ПЕРЕДМОВА

Практикум призначений для аудиторної та самостійної роботи з англійської мови за професійним спрямуванням для студентів спеціальності “ Газотурбінні установки і компресорні станції ”, а також для фахівців, які бажають поглибити свої знання англійської термінології з фаху.

Метою практикуму є комплексне навчання студентів, робота з фаховою літературою та формування навичок професійного спілкування. Навчальні тексти слугують не лише для розвитку навичок читання та перекладу фахової літератури, а й несуть у собі нову важливу інформацію, яку можна використовувати як основу для подальшого обговорення і створення тематичних ситуацій, максимально наближених до професійних.

Практикум складається з двох модулів, які містять автентичні тексти з тем: “ Forms of Energy. Fluid Dynamics.Thermodynamics. Heat Engineering”, “Hydraulics. Types of Engines. Gas Compressor Units. Gas Turbines”, що містять автентичні тексти. Термінологічні словники-мінімуми до кожного тексту допомагають краще оволодіти лексичним матеріалом та дають змогу розширити словниковий запас.

Вправи лексично-граматичного і комунікативного характеру, спрямовані на розвиток усіх видів мовленнєвої діяльності, розподіляються за рівнем складності, дозволяючи працювати окремо з лексичними одиницями, зі словосполученнями, реченнями та з текстом. Лексичні вправи передбачають пошук українсько-англійських та англо-українських термінологічних еквівалентів, добір синонімів, антонімів. Граматичні вправи охоплюють основні граматичні явища, характерні для англійської науково-технічної літератури. Комунікативні вправи сприяють розвитку навичок висловлювання власної думки, аргументації; участі в дискусіях, студентських конференціях тощо.

Практикум містить додаткові оригінальні інформаційно насичені тексти для самостійного опрацювання, які супроводжуються творчими завданнями та поясненням важкозрозумілих термінологічних словосполучень.

UNIT I. The Concept of Energy. Fluid and Thermodynamics.

Exercise 1. *Read, practice and memorize the following words and word combinations.*

Quantitative – кількісний
property – властивість
transfer – передавати
heat – 1.тепло; 2. нагрівати
store – накопичувати(-ся), зберігати (-ся)
energy conservation– енергозбереження
International System unit (SI unit) – одиниця Міжнародної Системи Одиниць (СІ)
hydraulic energy – гідравлічна енергія, гідроенергія
windmill – вітряк
pump – 1.насос; 2. качати, викачувати, помпувати
coal – вугілля
tension – напруга, напруженість
compress – стискувати
stretch – 1.витягування, розтягування; 2.натягувати(ся)
rubber band – гумова стрічка
petroleum – бензин, нафтопродукт
burn – спалювати
gasoline – бензин
battery – акумулятор, батарея
bond – зв'язок
wood – деревина
nuclear energy – ядерна енергія
nucleus (nuclei (pl.)) – ядро (атома)
nuclei (pl.) – ядра (атома)
release – виділяти (ся)
split – 1. щілина, розщеплення; 2. розщеплювати(ся)
turbine – турбіна
force – 1.сила; 2.змушувати (рухатися)
radiant energy – радіаційна енергія
substance – речовина
x-ray – рентгенівський промінь

radio wave – радіохвиля
particle – елементарна частка
instant – мить, момент
transverse / transversal – поперечний
longitudinal – поздовжній
cause – 1.причина; 2. викликати, призводити
tiny – крихітний
charge – 1.заряд, 2. заряджати
wire – провід, дріт
lightning – блискавка

Exercise 2. *Read, translate and give the gist of text 1.*

Text 1. Energy. Forms of energy

In physics energy is a quantitative property that must be transferred to an object in order to work on an object or heat it. Energy is a stored quantity. The law of energy conservation states that energy can be transformed into a form but not created or destroyed. The conservation of energy is formulated in the First Law of Thermodynamics. The SI unit of energy is joule, which is the energy transferred to an object by moving it a distance of 1 meter against a force of 1 newton.

The total energy system can be subdivided and classified into potential energy, kinetic energy or combinations of the two in various ways.

Potential energy reflects the potential of an object to have motion, and generally is a function of the position of an object within a field or may be stored in the field itself.

Kinetic energy is determined by the movement of an object or the composite motion of the components of an object. Kinetic energy is the motion of waves, electrons, atoms, molecules, substances and objects. The faster an object moves, the higher[1] its kinetic energy. The energy of rivers (hydraulic energy) and of the wind (wind energy) is a form of kinetic energy. This energy can be converted into mechanical energy by water mills, windmills or pumps connected to turbines or into electricity when it drives a generator.

Mechanical energy is the sum of two energy sources: kinetic energy and potential energy. Mechanical energy is the energy stored in objects by tension. Compressed springs and stretched rubber bands are examples of stored mechanical energy.

Chemical energy is the energy stored in the bonds of atoms and molecules. Batteries, biomass, petroleum, natural gas and coal are examples of chemical energy. Chemical energy is converted to thermal energy when people burn wood in a fireplace or burn gasoline in a car's engine.

Nuclear energy is the energy stored in the nucleus of an atom, the energy that holds the nucleus together. Large amounts of energy can be released when the nuclei are combined or split apart.

Gravitational energy is the energy stored in an object's height. The higher and heavier the object, the more gravitational energy is stored. When a person rides a bicycle down a steep hill and picks up speed, the gravitational energy is converting to motion energy. Hydropower is another example of gravitational energy, where gravity forces water down through a hydroelectric turbine to produce electricity.

Radiant energy is the electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays, and radio waves. Light is one type of radiant energy. Sunshine is radiant energy, which provides the fuel and warmth that make life on earth possible.

Thermal energy, or heat, is the energy that comes from the movement of atoms and molecules in a substance. Heat increases when these particles move faster. Geothermal energy is the thermal energy in the earth.

Motion energy is the energy stored in the movement of objects. The faster they move, the more[1] energy is stored. It takes energy to get an object moving, and energy is released when an object slows down. Wind is an example of motion energy. A dramatic example of motion energy is a car crash when a car comes to a total stop and releases all of its motion energy at once in an uncontrolled instant.

Sound is the movement of energy through substances in longitudinal waves. Sound is produced when a force causes an object or substance to vibrate. The energy is transferred through the substance in a wave. Typically, the energy in sound is smaller than in other forms of

energy.

Electrical energy is delivered by tiny charged particles called electrons, typically moving through a wire. Lightning is an example of electrical energy in nature.

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1. the faster ..., the higher – чим швидше ..., тим вище
2. the higher and heavier ..., the more – чим вище і важче. .., тим більше
3. the faster ..., the more – чим швидше ..., тим більше

Exercise 3. *Translate the following universal words without a dictionary. Mind the difference in their pronunciation and spelling in English and Ukrainian.*

Potential energy, kinetic energy, gravity, gravitational energy, electricity, thermal energy, electrical energy, mechanical energy, chemical energy, joule, newton, atom, molecule, electrons, electromagnetic, form, battery, biomass, gas, function, position, generator, turbine.

Exercise 4. *Write out of text 1 words that can be used both as a noun and a verb. Translate the pairs.*

***Model*:** function – to function функція – функціонувати

Exercise 5. *Give the initial form of the following words.*

Conservation, moving, movement, motion, combination, states, various, generally, natural, holds, travels, provided, increases, slows, higher, heavier, more, faster, generator, converting, typically, rubber, smaller, batteries, generator, transferred, classified, warmth, uncontrolled.

Exercise 6. Give Past Participle forms of the following regular verbs. Mind the pronunciation of the **-ed** ending.

a) [d]: cause, supply, carry, compare, arrange, vary, transfer ;
b) [t]: produce, pass, switch, place, develop, fix;
c) [id]: conduct, direct, convert, end, depend, heat, include.

Exercise 7. *Make Passive infinitives and translate the pairs after*

the model:

Model: translate – be translated перекладати – перекладатися do – be done робити – бути зробленим

Use, transform, transfer, define, store, destroy, formulate, take, create, subdivide, classify, heat, call, convert, release, burn, drive, transmit, combine, compress, stretch, put, determine, charge, cause, split, deliver, take, move, make, control , produce, combine, hold.

Exercise 8. *Give Ukrainian equivalents of the following word combinations.*

Must be transferred to an object; is a stored quantity; can be transformed into a form; can not be created or destroyed; can be subdivided and classified into potential energy, kinetic energy; to have motion; may be stored in the field; is stored in the bonds of atoms and molecules; is converted to thermal energy; is stored in objects; compressed springs and stretched rubber bands; stored mechanical energy; is stored in the nucleus of an atom; is converting to motion energy; the higher and heavier the object, the more gravitational energy; to produce electricity; is determined by the movement of an object; comes from the movement of atoms and molecules; move faster; causes an object or substance to vibrate; is transferred through the substance; is delivered by tiny charged particles; typically moving through a wire.

Exercise 9. *Use the verbs in brackets in the proper tense and voice form. Translate the sentences.*

1. The law of energy conservation (state) that energy can (transform) into a form but not (create) or (destroy). 2. Potential energy (reflect) the potential of an object to have motion. 3. Chemical energy (store) in the bonds of atoms and molecules. 4. Chemical energy (convert) to thermal energy when people (burn) wood in a fireplace or (burn) gasoline in a car's engine. 5. Large amounts of energy can (release) when the nuclei (combine) or (split) apart. 6. The higher and heavier the object, the more gravitational energy (store). 7. Radiant energy (include) visible light, x-rays, gamma rays, and radio waves. 8. Motion energy (store) in the movement of objects. 9 Energy (release)

when an object (slow) down.10. Sound (produce) when a force (cause) an object or substance to vibrate. 11. Tiny charged particles (call) electrons, typically moving through a wire.

Exercise 10. *Fill in the blanks with the following terms:* ***tension, thermal energy, nuclei, potential, kinetic energy, energy conservation, gravitational energy, thermal energy, transverse waves, wire, radiant energy, longitudinal waves.***

1. The law of ,,. ,,, states that energy can be transformed into a form but not created or destroyed.2. Potential energy reflects the … of an object to have motion.3. Chemical energy is converted to … … . 4. Mechanical energy is energy stored in objects by … .5. Large amounts of energy can be released when the … are combined or split apart. 6. The higher and heavier the object, the more … is stored.7. … … is the motion of waves, electrons, atoms, molecules, substances, and objects. 8. … … includes visible light, x-rays, gamma rays, and radio waves.9. Geothermal energy is the … … in the earth.10. Sound is the movement of energy through substances in … … . 11. Radiant energy is electromagnetic energy that travels in … … 12. Electrical energy typically moves through a … .

Exercise 11. *Match the English-Ukrainian equivalents.*

1) energy conservation	a) турбіна
2) heat	b) гравітаційна енергія
3) gasoline	c) двигун
4) gravitational energy	d) гідроенергія
5) transverse wave	e) поздовжня хвиля
6) nuclear energy	f) напруженість
7) turbine	g) пальне
8) hydropower	h) тепло,нагрівати
9) substance	i) ядерна енергія
10) fuel	j) енергозбереження
11) tension	k) бензин
12) engine	l) поперечна хвиля
13) longitudinal wave	m) речовина

Exercise 12. *Complete the sentences using English equivalents of*

the words in brackets.

1. (Закон збереження енергії) states that energy can be transformed into a form but not created or destroyed. 2. (Загальна енергетична система) can be subdivided and classified into potential energy, kinetic energy or combinations of the two in various ways. 3. Potential energy reflects the potential of an object to have (рух). 4. Batteries, biomass, (нафта, природний газ та вугілля) are examples of chemical energy. 5.Mechanical energy is the energy stored in objects by (напруга). 6.Nuclear energy is the energy that holds the (ядро) together. 7. Gravitational energy is energy stored in an (висота об'єкта). 8. (Кінетична енергія) is determined by the movement of an object or the composite motion of the (складові) of an object. 9. Radiant energy is the electromagnetic energy that travels in (поперечні хвилі). 10. (Енергія руху) is energy stored in the movement of objects. 11. Sound is the movement of energy through substances in (поздовжні хвилі).12. Tiny (заряджені частинки) are called electrons.

Exercise 13. *Match the terms (1-5) with their definitions (a-l).*

1) Energy	a) is a function of the position of an object within a field or may be stored in the field itself.
2) Electrical energy	b) is energy stored in an object's height.
3) Potential energy	c) is the sum of two energy sources: kinetic energy and potential energy.
4) Chemical energy	d) is a quantitative property that must be transferred to an object to do work.
5) Motion energy	e) is the energy transferred to an object by moving it a distance of 1 meter against a force of 1 newton.
6) Thermal energy	f) is the motion of waves, electrons, atoms, molecules, substances and objects.
7) Gravitational energy	g) is the electromagnetic energy that travels in transverse waves.
8) Kinetic energy	h) is the energy stored in the bonds of atoms and molecules.
9) Radiant energy	i) is the energy stored in the nucleus of an atom.

10) Nuclear energy	j) is the energy that comes from the movement of atoms and molecules in a substance.
11) Mechanical energy	k) is the energy stored in the movement of objects.
12) Joule	l) is the energy delivered by tiny charged particles called electrons, typically moving through a wire.

Exercise 14. *Translate the following sentences into English.*

1. У фізиці енергія - це кількісна властивість, яку необхідно передати об'єкту, щоб працювати над об'єктом або нагрівати його. 2. Одиницею енергії СІ є джоуль, тобто енергія, що передається об'єкту шляхом переміщення його на відстань 1 метр проти сили 1 ньютон. 3. Загальну енергетичну систему можна поділити і класифікувати на потенційну енергію, кінетичну енергію або їх поєднання різними способами. 4. Механічна енергія - це енергія, накопичена в предметах під дією напруги.5. Стиснуті пружини та натягнуті гумові стрічки - приклади накопиченої механічної енергії. 6. Ядерна енергія - це енергія, що зберігається в ядрі атома, енергія, яка утримує ядро укупі.7. Чим вище і важче об'єкт, тим більше зберігається гравітаційної енергії. 8. Кінетична енергія - це рух хвиль, електронів, атомів, молекул, речовин та предметів. 9. Радіаційна енергія включає видиме світло, рентгенівські промені, гамма-промені та радіохвилі. 10. Теплова енергія, або тепло - це енергія, яка походить від руху атомів і молекул речовини. 11. Чим швидше рухається об'єкт, тим більше енергії зберігається. 12.Для того, щоб об'єкт рухався, потрібна енергія, і енергія виділяється, коли об'єкт сповільнюється. 13. Звук утворюється, коли сила викликає вібрацію предмета чи речовини. 14. Електрична енергія доставляється крихітними зарядженими частинками, що називаються електронами, які зазвичай рухаються по дроту.

Exercise 15. *Answer the questions on text 1.*

1. How is energy defined in physics? 2. What does the law of energy conservation state? 3. What is joule? 4. What can the total energy

system be subdivided into? 5. What does potential energy reflect? 6. What is kinetic energy determined by? 7. What is kinetic energy? 8. What is mechanical energy? 9. What is chemical energy? 10. How is chemical energy converted to thermal energy? 11. How is nuclear energy defined? 12. How can gravitational energy be explained? 13. What does radiant energy include? 14. What does thermal energy, or heat, come from? 15. How is motion energy stored? 16. How does sound energy move through substances? 17. What is electrical energy delivered by?

Exercise 16. *Give the gist of text 1 using the following phrases: The text deals with…, It describes…, The text focuses on…, It mentions…or touches upon…, The key-note of the text is….*

Exercise 17. *Write different types of questions on the following sentences after the models.*

Model 1: ***general question***	1. Energy **can be transformed** into another form of energy. – **Can** energy **be transformed** into another form of energy? 2. Kinetic energy **is** motion. – **Is** kinetic energy motion ? 3. Thermodynamics **studies** the movement of energy. – **Does** thermodynamics **study** the movement of energy?

1. Energy can be found in a number of different forms.2. Heat is a type of energy. 3. Energy has always existed in one form or another.4. Stored energy in a flash light batteries becomes light energy. 5. During the day the sun gives out light and heat energy.

Model 2: ***subject question***	1. **A flow of electrons** creates an electric current. – **What** create**s** an electric current? 3. **Mechanical energy** is the sum of kinetic and potential energy. – **What energy** is the sum of kinetic and potential energy?

1. Radiant energy includes visible light, x-rays, gamma rays, and radio waves.2. Kinetic energy can be converted into mechanical energy.3. The

English invented British thermal unit.4. Radiation is the final form of movement of heat energy. 5. Potential energy is transformed into more active types of energy such as kinetic or radiant energy.

Model 3: ***special question***	1. Gravity is **the force of attraction towards the centre of the earth.** – **What is** gravity? 2. The word 'energy' derives from **Greek energeia.** – **What does** the word 'energy' derive **from**?

1. Sound is produced when a force causes an object or substance to vibrate.2. Chemical energy is converted to thermal energy. 3. In 1853 William Rankine coined the term 'potential energy'.4. The SI unit of energy is joule. 5. Large amounts of energy can be released when the nuclei are combined or split apart.

Model 4: ***alternative question***	1. Radiant energy **is** the electromagnetic energy that travels in transverse waves. – **Is** radiant **or** sound energy the electromagnetic energy that travels in transverse waves? 2. Producing goods **takes** huge energy. – **Does** producing goods take huge **or** little energy?

1. Heat increases when these particles move faster. 2. Cars use the chemical energy from gasoline.3. Energy can be saved in various forms.4. Mechanical energy is the sum of two energy sources. 5. The SI unit of energy is joule.

Model 5: ***disjunctive /tag question***	1. A flow of electrons **creates** an electric current. – A flow of electrons creates an electric current, **doesn't it**? – A flow of electrons doesn't create an electric current, **does it**? 2. Typically, the energy in sound **is** smaller than in other forms of energy. – Typically, the energy in sound is smaller than in other forms of energy, **isn't it** ? – Typically, the energy in sound is not smaller than in other forms of energy, **is it** ?

	3. The results of thermodynamics are essential. –The results of thermodynamics are essential, **aren't they**? –The results of thermodynamics are not essential, **are they**?

1. The energy of rivers is a form of kinetic energy. 2. Static electricity doesn't move.3. Darker surfaces do not reflect the radiation. 4. The higher and heavier the object, the more gravitational energy is stored. 5. Energy is released when an object slows down.

Exercise 18. *Compose a dialogue on "Alternative Energy Sources".*

Exercise 19. *Memorize the following words and word combinations to text 2.*

Renewable energy sources (RES) – відновлювані джерела енергії
power plant – електростанція
replenish – поповнювати
emit – виділяти, випромінювати; випускати
occur –*геол.* зустрічатися, залягати
trap – утримувати, захоплювати
fossil fuel – викопне пальне
catalyze – активізувати, пришвидчувати
carbon dioxide – двоокис вуглецю
hydrocarbon – вуглеводень
crust – кора
remain – залишатися
remains – залишки, рештки
account for – бути основною причиною
emission – виділення, викид (тепла, тощо); емісія
greenhouse – парниковий
unrestrained – необмежений
consume – споживати
waste – марнувати
raw – сировина
source – ресурс
pollute – забруднювати
environment – навколишнє середовище

Exercise 20. *Answer the following questions and read the text below to check your answers.*

1. What is the difference between renewable and non – renewable energy sources?

2. Why is it so important to develop alternative energy sources?

Exercise 21. *Read, translate and give the gist of text 2.*

Text 2. Alternative Energy

There are two major categories of energy: renewable and non-renewable. Non-renewable energy resources are available in limited supplies, usually because they take a long time to replenish. The advantage of these non-renewable resources is that power plants that use them are able to produce more power on demand. The non-renewable energy resources are: coal, nuclear, oil, natural gas.

Renewable resources, on the other hand, replenish themselves. The five major renewable energy resources are: solar, wind, water, also called hydro, biomass or organic material from plants and animals, geothermal, which is naturally occurring heat from the earth.

When coal, natural gas and oil are burned to produce energy, they emit heat-trapping gases such as carbon dioxide. This process of trapping heat is what drives climate change, and the failure to address this problem is what's catalyzing the current climate crisis.

Fossil fuels are hydrocarbon-containing materials like coal or gas that are found in the Earth's crust and formed in the geological past from the remains of living organisms. These energy sources account for the majority of the world's greenhouse gas emissions**.**

If emissions continue unrestrained, the atmosphere could warm by as much as 2.7 degrees Fahrenheit above preindustrial levels by the year 2040, according to the latest report from the Intergovernmental Panel on Climate Change, a group of international scientists empowered by the United Nations to advise world leaders.

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 energy sources.

Still, the overall efficiency of energy production remains extremely low: on average, more than 90% of energy consumed is lost or wasted in the process of conversion from raw materials such as coal to the final energy service such as the light. The main problem isn't that we use energy, but how we produce and consume energy resources. We really need energy sources that will last forever and can be used without polluting the environment. Conserving energy has become the need of the day, be it in the transport, household or industrial sectors.

Exercise 22. *Give English equivalents of the following terminological word combinations.*

Відновлювана та невідновлювана енергія; гази, що утримують тепло; здатні виробляти більше енергії згідно попиту; зумовлювати зміну клімату; пришвидшує поточну кліматичну кризу; викопне паливо; вуглеводовмісні матеріали; залишки живих організмів; викиди парникових газів; нагріватися що найменше на 2,7 градуса за Фаренгейтом; міжурядова група з питань зміни клімату; частка первинної енергії; загальна ефективність виробництва енергії; втрачати або марнувати понад 90% споживаної енергії; в процесі перетворення з сировини; виробляти та споживати енергетичні ресурси; забруднення навколишнього середовища; збереження енергії; транспортний, побутовий, промисловий сектори.

Exercise 23. *Complete the sentences using English equivalents of the words in brackets.*

1. (Невідновлювані енергетичні ресурси) take a long time (поповнюватись). 2. When coal, natural gas and oil are burned to produce energy, they (виділяють такі гази, що утримують тепло) such as (вуглекислий газ).3.The process of trapping heat (зумовлює зміну клімату). 4. Fossil fuels account for the majority of the world's (викиди парникових газів). 5. If emissions continue unrestrained, the atmosphere could (нагріватися що найменше на 2,7 градуса за Фаренгейтом).6. The main problem isn't that we use energy, but how we (виробляємо та споживаємо енергетичні ресурси). 7. (Збереження енергії) has become the need of the day, be it in the (транспортний, побутовий, промисловий сектори).

Exercise 24. *Give the terms corresponding to the following definitions.*

1. Energy sources that can be easily replenished –
2. Energy produced by burning fossil fuels –
3. Sources that can never be exhausted –
4. Sources that emit carbon dioxide –
5. Sources of energy that account for the majority of the world's greenhouse gas emissions –
6. Energy sources that can be used without polluting the environment –

Exercise 25. *Distribute the following sources into two columns.*

Energy sources	Renewable	Non- renewable
Sun		
Biomass		
Coal		
Geothermal sources		
Wind		
Crude oil		
Water		
Radiation		
Natural gas		

Exercise 26. *Say whether the following statements are true or false. Correct the false ones using one of the following phrases:* ***I don't think so, I'm afraid I can't agree with you here, it's not quite so, on the contrary, nothing of the kind.***

1. Non-renewable energy resources are available in limited supplies. 2. The renewable energy resources are: coal, nuclear, oil, natural gas. 3. Fossil fuels doesn't account for the majority of the world's greenhouse gas emissions.4. Coal is the cleanest fossil fuel. 5. The overall efficiency of energy production remains extremely low. 6. Conserving energy has become the need of the day, be it in the transport, household or industrial sectors.

Exercise 27. *Answer the questions on text 2.*

1. What groups are energy sources divided into? 2. What are renewable and non-renewable energy sources? 3. What process drives climate change ? 4. Why have alternative sources of energy become important and relevant in today's world? 5. Why does the overall efficiency of energy production remain extremely low? 6. What problems does the mankind face in energy consumption?

Exercise 28. *Speak on:*

1. Forms of energy.
3. Alternative energy sources.

Exercise 29. *Memorize the following words and word combinations to text 3.*

Fluid dynamics – гідрогазодинаміка
fluid mechanics – механіка рідин і газів
subdiscipline – підрозділ дисципліни
liquid – рідина
aerodynamics – аеродинаміка
gas dynamics – газодинаміка
hydrodynamics – гідродинаміка
application – застосування
calculating force – розрахункова сила
determine – визначати
flow rate – швидкість потоку
pipeline – трубопровід
predict – прогнозувати
nebula (pl. nebulae) – туманність
interstellar space – міжзоряний простір
fission weapon– ядерна зброя
traffic engineering – технологія руху транспорту
solid – тверде тіло
melt – танути, плавити(ся)
boil – кипіти
state – стан
pure – чистий, у чистому вигляді
elemental – елементарний; початковий
mixture – суміш

distinguish – вирізняти, розрізняти; відрізнятися
separation – відокремлення
resist – чинити опір, противитися
compression – стискання
disperse – поширюватися
density– щільність
surface tension – поверхневий натяг
wetting – зволоження
phenomenon (pl.phenomena) – явище
condensed – конденсований
linear momentum – імпульс сили
quantum mechanics – квантова механіка
general relativity – загальна теорія відносності

Exercise 30. *Read, translate and write a brief summary of text 3.*

Text 3. Fluid Dynamics

In physics fluid dynamics is a subdiscipline of fluid mechanics that deals with fluid flow. It is the natural science of fluids (liquids and gases) in motion. It has several subdisciplines itself, including aerodynamics (the study of air and other gases in motion) and hydrodynamics. Fluid dynamics has a wide range of applications, including calculating forces and moments on aircraft, determining the flow rate of petroleum through pipelines, predicting weather, understanding nebulae in interstellar space and modeling fission weapon detonation. Some of its principles are even used in traffic engineering, where traffic is treated as a continuous fluid.

Near absolute zero, a substance exists as a solid. As heat is added to this substance it melts into liquid at its melting point, boils into gas at its boiling point, and if heated high enough would enter a plasma state. A pure gas may be made up of individual atoms (like neon), elemental molecules made from one type of atom (e.g. oxygen) or compound molecules made from a variety of atoms (e.g. carbon dioxide). A gas mixture would contain a variety of pure gases like the air we breathe. What distinguishes a gas from liquids and solids is the vast separation of gas molecules.

Like gas, liquid is able to flow, but like a solid, it resists compression. Unlike gas, a liquid does not disperse to fill the space of a

container and maintains a fairly constant density. A distinctive property of a liquid state is surface tension, leading to wetting phenomenon. The density of liquid is usually close to that of a solid and much higher than in gas. Therefore, liquid and solid are both termed condensed matter. On the other hand, as liquids and gases share the ability to flow, they are both called fluids.

The foundational axioms of fluid dynamics are the conservation laws, specifically, conservation of mass, conservation of linear momentum (also known as Newton's Second Law of Motion), and conservation of energy (also known as the First Law of Thermodynamics). They are based on classical mechanics and are modified in quantum mechanics and general relativity.

Exercise 31. *Translate the following word combinations.*

Fluid dynamics, fluid mechanics, fluid flow, aerodynamics, calculating forces, flow rate of petroleum, predicting weather, fission weapon detonation, traffic engineering, state of matter, weather pattern, natural science of fluids, plasma state, individual atoms, carbon dioxide, gas mixture, pure gas, surface tension, wetting phenomenon, melting point, boiling point, separation of gas molecules, resist compression, constant density, condensed matter, foundational axiom, conservation law, conservation of mass, conservation of linear momentum, general relativity.

Exercise 32. *Find in text 3 the English for:*

вивчає потік рідини; вивчення руху повітря та інших газів; широкий спектр застосування; обчислення сил і моментів на літаку; моделювання детонації зброї; визначення швидкості руху потоку нафти по трубопроводах; плавиться в рідину при температурі плавлення; перетворюється на газ при температурі кипіння; переходить у стан плазми; складатися з окремих атомів; різноманітність чистих газів; величезне розділення молекул газу; здатний текти; протистоїть стисненню; зберігає постійну щільність; поверхневий натяг, що призводить до явища змочування; близький до щільності твердого тіла; також називаються конденсованою речовиною; мають здатність текти; відомий як другий закон Ньютона про рух; відомий як перший

закон термодинаміки; засновані на класичній механіці; модифіковані в квантовій механіці та загальній теорії відносності.

Exercise 33. *Work in pairs. Correct the following statements.*

1. Gas is one of two classical states of matter.
2. Near absolute zero, a substance exists as a liquid.
3. If we heat water up to 90º C, it boils.
4. A pure gas may be made of compound molecules.
5. A liquid disperses to fill every space of a container.
6. A distinctive property of a gas is surface tension.
7. Only liquids have the ability to flow.

Exercise 34. *Match the English term in the left column with its definition in the right column.*

Terms	**Definitions**
1. Liquid	a) a kind of air like substance that does not become liquid or solid at ordinary temperatures.
2. Boiling point	b) a substance like water or oil that flows freely.
3. Tension	c) the smallest unit (one or more atoms) into which a substance can be divided without a change in its chemical nature.
4. Gas	d) a temperature at which a liquid boils.
5. Molecule	e) expansive force of gas or vapour.

Exercise 35. *Work in pairs. Make questions for each answer below with reference to text 3.*

1. Fluid dynamics studies liquids and gases in motion.
2. Fluid dynamics has a wide range of applications.
3. Near absolute zero substance exists as a solid.
4. Liquid boils into a gas at its boiling point.
5. A gas mixture contains a variety of pure gases like the air that we breathe.
6. Solid substance melts when heat is added.
7. The vast separation of the individual gas particles distinguishes a gas from liquids.
8. Some principles of fluid dynamics are used in traffic engineering.

Exercise 36. *Turn the following into the Past and Future Simple Active Voice according to the model. Add words indicating past and future moments, if necessary.*

Model: - The students **study** the topic "Properties of Liquids and Gases" at the first year.
- The students **studied** the topic "Properties of Liquids and Gases" **last** year.
- The students **will study** the topic "Properties of Liquids and Gases" **next** year

1. In geology, continental drift, mountain ranges, volcanoes and earthquake are phenomena that can be explained in terms of energy transformations in the Earth's interior.2. Today, the wind is also used to make electricity. 3. Fossil fuels take millions of years to create. 4. Pollutant emissions from the industrial sector and electric utilities contribute greatly to environmental problems.5. Electric generation and industrial applications require energy. 6. Because of its clean burning nature, the use of natural gas can help to reduce the emission of harmful pollutants.7. Emissions from vehicles contribute to smog, low visibility, and various greenhouse gas emissions. 8. Reducing carbon dioxide emissions plays a huge role in combating the greenhouse effect and global warming.

Exercise 37. *Rewrite the following sentences in the Passive Voice according to the model.*

Model: 1. Liquids and gases **share** the ability to flow.
- The ability to flow **is shared** by liquids and gases.
2. Archimedes **investigated** fluid statics.
- Fluid statics **was investigated** by Archimedes.
3. The students **have studied** fluid dynamics.
- Fluid dynamics **have been studied by** the students.

1. A modern discipline, called computational fluid dynamics, analyzes and simulates fluid flows.
2. Students have studied such properties of fluid flow as density, pressure, temperature and velocity.
3. The equations describe the balance of forces.
4. Arhcimedes and Pascal contributed greatly to fluid statics.
5. The Swiss mathematician and physicist Daniel Bernoulli

conducted experiments with liquids.

6. American physicist William R. Bennett invented the first gas laser in 1960.

7. Any chemical laser uses gas-dynamic processes to increase its efficiency.

Exercise 38. *Put the verbs in brackets into the correct active or passive tense forms.*

1. Fluid statics (call) also hydrostatics. 2. It (be) the science of fluids at rest. 3. The study of fluid mechanics (go) back at least to the days of ancient Greece, when Archimedes (investigate) fluid statics. 4. If the forces (balance), the fluid (move) in the direction of the resulting force. 5. The law (formulate) by the French mathematician and philosopher Blaise Pascal in 1647 and would later (know) as Pascal's law. 6. Fluids (compose) of molecules that (collide) with one another and solid objects. 7. Some principles of fluid dynamics (use) in traffic engineering, where traffic (treat) as a continuous fluid.

Exercise 39. *Translate into English.*

1.Гідрогазодинаміка є підрозділом "механіки рідини", яка вивчає рідини в русі. 2. Принципи гідродинаміки широко застосовуються в авіації для прогнозування погодних умов, у проектуванні нафтопроводів і технологій руху транспорту, де транспорт розглядається як безперервний потік. 3. Матерія має три основні стани: газоподібний, рідкий та твердий. 4. Близько абсолютного нуля речовина існує у вигляді твердої речовини. 5.Зміна температури й тиску веде до зміни щільності рідини. 6. Якщо нагрівати тверду речовину, вона перетворюється на рідину при температурі плавлення, у газ при температурі кипіння і при досить сильному нагріванні переходить у стан плазми. 7. Як і газ, рідина здатна текти, але як тверда речовина протистоїть тиску. 8.На відміну від газу, рідина не розсіюється, щоб заповнити простір контейнера, а підтримує досить постійну щільність. 9. Відмінною властивістю рідинного стану є поверхневий натяг, що призводить до явища зволоження. 10.Щільність рідини зазвичай близька до щільності твердої речовини, тому рідка і тверда речовини називаються конденсованими речовинами.11. З іншого боку,

оскільки рідини та гази мають здатність текти, їх називають рідинами.

Exercise 40. *Answer the questions on text 3.*

1. What is fluid dynamics**?** 2. What subdisciplines is fluid dynamics subdivided into? 3. How does a substance change its state? 4.What would a gas mixture contain? 5. What distinguishes a gas from liquids and solids? 6. What is a distinctive property of a liquid state? 7. Why are liquid and solid both termed condensed matter? 8. Why are liquids and gases both called fluids? 9. What are the foundational axioms of fluid dynamics? 10. What are they based on and modified in?

Exercise 41. *Read text 4 about fluids. 4 sentences have been removed from the text and given after the text. Choose the most suitable places for each of them. There is one extra sentence which you do not need to use.*

Text 4. Fluids and the World Around us

Fluids - which include both liquids and gases - play a central role in our daily lives. ... A rather vital fluid circulates in the human cardiovascular system. There are the fluid ocean and the fluid atmosphere.

In a car, there are fluids in the tires, the gas tank, the radiator, the combustion chamber of the engine, the exhaust manifold, the battery, the air-conditioning system, the windshield wiper reservoir, the lubrication system, and the hydraulic system. ... The next time you see a large piece of earthmoving machinery, count the hydraulic cylinders that permit the machine to do its work**.** …

We use the kinetic energy of a moving fluid in windmills, and the potential energy of another fluid in hydroelectric power plants. … We often travel great distances just to watch fluids move. Perhaps it is time to see what physics can tell us about fluids.

1. Hydraulic means operated via a liquid.
2. Given time, fluids carve the landscape.
3. Physical quantities, that we find useful, are mass and force.
4. We breathe and drink them.
5. Large jet planes have scores of them.

Exercise 42. *Discuss the following topics in groups.*

1.Gas and its properties.
2.Liquid and its properties.
3.What distinguishes gas from liquids and solids.

Exercise 43. *Memorize the following words and word combinations to text 5.*

Motion – рух
subject – піддавати (*впливу, тощо*)
stress – навантаження
pour – лити(ся)
pitcher - глечик
lip – край
gravity - сила тяжіння
tilted - нахилений
contribute – робити внесок
at rest – в стані спокою
arise - виникати
exert – спричиняти / створювати *(тиск*)
inversely related – обернено пропорційний
laminar flow – ламінарний, упорядкований потік
streamline – рівномірний потік
disruption – розрив
turbulent flow – турбулентний потік
smooth – рівний, однорідний
rough – нерівний; бурхливий
airfoil – аеродинамічний профіль
shape – 1. форма; 2. формувати
lift – 1. підйом; 2. піднімати

Exercise 44. *Read text 5. Select the key words and expressions for a five-minute conversation with your partners on the following topic: "Bernoulli's principle application in airplane wing design".*

Text 5. Fluid flow

Motion of any fluid is subjected to unbalanced forces or stresses. The motion continues as long as unbalanced forces are applied. For example, in the pouring of water from a pitcher the water velocity is very high over the lip and very low near the bottom of the pitcher. The

unbalanced force is gravity, that is, the weight of the water near the surface. The flow continues as long as water is available and the pitcher remains tilted.

Arhcimedes and Pascal contributed greatly to what became known as fluid statics. But the father of fluid mechanics was the swiss mathematician and physicist Daniel Bernoulli (1700-1782). He considered the properties of basic importance in fluid flow, particularly pressure, density, and velocity and set forth their fundamental relationship. Any fluid at rest exerts pressure – what Bernoulli called "static pressure" – on its container. As the fluid begins to move, however, a portion of the static pressure is converted to what Bernoulli called dynamic pressure or the pressure of movement.

While conducting experiments with liquids, Bernoulli observed that when the diameter of a pipe is reduced, the water flows faster. This suggested to him that some force must be acting upon the water, a force that he reasoned must arise from difference in pressure. As a result, he concluded that pressure and velocity are inversely related – in other words, as one increases, the other decreases. Hence, he formulated Bernoulli's principle, which states that for all changes in movement, the sum of static and dynamic pressure in fluid remains the same.

According to Bernoulli's principle, the greater the velocity of flow in a fluid, the greater the dynamic pressure and the less the static pressure. In other words, slower-moving fluid exerts greater pressure than faster-moving fluid.

Fluid flows can be divided into two different types: laminar flows and turbulent flows. Laminar flow, sometimes known as streamline flow, occurs when fluid (gas or liquid) flows in parallel layers, with no disruption. It is the opposite of turbulent flow. If laminar flow is "smooth", turbulent flow is "rough". Turbulent flow is characterized by chaotic property changes and rapid variation of pressure and velocity in space and time.

The Bernoulli principle has a wide range of applications in engineering fluid dynamics, from aerospace wing design to designing pipes for hydroelectric plants.

Bernoulli's principle ultimately became the basis for the airfoil, the design of an airplane's wing. An airfoil is shaped like an asymmetrical teardrop. Due to this specific shape of wings when the

aeroplane runs, air passes at higher speed over it as compared to its lower surface. This difference of air speeds above and below the wings, in accordance with Bernoulli's principle, creates a pressure difference, due to which an upward force called 'dynamic lift' acts on the plane. If this force becomes greater than the weight of the plane, the plane will rise up.

In the case of a hydroelectric plant that utilizes water flow from mountain reservoir, knowing the elevation change from the reservoir in the mountains to the plant in town helps engineers determine how fast the water will be flowing through the energy-generating turbines in the plant.

Exercise 45. *Translate the following word combinations.*

Unbalanced forces; properties of basic importance; fluid flow; high velocity; conduct experiments; pressure difference; slow-moving fluid; inversely related; dynamic pressure; slower-moving fluid; exert greater pressure; laminar flow; turbulent flow; with no disruption; rapid variation of pressure and velocity; engineering fluid dynamics; wing design; hydroelectric plant; width of a pipe; basis for the airfoil; above and below the wings; in accordance with Bernoulli's principle; upward force; weight of the plane; utilize water flow; elevation change; energy-generating turbine.

Exercise 46. *Match the synonyms.*

1) rapid	a) elevation
2) velocity	b) rough
3) airplane	c) split
4) lift	d) increase
5) turbulent	e) aircraft
6) disrupt	f) speed
7) growth	g) wide
8) fluid	h) liquid
9) design	i) quick
10) broad	j) construction

Exercise 47. *Give English equivalents of the following word combinations.*

Рух будь-якої рідини; неврівноважені сили або напруги; незбалансовані сили; робили великий внесок; визначати властивості потоку рідини; властивості, які мають основне значення в течії рідини; тиск, щільність і швидкість; чинити тиск; перетворюватися в динамічний тиск; виникати через різницю тиску; бути обернено залежними; сума статичного і динамічного тиску в рідині; чим більша швидкість, тим більше динамічний тиск і менше статичний тиск; рідина з повільнішим рухом; чинити більший тиск; відомий як рівномірний потік; тече паралельними шарами; характеризуватися хаотичними змінами властивостей; інженерна гідродинаміка; конструкція аерокосмічного крила; аеродинамічний профіль; специфічна форма крил; піднімальна сила; гідроелектро-станція; турбіни, що виробляють енергію.

Exercise 48. *Match the antonyms*

1) smooth	a) controlled
2) rapid	b) wide
3) chaotic	c) dynamic
4) parallel	d) solid
5) liquid	e) perpendicular
6) static	f) rough
7) narrow	g) slow

Exercise 49. *Match the terms in the left column and with their definitions in the right column.*

Terms	**Definitions**
1. Gravity	a) gas or liquid substance
2. Statics	b) science of motion and force
3. Fluid	c) force of attraction towards the centre of the earth
4. Air	d) branch of knowledge dealing with bodies remaining at rest or with forces which balance one another
6. Mechanics	e) mixture of gases that surrounds the earth and which we breathe

Exercise 50. *Translate into English.*

1. Рух будь-якої рідини піддається неврівноваженим силам або напругам. 2. Рух рідини триває доти, доки діють незбалансовані сили. 3.Незбалансованою силою є сила тяжіння. 4. Архімед і Паскаль зробили великий внесок у те, що стало відомим як статика рідини.5. Щвейцарський математик і фізик Даніель Бернуллі визначив властивості потоку рідини, зокрема тиск, щільність і швидкість. 6. Якщо діаметр труби зменшується, рідина починає текти швидше. 7. Чим більша швидкість потоку рідини, тим вищий динамічний тиск. 8. Властивості рідин, такі як швидкість, тиск, щільність і температура, враховуються при розрахунках потоку рідини. 9. Рідинний потік рухається швидше у вузькому місці, таким чином однакова маса рідини проходить певну відстань за певний проміжок часу. 10. Тиск рідини та швидкість руху рідини є обернено пропорційними – якщо тиск зростає, швидкість зменшується. 11. Ламінарний потік, який іноді називають упорядкованим потоком, виникає, коли рідина тече безперебійно паралельними шарами. 12. Принцип Бернуллі зрештою став основою для проектування аеродинамічного профілю, конструкції крила літака.

Exercise 51. *Work in pairs. Arrange words in the jumbled questions correctly and answer them.*

Model: flow, in, Why, a, does, river, a, place, narrower, faster? Why does a river flow faster in a narrower place?

1. unbalanced, is, What, subjected, to, forces?
2. observe, Bernoulli, did, while, What, with, conducting, liquids, experiments?
3. related, Are, pressure, inversely, and, velocity?
4. rapid, of, variation, What, is, flow, by, characterized, and, velocity, pressure?
5. static, and, pressure, dynamic, Does, in fluid, the same, remain, the sum of?
6. flow, if, Why, water, does, the, diameter, faster, is, a, reduced, pipe, of?

Exercise 52. *Speak on:*

1. Fluid dynamics.

2. Fluid flow characteristics.

Exercise 53. *Memorize the following words and word combinations to text 6.*

Coin – створювати (нові слова)
designate – позначати, називати
elastic energy - енергія пружності
Btu (British thermal unit) – британська теплова одиниця
match – сірник
weigh – важити; зважувати
pound – фунт
inch – дюйм
conduction – провідність
convection – конвекція
pass – передаватися
stir – помішувати, розмішувати
conductor – провідник
replace – замінити
current – потік
absorb – поглинати(ся)
reflect –відбивати(ся)

Exercise 54. *Read, translate and give the gist of text 6.*

Text 6. Thermodynamics. How it started

The term 'thermodynamics' was coined by James Joule in 1859 to designate the science of relations between heat and power. By 1858, 'thermodynamics', as a functional term, was used in William Thomson's paper "An Account of Carnot's Theory of the Motive Power of Heat". The first textbook in thermodynamics was written in 1859 by William Rankine, originally trained as a physicist and mechanical engineering professor at the University of Glasgow. Thermodynamics is the study of the conversion of heat energy into different forms of energy.

As you know, there are several different forms of energy: kinetic, potential, thermal, gravitational, sound energy, light energy, elastic,

electromagnetic, chemical and nuclear. While one form of energy may be transformed to another, the total energy remains the same.

Energy is measured in many ways. One of the basic measuring blocks is called a Btu. This stands for British thermal unit and was invented by, of course, the English. Btu is the amount of heat energy it takes to raise the temperature of one pound of water by one degree Fahrenheit at sea level. One Btu equals about one blue tip kitchen match. It takes about 2,000 Btus to make a pot of coffee. Energy also can be measured in joules. A thousand joules is equal to a British thermal unit. 1,000 joules = 1 Btu. The term 'joule' is named after an English scientist James Prescott Joule who discovered that heat is a type of energy. One joule is the amount of energy needed to lift something weighing one pound to a height of nine inches. Around the world scientists measure energy in joules rather than Btus.

Heat energy moves in three ways: conduction, convection, radiation.

Conduction occurs when energy is passed directly from one item to another. If you stirred a pan of soup on the stove with a metal spoon, the spoon will heat up. The heat is being conducted from the hot area of the soup to the colder area of spoon. Metals are excellent conductors of heat energy. Wood or plastics are not.

Convection is the movement of gases or liquids from a cooler spot to a warmer spot. The wind we feel outside is often the result of convection currents. You can understand this by the winds you feel near the ocean. Warm air is lighter than cold air and so it rises. During the daytime, cool air over water moves to replace the air rising up as the land warms the air over it. During the night time, the directions change – the surface of the water is sometimes warmer and the land is cooler.

Radiation is the final form of movement of heat energy. The sun's light and heat cannot reach us by conduction or convection because space is almost completely empty. The sun's rays travel in straight lines and are called heat rays. When rays move that way, it is called radiation. When sunlight hits the Earth, its radiation is absorbed or reflected. Darker surfaces absorb more of the radiation and lighter surfaces reflect the radiation. So you would be cooler if you wear light or white clothes in summer.

Exercise 55. *Translate the following word combinations.*

Conversion of heat energy; total energy; basic measuring blocks; British thermal unit; amount of heat energy; the temperature of one pound of water; by one degree Fahrenheit at sea level; movement of gases or liquids; lighter than cold air; surface of the water; final form of movement of heat energy; can be measured in joules; is named after an English scientist; measure energy in joules rather than Btus; conducted from the hot area to the colder area; conductors of heat energy; to replace the raising up air; by conduction or convection; almost completely empty; heat rays; absorbed or reflected radiation.

Exercise 56. *Rewrite the following sentences in Past Simple and Present Perfect. Add adverbial modifiers, where necessary.*

Model: The session begins …
The session began …
The session has already begun …

1. The situation changes over time.
2. Scientists achieve considerable technical progress.
3. The discovery is widely used by scientists in many countries.
4. He prepares new programs for the computers.
5. The students study the properties of potential and kinetic energy.
6. Electrical energy is generated in many ways.
7. The company develops the project under the leadership of the British company.
8. The scientists introduce technologies for integrating and maximizing the advantages of different energy sources.
9. We plan to implement the project in three stages.

Exercise 57. *Change the following sentences into the Passive Voice.*

1. Nobody can create or destroy energy. 2. The Arabian physicist defined light rays as streams of minute energy particles. 3. Thomas Young was the first to use the term ‘energy’. 4. Our body uses stored energy to do work. 5. Scientists have studied different forms of energy. 6. Lord Kelvin formulated the laws of thermodynamics. 7. One can find energy in a number of different forms. 8. William Rankine coined the

term ‘potential energy’. 9. The lecturer is explaining the concept of energy and its transformations.

Exercise 58. *Use the verbs in brackets in the proper tense and voice form.*

1.The term thermodynamics (coine) by James Joule in 1859 to designate the science of relations between heat and power. 2. Energy (measure) in many ways. 3. A Btu (stand) for British thermal unit and (invent) by, of course, the English. 4. Energy also can (measure) in joules. 5. A thousand joules (equal) to a British thermal unit. 6. The term ‘joule’ (name) after an English scientist James Prescott Joule who (discover) that heat (be) a type of energy. 7. Around the world scientists (measure) energy in joules rather than Btus.8. Heat energy (move) in three ways: conduction, convection, radiation. 9. Conduction (occur) when energy (pass) directly from one item to another. 10. The sun’s rays travel in straight lines and (call) heat rays. 11. When sunlight (hit) the Earth, its radiation (absorb) or (reflect).

Exercise 59. *Ask:*

a) if one form of energy can be transformed into another;
if there are different forms of energy;
if the total energy of a system changes with time;
if Boyle formulated the law which stated that pressure and volume are inversely proportional;

b) what the energy from the Sun is called;
what the laws of thermodynamics postulate;
when Robert Boyle built the air pump;
how energy is often defined in physics;
who coined the term ‘potential energy’.

Exercise 60. *Translate into English.*

1. Термодинаміка вивчає перетворення теплової енергії в різні форми енергії. 2. Хоча одна форма енергії може трансформуватися в іншу, загальна енергія залишається незмінною. 3. Британську теплову одиницю було винайдено, звісно, англійцем. 4. Британська теплова одиниця - це кількість теплової енергії, необхідної для підвищення температури одного фунта води на один градус за

Фаренгейтом на рівні моря. 5. Енергію також можна виміряти в джоулях. 6. Термін «джоуль» названо на честь англійського вченого Джеймса Прескотта Джоуля, який відкрив, що тепло є різновидом енергії. 7. Рух теплової енергії здійснюється трьома способами: провідністю, конвекцією, випромінюванням. 8. Провідність відбувається, коли енергія передається безпосередньо від одного предмета до іншого.9. Конвекція - це переміщення газів або рідин з більш прохолодного місця в більш тепле. 10. Коли сонячні або теплові промені рухаються по прямих лініях, це називається радіацією. 11. Темніші поверхні поглинають більше випромінювання, а світліші відбивають випромінювання.

Exercise 61. *Memorize the following words and word combinations to text 7.*

Validity – придатність; обґрунтованість; доведеність
zeroth law – нульовий закон (термодинаміки)
emission – випромінювання, виділення; поширювання
equilibrium – рівновага
equivalence – рівноцінність, еквівалентність
surrounding – навколишнє середовище
obviously – очевидно
experience – досвід
entropy – ентропія
conversely – навпаки; обернено
spontaneous – мимовільний, спонтанний
internal – внутрішній
asymptotically – асимптотично
approach – наближатися
cease – припиняти(ся)
reach – досягати

Exercise 62. *Read, translate and write a brief summary of text 7.*

Text 7. The Laws of Thermodynamics

The laws of thermodynamics give motion to everything that happens in the universe. The laws of thermodynamics are a set of postulates that are the basis of thermodynamics. The laws of thermodynamics, in

principle, are physical laws that describe the features of heat transfer and work in thermodynamic processes. They have become one of the most important both in physics and in other fields of science related to thermodynamics. In thermodynamics there are four laws of very general validity. The four laws are:

- Zeroth law of thermodynamics states that thermodynamic equilibrium is an equivalence relation. If two thermodynamic systems are separately in thermal equilibrium with a third one, they are also in thermal equilibrium with each other.

A system in thermal equilibrium is a system whose macroscopic properties (like pressure, temperature, volume, etc.) are not changing in time. A hot cup of coffee on a kitchen table is not in equilibrium with its surroundings because it is cooling off and decreasing in temperature. Once its temperature stops decreasing, it will be at room temperature, and it will be in thermal equilibrium with the surroundings.

The first law of thermodynamics basically states that a thermodynamic system can store or hold energy and that this internal energy is conserved. Heat is a process by which energy is added to a system from a high-temperature source. In addition, energy may be lost by the system when it does mechanical work on its surroundings, or conversely, it may gain energy as a result of work done on it by its surroundings. The change in the internal energy is equal to the amount added by heating minus the amount lost by doing work on the environment.

There are many statements of the second law which use different terms, but they are all equivalent. The simplest formulation of the second law is: heat cannot flow spontaneously from a lower-temperature material to a higher-temperature material. It is obviously true from everyday experience. For example, in a refrigerator heat flows from cold to hot, but only when electrical energy is added. Note that from the mathematical definition of entropy, a process in which heat flows from cold to hot has decreasing entropy.

The formulation of the second law given by William Thomson (Lord Kelvin) states that it is impossible to convert heat completely into work. Thus, a heat engine with 100% efficiency is thermodynamically impossible.

The third law of thermodynamics is about absolute zero

temperature. As a system asymptotically approaches the temperature of absolute zero, all processes virtually cease and the entropy of the system asymptotically approaches a minimum value. It is impossible to reach the temperature of absolute zero by any finite number of processes.

Exercise 63. *Translate the following word combinations into Ukrainian.*

Laws of thermodynamics, set of postulates, features of heat transfer, spontaneous emission, current research, thermal equilibrium, measurement of temperature, macroscopic properties, mathematical definition, formulation of the law, high-temperature energy source, heat engine, absolute zero, finite number of processes, engine efficiency, leading scientists.

Exercise 64. *Translate and comment upon the following verb grammar forms.*

Describe the features of heat transfer, was coined; was written; do not depend on; can be applied; are not changing; is assumed; can store; may be lost; does; states; is cooling off and decreasing; to convert; is conserved; stops decreasing; may gain; to reach.

Exercise 65. *Put the verbs in brackets into the correct active or passive tense forms.*

1. The laws of thermodynamics, in principle, (be) physical laws that (describe) the features of heat transfer and work in thermodynamic processes.. 2. The laws of thermodynamics (become) one of the most important both in physics and in other fields of science related to thermodynamics. 3. A system in thermal equilibrium is a system whose macroscopic properties (not to change) in time. 4. The first law of thermodynamics basically (state) that a thermodynamic system can (store) or (hold) energy and that this internal energy (conserve). 5. Heat is a process by which energy (add) to a system from a high-temperature source.6. In addition, energy may (lose) by the system when it (do) mechanical work on its surroundings, or conversely, it may (gain) energy as a result of work done on it by its surroundings.7. The formulation of the second law given by Lord Kelvin (state) that it is impossible to convert heat completely into work. 8. As a system asymptotically (ap-

proach) the temperature of absolute zero, all processes virtually (cease) and the entropy of the system asymptotically (approach) a minimum value.

Exercise 66. *Complete the sentences with English equivalents of the words in brackets.*

1. The (закони термодинаміки) are a (набір постулатів) that are the basis of thermodynamics. 2. The (закони термодинаміки), in principle, are (фізичні закони) that describe the features of (теплопередача) and work in (термодинамічні процеси). 3. The laws of thermodynamics have become one of the most important both in physics and in other (галузі науки) related to thermodynamics. 4. Zeroth law of thermodynamics states that (термодинамічна рівновага) is an (відношення еквівалентності). 5. If two (термодинамічні системи) are separately in (теплова рівновага) with a third one, they are also in (теплова рівновага) with each other. 6. A system in (теплова рівновага) is a system whose (макроскопічні властивості) (наприклад, тиск, температура, об'єм тощо) are not changing in time. 7. Heat is a process by which energy is added to a system from a (високотемпературне джерело). 8. The (найпростіше формулювання) of the second law is: heat cannot flow spontaneously from a (об'єкт з нижчої температурою) to a (об'єкт з вищою температурою). 9. A (тепловий двигун) with 100% (ефективність) is thermodynamically impossible. 10. As a system asymptotically approaches the (температура абсолютного нуля), all processes virtually cease and the entropy of the system asymptotically approaches a minimum (значення).

Exercise 67. *Say whether the following statements are true or false. Correct the false ones..*

1. There are three laws of thermodynamics.
2. The term 'thermodynamics' was coined by James Joule in 1859.
3. The first law of thermodynamics states that thermodynamic equilibrium is an equivalence relation.

4. Heat is a process by which energy is added to a system from a low-temperature source.

5. Heat can flow spontaneously from a lower-temperature material to a higher-temperature material.

6. The system gains energy when it does mechanical work.

7. The formulation of the second law given by William Thomson (Lord Kelvin) states that it is possible to convert heat completely into work.

8. A thermodynamic system can't store or hold energy.

9. Internal energy is always conserved.

10. A heat engine with 100% efficiency is thermodynamically quit possible.

Exercise 68. *Translate the following sentences into English.*

1.Термін 'термодинаміка' був введений Джеймсом Джоулем у 1859 році для позначення науки про співвідношення між теплом та енергією. 2.Термодинаміка вивчає перетворення теплової енергії в різні форми енергії. 3.У термодинаміці є чотири закони загального значення. 4.Нульовий закон термодинаміки стверджує, що термодинамічна рівновага є відношенням еквівалентності. 5.Якщо дві термодинамічні системи окремо перебувають у тепловій рівновазі з третьою, вони також перебувають у тепловій рівновазі одна з одною. 6 .Перший закон термодинаміки стверджує, що термодинамічна система може зберігати або утримувати енергію і що ця внутрішня енергія зберігається. 7.Нагрівання - це процес, за допомогою якого до системи додається енергія від джерела високої температури. 8. Зміна внутрішньої енергії дорівнює кількості енергії, доданої при нагріванні, мінус кількість енергії, втраченої при виконанні роботи з навколишнім середовищем. 9. Другий закон термодинаміки стверджує, що тепло не може самовільно перетікати від об'єкту з нижчою температурою до об'єкту з більш високою температурою. 10.Другий закон термодинаміки, сформульований Лордом Кельвіном, говорить, що неможливо повністю перетворити тепло в роботу. 11. У третьому законі термодинаміки йдеться про температуру абсолютного нуля.12.Оскільки система асимптотично наближається до температури абсолютного нуля, усі процеси

практично припиняються, а ентропія системи асимптотично наближається до мінімального значення. 13. За будь-якою кінцевою кількістю процесів неможливо досягти температури абсолютного нуля.

Exercise 69. *Work in pairs. Translate the following questions and answer them.*

1. Як визначають закони термодинаміки?
2. Яке значення законів термодинаміки?
3. Скільки існує законів термодинаміки?
4. Що таке термодинамічна рівновага?
5. Яка система є системою в тепловій рівновазі?
6. Яке найпростіше формулювання другого закону термодинаміки?
7. Яким чином відбувається теплообмін між предметами з різною температурою? Наведіть приклади.
8. Що таке ентропія?
9. Про що говорить третій закон термодинаміки?

Exercise 70. *Memorize the following words and word combinations to text 8.*

Heat/ thermal engineering – теплотехніка
mechanical engineering – машинобудування
transmission – передача
heat exchanger – радіатор, теплообмінник
medium (pl. media) – засіб; спосіб; середовище
process plant – переробний завод
combustible shale – горючий сланець
peat – торф
refine – очищати
piston engine – поршневий двигун
jet engine – реактивний двигун
diesel fuel – дизельне паливо
scale – масштаб
scrap wood – відходи деревини
waste materials – відходи
disposal – утилізаціїя

exhaust – 1.випускання (*газів*), вихлоп; 2.випускати, вивільняти, видаляти
furnace – піч, топка
waste-heat boiler – котел для відходів
centralized boiler room – централізована котельня
power unit – енергоблок
installation – установка

Exercise 71. *Read, translate and write a brief summary of text 8.*

Text 8. Heat Engineering

Heat or thermal engineering is a specialized sub-discipline of mechanical engineering that deals with the movement and transmission of heat energy. Energy can be transferred between two media or converted into other forms of energy. The heating engineer must know thermodynamics and the process of converting energy generated by heat sources into chemical, mechanical or electrical energy. Many process plants use a wide variety of machines that utilize components that use heat transfer in some way. Many plants use heat exchangers in their operations. Some systems include boilers, heat pumps, water pumps, engines and etc.

The principal sources of heat today are fossil fuels, which release heat when burned. These fuels may be solid, liquid or gaseous. Among the more common solid fuels are coals, combustible shales and peat. Petroleum is a natural liquid fuel, but it is seldom used directly to produce heat. Instead, it is refined to produce gasoline for automotive and piston aircraft engines, kerosine for jet engines and certain types of piston engines and various types of diesel fuel and mazut, used chiefly in nonnuclear thermal power plants. The most important gaseous fuel is natural gas, which consists of methane and other hydrocarbons. On a smaller scale, wood (firewood, scrap wood) also serves as a fuel. Methods are now being developed to burn industrial and domestic waste materials for purposes of both disposal and heat generation.

Of great importance in view of the need to conserve natural fuels is the use of secondary heat sources. These sources include the hot exhaust gases of metallurgical furnaces or internal combustion engines whose heat is utilized in waste-heat boilers.

A substantial portion of the heat produced during the colder part of the year is for household consumption; that is, it compensates for heat losses through the walls of buildings and losses involved in ventilation. Heat and electric power plants and centralized boiler rooms provide heat for homes in most cities. The boilers at these plants and rooms heat water that is then sent to the home to supply heat. Home heaters can take the form of radiators or of pipes mounted in wall panels.

Mechanical work is obtained from heat by using heat engines, the principal power units of factories, transport vehicles, and other installations run on heat. Heat is converted into electric power by, for example, magnetohydrodynamic generators and thermoelectric generators.

Exercise 72. *Match the English-Ukrainian equivalents.*

1) process plant	a) машинобудування
2) heat exchanger	b) відходи
3) power unit	c) реактивний двигун
4) heat energy	d) котел для відходів
5) piston engine	e) джерело тепла
6) jet engine	f) теплообмінник
7) conversion of energy	g) нафта
8) waste materials	h) теплова енергія
9) waste-heat boiler	i) теплотехніка
10) fossil fuel	j) централізована котельня
11) heat source	k) переробний завод
12) petroleum	l) поршневий двигун
13) mechanical engineering	m) перетворення енергії
14) thermal engineering	n) енергоблок
15) centralized boiler room	o) викопне пальне

Exercise 73. *Find English equivalents in text 8. It will help you to translate it.*

Передача теплової енергії; між двома середовищами; процес перетворення енергії; машини, що використовують компоненти; виділяти тепло при згорянні; більш поширене тверде паливо; горючі сланці і торф; природне рідке паливо; для виробництва тепла; виробляти бензин для автомобільних та поршневих

авіаційних двигунів; виробляти керосин для реактивних двигунів та деяких типів поршневих двигунів; природний газ, який складається з метану та інших вуглеводнів; спалювати промислові та побутові відходи як для утилізації, так і для виробництва тепла; неядерні теплові електростанції; для економії природних видів палива; використання вторинних джерел тепла; включають гарячі вихлопні гази металургійних печей або двигунів внутрішнього згоряння; для побутового споживання; втрати тепла через стіни будівель та втрати, пов'язані з вентиляцією; основні енергоблоки заводів, транспортних засобів та інших установок; працюють на тепловій енергії; спалення промислових та побутових відходів; магнітогідродинамічний генератор; термоелектричний генератор.

Exercise 74. *Complete the following sentences, filling in the blanks with the terminological words and word combinations:* ***boilers, heat pumps, water pumps, engines; heat exchangers; thermodynamics; heat or thermal engineering; natural gas; coals, combustible shales and peat; exhaust gases; petroleum; internal combustion engines; heat engines; centralized boiler rooms.***

1. __ __ is a specialized sub-discipline of mechanical engineering that deals with the movement and transmission of heat energy. 2. The heating engineer must know ___ and the process of converting energy generated by heat sources into chemical, mechanical or electrical energy. 3. Many plants use ___ ___ in their operations.4. Some systems include ___ , ___ ___, ___, ___ and etc.5. Among the more common solid fuels are ___, ___ ___ and ___. 6. The most important gaseous fuel is __ __. 7. ___ is a natural liquid fuel. 8. Secondary heat sources include the hot ___ ___ of metallurgical furnaces or ___ ___ ___ . 9. Heat and electric power plants and ___ ___ ___ provide heat for the home in most cities.10. Mechanical work is obtained from heat by using __ ___, the principal power units of factories, transport vehicles, and other installations run on heat.

Exercise 75. *Translate into English.*

1. Теплотехніка займається переміщенням і передачею теплової енергії.2. Багато підприємств використовують теплообмінники у своїй роботі.3. Основними джерелами тепла сьогодні є викопне

паливо, яке виділяє тепло при спалюванні.4. Серед найбільш поширених твердих видів палива - вугілля, горючі сланці та торф. 5. Нафта - це природне рідке паливо, але воно рідко використовується безпосередньо для виробництва тепла.6. Найважливішим газоподібним паливом є природний газ, який складається з метану та інших вуглеводнів.7. Зараз розробляються методи спалення промислових та побутових відходів як для утилізації, так і для виробництва тепла.8. Велике значення з огляду на необхідність збереження природного палива має використання вторинних джерел тепла. 9. Теплоелектростанції та централізовані котельні забезпечують теплом будинки у більшості міст.10.Механічна робота отримується від тепла за допомогою теплових двигунів, основних енергоблоків заводів, транспортних засобів та інших установок, що працюють на тепловій енергії.

Exercise 76. *Comment upon the following questions.*

1. What is heat engineering? 2. What does heat engineering deal with? 3. What process is heat engineering based on? 4. What machines do many plants use in their operation? 5. What common fuels are used to produce heat? 6. What fuels are of great importance in view of the need to conserve natural fuels? 7. What do these sources include? 8. How is heat provided for household consumption in most cities? 9. How is mechanical work obtained? 10. What converts heat into electric power?

Exercise 77. *Speak on:*

1. Thermodynamics.
2. The laws of thermodynamics
3. Heat Engineering.

UNIT II. Hydraulics. Types of engines. Gas compressor units and turbines.

Exercise 1. *Memorize the basic vocabulary to text 1.*

Hydraulics – гідравліка

hydraulics-based – (*система*) на основі гідравліки

cylinder – циліндр, валик, барабан
hydraulic fluid – гідросуміш
viscosity – в'язкість
resistance – опір
medium – 1. засіб; спосіб 2. середовище
lubricating medium – мастильний/змащувальний засіб
friction - тертя
carry away – відносити
be regarded as – розглядатися як, вважатися чимось
incompressible - що не стискається / не ущільнюється
constant - сталий, незмінний
operating range - радіус дії; робочий цикл
confine - обмежувати
pipe – 1.труба 2.трубопровід
velocity – швидкість
represent – 1. являти собою; становити; бути 2. представляти; репрезентувати
law of conservation of energy – закон збереження енергії
convert – перетворювати
subtract – віднімати
discharge – виштовхувати, випускати
available – 1. наявний, присутній 2. досяжний; доступний
valve mechanism – клапанний механізм
actuating cylinder – силовий циліндр, циліндр приводу *(механізму)*
hydraulic motor – гідравлічний двигун
filter – 1. фільтр 2.фільтрувати, проціджувати, очищати
reservoir – резервуар
store – 1.зберігати 2. запасати, відкладати, накопичувати
pressure regulator – регулятор тиску
relief valve – клапан стравлювання / скидання *(тиску)*; запобіжний клапан, розвантажувальний клапан
relieve – полегшувати, зменшувати, послабляти (*тиск, напруження*);
burst – вибухати; лопатися *(про пневматику)*
aerospace-vehicle system – аерокосмічна система
power hydraulics - силова гідравліка
landing gear door – стулка ніші шасі

flight control – *(орган)* керування польотом
accurate – точний; правильний.

Exercise 2. *Read and translate text 1.*

Text 1. Hydraulics And Its Basic Principle

Hydraulics is a division of the science of fluid mechanics which includes the study of liquids and their physical characteristics, both at rest and in motion. At a very basic level, hydraulics is a mechanical function that operates through the force of liquid pressure. In hydraulics-based systems mechanical movement is produced by contained, pumped liquid, typically through cylinders moving pistons.

Hydraulic fluids make possible the transmission of pressure and energy. One of the most important properties of any hydraulic fluid is its viscosity, which is internal resistance to flow. Hydraulic fluids act as a lubricating medium, thereby reducing the friction between moving parts and carrying away some of the heat.

In general, and for practical purposes, liquids are regarded as being incompressible. This means that the volume of a given quantity of a liquid will remain constant even though it is subjected to high pressure. Because of this characteristic, it is easy to determine the volume of hydraulic fluid required to move a piston through its operating range.

A basic principle of hydraulics is expressed in Pascal's law formulated in the seventeenth century. This law states that a confined hydraulic fluid exerts equal pressure at every point and in every direction in the fluid. This is true under static conditions and when the force of gravity is not taken into consideration. In actual practice the weight of the fluid would cause a small increase in the pressure on the bottom and lower sides of the container.

When liquids are in motion, certain dynamic characteristics must be taken into consideration. One of the principal factors in liquid motion is friction. Friction exists between the molecules of the liquid and between the liquid and the pipe through which it is flowing. The effects of friction increase as the velocity of liquid flow increases. Friction in a moving liquid produces heat, and this heat represents a loss of energy in a hydraulic system. According to the law of conservation of energy,

which states that energy can neither be created nor destroyed, energy converted to heat must be subtracted from the total energy of the moving liquid. Hence, if a hydraulic pump is discharging hydraulic fluid the power available for useful work is reduced.

Basically, a simple hydraulic system requires a source of hydraulic power (the pump); pipes to carry the hydraulic fluid from one point to another; a valve mechanism to control the flow and direction of the hydraulic fluid, a device for converting the fluid power into movement (actuating cylinder or hydraulic motor), filters to clean the hydraulic fluid and reservoir to store it.

In an actual system, a pressure regulator or relief valve is necessary between the pump and the valve in order to relieve pressure when the cylinder reaches the end of its travel. Otherwise, the pump would be damaged or the tubing would burst.

The type of hydraulics applied to aircraft and other aerospace-vehicle systems is called power hydraulics because it involves the application of power through the medium of hydraulics. Among the uses of hydraulic systems in aerospace-vehicle components are the operation of landing gear doors, flight controls, brakes, and a wide variety of other devices requiring high power, quick action, and/or accurate control.

Exercise 3. *Give Ukrainian equivalents of the following terms and terminological word combinations.*

Fluid mechanics, liquid pressure, hydraulics-based system, mechanical movement, pumped liquid, hydraulic fluid, pressure transmission, resistance to flow, fluid viscosity, lubricating medium, moving parts, practical purpose, incompressible liquid, constant pressure, operating range, confined hydraulic fluid, equal pressure, static conditions, force of gravity, dynamic characteristics, principal factor, liquid motion, the law of energy conservation, hydraulic pump, available power, valve mechanism, actuating cylinder, hydraulic motor, relief valve, actual system, aerospace-vehicle system, flight controls, accurate control.

Exercise 4. *Give English equivalents of the following terms and terminological word combinations.*

Механіка рідин, гідросуміш, системи на основі гідравліки, базовий рівень, силова гідравліка , передача тиску та енергії, у

спокої та в русі, мастильний засіб, робочий цикл, постійний тиск, важливі властивості гідравлічної рідини, клапанний механізм, динамічні характеристики, гідравлічний двигун, сила тяжіння, регулятор тиску, силовий циліндр, клапан стравлювання, корисна робота, аерокосмічна система, наявна потужність, підвищення тиску, рідини, що рухаються, збереження енергії.

Exercise 5. *Make up sentences with the following word combinations.*

To study liquids at rest and in motion; to operate through the force of liquid pressure; to make possible transmission of energy; to act as a lubricating medium; to reduce friction between moving parts; to carry away some heat; to be regarded as incompressible; to remain constant; to be subjected to high pressure; to determine the volume of hydraulic fluid; to move a piston; to exert equal pressure; to be under static conditions; to cause pressure increase; to reduce friction; to increase velocity of liquid flow; to convert energy to heat; to be subtracted from energy of the moving liquid; to represent loss of energy; to relieve pressure; to damage pump; to involve application of power.

Exercise 6. *Match the terms (A) with their definitions (B).*

A	**B**
1) velocity	a) the process of moving or the way that someone or something moves.
2) friction	b) energy that can be used to make a machine work or to make electricity.
3) pressure	c) a piece of equipment that makes a vehicle go more slowly or stop.
4) motion	d) the natural force that prevents one surface from sliding easily over another surface.
5) power	e) a measure of fluid resistance to deformation at a given rate.
6) brake	f) the force produced by the quantity of gas or liquid in a place or container.
7) volume	g) the speed of something that is moving in a particular direction.
8) direction	h) the property of being resistant to compression.

9) viscosity	i) the way something or someone moves, faces or is aimed.
10) incompressibility	j) the total amount of something, especially when it is large or increasing.

Exercise 7. *Fill in the gaps with the following terms***: at rest and in motion, conservation of energy, fluid mechanics, power hydraulic, a mechanical function, a loss of energy , the study of liquids, equal pressure, the force of liquid pressure, transmission of pressure and energy, a source of hydraulic power, confined, the moving liquid.**

1. At a very basic level, hydraulics is …. that operates through …. . 2. Hydraulics is a division of the science of …. which includes …. and their physical characteristics, both …. . 3. Hydraulic fluids make possible …. . 4. Pascal's law states that …. hydraulic fluid exerts …. at every point and in every direction in the fluid. 5. Heat represents …. in a hydraulic system. 6. A simple hydraulic system requires …. . 7. The type of hydraulics applied to aircraft and other aerospace-vehicle systems is called …. . 8. According to the law of …. , energy converted to heat must be subtracted from the total energy of …. .

Exercise 8. *Say whether the following sentences are true or false. Correct the false ones.*

1. The word hydraulics is based on the Greek word for water. 2. Originally hydraulics meant the study of the physical behaviour of water at rest and in motion, but today the meaning has been expanded to include the physical behaviour of all liquids, including hydraulic fluids.
3. A basic principle of hydraulics is expressed in the law of conservation of energy formulated in the seventeenth century. 4. Pascal's law states that energy can neither be created nor destroyed. 5. According to the law of conservation of energy, energy converted to heat must be subtracted from the total energy of the liquid at rest. 6. Hydraulic fluids act as a lubricating medium, thereby increasing the friction between moving parts. 7. The effects of friction decrease as the velocity of liquid flow increases. 8. In an actual system, a pressure regulator or relief valve is not necessary between the pump and the valve. 8. The type of hydraulics applied to aircraft and other aerospace-vehicle systems is called power

hydraulics.

Exercise 9. *Answer the questions on text 1.*

1. What does hydraulics study? 2. What mechanical function does hydraulics imply at a basic level? 3. How is movement produced in hydraulics-based systems? 4. What is one of the most important properties of any hydraulic fluid? 5. Why are hydraulic fluids important as a lubricating medium? 6. Liquids are regarded as being incompressible, aren't they? What does it mean? 7. Who expressed a basic principle of hydraulics and when was it formulated? 8. What does Pascal's law state?
9. What characteristics of liquids are taken into consideration when they are in motion? 10. What does a simple hydraulic system require? 11. Why is a pressure regulator necessary between the pump and the valve? 12. Why is hydraulics applied to aerospace-vehicle systems called power hydraulics?

Exercise 10. *Put questions on the italicized words.*

1. *Hydraulic fluids* make possible *the transmission of pressure and energy*. 2. *Hydraulic fluid* acts as *a lubricating medium*. 3. *Liquids* are regarded as *being incompressible*. 4. *Dynamic characteristics* must be taken into consideration, *when liquids are in motion*. 5. *The effects of friction* increase as *the velocity of liquid flow increases*. 6. *A pressure regulator* is necessary *between the pump and the valve* in order *to relieve pressure*. 7. *Hydraulics applied to aircraft* is called *power hydraulics* because *it involves the application of power through the medium of hydraulics.*

Exercise 11. *Translate the following sentences into English.*

1. Гідравліка як розділ науки механіки рідин вивчає рідини та їх фізичні характеристики як у стані спокою, так і в русі. 2. Гідравліка діє за рахунок сили тиску рідини. 3. Гідравлічні рідини зменшують тертя між рухомими частинами і відводять частину тепла. 4. Гідравлічні рідини дозволяють передавати тиск і енергію. 5. Однією з найважливіших властивостей будь-якої гідравлічної рідини є її в'язкість, тобто внутрішній опір течії. 6. Обмежена гідравлічна рідина чинить однаковий тиск у кожній точці і в кожному напрямку потоку рідини. 7.Тип гідравліки, що

застосовується до літаків та інших аерокосмічних систем, називається силовою гідравлікою. 8. Силова гідравліка передбачає застосування сили за допомогою гідравліки. 9. В аерокосмічних транспортних засобах гідравлічні системи застосовуються для роботи стулок шасі, органів керування польотом, гальм та широкого спектру інших пристроїв, що вимагають високої потужності, швидкої дії та точного керування.

Exercise 12. *Compose a dialogue on "Hydraulics". Ask about the focus of its studies, hydraulic fluids and their properties; the basic principles expressed in Pascal's law and the law of energy conservation; power hydraulics used in aerospace-vehicle systems.*

Exercise 13. *Memorize the basic vocabulary to text 2.*

hydraulic machinery – гідравлічні машини
hydraulic brakes – гідравлічні гальма
automatic transmission – автоматична коробка передач
garbage truck – сміттєвоз
power steering system – система кермового керування з гідропідсиленням
power steering fluid – рідина для механізму посиленого кермового керування
aircraft flight control system – система керування літаком у польоті
compressibility – стисненність
convey – транспортувати, постачати, передавати, переносити
sealing – ущільнення, герметизація
efficiency – 1. ефективність, дієвість; 2. продуктивність; рентабельність
vegetable-base fluid – рідина на рослинній основі
mineral-base fluid– рідина на мінеральній основі
fire-resistant fluid – вогнестійка рідина
castor oil – рицинова олія
hydraulic-power system – гідроенергетична система
petroleum oil – нафта, нафтопродукт
fire hazard - ризик виникнення пожежі
corrosive – їдкий; корозійний;
phosphate ester – фосфат, що містить ефір, фосфорнокислий ефір
soften – робити менш твердим; розм'якшувати

dissolve – розчиняти; розріджувати; розкладати
lacquer – лак, палітура
enamel – емаль
contaminate – забруднювати; псувати
coating – покриття, захисний шар
spill – проливати, розсипати
silicone-base fluid – рідина на основі силікону
synthetic base oil – синтетичне масло
viscous – в'язкий
coupling – 1. з'єднання; 2. муфта; зчеплення; сполучення;
failure – тех. пошкодження, розрив, зупинка, аварія
automatic transmission fluid – рідина для автоматичної трансмісії

Exercise 14. *Read and translate text 2.*

Text 2. Hydraulic fluids

A hydraulic fluid or hydraulic liquid is the medium by which power is transferred in hydraulic machinery. Common hydraulic fluids are based on mineral oil or water. Examples of equipment that might use hydraulic fluids are excavators, hydraulic brakes, power steering systems, automatic transmissions, garbage trucks, aircraft flight control systems, lifts, and industrial machinery.

Hydraulic systems like the ones mentioned above will work most efficiently if the hydraulic fluid used has zero compressibility.

The primary function of a hydraulic fluid is to convey power. In use, however, there are other important functions of hydraulic fluid such as protection of the hydraulic machine components. It can serve as medium for power transfer and control, heat transfer, sealing, lubricating, providing pump efficiency, etc.

There are three principal types of hydraulic fluids: vegetable-base fluids, mineral base fluids, and fire-resistant fluids. Vegetable-base fluids are usually mixtures containing castor oil and alcohol and are coloured blue, blue-green, or almost clear. They are still used in some brake systems but are not generally found in hydraulic-power systems.

Mineral-base fluids consist of a high-quality petroleum oil and are usually coloured red. They are used in many systems, especially where

the fire hazard is comparatively low. Mineral-base fluids are less corrosive and less damaging to certain parts than other types of fluid.

Fire-resistant fluids used in transport aircraft are usually of the phosphate ester type. These fluids are coloured light green, blue, and purple. Great care must be taken to see that the units installed in the hydraulic system are of the type designed for fire-resistant fluid.

Fire resistant hydraulic fluid will soften or dissolve many types of paints, lacquers, and enamels. For this reason, areas which may be contaminated with this type of fluid must be finished with special coatings. When any of the fluid is spilled, it should immediately be removed and the area washed.

Power steering fluid is a subtype of hydraulic fluid. Most are mineral oil or silicone base fluids, while some use automatic transmission fluid, made from synthetic base oil. Automatic transmissions use fluids for their lubrication, cooling and, due to their hydraulic properties, for viscous couplings. Use of the wrong type of fluid can lead to failure of the power steering pump.

Exercise 15. *Give antonyms to the following words.*

High-quality, increase, advantage, broad, common, possible, reduce, extensively, positive, approved, soften, contaminated, coloured, slow, accurate, efficient.

Exercise 16. *Translate the derivative chains.*

Locate-located-location; lubricate-lubricated-lubrication; present-presented-presence; arrange-arranged-arrangement; detect-detected-detection; apply-applied-application; maintain-maintained-maintenance; transmit- transmitted-transmission; reduce-reduced-reduction; connect-connected-connection; correct-corrected-correction; provide-provided-provision.

Exercise 17. *Translate and memorize the words, which are used both as verbs and nouns.*

Line, change, drive, level, switch, transfer, control, supply, store, pump, flow, service, start, use, pump, filter, condition, float, design, power, present, stop, charge, discharge, fuel, balance, check, force, function.

Exercise 18. *Translate noun + noun terminological collocations.*

Mineral oil, power system, garbage truck, control system, machine component, heat transfer, pump efficiency, vegetable-base fluid, fire resistance, castor oil, brake system, transport aircraft, mineral base, hydrocarbon fluid, fire hazard.

Exercise 19. *Give English equivalents of the following terms and terminological word combinations.*

Передавати енергію; захищати компоненти гідравлічної машини; гідроенергетична система; використовуватися у гідравлічних гальмах; стисненність рідини; служити середовищем для передачі енергії та теплообміну; автоматична коробка передач; рідина для механізму посиленого кермового керування; рідина на рослинній основі; система керування літаком у польоті; вогнестійка рідина; зменшувати ризик виникнення пожежі; розчиняти фарбу; синтетичне масло; рідина для автоматичної трансмісії; забруднювати територію.

Exercise 20. *Ask questions on the missing information. Complete the following statements.*

1. Common hydraulic fluids are based on …. . 2. The primary function of a hydraulic fluid is …. . 3. Hydraulic fluid can serve as …. . 4. There are three principal types of hydraulic fluids:…. . 5. Vegetable-base fluids are used in …. .6. Mineral-base fluids consist of …. .7. Fire resistant hydraulic fluid softens or dissolves …. .8. Areas contaminated with fire resistant hydraulic fluid must be finished with …. . 9. Automatic transmissions use fluids for …. . 10. Use of the wrong type of fluid can lead to …. .

Exercise 21. *Answer the questions on text 2.*

1. What is hydraulic fluid and how important is it to machinery? 2. What are common hydraulic fluids based on? 3. What are the examples of equipment that uses hydraulic fluid? 4. What is the primary function of a hydraulic fluid? 5. What are three principal types of hydraulic fluids? 6. What is the difference between vegetable-base fluids, mineral

base fluids, and fire-resistant fluids? 7. Is power steering fluid a type of hydraulic fluid?

Exercise 22. *Make questions for each sentence using the question word given in brackets.*
1. Hydraulics studies liquids and their physical characteristics (What…? 2 questions) 2. Mineral-base fluids consist of a high-quality petroleum oil. (What…? 2 questions) 3. The pressure is the same at all points on the bottom of the container (Where …? What …? 2 questions) 4. The weight of the fluid can cause a small increase in the pressure (What …?) 3 questions). 5. Automatic transmissions use fluids for their lubrication (What? Why? When? How? Where?).

Exercise 23. *Memorize the basic vocabulary to text 3.*
internal combustion engine – двигун внутрішнього згоряння
combustion chamber – камера згоряння
oxidizer – окисник
permit – 1. дозволяти, давати дозвіл; 2. давати можливість
expand – 1. розширювати*(ся);* поширювати*(ся);* 2. збільшувати *(розмір тощо*); збільшуватися *(в розмірі);* розтягуватися
feature – риса, характерна особливість; ознака, властивість, деталь
rotor – 1. ротор; 2. *ав.* тяговий ґвинт *(вертольота)*; 3. *тех.* робоче колесо.
press – тиснути, натискати
contrast – 1. протиставляти; порівнювати, зіставляти;
2. контрастувати
external – зовнішній
steam engine – паровий двигун
working fluid – робоча рідина
actuate – 1. приводити в дію, в рух; 2. спонукати
refer – 1.відносити *(до класу тощо)*; 2. посилатися *(на когось, на щось – to)*
specifically – зокрема, саме
reciprocating engine – поршневий двигун
continuous combustion engine – двигун безперервного згоряння
intermittent-combustion engine – двигун періодичного згоряння
gas turbine – газова турбіна

portable – 1. портативний; 2. переносний; пересувний
portability – 1. портати́вність 2. *(комп.)* мобі́льність
non-electric motor – неелектричний двигун/мотор
tool – 1. інструмент; 2. засіб
vehicle – 1. засіб пересування; 2. *pl* транспорт, що рухається; 3. літальний апарат
put out – розповсюджувати
obsolete – невживаний, що вийшов з ужитку; застарілий
discard – 1. відкидати; відмовлятися; 2. списувати *(через непридатність)*
strength – сильна сторона, перевага
weakness – слабка сторона, недолік
energy-dense fuel – енергонасичене паливо
deliver – 1. доставляти, розносити; 2. *тех.* виробляти, постачати
power-to-weight ratio – відношення потужності до ваги
steady flow – сталий потік
stable flame – стійке полум'я
ignition – запалювання, запал
discrete – окремий; дискретний
cyclic – циклічний
spark-ignition engine – двигун із іскровим запалюванням
spark plug – свічка запалювання
compression-ignition engine – двигун із запалюванням від стиснення

Exercise 24. *Read and translate text 3.*

Text 3. Internal combustion engine

The internal combustion engine is an engine in which the burning of a fuel occurs in a confined space called a combustion chamber. This reaction of a fuel with an oxidizer creates gases of high temperature and pressure, which are permitted to expand. The main feature of an internal combustion engine is that useful work is performed by the expanding hot gases acting directly to cause movement, for example by acting on pistons, rotors, or even by pressing on and moving the entire engine itself.

This contrasts with external combustion engines, such as steam engines, which use the combustion process to heat a separate working flu-

id, typically water or steam, which then in turn does work, for example by pressing on a steam actuated piston.

The term Internal Combustion Engine (ICE) is almost always used to refer specifically to reciprocating engines and similar designs in which combustion is intermittent. However, continuous combustion engines, such as jet engines, most rockets and many gas turbines are also internal combustion engines.

Internal combustion engines are seen mostly in transportation. Several other uses are for any portable situation where you need an non-electric motor. The largest application in this situation would be an internal combustion engine driving an electric generator. That way, you can use standard electric tools driven by an internal combustion engine.

The advantage of this engine type is the portability. It is more convenient to use this type of engine in vehicles over electricity. Even in cases of hybrid vehicles, they still use an internal combustion engine to charge the battery. The disadvantage is the pollution that they put out. Here we mean not only the obvious air pollution, but also pollution of broken or obsolete engines and waste parts, such as oil or rubber items that have to be discarded. Noise pollution is another factor as many internal combustion engines are very loud.

A large number of different designs for ICEs have been developed and built with a variety of different strengths and weaknesses. Powered by an energy-dense fuel, which is very frequently petrol, the ICE delivers an excellent power-to-weight ratio.

Internal-combustion engines are divided into two groups: continuous-combustion engines and intermittent-combustion engines. The continuous-combustion engine is characterized by a steady flow of fuel and oxidizer into the engine. A stable flame is maintained within the engine e.g., jet engine. The intermittent-combustion engine is characterized by periodic ignition of air and fuel and is commonly referred to as a reciprocating engine. Discrete volumes of air and fuel are processed in a cyclic manner. Gasoline piston engines and diesel engines are examples of this second group.

There are two main types of internal-combustion engines: gasoline engines and diesel engines. The gasoline engine, found in most cars, is a spark-ignition engine. It uses electricity and spark plugs to ignite the fuel and air mixture in the engine cylinders. The diesel engine is a com-

pression-ignition engine. It compresses the air in the cylinders, causing the temperature of the air to rise. Fuel injected into the hot, compressed air immediately ignites.

Exercise 25 . *Translate the terms and verb combinations from text 3.*

a) internal combustion engine, oxidizer, steam engine, reciprocating engine, continuous combustion engine, jet engine, gas turbine, an non-electric motor, electric generator, electric , energy-dense fuel, power-to-weight ratio, intermittent-combustion, steady flow, stable flame, periodic ignition, discrete volume, diesel engine, cyclic manner, spark-ignition engine, compression-ignition, hybrid vehicles;

b) to create gases of high temperature; to expand gases; to perform useful work; to cause movement; to heat working fluid; to actuate a piston; to refer specifically to reciprocating engine; to drive an electric generator; to charge a battery; to put out pollution; to have strengths and weaknesses; to be powered by energy-dense fuel; to maintain stable flame; to be processed in a cyclic manner; to ignite fuel; to compress the air in the cylinder; to cause temperature rise; to inject fuel.

Exercise 26 . *Give English equivalents of the following terms and terminological word combinations.*

Реакція палива; корисна робота; робоча рідина; газова турбіна; енергонасичене паливо; сталий потік; паровий поршень, стійке полум'я; циклічний спосіб; гарячі гази, що розширюються; забруднення повітря; окисник; відпрацьовані частини; застарілі двигуни; періодичне горіння палива; бензиновий поршневий двигун.

Exercise 27. *Match the English – Ukrainian equivalents.*

1) continuous combustion engine	a) двигун із запалюванням від стиснення
2) spark-ignition engine	b) камера згоряння
3) steam engine	c) двигун внутрішнього згоряння
4) reciprocating engine	d) двигун безперервного згоряння
5) compression-ignition engine	e) свічка запалювання
6) combustion chamber	f) паровий двигун
7) internal combustion engine	g) бензиновий поршневий двигун

8) intermittent-combustion engine	h) двигун із іскровим запалюванням
9) non-electric motor	i) двигун періодичного згоряння
10) gasoline piston engine	j) енергонасичене паливо
11) spark plug	k) поршневий двигун
12) energy-dense fuel	l) неелектричний двигун

Exercise 28. *Complete the sentences giving English equivalents of the words in brackets.*

1. The internal combustion engine is an engine in which (горіння палива відбувається в замкнутому просторі, який називається камерою згоряння). 2. The main feature of an internal combustion engine is that (корисна робота виконується гарячими газами, які діють безпосередньо, викликаючи рух). 3. External combustion engines use the combustion process (нагріти окрему робочу рідину). 4. Continuous combustion engines, such as (реактивні двигуни, більшість ракет і багато газових турбін) are also internal combustion engines. 5. The disadvantage of internal combustion engines is (забруднення зламаних або застарілих двигунів і відпрацьованих частин, таких як масло або гумові вироби, які необхідно утилізувати). 6. Internal combustion engines (забезпечує чудове співвідношення потужності та ваги). 7. Internal-combustion engines are divided into two groups: (двигуни безперервного згоряння та двигуни періодичного згоряння). 8. The continuous-combustion engine is characterized by (постійним потоком палива та окислювача у двигун.)

Exercise 29. *Explain the difference between the following terms.*

Internal combustion engine and external combustion engine; continuous-combustion engine and intermittent-combustion engine; gasoline engine and diesel engine; a spark-ignition engine and compression-ignition engine.

Exercise 30. *Answer the questions on text 3.*

1. Where does burning of fuel occur in the internal combustion engine? 2. What does the reaction of a fuel with an oxidizer create? 3. Is the main feature of an internal combustion engine that useful work is

performed by heated working fluid pressing on a steam actuated piston? 4. What is the term Internal Combustion Engine specifically referred to? 5. What are the examples of continuous combustion engines? 6. Where are internal combustion engines mostly used today? 7. What are the advantages and disadvantages of internal combustion engines? 8. What groups are internal combustion engines divided into? 9. Is continuous-combustion or intermittent-combustion engine characterized by periodic ignition of air and fuel? 10. Is the gasoline engine, found in most cars a spark-ignition or compression-ignition engine?

Exercise 31. *Open the brackets using the verb in the Present Indefinite Active or Passive*

1. An engine (gain) its energy from heat released during the combustion of the nonreacted working fluids and the oxidizer-fuel mixture. 2. Useful work (generate) by an internal-combustion engine. 3.The engine (convert) the energy from the combustion to work. 4. The fuel (mix) with air and then (induct) into the cylinder during the intake process. 5. Internal-combustion engines the most broadly (apply) and a widely (use) power-generating devices. 6. The engine (consist) of a fixed cylinder and a moving piston. 7. Internal-combustion engines (divide) into two groups: continuous-combustion engines and intermittent-combustion engines. 8. The continuous-combustion engine (characterize) by a steady flow of fuel and oxidizer into the engine. 9. Internal-combustion engines can (combine) with hybrid electric powertrains to increase fuel economy. 10. A stable flame (maintain) within the engine.

Exercise 32. *Change sentences from Active to Passive.*

1. An internal-combustion engine generates useful work. 2. The compressor compresses the air. 3. The hot gases drive turbines directly without a combustion chamber. 4. An engine gains its energy from heat released during the combustion. 5. Compressors provide the required pressure ratio. 6. The combustion chamber expands the air by burning fuel in the air stream. 7. The exhaust cone discharges exhaust gases. 8. The exhaust cone discharges exhaust gases.

Exercise 33. *Translate the following sentences into English.*

1. Термін «двигун внутрішнього згоряння» відноситься до поршневих двигунів та подібних конструкцій, у яких згоряння є переривчастим. 2.Двигуни внутрішнього згоряння найчастіше зустрічаються на транспорті. 3. Двигуни внутрішнього згоряння використовуються для будь-яких ситуацій, коли потрібен неелектричний двигун. 4. Гібридні транспортні засоби все ще використовують двигун внутрішнього згоряння для зарядки акумулятора.
5. У реактивному двигуні підтримується стабільне полум'я. 6. Прикладами двигунів переривчастого згоряння є бензинові поршневі та дизельні двигуни. 7. Бензиновий двигун використовує електрику та свічки запалювання для запалювання паливно-повітряної суміші в циліндрах двигуна. 8. Дизельний двигун стискає повітря в циліндрах, викликаючи підвищення температури повітря.

Exercise 34. *Put questions of different kinds on the following sentences.*

1. Internal-combustion engines are the most widely used power-generating devices. 2. The engine gains its energy from heat released during the combustion of oxidizer-fuel mixture. 3. The combustion process occurs within the engine. 4. The continuous-combustion engine is characterized by a steady flow of fuel and oxidizer into the engine.
5. Examples of internal-combustion engines include gasoline engines, diesel engines, gas-turbine engines, and rocket-propulsion systems. 6. There are two kinds of internal combustion engines currently in production: the spark ignition gasoline engine and the compression ignition diesel engine. 7. Discrete volumes of air and fuel can be processed in a cyclic manner.

Exercise 35. *Speak about internal-combustion engine: its types and classification; design; main principle of operation; advantages and disadvantages; its possible application.*

Exercise 36. *Memorize the basic vocabulary to text 4.*

Gasoline engine – бензиновий двигун
heat engine – тепловий двигун

power – 1. сила, потужність; енергія; 2. приводити в дію/рух; 3. живити *(електро)*енергією
motor vehicle – автомобіль
piston-driven – з поршневим приводом
rotary engine – роторний двигун
move up and down – рухатися вгору та вниз
back and forth – назад-вперед
crankshaft – колінчатий вал
reciprocating motion – зворотно-поступальний рух
rotary motion – обертальний рух
piston stroke – хід поршня
valve - клапан
arrangement – розташування
two- /four-stroke cycle – дво/ чотиритактний цикл
fuel-air mixture – паливно-повітряна суміш
intake – впускний пристрій; забірний отвір *(насоса)*; впуск;
exhaust stroke – хід випуску/вихлопу
power stroke – робочий хід
fuel-efficient – паливозберігаючий
lawn-mover - газонокосарка
compression ratio – ступінь стискання
high-compression engine – двигун з високим ступенем стиснення
high-octane gasoline – високооктановий бензин
lead - свинець
additive – присадка *(до масла);* добавка *(до палива)*
pollutant – речовина, що забруднює
automobile exhausts – вихлопи автомобілів
catalytic converter – каталітичний конвертор
interfere – шкодити, завдавати шкоди
lead-free gasoline – бензин без вмісту свинця

Exercise 37. *Read and translate text 4.*

Text 4. Kinds of gasoline engines

A gasoline engine is a type of heat engine, specifically an internal combustion, that is powered by gasoline. These engines are the most common ways of making motor vehicles move. While turbines can be

powered by gasoline, a gasoline engine refers specifically to piston-driven gasoline engines.

There are two main types of gasoline engines, reciprocating engines and rotary engines. Reciprocating engines have pistons that move up and down or back and forth. A part called a crankshaft changes this reciprocating motion into rotary motion. A rotary engine uses devices called rotors instead of pistons. The rotors produce rotary motion directly. We will consider reciprocating engines, the more common type.

Reciprocating gasoline engines are classified in a number of ways. These include:

1) by the number of piston strokes per cycle;
2) by the type of compression;
3) by the way they are cooled;
4) by their valve arrangement;
5) by their cylinder arrangement;
6) by the way they are supplied with air and fuel.

Cycle. Most reciprocating gasoline engines operate on either a two-stroke or a four-stroke cycle. Cycle means the steps that must be repeated for each combustion of the fuel-air mixture in the cylinders. Stroke means the up-and-down or back-and-forth movements of the pistons. A four-stroke cycle engine has intake, compression, power, and exhaust strokes. A two-stroke cycle engine combines the exhaust and intake steps near the end of the power stroke. Although two-stroke cycle engines are less fuel-efficient than four-stroke cycle engines, they are simpler and cheaper to build. A two-stroke cycle engine is used where low cost is important, as in a power lawn mover. It delivers more power for a given weight and size than does a four-stroke cycle engine. Each cylinder in a two-stroke cycle engine produces a power stroke for every turn of the crankshaft. But in a four-stroke cycle engine, a cylinder produces a power stroke on every other turn.

High and low compression. As a piston moves from the bottom to the top of a cylinder, it compresses the air and gasoline mixture. A number, called the compression ratio, tells how much the mixture is compressed. A high-compression engine may have a compression ratio of 10 to 1. Such an engine compresses the mixture to a tenth of its original volume. A low-compression engine may have a ratio of 8 to 1.

High-compression engines burn gasoline more efficiently than do low-compression engines. But high-compression engines require high-octane gasoline. Until the 1970's, the octane level of gasoline depended on the amount of lead additives - the more lead, the higher the octane. In the mid-1970s, manufacturers began to equip automobiles with devices called catalytic converters that reduce the pollutants in automobile exhausts. Lead was found to interfere with the effectiveness of catalytic converters. Automobiles with catalytic converters had to use low-octane gasoline because high-octane lead-free gasoline was costly to use.

The widespread use of gasoline engines explains why the world takes so much oil out of the ground to refine into petroleum products like gasoline. Worldwide, transportation is roughly 18% of our primary energy use and gasoline is a little less than half of that. This means that gasoline engines use roughly 8% of the total primary energy of the world.

Exercise 38. *Translate the terms and verb combinations from text 4.*

a) heat engine, motor vehicles, piston-driven gasoline engine, rotary engine, crankshaft, reciprocating motion, rotary motion, piston stroke, valve arrangement, four-stroke cycle, fuel-air mixture, exhaust stroke, power stroke, fuel-efficient engine, gasoline mixture, compression ratio, high-compression engine, high-octane gasoline, lead additive, catalytic converter, automobile exhausts, low-octane gasoline, lead-free gasoline, gasoline product;

b) to be powered by gasoline; to move up and down; to move back and forth; to produce rotary motion; to operate on a two-stroke cycle; to be less fuel-efficient; to produce a power stroke; to moves from the bottom to the top of a cylinder; to compresses air and gasoline mixture; to equip automobile with catalytic converters; to depended on the amount of lead additives.

Exercise 39. *Answer the questions on text 4.*

1. What type of engine is a gasoline engine? 2. Does a gasoline engine refer to piston-driven or turbine-driven gasoline engines? 2. What are the two main types of gasoline engines? 3. What is the difference between reciprocating engines and rotary engines? 4. How are reciprocating gasoline engines classified? 5. What cycle do most reciprocating gasoline engines operate on? 6. What does a stroke mean?

7. Which engine is more fuel-efficient two-stroke cycle or four-stroke cycle one? 8. Where is a two-stroke cycle engine mostly used? 9. What number is called compression ratio? 10. Which engine burns fuel more efficiently high-compression or low-compression one? 11. Why did automobile manufacturers begin to equip their automobiles with catalytic converters? 12.Do gasoline engines constitute a large part of the world transport?

Exercise 40. *Translate the following sentences into English.*

1. Бензиновий двигун - це тип теплового двигуна, який працює на бензині. 2. Існує два основних типи бензинових двигунів: поршневі та роторні двигуни. 3. Бензиновий двигун відноситься до поршневих бензинових двигунів. 4. Колінчастий вал перетворює зворотно-поступальний рух на обертальний. 5. Роторний двигун замість поршнів використовує ротори. 6. Більшість поршневих бензинових двигунів працюють на двотактному або чотиритактному циклі. 7. Двотактний двигун використовується там, де важлива низька вартість. 8. Чотиритактний двигун має такти впуску, стиснення, робочого ходу та випуску. 9. Двигуни з високою компресією спалюють бензин більш ефективно, ніж двигуни з низькою компресією.

Exercise 41. *Compose a dialogue on the basis of text 4. Speak about gasoline engine; its types and classification; design; main principle of operation; advantages and disadvantages; its possible application.*

Exercise 42. *Memorize the basic vocabulary to text 5.*

ignite – запалювати
freight truck – вантажівка
diesel-powered – дизельний, з дизельним двигуном
electric-power generator – електрогенератор
set – установка; агрегат
intermittent-combustion piston-cylinder device – поршнево-циліндровий пристрій періодичного згоряння
spark-ignition engine – двигун з іскровим запалюванням
induce – 1. *ел.* індукувати; 2. *фіз.* наводити

intake stroke – такт впуску, хід впуску
in the range – у діапазоні
gain – одержувати, здобувати, діставати
spray –розпилювати; пульверизувати; розбризкувати
charge – 1.заряд; 2. пальна суміш
in excess– в надлишку
initiation – 1. виникнення, почáток 2. ініціювання
electric spark – електрична іскра
dead centre – мертва точка
precombustion chamber – камера попереднього згоряння
piston-cylinder combustion chamber – поршнево-циліндрова камера згоряння
obtain – 1. одержувати; діставати, здобувати;2. досягати
cease – переставати; припиняти*(ся)*
achieve – досягати , добиватися
drawback – хиба; вада
particulate matter – тверді частинки
reactive nitrogen compound – реактивна сполука азоту
odour – запах, пахощі
consequently – отже; тому; а тому
consumer acceptance – прийняття споживачем

Exercise 43. *Read and translate text 5.*

Text 5. Diesel engine

Diesel engine, any internal-combustion engine in which air is compressed to a sufficiently high temperature to ignite diesel fuel injected into the cylinder, where combustion and expansion actuate a piston. It converts the chemical energy stored in the fuel into mechanical energy, which can be used to power freight trucks, large tractors, locomotives, and marine vessels. A limited number of automobiles also are diesel-powered, as are some electric-power generator sets.

The diesel engine is an intermittent-combustion piston-cylinder device. It operates on either a two-stroke or four-stroke cycle; however, unlike the spark-ignition gasoline engine, the diesel engine induces only air into the combustion chamber on its intake stroke. Diesel engines are typically constructed with compression ratios in the range 14:1 to 22:1.

The diesel engine gains its energy by burning fuel injected or sprayed into the compressed, hot air charge within the cylinder. The air must be heated to a temperature greater than the temperature at which the injected fuel can ignite. Fuel sprayed into air that has a temperature higher than the "auto-ignition" temperature of the fuel spontaneously reacts with the oxygen in the air and burns. Air temperatures are typically in excess of 526 °C (979 °F). Diesel engines are sometimes called compression-ignition engines because initiation of combustion relies on air heated by compression rather than on an electric spark.

In a diesel engine, fuel is introduced as the piston approaches the top dead centre of its stroke. The fuel is introduced under high pressure either into a precombustion chamber or directly into the piston-cylinder combustion chamber. Engine work is obtained during the power stroke. The power stroke includes both the constant-pressure process during combustion and the expansion of the hot products of combustion after fuel injection ceases.

The most outstanding feature of the diesel engine is its efficiency. Higher compression ratios can be achieved with diesel engines than with the spark-ignition variety. It should be noted that for a given compression ratio the theoretical efficiency of the spark-ignition engine is greater than that of the compression-ignition engine.

The principal drawback of diesel engines is their emission of air pollutants. These engines typically discharge high levels of particulate matter, reactive nitrogen compounds, and odour compared with spark-ignition engines. Consequently, in the small-engine category, consumer acceptance is low.

Exercise 44. *Form antonymous adjectives from the following words by adding negative prefixes:* **-in, -ir, -dis, -im, -un, -il** *and translate them.*

Active, able, capable, relevant, formal, dependent, direct, legal, safe, necessary, logical, possible, efficient, visible, practical, measurable, secure, regular, predictable, usual, responsible, probable, reliable.

Exercise 45. *Translate the derivative chains.*

Accomplish - accomplished - accomplishment; accuracy - accurate - accurately; achieve- achievement - achievable; combine - combination -

combined; compare - comparison - comparative - comparatively; define-definition - definite - definitely; fail - failure; harm - harmful- harmfully; innovate - innovator - innovation - innovative; limit-limitation - limited; period - periodical - periodically; save – (un)safe - safety - safely; separate - separation - separately; use - user - useful - usefully.

Exercise 46. *Find English equivalents in text 5.*

Електрогенератор, поршнево-циліндровий пристрій періодичного згоряння, з дизельним двигуном, такт впуску, поршнево-циліндрова камера згоряння, пальна суміш, у діапазоні, камера попереднього згоряння, прийняття споживачем.

Exercise 47. *Give definitions of the following terms.*

Internal-combustion engine, continuous-combustion engine, intermittent-combustion engine, gasoline engine, diesel engine, reciprocating engine, rotary engine, compression-ignition engine, engine efficiency.

Exercise 48. *Put key questions on text 5*

Exercise 49. *Compose a summary of text 5.*

Exercise 50. *Compose a dialogue on the basis of text 5. Speak about diesel engine; its design; main principle of operation; advantages and disadvantages; its possible application.*

Exercise 51. O*n the basis of texts 3-5 speak about different types of engines. Compare their design, operation, advantages and disadvantages, possible application.*

Exercise 52 . *Memorize the basic vocabulary to text 6.*

Gas-turbine engine – газотурбінний двигун
employ – вживати, застосовувати, використовувати
conventionally – традиційно; стандартно; звичайно
compressor – компрессор
inlet duct and guide vanes – вхідний напрямний апарат

supply – 1. постачати *(щось – with)*; 2. доставляти, поставляти; 3. *mex.* подавати, підводити *(струм);* живити
pressure ratio – ступінь стиснення
diffuser – дифузор
air stream – повітряний потік
additional – додатковий
nozzle diaphragm – сопловий апарат
exhaust cone – конус реактивного сопла
extract – вилучати, відбирати
jet stream – реактивний потік
accessory – 1. додатковий; другорядний; допоміжний; 2. *pl* приладдя, аксесуари, приналежності; арматура, обладнання
afterburner – форсажна камера
transition – перехід, переміщення
nozzle vane – лопатка соплового апарату
bucket – лопатка *(турбіни)*
proper – правильний, належний
angle – кут
turbine wheel – робоче колесо турбіни
expel – виштовхувати, викидати
motive power – рушійна сила
jet propulsion – реактивний рух
compete – 1. змагатись; 2. конкурувати *(against, with)*
power station – електростанція
incorporate – об'єднувати*(ся);* з'єднувати*(ся);* сполучатися; приєднуватися *(into)*
oil refining – переробка нафти
pressurize – 1. герметизувати; 2. *mex.* підтримувати великий тиск
centrifugal compressor – відцентровий компресор

Exercise 53. *Read and translate text 6.*

Text 6. Main sections of the gas turbine engine

Gas-turbine engine is any internal-combustion engine employing gas as the working fluid to turn a turbine. The term also is conventionally used to describe a complete internal-combustion engine consisting of a compressor, a combustion chamber, and a turbine.

Any gas turbine engine consists of three main sections: the compressor section, the combustion section and the turbine section. The air enters the engine through the inlet duct and guide vanes.

The function of the inlet duct and guide vanes is to supply air to the engine inlet under all conditions of operation. Aircraft engine inlet ducts have various shapes. From the inlet duct the air flows to the compressor. The compressor is located after the inlet duct. The function of the compressor is to compress the air and to provide the required pressure ratio. From the compressor section through the diffuser the compressed air flows to the combustion section. There the combustion chamber is located.

The function of the combustion chamber is to expand the air by burning fuel in the air stream. The turbine section of the engine is located after the combustion chamber between two additional components: the nozzle diaphragm and exhaust cone. The turbine section is designed to extract power from the jet stream to drive the compressor and accessories.

The diffuser, the nozzle diaphragm, the exhaust cone, the afterburner and the accessory section serve to provide transition from one main section to another. The diffuser directs air from the compressor to the combustion chamber and serves to change air pressure and velocity. A typical nozzle diaphragm consists of a group of nozzle vanes. The function of the nozzle diaphragm is to increase the velocity of the heated gases and to direct them to strike the turbine buckets at the proper angle.

The exhaust cone is located directly behind the turbine wheel and its main function is to collect burned gases from the turbine wheel and expel them at the correct velocity. In many cases the afterburner is used with turbojet engines. The afterburner serves for burning additional amount of fuel to increase power.

By far the most important use of gas turbines is in aviation, where they provide the motive power for jet propulsion. In the field of electric power generation, gas turbines must compete with steam turbines in large central power stations and with diesel engines in smaller plants. Even though the initial cost of a gas turbine is less than either alternative for moderately sized units, its efficiency is also lower.

Industrial gas-turbine engines can be used for many applications. These include driving compressors for pumping natural gas through

pipelines, where a small part of the pumped gas serves as the fuel. A gas turbine can also be incorporated in an oil refining process. The hot gases drive a turbine directly without a combustion chamber. The turbine, in turn, drives a compressor to pressurize the air for the process. Small portable gas turbines with centrifugal compressors also have been used to operate pumps.

Exercise 54. *Translate **"noun + noun"** terminological collocations.*

Inlet duct, guide vanes, compressor section, engine inlet, combustion section, pressure ratio, air stream, engine operation, turbine section, jet stream, turbine bucket, air pressure, turbine wheel, engine bottom, aircraft operation, combustion chamber, exhaust cone, operation mode, flight range, engine thrust, jet propulsion.

Exercise 55. *Make up sentences using the following word combinations.*

To enter the engine, to supply air, to have various shapes, to expand air, to compress air, to provide the required pressure ratio, to burn fuel, to extract power, to drive the compressor, to provide transition, to increase the velocity, to strike the turbine buckets, to change air pressure, to collect burned gases, provide the motive power, to operate pumps.

Exercise 56. *Match the English - Ukrainian equivalents.*

1) turbine wheel	a) секція допоміжних агрегатів
2) combustion chamber	b) конус реактивного сопла
3) nozzle diaphragm	c) напрямна лопатка
4) turbine bucket	d) вхідний отвір двигуна
5) nozzle vane	e) ступінь стискання
6) pressure ratio	f) лопатка соплового апарата
7) exhaust cone	g) колесо турбіни
8) engine inlet	h) сопловий апарат
9) guide vane	i) камера згоряння
10) accessory section	j) лопатка турбіни

Exercise 57. *Give English equivalents of the following terms and terminological word combinations.*

Вхідний напрямний апарат; необхідний ступінь стиснення; відпрацьований газ; реактивний потік; секція допоміжних агрегатів; додаткова кількість палива; конус реактивного сопла; вхідний отвір двигуна; сопловий апарат; форсажна камера, промислові газотурбінні двигуни, рушійна сила, електростанція, переробка нафти.

Exercise 58. *Complete the following sentences.*

			supply …
	inlet duct		direct …
	guide vanes		compress …
	compressor		provide …
	diffuser		serve …
The function of the	combustion chamber	is to	change …
	nozzle diaphragm		expand …
	turbine section		accelerate …
	exhaust cone		extract …
	afterburner		burn …
	accessory section		drive …
			expel …

Exercise 59. *Translate the following prepositions and prepositional phrases.*

In front of, at the nose, before, after, between, behind, below, up, beyond, near, down, above, inside, outside, round, towards, under, with, from, through, to, at the bottom, at the top.

Exercise 60. *Fill in the blanks with proper prepositions*

1. … the inlet duct the air flows … the compressor. 2. The compressor is located … the inlet duct. 3. … the compressor section … the diffuser the compressed air flows … the combustion section. 4. The combustion section is located … the diffuser and the nozzle diaphragm.

5. The turbine section of the engine is located … the combustion chamber … two additional components: the nozzle diaphragm and exhaust cone. 6. The exhaust cone is located … the turbine wheel. 7. The afterburner may be located … the turbine wheel to increase power.

Exercise 61. *Answer the questions on text 6.*

1. What main sections does any gas turbine engine consist of ? 2. What enters the engine through the inlet duct and guide vanes? 3. Where is the compressor located? 4. What is the function of the compressor? 5. What air flows through the diffuser to the combustion chamber? 6. Does the diffuser direct the air to the compressor or to the combustion chamber? 7. What is located after the combustoin chamber? 8. What section is designed to extract power from the jet stream for driving the compressor and accessories? 9. What components serve to provide transition from one main section to another? 10. What does the exhaust cone serve for? 11. What is the function of the combustion chamber? 12. What does the nozzle diaphragm serve for? 13. What is the application of a gas turbine in aviation? 14. What can ndustrial gas-turbine engines be used for?

Exercise 62. *Translate the following sentences into English.*

1. Призначення повітрозабирача - подавати повітря до двигуна. 2. Повітрозабирачі можуть мати різні форми. 3. Конструкція повітрозабирача доволі проста. 4. Напрямні лопатки спрямовують повітря в компресор. 5. Конструкція повітрозабирача має багато переваг. 6. Повітрозабирач складається із зовнішнього та внутрішнього кожухів. 7. Компресор - це та частина двигуна, де повітря стискається до певного ступеня. 8. Камера згоряння знаходиться між дифузором і сопловим апаратом. 9. Функція камери згоряння – розширювати повітря шляхом спалювання палива в повітря-ному потоці. 10. Секція турбіни двигуна призначена для того, щоб вилучати енергію з високошвидкісних газів, що залишають камеру згоряння, для приведення в дію компресора та допоміжних агрегатів.

Exercise 63. *Memorize the basic vocabulary to text 7.*

compressor station – компресорна станція

gas compressor unit – газокомпресорна установка
oil and gas production field – родовище видобутку нафти і газу
industrial facility – промисловий об'єкт
flow rate – швидкість потоку
network – мережа
carrying capacity – пропускна здатність
re-pressurize – відновити тиск
channel – пускати по каналу; направляти в русло
enable – 1. давати змогу (*можливість*) 2. робити можливим; полегшувати
transport line – транспортна мережа
natural gas engine – двигун, що працює на природному газі
reciprocating compressor – поршневий компресор
critical – важливий, вагомий
incoming gas – вхідний газ
gas turbine driven – з приводом від газової турбіни
electric type driven – з електричним приводом
engine driven compressor – компресор з приводом від двигуна
rub – 1. терти 2. тертися *(об щось)*
suit – підходити, годитися
continuous-duty – безперервний режим роботи
ventilation fan – *(витяжний)* вентилятор
air mover – вентилятор
cooling unit – блок охолодження
vaned disk – диск з лопатками
housing – корпус, кожух
rim – 1. обід; край 2. бандаж *(обода)*
impeller – обертове силове [робоче] колесо *(вітродвигуна, водяної або газової турбіни, повітряної помпи, газового компресора)*; крильчасте колесо
stationary – нерухомий; закріплений; стаціонарний
multi-staged – багатоступеневий
horsepower (hp) – потужність у кінських силах
automotive – автомобільний
intermittent – періодичний
axial-flow compressor – осьовий компресор
fan-like – віялоподібний

rotor blade – робоча лопать турбіни, лопать ротора
diminish – 1. зменшувати, убувати 2. послабляти
Mach number – число Маха *(безрозмірна величина, що дорівнює відношенню швидкості газу до місцевої швидкості)*
purify – очищувати*(ся) (від чогось – of)*
refrigeration system – холодильна система
submarine – підводний човен
air brake – пневматичне гальмо

Exercise 64. *Read and translate text 7.*

Text 7. Compressor stations and gas compressor units

Natural gas must travel long distances from the oil and gas production fields to industry users and end customers. A natural gas compression station is an industrial facility that stabilizes the pressure and flow rate of gases within a pipeline network at optimal levels required to obtain the maximum carrying capacity. A properly operated gas compression facility efficiently collects gas reaching it, re-pressurizes it and channels it to various industries and end processes.

Natural gas flowing through a pipeline needs to be pressurized at intervals typically between 40-100 miles to enable it to continue flowing at the desired rate. This routine augmentation in the pipeline pressure is required to correct losses that occur as pressure loss is experienced along the transport line.

Natural gas compressor stations utilize electric motors, natural gas engines and gas turbines to power reciprocating and centrifugal compressors that are their most critical parts. Gas compressor is used to collect incoming gas, compress it to increase its flow pressure, and channel it to the next station. Depending on the volume of gas to be processed and the distance, the size of the compressor and quantity of compressor stations will vary.

In general, a gas compressor unit is a mechanical device that increases the pressure of a gas by reducing its volume. Compressors are similar to pumps: both increase the pressure on a fluid and both can transport

the fluid through a pipe. Most of the high-pressure natural gas compressor stations use one of three types of compressor/engine systems to achieve gas re-pressurization: gas turbine driven centrifugal compressors, electric type driven centrifugal or reciprocating compressors and reciprocating engine driven compressors.

Centrifugal compressors are used throughout industry because they have fewer rubbing parts. Centrifugal fan is more suited to continuous-duty applications such as ventilation fans, air movers, cooling units, and other uses that require high volume with little or no pressure increase. Centrifugal compressors use a vaned rotating disk or impeller in a shaped housing to force the gas to the rim of the impeller, increasing the velocity of the gas. A diffuser section converts the velocity energy to pressure energy.

Reciprocating compressors use pistons driven by a crankshaft. They can be either stationary or portable, can be single or multi-staged, and can be driven by electric motors or internal combustion engines. Small reciprocating compressors from 5 to 30 horsepower (hp) are commonly seen in automotive applications and are typically for intermittent duty. Larger reciprocating compressors up to 1000 hp are still commonly found in large industrial applications, but their numbers are declining as they are replaced by various other types of compressors.

Another widely used type of gas compressors is *axial-flow compressor*. Axial-flow compressors use a series of fan-like rotor blades to progressively compress the gas flow. Stationary stator vanes, located downstream of each rotor, redirect the flow onto the next set of rotor blades. The area of the gas passage diminishes through the compressor to maintain a roughly constant axial Mach number. Axial-flow compressors are normally used in high flow applications, as a medium to large gas turbine engines. They are almost always multi-staged.

Gas compressors are useful for a wide variety of applications, including: transporting natural gas through pipelines, storing purified gases in small volumes, compressing intake air in gas turbines, pressurizing aircraft cabins, moving heat in refrigeration systems, storing air in submarines, and providing compressed air for air brakes.

Exercise 65. *Give Ukrainian equivalents of the following terms and terminological word combinations.*

Oil and gas production field, industrial facility, flow rate, pipeline network, carrying capacity, transport line, natural gas engine, critical part, flow pressure, gas turbine driven centrifugal compressor, electric type driven centrifugal compressor, ventilation fan, air mover, cooling unit, rim of the impeller, multi-staged compressor, horsepower, axial-flow compressor, high-pressure natural gas, fan-like rotor blade, Mach number, air brakes

Exercise 66. *Translate the verb combinations from text 7.*

To travel long distances, to stabilize pressure, to collects gas, to re-pressurize gas, to channel to end process, to continue flowing, to correct losses, to utilize electric motor, to increase pressure, to reduce volume, to achieve re-pressurization, to convert energy, to move heat, to provide compression, to purify gas.

Exercise 67. *Make up sentences with the following verb combinations.*

To obtain the maximum carrying capacity; to channel gas to various industries and end processes; to be pressurized at intervals; to transport fluid through a pipe; to be suited to continuous-duty applications; to require high volume; to be driven by a crankshaft; to force the gas to the rim of the impeller; to increase velocity of the gas; to convert velocity energy to pressure energy; to progressively compress the gas flow; to be located downstream of each rotor; to redirect the flow onto the next set of rotor blades.

Exercise 68. *Find English equivalents in text 7.*

Промисловий об'єкт; отримувати максимальну пропускну здатність, відновити тиск газу; транспортна мережа; поршневий компресор з приводом від газового двигуна; безперервний режим роботи; блок охолодження; лопатевий диск; витяжний вентилятор; багатоступеневий поршневий компресор; розташовуватися нижче кожного ротора; використовувати серію віялоподібних лопатей ротора; поступово стискати газовий потік; підтримувати постійне осьове число Маха; великі промислові застосування; забезпечувати стиснення повітря для пневматичних гальм.

Exercise 69. *Complete the following statements based on text 7.*

1.Natural gas must travel long distances from …. to …. . . 2. A natural gas compression station is an industrial facility that stabilizes …. to obtain the maximum carrying capacity. 3. A properly operated gas compression facility is used to …. . 4. Natural gas compressor stations utilize …. . 5. A gas compressor unit is a mechanical device that …. . 6. Compressors are similar to pumps: both …. 7. Centrifugal compressors are used throughout industry because …. . 8. Reciprocating compressors can be … . 9. Axial-flow compressors use …. .10. Gas compressors are useful for a wide variety of applications, including: …. .

Exercise 70. *Give definitions of the following terms.*

Natural gas compressor station, natural gas engine, gas compressor unit, centrifugal compressor, reciprocating compressor, axial-flow compressor.

Exercise 71. *Distribute the information below in the columns to describe three types of gas compressors.*

Centrifugal compressor	**Reciprocating compressor**	**Axial-flow compressor**

Is widely used throughout industry; is normally used in high flow applications; is used as a medium to large gas turbine engines; is commonly seen in automotive applications; is typical for intermittent duty; is more suited to continuous-duty applications; is suited to uses that require high volume with little or no pressure increase; uses pistons driven by a crankshaft; uses a series of fan-like rotor blades; has fewer rubbing parts; can be either stationary or portable, is almost always multi-staged; its stationary stator vanes, located downstream of each rotor, redirect the flow onto the next set of rotor blades.

Exercise 72. *Answer the questions on text 7.*

1. What pressure does a natural gas compression station stabilize? 2. What does a properly operated gas compression facility do efficiently? 3. Natural gas flowing is pressurized at intervals typically between 10-40 miles, isn't it? 4. What major components do natural gas compressor stations utilize? 5. What is a gas compressor used for? 6. Are compres-

sors similar to pumps in the way they function? 7. What types of compressor/engine systems do most high-pressure natural gas compressor stations use? 8. Is a centrifugal compressor or axial-flow compressor more suited to continuous-duty applications? 9. What type of compressor is more typical for intermittent duty? 10. Why are centrifugal compressors popular throughout industry? 11.What components does a reciprocating compressor consist of? 12. What blades structure does axial-flow compressor use to compress gas flow? 13. Where are gas compressors used today?

Exercise 73. *Translate the following sentences into English.*

1. Компресорна станція природного газу стабілізує тиск і витрату газів у трубопроводній мережі на оптимальних рівнях. 2. Установка для стиснення газу збирає газ, що надходить до неї, відновлює його тиск і направляє його в різні галузі промисловості. 3. Відцентрові компресори мають менше частин, які труться. 4. Відцентрові компресори використовують лопатевий обертовий диск або крильчатку, щоб спрямувати газ до краю робочого колеса. 5. Поршневий компресор використовує поршень, що приводиться в рух колінчастим валом. 6. Осьовий компресор використовує серію віялоподібних лопатей ротора для поступового стиснення газового потоку. 7. Газові компресори мають широкий спектр застосувань. 8. Газові компресори використовуються для транспортування природного газу по трубопроводах, зберігання очищеного газу в невеликих обсягах та стискання повітря, що всмоктується в газових турбінах.

Exercise 74. *Memorize the basic vocabulary to text 8.*

Single-stage – одноступеневий
recuperator – рекуператор *(що відновлює, генерує)*
bearing – підшипник
foil bearing – пластинковий підшипник
ball bearing – кульковий підшипник
upstream/downstream – верхній/ніжній *(відносно течії потоку)*
air compressor – повітряний компресор
couple – з'єднувати*(ся*); зчіпляти; зв'язувати; сполучати*(ся);*

spin – крутитися, вертітися
nozzle – сопло; форсунка; випускний отвір; патрубок
thrust – тяга
accelerate – прискорювати*(ся)*
expansion – розширення, розтягування; збільшення *(в обсязі)*
power – потужність; живити *(електро)*енергією
shaft – вісь, вал; штифт, стрижень
shaft power – потужність на валу, ефективна потужність
cyclic– циклічний
make up – складати, збирати
withstand – протистояти
recover – відновлювати; регенерувати; видаляти; утилізувати
exhaust heat – тепло вихлопу
waste – 1.відпрацьований; 2.марно витрачати
co-generation – сумісне виробництво (*тепла та електрики)*
sophisticated – ускладнений
stator blade – лопать статора
vast – 1.широкий 2. численний
hydrodynamic oil bearing – гідродинамічний масляний підшипник
oil-cooled – з масляним охолодженням
ducted fan – тяговий вентилятор
impulse – імпульс
turbojet – турбореактивний двигун
turbofan – турбовентиляторний двигун
start up – запускати *(двигун)*

Exercise 75. *Read and translate text 8.*

Text 8. Gas turbines

A gas turbine is a machine which has a single-stage centrifugal compressor, turbine, a recuperator and foil bearings. A gas turbine extracts energy from a flow of hot gas by combustion of gas or fuel oil in a stream of compressed air. It has an upstream air compressor mechanically coupled to a downstream turbine and a combustion chamber. “Gas turbine” may also refer to just the turbine element. Energy is released when compressed air is mixed with fuel and ignited in the combustion chamber. The resulting gases are directed over the turbine blades, spin-

ning the turbine and mechanically powering the compressor. Finally, the gases are passed through a nozzle, generating additional thrust by accelerating the hot exhaust gases by expansion back to atmospheric pressure.

Energy extracted in the form of shaft power, compressed air and thrust is used to power aircraft, trains, ships, electrical generators, and even tanks.

With all cyclic heat engines, higher combustion temperature means greater efficiency. The limiting factor is the ability of the steel, nickel, ceramic or other materials that make up the engine to withstand heat and pressure. Considerable engineering goes into keeping the turbine parts cool. Most turbines also try to recover exhaust heat, which otherwise is wasted energy. Recuperators are heat exchangers that pass exhaust heat to the compressed air prior to combustion. Combined cycle designs pass waste heat to steam turbine systems. A co-generation of heat and power in such designs uses waste heat for hot water production.

Mechanically, gas turbines can be considerably less complex than internal combustion piston engines. Simple turbines might have one moving part: the shaft, compressor, turbine, alternative rotor assembly not counting the fuel system.

More sophisticated turbines, such as those found in modern jet engines, may have multiple shafts, hundreds of turbine blades, movable stator blades, a vast system of complex piping, combustors and heat exchangers.

Thrust bearings and journal bearings are a critical part of design. Traditionally they have been hydrodynamic oil bearings or oil-cooled ball bearings.

Jet engines are gas turbines optimized to produce thrust from the exhaust gases or from ducted fans connected to the gas turbines. Jet engines that produce thrust primarily from the direct impulse of exhaust gases are often called turbojets. Jet engines that generate most of their thrust from the action of a ducted fan are often called turbofans.

Auxiliary power units (APUs) are small gas turbines designed for auxiliary power of larger machines, such as those inside an aircraft. They supply compressed air for aircraft ventilation, generate electrical and hydraulic power and start up power for larger jet engines.

Exercise 76. *Match the English - Ukrainian equivalents.*

1) ducted fan	a) потужність на валу
2) foil bearing	b) лопать статора
3) exhaust heat	c) турбореактивний двигун
4) stator blade	d) тяговий вентилятор
5) nozzle	e) пластинковий підшипник
6) turbofan	f) тепло вихлопу
7) shaft power	g) сопло; форсунка
8) turbojet	h) турбовентиляторний двигун

Exercise 77. *Translate the terms and verb combinations from text 8.*

а) одноступеневий відцентровий компресор, турбореактивний двигун, циклічний тепловий двигун, рекуператор, тепло вихлопу, кульковий підшипник, повітряний компресор, лопать статора, тяговий вентилятор, форсунка, тяга, потужність на валу, гідродинамічний масляний підшипник, турбовентиляторний двигун, вихлопні гази, реактивний двигун, збірка ротора;

б) отримувати енергію з потоку гарячого газу; бути механічно з'єднаним з турбіною, що знаходиться нижче по ходу; спрямовувати над лопатками турбіни; обертати турбіну; пропускатися через форсунки; створювати додаткову тягу; прискорювати гарячі вихлопні гази шляхом розширення до атмосферного тиску; витримувати тепло та тиск; відновлювати тепло відпрацьованих газів; подавати стиснене повітря для вентиляції літака, створювати тягу від вихлопних газів; генерувати електричну та гідравлічну потужність, бути призначеним для допоміжної потужності більших машин.

Exercise 78. *Complete the following statements based on text 8.*

1. A gas turbine is a machine which has …. . 2. A gas turbine extracts energy from …. . 3. A gas turbine has an upstream air compressor mechanically coupled to …. . 4. Energy is released when …. . 5. Finally, the gases are passed through …. . 6. Considerable engineering goes into …. . 7. Simple turbines might have …. . 8. More sophisticated turbines may have …. 9. Auxiliary power units are small

gas turbines designed for … . 10. Jet engines are gas turbines optimized to produce …. .

Exercise 79. *Ask questions about missing information in exercise 78* .

Exercise 80. *Put the following processes in the correct order to describe how gas turbine produces electricity.*

1. … 2. …. 3. …. 4. …. 5. ….

Hot gas spins turbine blades; turbine rotation powers the generator; generator magnet causes electrons to move and creates electricity; air-fuel mixture ignites; spinning blades turn the drive shaft.

Exercise 81. *Translate the questions into English and answer them on text 8.*

1. До якого типу машини відноситься газова турбіна? 2. З чого витягує енергію газова турбіна? 3. Чи може «газова турбіна» позначати лише елемент турбіни? 4. Як виділяється енергія всередині газової турбіни? 5. Чи видобувається енергія у вигляді валової потужності, стисненого повітря чи тяги? 6. Вища температура горіння означає більшу чи нижчу ефективність? 7. З яких компонентів складаються прості турбіни? 8. Які елементи можуть мати більш складні турбіни? 9. Чи є реактивні двигуни різновидом газових турбін? 10. Які реактивні двигуни називають турбореактивними? 11. Для чого призначені допоміжні силові агрегати?

Exercise 82. *Put questions of different kinds on the following sentences.*

1. A gas turbine extracts energy from a flow of hot gas by combustion of gas or fuel. 2. Gas turbines can be considerably less complex than internal combustion piston engines. 3. Jet engines are gas turbines optimized to produce thrust from the exhaust gases. 4. Auxiliary power units supply compressed air for aircraft ventilation. 5. Energy is released when compressed air is mixed with fuel.

Exercise 83. *Write out of text 8 a) Passive verb forms; b) Gerund forms; c) Participles I and II forms.*

Exercise 84. *Fill in the blanks with proper prepositions:* ***with, to, at, of, through, into.*** *Translate the sentences.*

1. The compressor, which draws air …. the engine, pressurizes it, and feeds it …. the combustion chamber …. speeds …. hundreds of miles per hour. 2. The combustion system, typically made up …. a ring …. fuel injectors that inject a steady stream of fuel …. combustion chambers where it mixes …. the air. 3. The mixture is burned …. temperatures …. more than 2000 degrees F. 4. The combustion produces a high temperature, high pressure gas stream that enters and expands …. the turbine section. 5. The turbine is an array …. stationary and rotating blades. 6. As hot combustion gas expands …. the turbine, it spins the rotating blades.7. The rotating blades perform a dual function: they drive the compressor to draw more pressurized air …. the combustion section, and they spin a generator to produce electricity.

Exercise 85. *Open the brackets using the verb in the Present Indefinite Active or Passive*

1.Gas turbines (install) in many of today's natural gas power plants. 2.The compressors (draw) air into the engine, (pressurize) it, and (feed) it to the combustion chamber. 3. The combustion (make up) of a ring of fuel injectors. 4. The combustion (produce) a high temperature and then high pressure gas stream that (expand) through the turbine section. 5. Jet engines (design) to produce thrust from the exhaust gases. 6. Recuperator (pass) exhaust heat to the compressed air prior to combustion. 7. The resulting gases (direct) over the turbine blades, spinning the turbine.
8. Most turbines (try) to recover exhaust heat.

Exercise 86. *Compose a dialogue on the basis of text 8. Speak about gas turbines; their types and functions; design; main principle of operation and possible applications.*

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