально важный	indivisible ['ɪndɪ'vɪzəb(ə)l] – невидимый
to puncture ['pʌŋkʧə] – проколоть	quanta ['kwɔntə] –кванты
to acquire [ə'kwaɪə] – приобретать	to assume [ə'sju:m] – предположить
probability ['prɔbə'bɪlɪtɪ] – вероятность	measurement ['meʒəmənt] – измерение
disorder [dɪs'ɔ:də] – беспорядок	spontaneous [spɔn'teɪnɪəs] – спонтанный

Task 1. Read the text.



There is a concept that is crucial to chemistry and physics. It helps explain why physical processes go one way and not the other: why ice melts, why cream spreads in coffee, why air leaks out of a punctured tire. It is entropy, and it is notoriously difficult to wrap our heads around. Entropy is often described as a measurement of disorder. That’s a convenient image, but it’s, unfortunately, misleading. For example, which is more disordered – a cup of crushed ice or a glass of room temperature water? Most people would say the ice, but that actually has lower entropy. So here’s another way of thinking about it through probability. This may be trickier to understand, but take the time to internalize it and you'll have a much better understanding of entropy.

Consider two small solids which are comprised of six atomic bonds each. In this model, the energy in each solid is stored in the bonds. Those can be thought of as simple containers which can hold indivisible units of energy known as quanta. The more energy a solid has, the hotter it is.

It turns out that there are numerous ways that the energy can be distributed in the two solids and still have the same total energy in each. Each of these options is called a microstate. For six quanta of energy in Solid A and two in Solid B, there are 9,702 microstates. Of course, there are other ways our eight quanta of energy can be arranged. For example, all of the energy could be in Solid A and none in B, or half in A and half in B. If we assume that each microstate is equally likely, we can see that some of the energy configurations have a higher probability of occurring than others. That’s due to their greater number of microstates.

Entropy is a direct measure of each energy configuration’s probability. What we see is that the energy configuration in which the energy is most spread out between the solids has the highest entropy. So, in a general sense, entropy can be thought of as a measurement of this energy spread. Low entropy means the energy is concentrated. High entropy means it’s spread out.

To see why entropy is useful for explaining spontaneous processes, like hot objects cooling down, we need to look at a dynamic system where the energy moves. In reality, energy doesn’t stay put. It continuously moves between neighboring bonds. As the energy moves, its configuration can change. Because of the distribution of microstates, there’s a 21% chance that the system will later be in the configuration in which the energy is maximally spread out, there’s a 13% chance that it will return to its starting point, and an 8 % chance that A will actually gain energy.

Again, we see that because there are more ways to have dispersed energy and high entropy than concentrated energy – the energy tends to spread out. That’s why if you put a hot object next to a cold one, the latter will warm up and the former will cool down. But even in that example, there is an 8% chance that the hot object would get hotter. Why doesn't this ever happen in real life? It's all about the size of the system. Our hypothetical solids only have six bonds each. Let's scale the solids up to 6,000 bonds and 8,000 units of energy, and again start the system with three-quarters of the energy in A and one-quarter in B. Now we find that chance of A, spontaneously acquiring more energy, is this tiny number.

Familiar, everyday objects have much more particles than this. The chance of a hot object in the real world to get hotter is absurdly small to ever happen. Ice melts, cream mixes in, and tires deflate because these states have more dispersed energy than the originals. There's no mysterious force nudging the system towards higher entropy. It's just that higher entropy is always statistically more likely. That's why entropy has been called time's arrow. If energy has the opportunity to spread out, it will.

Task 2. Answer the following questions.

1. What is a simple definition of entropy?
2. Can you give any examples of entropy in real life?
3. Why does a hot object become cooler?
4. How are entropy and temperature related?
5. How does entropy allow for life?
6. What factors affect entropy?
7. Why is entropy called time's arrow?
8. Does entropy increase as temperature increases?

Task 3. Match:

a) the synonyms of the verbs

to assist	to obtain
to fix	to act
to assemble	to manufacture

b) the antonyms of the verbs

to stay put	to increase
to reduce	to destroy
to shorten	to lend

to diminish	to keep away		to restore	to remove
to avoid	to get together		to gain	to extend
to acquire	to help		to remember	to lose
to produce	to decrease		to minimize	to forget
to behave	to repair		to borrow	to maximize

Task 4. Match:

a) the synonyms of the adjectives

large	acute
sharp	huge
small	distant
new	compact
remote	modern

b) the antonyms of the adjectives

wide	distant
heavy	concentrated
sharp	light
neighbouring	narrow
dispersed	blunt

5.3. LAWS OF THERMODYNAMICS

Task 1. Read the texts.

The First Law of Thermodynamics

law [lɔ:] – закон	explosion [ɪk'spləuʒ(ə)n] – взрыв
thermodynamics [ˌθɜːməʊdaɪ'næmɪks] – термодинамика	liquify ['likwɪfaɪ] – превращать в жидкость, разжижать
entropy ['entrəpɪ] – энтропия	residual [rɪ'zɪdjuəl] – остаточный
hydrogen ['haɪdrəʤ(ə)n] – водород	amount [ə'maunt] – количество
oxygen ['ɒksɪdʒən] – кислород	process ['prəuses] – процесс
chemical ['kemɪk(ə)l] – химический	solidify [sə'lɪdɪfaɪ] – превращать

degree [dɪ'gri:] – степень	в твёрдое тело, отвердевать
principle ['prɪnsɪp(ə)l] – принцип balloon [bə'lu:n] – воздушный шар	spontaneously [spɒn'teɪnɪəslɪ] – спонтанно
irreversible ['ɪrɪ'vɜ:səb(ə)l] – необратимый	fundamental ['fʌndə'mentl] – фундаментальный

Let's carry out a simple experiment. We have a balloon filled with hydrogen. It has a lot of chemical energy as hydrogen gas, when mixed with oxygen, it is a very potent fuel. By igniting the balloon, I add energy and set off a reaction between hydrogen and oxygen that releases a lot of energy in the form of heat. The conservation of energy is one of the fundamental principles of our universe. Simply put, in a closed system, no energy can ever be created or destroyed, it only transforms from one form to another.

The first law of thermodynamics takes this idea and modifies it for thermodynamic systems. It relates the internal energy of a system to the amount of heat added to the system and the amount of work done by the system. If we look at the explosion again with a thermal camera, we can see quite clearly how hot the explosion was. But the total amount of energy in the room is still the same as before the balloon has been blown up. It has just changed from chemical energy in the bonds to heat energy.

The Second Law of Thermodynamics

pour [pɔ:] – наливать	measure ['meʒə] – мера
generate ['ʤenəreɪt] – создавать	disorder [dɪs'ɔ:də] – беспорядок
significant [sɪg'nɪfɪkənt] – значительный	spontaneously [spɒn'teɪnɪəslɪ] – спонтанно
concept ['kɔnsept] –	statistically [stəˈtɪstɪkli] –

идея, концепция	статистически
arrow ['ærəu] – стрела	chaos ['keɪɔs] – хаос
expense [ɪk'spens] – трата, расход	puzzle ['pʌz(ə)l] – загадка
	spread [spred] – распространяться

The second law of thermodynamics states that the entropy, or disorder of a closed system, is always increasing. One way of thinking about entropy is a measure of disorder or chaos in the universe. The more entropy we generate, the less energy is left over to do useful work.

If you think about entropy statistically, you could think about it in terms of a puzzle where you have to figure out how many combinations there are of putting three balls into three boxes. Well, there are 10 combinations. In three cases you'll have three balls in one of the boxes. There's one where there's a ball in every box. And the other six will have them all spread out to a different degree. If you imagine that there were trillions upon trillions of atoms and trillions upon trillions of boxes, then statistically you could see that it's much more likely that the atoms would be disordered rather than ordered.

Perhaps the most significant conclusion from the second law of thermodynamics is the concept of the arrow of time which tells you which direction time is travelling in. For example, if a process generates entropy, it will happen spontaneously and will be irreversible unless you input more energy. When I pour cream on my coffee, I wouldn't be surprised to see the two liquids mixing and becoming more disordered over time. I would, however, be surprised if the cream and coffee separated again after I had stirred them.

An ice cube in coffee will melt and become a more disordered liquid. But under those conditions it cannot spontaneously reform itself back into an ice cube. You might be tempted to think that if this is true and if entropy can never be decreased, then how can human beings or more complex living organisms even exist? Well, the key here is that humans are not a closed system. We are always exchanging heat with our surroundings and we're decreasing local entropy at the expense of the entropy of our environments.

The Third Law of Thermodynamics

absolute zero ['æbsəlu:t 'zɪ(ə)rəu] – нуль Кельвина, абсолютный нуль	sodium ['səʊdɪəm] – натрий potassium [pə'tæsɪəm] – калий
to define [dɪ'faɪn] – определять	minimize ['mɪnɪmaɪz] – уменьшать
conversely [kən'vɜːslɪ] – напротив	equally ['i:kwəlɪ] – в равной мере
dueto ['dju:tə] – в связи с	despite [dɪs'paɪt] – несмотря на
postulate ['pɒstʃəleɪt] – постулировать	create [krɪ'eɪt] – создавать
identical [aɪ'dentɪk(ə)l] – одинаковый	positioned [pə'zɪʃnd] – расположенный

The coldest place in the universe is the Boomerang Nebula in the Centaurus constellation.

At –272 ^{0}C, or 1 K, it is only a single degree above absolute zero. Here on Earth scientists have been able to get even lower temperatures that by using lasers to cool individual molecules of sodium and potassium to 500 nK. But they even couldn't get to absolute zero. The third law of thermodynamics defines what absolute zero is and ties together the concepts of entropy and temperature. It states that the entropy of a perfect crystal approaches zero at a temperature of absolute zero.

An important idea to note is that absolute zero may not be able to be achieved experimentally. This is because we know from the second law of thermodynamics that heat will spontaneously move from a warmer body to a cooler one. So the object that you are trying to cool to absolute zero will be taking in heat from its surroundings. Despite this, absolute zero is an important theoretical concept. The lowest possible entropy can only occur in a perfect crystal which is a structure where all of the atoms that form it are identical and positioned in perfectly symmetrical ways.

Any imperfections in the crystal carry energy, so the entropy won't be minimized. Equally any residual thermal energy within the crystal will create thermal motion within it and again, the entropy won't be at a minimum. Conversely, that means that if we can't get to absolute zero, then nothing in the universe is going to be completely still as we'll always have some motion due to thermal energy.

One of the earliest forays into low temperature research was made by James Dewar who was the first person who was able to liquify and then solidify hydrogen gas. This reached a then record low temperature of 13 degrees above absolute zero at which point he postulated: "…there or thereabouts our progress is barred". Nearly a decade later Walther Nernst, a Prussian scientist, announced his heat theorem which would later become known as the third law of thermodynamics.

Task 2. Answer the questions.

1. What does thermodynamics mainly deal with?
2. Why is it necessary to know the laws of thermodynamics?
3. What do the 3 laws of thermodynamics consist in?
4. Can absolute zero be achieved?

Task 3. Make up half a dozen questions of your own.

Task 4. Fill in the crossword:

Across:

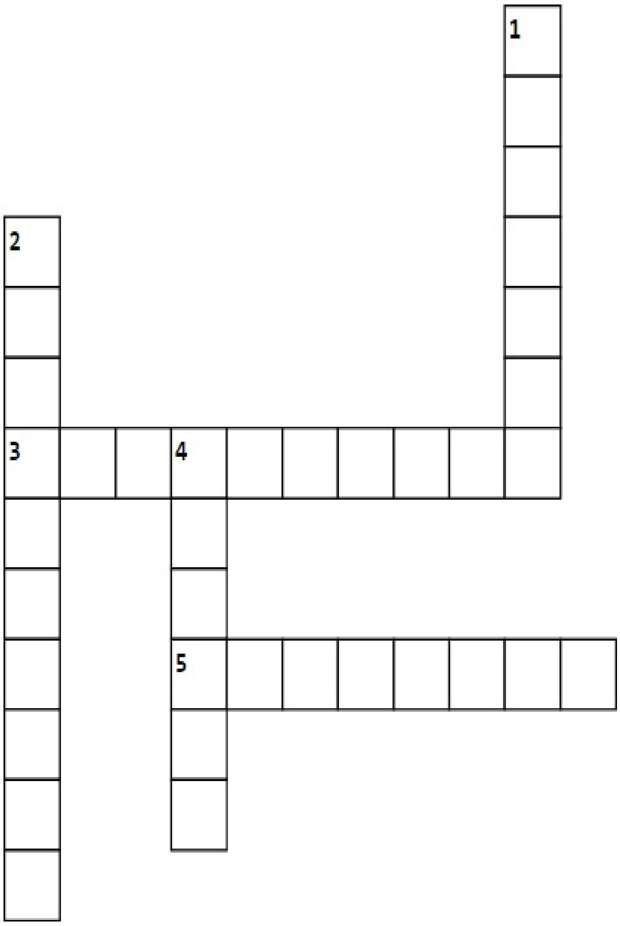
3. the sudden violent bursting and loud noise of something such as a bomb exploding; the act of deliberately causing something to explode.

5. a way of measuring the lack of order that exists in a system.

Down: **1.** the act or process of moving or the way something moves.

2. a person who studies or is an expert in one or more of the natural sciences (e.g. physics, chemistry or biology).

4. a powerful beam of light that can be used for cutting metal, in medical operations, etc.



Task 5. Mark the statements T(rue) or F(alse). Correct them if necessary:

1. The first law of thermodynamics states that the total energy of an open system is constant. Energy can be transformed from one form to another, but can neither be created nor destroyed.

2. The second law of thermodynamics states that as energy is transferred or transformed, more and more of it is wasted.

3. The third law of thermodynamics states that the entropy of a system approaches a constant value as the temperature approaches absolute zero.

Task 6. Make up sentences using the words given below.

1. of a system/ defined/ as a measure/ or/ entropy/ of/ randomness/ is/ disorder.
2. transferred/ is/ heat/ of different/ two materials/ between/ temperature.
3. the solid/ smoke and gases/ wood/ burns/ and/ becomes/ ash.
4. process/ chemical/ a/ is/ combustion.
5. reacts rapidly/ heat/ this substance/ oxygen/ and gives off/ with.

Task 7. Match:

a) the synonyms

to explode	to attain
to store	to annihilate
to complete	to bear
to achieve	to convey
to reach	to construct
to destroy	to decrease
to minimize	to carry out
to carry	to keep
to transfer	to attain
to create	to blow up

b) the antonyms

low	early
thin	superior
light	calm
straight	planned
rapid	external
extreme	heavy
late	thick
internal	slow
inferior	high
spontaneous	curved

TEXTS FOR INDEPENDENT READING

OCEAN ENERGY

ocean ['əuʃ(ə)n] – океан	satisfy ['sætɪsfaɪ] – удовлетворять
coastline ['kəustlaɪn] – береговая линия	worldwide ['wɜ:ld'waɪd] – всемирный; в мировом масштабе
Wells turbine ['welz ˌtɜːbaɪn] – турбина Уэльса	nuclear ['nju:klɪə] – ядерный, атомный
inexhaustible [ˌɪnɪg'zɔ:stəb(ə)l] – неиссякаемый, неисчерпаемый	ingenious [ɪn'ʤi:nɪəs] – изобретательный, остроумный
equal ['i:kwəl] – равняться, быть равным	greenhouse gases – газы, вызывающие парниковый эффект
hydro ['haɪdrəu] – гидро-	direction [d(a)ɪ'rekʃ(ə)n] – направление
reverse [rɪ'vɜ:s] – направленный в обратную сторону	wave [weɪv] – волна
sufficient [sə'fɪʃ(ə)nt] – достаточный	emission [ɪ'mɪʃ(ə)n] – выделение (газов), излучение (света)

Task 1. Read the text.

The water of the oceans of the world is almost always in motion. Hardly ever interrupted waves break at the coastlines: sometimes stronger, sometimes weaker. There is enormous energy potential that is available around the clock and free of charge. Its potential that is fully exploited could satisfy 40% of the worldwide demand for power. This equals the output of 700 to 800 nuclear power stations.

A number of companies develop technologies to convert this inexhaustible energy into electric power without the emission of harmful greenhouse gases. The operating principle of wave power stations is as simple as it is ingenious. An enclosed chamber has an opening beneath sea level which allows water to flow the sea into the chamber and back. The water level in the chamber rises and falls with the rhythm of the waves and air is forced forwards and backwards through the turbine connected to an upper opening in the chamber.

As it is compressed and decompressed the airflow has sufficient power to drive Wells turbine. It is a feature of the Wells turbine named after its inventor that it is driven in the same direction by both forward and reverse air flow through the turbine. Even relatively low wave motions can generate enough airflow to keep the turbine moving and to generate energy.

This is how easily energy can be generated with a wave power station day by day and night by night all year round as long as there are waves. The world's first power station of this kind was put in service as early as November 2000 on the Scottish island of Isla and has been feeding power to the grid ever since. The companies are convinced of the commercial potential of wave energy. It is certain that wave power stations can make a significant contribution to supplying the world with climate friendly energy.

Task 2. Write down the word/word combination and give its Russian equivalent:

[fri: əv ʧɑ:ʤ] –	[θru:] –
['i:zɪlɪ] –	[tek'nɔləʤɪ] –
['ʧeɪmbə] –	[sə'fɪʃ(ə)nt] –
[pə'tenʃ(ə)l] –	['fɔ:wəd] –

Task 3. Match the words with their Russian equivalents:

wave-activated power generating apparatus	относительно
significant	поток воздуха
convince	эксплуатация
grid	значительный
relatively	убеждать
service	волновая энергоустановка
airflow	вклад
contribution	электроэнергетическая система

Plant-e: living plants generate electricity

***Task 1. Read the text aloud and translate it*.**

Our world is confronted with an energy crisis on a global scale. Our traditional energy systems are polluting our planet with carbon dioxide and waste and some resources will perish in the next few decades. That's why the demand of new energy rises. Renewable and sustainable energy is available to everyone because all over the world 1.4 billion people don't have an access to an electricity; without electricity they have no light to read, no phone to communicate, no computer to participate in the world. People are limited in their economical and social development.

After the rise of solar energy, wind energy and hydropower plant-e introduces a new type of sustainable energy: electricity from living plants. David String, one of the founders of planting, explains how it works: "Welcome to our lab advising new universities. This is rarely invented how living plants generate electricity. The plant lives on solar energy. This process is called photosynthesis. The plant produces organic matter, about half of this organic matter is transported from plant foods into the soil. They're naturally occurring bacteria breaking down the organic matter. In this process electrons and protons produce as a kind of waste product. By providing a carbon electrode we can harvest this energy rich in electrons. In our technology the electrons flow from a power harvester to a cathode where oxygen photons and electrons meet to produce water. So, by easily placing two carbon electrodes in soil we can produce little green electricity. For some people this may be a demo of an apple battery which uses the copper penny and a signal to produce electricity. However, the apple battery consumes copper and zinc which poisons the apple, so this is not sustainable. The plenty of technologies are different. We may use the inert carbon electrodes, self repair plants and bacteria to make sustainable, clean electricity".

So in short, planty uses natural energy flows, all is that needed is light, carbon dioxide and water. In urban areas, for example the roofs of houses and offices are extremely suitable; equipped with this technology these roofs always generate the electricity, day or night, summer or winter. Sounds too good to be true?

After the years of development the first in the world green electricity roof of the Netherlands Institute of ecology has been realised. It combines the advantages of a green roof, for example, water storage and insulation of a building. After successfully introducing green electricity roofs in urban areas the ultimate goal is to accommodate every region in the world with planty electricity. A good start would be to equip existing rice fields with planty technology but, in fact, every kind of wetland is qualified even in problem areas where water has become brackish or is polluted, planty electricity is possible so that everyone in the world has plenty of it.

Task 2. Do you think that green electricity is a good enough change for a common one? Discuss this in your group.

ЗАКЛЮЧЕНИЕ

Обучение студентов технических вузов иностранному языку предполагает не только формирование и закрепление общих представлений о фонетике, грамматике и лексике данного языка, но и изучение специфической лексики соответствующей специальности. Владение такой лексикой и знание терминологии – весомая составляющая формирования коммуникативной компетенции студентов. Чтение текстов по специальности способствует как усвоению языкового материала, так и расширению профессиональных знаний. Способность будущего специалиста реализовать коммуникативные навыки в устной или письменной форме является неотъемлемой частью его профессиональной языковой компетентности.

Достигнутый при освоении материалов учебного пособия уровень владения английским языком будет способствовать, прежде всего, пониманию и анализу литературы специального назначения, использованию полученных знаний как основы профессионального общения. Систематические занятия позволят поддерживать уровень языковых знаний и умений вне языковой среды.

Освоение и совершенствование коммуникативно-речевых компетенций оказывает огромное влияние на возможности самореализации, профессионального и карьерного роста.

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