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ENGLISH FOR PROFESSIONAL PURPOSES. APPLIED MECHANICS

Part I

Course Book

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as a Course Book for students of speciality
131 “Applied Mechanics”
(the first (bachelor) level of higher education)

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МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

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Англійська мова професійного спрямування. Прикладна механіка

Частина І

Підручник

Затверджено Вченою радою КПІ ім. Ігоря Сікорського
як підручник для здобувачів першого (бакалаврського) рівня вищої освіти
за спеціальністю 131 «Прикладна механіка»

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Підручник «Англійська мова професійного спрямування. Прикладна механіка» призначений для студентів-майбутніх інженерів з прикладної механіки (3 курс, перший (бакалаврський) рівень вищої освіти) у галузі механічна інженерія, які опановують англійську мову з фаху у технічних університетах. Метою підручника є формування професійно орієнтованої англомовної компетентності на достатньому рівні володіння мовою (B2). Також використання даного підручника сприяє удосконаленню організації іншомовного навчання в аудиторний і позааудиторний час, посиленню міждисциплінарних зв'язків гуманітарного та фахового напрямків; зміцненню знань фахових дисциплін; розвитку вміння вчитися самостійно; удосконаленню критичного мислення у майбутніх фахівців галузі механічної інженерії. Підручник містить вісім розділів, які охоплюють фахову тематику галузі прикладної механіки ("Machines: Efficiency and Mechanical Advantage", "Machine Parts: Bearings, Gears, Valves, Ratchet, Gauge", "Machine Tools Operations", "Application of Hydraulics in Mechanical Engineering", "Types of Pumps", "Engineering Material Properties", "Strength of Materials", "Automation"). Кожен розділ складається з восьми блоків, що орієнтовані на формування професійно орієнтованих англомовних компетентностей у читанні, аудіюванні, говорінні, письмі та перекладі.

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Foreword

"English for Professional Purposes. Applied Mechanics" is an ESP course for mechanical engineering students (3rd year, bachelor degree program) specializing in applied mechanics.

The course is aimed at the formation of professionally oriented English language competence at B2 language proficiency level. The use of this course also contributes to the improvement of the organization of classroom and online English language learning; strengthening of interdisciplinary ties of humanitarian and professional areas of learning; deepening of the knowledge of professional disciplines; development of the ability to learn independently; improvement of critical thinking of mechanical engineering students.

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Authentic texts from various websites, video and audio materials, books and articles, as an effective learning tool, create a kind of natural language environment, which is the main factor in the successful acquisition of a foreign language for specific purposes. They are of professional, scientific and cognitive interest for students.

A wide range of exercises of various kinds (non-communicative, conventionally communicative, communicative) and types (receptive, receptive-reproductive, receptive-productive, productive) are offered on each topic which are to be done as individual, group and whole class activities in the classroom and online learning. Particular focus is paid to the study of professional vocabulary, translation of texts from English to Ukrainian and vice versa. While performing exercises, students will learn to use educational and communicative strategies (cognitive, memorization, social, affective, metacognitive strategies, as well as strategies for mastering language competencies), which contributes to effective professional communication.

The course is supplemented by appendices which contain vocabulary, grammar, irregular verbs, audio scripts, tests and references. These appendices allow students to independently revise grammar and enrich vocabulary.

Authentic materials used in this course have been taken from various printed and electronic sources presented in the reference list.

We thank everyone who contributed to the creation of this course and hope that it will promote the successful formation of ESP competence in engineering students.

The authors

Передмова

Підручник «Англійська мова професійного спрямування. Прикладна механіка» призначений для студентів – майбутніх інженерів з прикладної механіки (3 курс, перший (бакалаврський) рівень вищої освіти) у галузі механічна інженерія, які опановують англійську мову з фаху у технічних університетах.

Метою підручника є формування професійно орієнтованої англомовної компетентності на достатньому рівні володіння мовою (B2). Також використання даного підручника сприяє удосконаленню організації іншомовного навчання в аудиторний і позааудиторний час, посиленню міждисциплінарних зв'язків гуманітарного та фахового напрямків; зміцненню знань фахових дисциплін; розвитку вміння вчитися самостійно; удосконаленню критичного мислення у майбутніх фахівців галузі механічної інженерії.

Підручник містить вісім розділів, які охоплюють фахову тематику галузі прикладної механіки ("Machines: Efficiency and Mechanical Advantage", "Machine Parts: Bearings, Gears, Valves, Ratchet, Gauge", "Machine Tools Operations", "Application of Hydraulics in Mechanical Engineering", "Types of Pumps", "Engineering Material Properties", "Strength of Materials", "Automation"). Кожен розділ складається з восьми блоків, що спрямовані на формування професійно орієнтованих англомовних компетентностей у читанні, аудіюванні, говорінні, письмі та перекладі.

Автентичні тексти з різноманітних веб-сайтів, відео- та аудіоматеріали, книги та статті, як ефективний засіб навчання, створюють своєрідне природне мовне середовище, а це, у свою чергу, є головним фактором успішного оволодіння іноземною мовою для спеціальних цілей. Вони представляють фаховий, науковий і пізнавальний інтерес для студентів.

В межах тематики розділів пропонується широкий спектр вправ різних видів (некомунікативні, умовно-комунікативні, комунікативні) та типів (рецептивні, рецептивно-репродуктивні, рецептивно-продуктивні, продуктивні), які орієнтовані на індивідуальний, груповий та всією групою формат їх виконання в аудиторний і позааудиторний час. Окремо приділяється увага вивченню фахової лексики, перекладу текстів з англійської на українську мову та навпаки. Виконуючи вправи, студенти вчаться використовувати навчальні і комунікативні стратегії (когнітивні стратегії, стратегії запам'ятовування, соціальні стратегії, афективні стратегії, метакогнітивні стратегії, стратегії оволодіння мовними компетентностями, стратегії оволодіння мовленнєвими компетентностями), застосування яких впливає на ефективний перебіг професійно орієнтованої комунікації.

Підручник доповнюється низкою додатків, які містять вокабуляр, граматичний довідник, стенограми аудіо- та відеозаписів, таблицю неправильних дієслів, тести. Ці додатки дозволяють студентам самостійно повторити граматичний матеріал та поповнити свій тезаурус. Також підручник містить інтерактивні лінки, які урізноманітнюють освітній процес.

Автентичні матеріали, використані у цьому підручнику, було взято з різних друкованих та електронних джерел представлених у переліку посилань.

Ми дякуємо усім, хто долучився до створення даного підручника. Сподіваємось, що цей підручник сприятиме успішному формуванню професійно орієнтованої англомовної компетентності у студентів – майбутніх інженерів з прикладної механіки.

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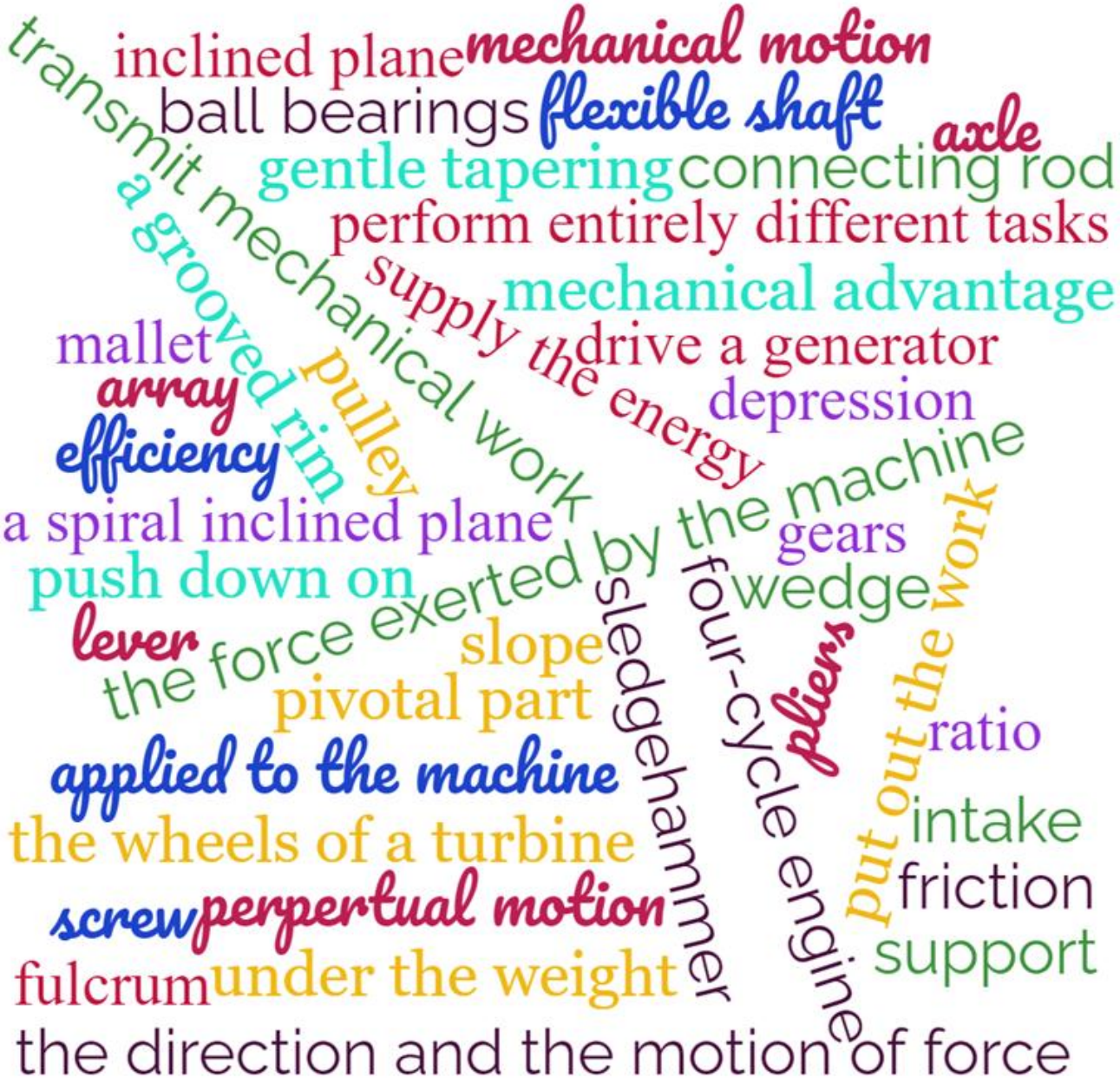
Unit 1. Machines: Efficiency and Mechanical Advantage



LEAD-IN

1. **In groups, discuss the following questions.**

1. How would you define a machine?
2. Which machines do you use every day?
3. Which machine is the most important for you? Explain why.
4. Which properties should a machine have?
5. What are advantages of using machines?
6. What are disadvantages of using machines?
7. What would the world without machines be?
8. What kind of a machine would you create? Describe it briefly.

2. **Work in pairs. Match idioms (A-H) with definitions (1-8). You can also do it using the Learning.Apps platform at this link.**

Idiom		Definition	
A	Hammer and tongs	**1**	Set to work vigorously
B	Press the button	**2**	With great energy and noise
C	Go through the mill	**3**	In an agitated state of suspense
D	Put your shoulder to the wheel	**4**	Initiate an action or train of events
E	On pins and needles	**5**	Engage in commercial and political scheming
F	On the ropes	**6**	Make all possible efforts
G	Wheel and deal	**7**	Have an unpleasant experience
H	Whistle in the wind	**8**	Expose something as a falsehood or deception
I	Do your level best	**9**	Try unsuccessfully to influence something that cannot be changed
J	Nail a lie	**10**	In a desperate position

Taken from Oxford Dictionary of Idioms, 2e (2004).

3. **Do you agree with these statements? Explain why or why not.**

1. The age we live in is often called the machine age.
2. The machines gave people great control over their environment.

READING

4. **Underline the stressed syllable. Practice reading the words.**

Ma***chi***ne, direction, electrical, generator, produce, efficiency, advantage, supply, perpetual-motion, equal, ratio, weight, crowbar, through, gears, axle, pulley, screw, mallet, gently, importance, almost.

5. **Work in pairs: students A and B. Each of you has to read some information (Text A – Student A, Text B – Student B) about efficiency and mechanical advantage of machines. By asking each other, find out the answers to the questions below.**

Student A asks Student B about Text B.

1. How many types of simple machines are described in the text?
2. What are the names of simple machines?
3. Which simple machine was created before others?
4. Which simple machine has a thick strong cord to lift the load?
5. Which simple machine has a revolving circular object?
6. What is the advantage of the lever?
7. Which simple machine involves moving a load smoothly along the surface?
8. Why is a thin wedge more effective that a thick one?
9. How do engineers create new machines?
10. What are the advantages of standardizing the parts of machines?

Student B asks Student A about Text A.

1. What is a machine?
2. What does a machine produce?
3. What is the efficiency of a machine?

4. Is it possible for a machine to have one hundred per cent efficiency?
5. What can serve as an example of a machine with high efficiency?
6. What is mechanical advantage?
7. How can mechanical advantage be illustrated?
8. What does a term “support” mean?
9. What is a kind of lever?
10. In which case may mechanical advantage be four to one?

MACHINES: EFFICIENCY AND MECHANICAL ADVANTAGE

Text A for Student A

Principles of machines

A machine produces force and controls the direction and the motion of force, but it cannot create energy. A machine can never do more work than the energy put into it. It only transforms one kind of energy, such as electrical energy, and passes it along as mechanical motion. For example, the energy of steam rushing through the wheels of a turbine produces rotary motion. The mechanical energy of the turbine can be used to drive a generator that produces electricity. Other machines simply transmit mechanical work from one part of a device to another part. They include six simple machines that are described below. A machine’s ability to do work is measured by two factors. They are (1) efficiency and (2) mechanical advantage.

Efficiency. The efficiency of a machine is the ratio between the energy it supplies and the energy put into it. Machines that transmit only mechanical energy may have an efficiency of nearly 100 per cent, but some machines have an efficiency as low as 5 per cent. No machine can operate with 100 per cent efficiency because the friction of its parts always uses up some of the machine’s energy. All machines produce some friction. For this reason, a perpetual-motion machine is impossible.

A simple lever is a good example of a machine that has a high efficiency. The work it puts out is almost equal to the energy it receives, because the energy used up by friction is quite small. On the other hand, a car engine has an efficiency of only 25 per cent because much of the energy supplied by the fuel is lost in the form of heat that escapes into the air.

Mechanical advantage. In machines that transmit only mechanical energy, the ratio of the force exerted by the machine to the force applied to the machine is known as *mechanical advantage*. This can be demonstrated with a crowbar, which is a type of lever. When one end of the crowbar is directly under the weight, a part of the crowbar must rest on a *fulcrum* (support). The closer the fulcrum is to the load, the less the effort required to raise the load by pushing down on the handle of the crowbar, and the greater the mechanical advantage of the crowbar. For example, if the load is 200 kilograms, and the distance from the load to the fulcrum is one fourth of the distance from the handle to the fulcrum, it will take 50 kilograms of effort to raise the load. Therefore, the mechanical advantage will be four to one. But the distance the load will be moved will be only one-fourth of the distance through which the effort is applied.

Text B for Student B

Six simple machines

Most machines consist of a number of elements, such as gears and ball bearings, that work together in a complex way. But no matter how complex they are, all machines are based in some way on six types of simple machines. These six types are the lever, the wheel and axle, the pulley, the inclined plane, the wedge, and the screw.

The lever is one of the earliest and simplest machines. Its advantage lies in the short distance between the fulcrum (pivotal part) and load, and in the long distance between the fulcrum and the point where effort is applied.

The wheel and axle has a rope attached to the axle to lift the load. The crank handle is the point where effort is applied. The effort is smaller than

the load because it is at a greater distance from the axle which is the fulcrum.

The pulley consists of a wheel with a grooved rim over which a rope is passed. It is used to change the direction of the effort applied to the rope. A block and tackle uses two or more pulleys to reduce the amount of effort needed to lift a load.

The inclined plane makes it easier to slide or skid a load upward than to lift it directly. The longer the slope, the smaller the effort required. The amount of work, however, is no less than if the load were lifted directly upward.

The wedge, when struck with a mallet or sledgehammer, exerts a large force on its slides. A gently tapering, or thin wedge is more effective than a thick one. The mechanical advantage of the wedge is of great importance.

The screw is a spiral inclined plane. The jackscrew is a combination of the lever and the screw. It can lift heavy load with relatively small effort. Therefore, it has a very high mechanical advantage for practical purposes.

Designing machines

By combining the principles of simple machines, engineers develop new and specialized machines. The parts for many of these machines are often standardized so they can be used in a variety of machines that perform entirely different tasks. Some of the more common parts found in machines include ball bearings, gears, pistons, V-belt pulleys, connecting rods, valves, universal joints, and flexible shafts.

Taken from World Book Encyclopedia (International)

6. **Read the text again and summarize the information about the principles of machines: describe six types of simple machines and provide examples of those, which are used in everyday life. Use the expressions:**

with regard to, to begin with, for instance, in addition, moreover, as well as, but in fact, eventually, in particular, that is why, overall.

USE OF ENGLISH

7. **Work in pairs. Give Ukrainian equivalents to the words and phrases.**

1.	the motion of force	20.	a crowbar
2.	electrical energy	21.	a lever
3.	mechanical motion	22.	under the weight
4.	the wheels of a turbine	23.	fulcrum / support
5.	drive a generator	24.	raise the load
6.	transmit mechanical work	25.	push down on
7.	efficiency	26.	gears
8.	mechanical advantage	27.	ball bearings
9.	the ratio between	28.	the axle
10.	the friction of	29.	the pulley
11.	perpertual motion	30.	the inclined plane
12.	put out the work	31.	thin wedge
13.	use up / supply the energy	32.	the screw
14.	the form of heat	33.	a grooved rim
15.	escape into the air	34.	a block and tackle
16.	exerted by the machine	35.	slide a load
17.	applied to the machine	36.	the slope
18.	a gentle tapering	37.	mallet
19.	a spiral inclined plane	38.	sledgehammer

8. **Explain the meaning of the words and phrases. Check in the dictionary.**

To produce force, to transform electrical energy, rotary motion, the friction of the parts, directly under the weight, to lift something directly.

9. **Fill in the table with the words derived from the given ones.**

Noun	Verb	Adjective
transformation	.....	.....
……	produce	.....
……	use	.....
.....	supply	.....
.....	measure	.....
.....	X	efficient
…….	apply	.....
…….	reduce	.....
.....	slide	……..
.....	strike	……..
standard	.....	……..
…….	.....	different

10. **Write the opposites of the following words. Use the dictionary if necessary.**

1) practical;
2) heavy;
3) often;
4) flexible;
5) different;
6) closer;
7) complex;
8) to create;
9) to produce;
10) advantage.

11. **Match the words with similar meaning.**

1 produce	**a** compute
2 motion	**b** utilize
3 measure	**c** multiplex
4 supply	**d** transit
5 use	**e** diminish
6 rest	**f** ascending
7 complex	**g** manufacture
8 attach	**h** diversity
9 reduce	**i** join
10 upward	**j** lie
11 variety	**k** provide

12. **Find the names of simple machines, then choose any three and make sentences.**

s	t	r	e	w	h	e	e	l	t	r	l
a	l	e	v	e	r	n	p	a	x	l	e
g	m	h	a	r	d	n	e	s	s	k	g
t	p	i	n	c	l	i	n	e	d	a	p
d	u	c	t	i	l	i	w	y	z	n	l
c	l	r	i	t	t	e	e	n	e	s	a
r	l	m	c	d	r	b	a	n	d	s	n
t	e	v	i	c	c	o	s	i	t	y	e
g	y	l	s	m	d	r	k	v	x	p	p
d	k	k	y	a	e	g	d	e	w	y	e
m	a	l	l	e	a	b	i	l	i	t	y

13. **Work in pairs. Using the information from the text (ex. 5), match 1-13 with a-m. Then choose any three phrases and make sentences.**

1	to control the direction	**a**	mechanical work to another part
2	the energy of steam	**b**	on six types of simple machines
3	to transmit	**c**	known as
4	to have an efficiency as low	**d**	and the motion of force
5	an example of a	**e**	change the direction of
6	the ratio is	**f**	the smaller the effort
7	to consist of	**g**	machine that has
8	to be used to	**h**	with a crowbar
9	to be based	**i**	as five per cent
10	can be demonstrated	**j**	a number of elements
11	the longer the slope	**k**	produces rotary motion
12	can be used in a variety	**l**	effective than
13	thin wedge is more	**m**	of machines

14. **Choose the odd word in each line.**

1) trucks, aeroplanes, trains, automobiles;
2) haul, transmit, pass, transform;
3) harness, produce, exploit, utilize;
4) coal, atom, oil, solar;
5) length, friction, scraping, abrasion;
6) linear, reciprocating, heavy; rotary;
7) lever, wheel, pulley, ratio;
8) drawback, advantage, benefit, virtue;
9) irrelevant, pivotal, crucial, vital;
10) reduce, diminish, decrease, increase.

15. **Fill in the gaps with the appropriate words from the list below. You can also do it using the Learning.Apps platform at this link.**

Depends, device, water, presses, gradually, products, constructed, find, improved, tools, computers, aeroplanes, needs, distances, haul.

Machine is a **1)** _____ that does work. Industries use giant drill **2)** _____, lathes, and presses to make the **3)** _____ we use. Businesses depend on typewriters, **4)** _____, and other office machines. Cars, buses, and **5)** _____ transport people swiftly over great **6)** _____. Trucks, railways, and ships are machines used to **7)** _____ goods to and from markets. Without machines, the residents of our cities would **8)** _____ it more difficult to live, and farmers could not grow enough food to feed us. Almost every activity of our daily life **9)** _____ in some way on machines.

People have **10)** _____ a wide variety of machines to satisfy their **11)** _____. Early people made stone axes that served as weapons and **12)** _____. The machines that were **13)** _____ developed gave people great control over their *environment* (physical surroundings). To operate these **14)** _____ machines, people harnessed the energy of falling **15)** _____ and of such fuels as coal, oil, and the atom. Today, we use so many machines that the age we live in is often called the machine age.

16. **Work in small groups. Make up wordsearch puzzles, exchange with your groupmates and solve them.**

17. **Revise words and phrases on the topic "Machines: efficiency and mechanical advantage". Use Quizlet flashcards.**

18. **Revise the information about the Present Tenses (Appendix 2) and choose the correct option.**

1. Here is the description of how machines _____ **(change / are changing)** the direction of motion.
2. Linear motion _____ **(is changed / change)** to rotary motion through the use of piston, connecting rod, crankshaft, and flywheel.
3. The back-and-forth movements of the piston push and pull the connecting rod, which _____ **(rotate / rotates)** the flywheel.
4. Rotary motion _____ **(is changed / is changing)** to linear motion through the use of a wheel, drive pan, and slotted yoke.
5. The drive pin on the revolving wheel_____ **(slide / slides)** within the slot of the yoke.
6. Consequently, the yoke and the rod attached to the drive pin _____ **(move / are moving)** back and forth.

19. **Read the sentences and choose the verbs in the Present Simple Active and the Present Simple Passive.**

1. There are three basic types of levers depending on where the effort is applied, on the position of the load and on the position of the fulcrum.
2. In a first class lever, such as crossbar, the fulcrum is between the load and the applied force.
3. In a second class lever, such as a wheelbarrow, the load lies between the fulcrum and the applied force.
4. In a third class lever the effort is applied between the load and the fulcrum.

5. When a person lifts a ball in the palm of the hand, the load is on the hand and the fulcrum is at the elbow.
6. The forearm supplies the upward force that lifts the ball.
7. The wedge is an adaptation of the inclined plane.
8. It is used to raise a heavy load over a short distance or to split a log.
9. The wedge is driven by blows from a mallet or sledgehammer.
10. The effectiveness of the wedge depends on the angle of the thin end.
11. The smaller the angle, the less is the force required to raise a given load.

20. **Put the verbs in brackets into the correct form.**

1. The wheel and axle _____ **(be)** essentially a modified lever but it can move a load farther than a lever can.
2. In a windlass used to raise water from a well, the rope that carries the load _____ **(wrap)** around the axle of the wheel.
3. The effort _____ **(apply)** to a crank handle on the side of the wheel.
4. The centre of the axle _____ **(serve)** as a fulcrum.
5. The mechanical advantage of the windlass _____ **(depend)** upon the ratio.
6. The ratio _____ **(be)** between the radius of the axle and the distance from the centre of the axle to the crank handle.
7. The wheel-and-axle machine _____ **(have)** important applications.
8. The wheel-and-axle machine _____ **(use)** to transport heavy goods by rolling rather than by sliding.
9. The wheel itself _____ **(regard)** as one of the most important inventions of all time.

10. The wheel _____ **(use)** is used practically in all types of machinery.

21. **Choose the correct option (Present Tenses).**

1. Machine gun **(is / being)** an automatic weapon that can fire from 400 to 1,600 rounds of ammunition each minute.
2. Machine gun barrels **(range / are ranging)** in size from 22 calibre (5.5 millimetres) to 30 millimetres.
3. Ammunition **(feed / is fed)** into the gun from a cloth or metal belt, or from a cartridge holder called a *magazine.*
4. Because machine guns **(fires / fire)** so rapidly, they must be cooled by water or air.
5. Machine guns are heavy weapons, that is why they **(mount / are mounted)** on a support.

22. **Put the verbs in brackets into the correct form.**

1. In all machine guns, extremely high gas pressure _____ **(provide)** the operating energy for the firing cycle.
2. The cycle begins when the propellant charge in the cartridge case _____ **(burn)**.
3. This combustion creates the gas pressure that _____ **(use)** in the *blowback, gas, and recoil* operating systems.
4. All three systems _____ **(fire)** the projectile through the bore of the barrel, eject the cartridge case, place a new cartridge in the firing chamber, and ready the mechanism to repeat the cycle.
5. In the blowback system, the operating energy comes from the cartridge case as the case _____ **(force)** to the rear by the gas pressure.

6. The case _____ **(move** against the bolt driving the bolt backward against a spring.
7. The case _____ **(eject)**, and the compressed spring drives the bolt forward.
8. As the bolt moves forward, it cocks the firing mechanism, picks up a new cartridge, carries it into the chamber, and the cycle _____ **(begin)** again.
9. In the *gas system* the gas pressure _____ **(drive)** a piston against the bolt.
10. The bolt _____ **(drive)** to the rear providing energy for a cycle like that of the blowback system.
11. In the *recoil system* the bolt locks to the barrel when the gun _____ **(fire).**
12. These parts remain locked together as they _____ **(force)** to the rear by the gas pressure.
13. This movement _____ **(provide)** energy to operate the gun.

23. **Choose the appropriate word.**

1. There is no doubt that 7.62 millimetre M60 machine gun is a _____ infantry weapon.
   a) major b) majorer c) majoring
2. M60 machine gun _____ air-cooled and gas-operated and fires about 600 rounds a minute.
   a) is been b) is c) is being
3. The M60 replaced the Browning machine gun, an important _____ in World Wars I and II, and the Korean War.
   a) weapon b) weapons c) weaponing
4. In fact, _____ types of machine guns are mounted on aeroplanes.
   a) Several b) Much c) Less

5. _____ types include the Vickers, Maxim, Hotch kiss, Colt-Martin and Lewis.

   a) This b) These c) That

6. Some machine guns _____ to fire in between the blades of propellers of aeroplanes.

   a) are synchronized b) synchronize c) synchronizing

7. _____ World War II fighters and bombers carried machine guns as armament.

   a) While b) Whilst c) During

8. Fighters and bombers also carried automatic cannons up to 20 millimetres _____ size.

   a) in b) at c) for

9. Today, most fighter planes and gunships _____ rockets for air-to-air and air-to-ground use.

   a) carrying b) carry c) are carried

10. Bombers _____ machine guns mounted in groups of two or four in power driven turrets.

    a) are used b) are using c) use

11. The Vulcan 20-millimetre aircraft cannon _____ six rotating barrels.

    a) has b) have c) is having

12. The Vulcan 20-millimetre aircraft cannon can fire more _____ than a ton of metal and explosives each minute.

    a) that b) then c) than

13. The 50-calibre (12 millimetre) Browning machine gun _____ an antiaircraft weapon.

    a) being b) is c) is being

14. The 50-calibre Browning machine gun is used alone, or _____ groups of two or four.

    a) in b) at c) of

15. Large caliber automatic cannons _____ explosive shells, they are also antiaircraft weapons.

    a) are fired b) are firing c) fire

16. The 20-millimetre, Swiss made Oerlikor gun is a self-fed, self-firing cannon _____ could fire 600 rounds a minute.

    a) this b) who c) that

TRANSLATION

24. Translate the sentences into Ukrainian in written form.

1. A pulley is a wheel over which a rope or belt is passed.
2. The mechanical advantage of a single pulley is one, because the downward force exerted on the rope equals the weight lifted by the other end and the rope that passes over the end of the pulley.
3. The main advantage of the single pulley is that it changes the direction of the force.
4. For example, to lift a load, a person can conveniently pull down on a rope, using the weight of the body.
5. When one pulley is attached to a support and another is attached to the load and allowed to move freely, a definite mechanical advantage is obtained.
6. The inclined plane is such a simple device that it scarcely looks like a machine at all.
7. The average person cannot raise a 100 kilogram box 1 metre into the rear of the truck.
8. However, by placing a 4-metre plank from the truck to the ground, a person could raise the load easily.

9. If there were no friction, the force required to move the box would be exactly 25 kilograms.
10. The mechanical advantage of an inclined plane is the length of the incline divided by the vertical rise.

Taken from World Book Encyclopedia (International)

25. Translate the sentences into English in written form.

1. Механічна перевага похилої площини збільшується в міру зменшення кута нахилу.
2. Однак тоді вантаж доведеться перемістити на більшу відстань.
3. Додавши ролики, можна зробити роликовий конвеєр, який зменшить тертя та матиме велику ефективність.
4. Гвинт фактично є похилою площиною, закрученою по спіралі навколо валу.
5. Механічна перевага гвинта приблизно дорівнює відношенню окружності гвинта до відстані, на яку гвинт просувається під час кожного оберту.
6. Домкрат, такий як той, що використовується для підняття будинків та інших конструкцій, поєднує корисні властивості гвинта та важеля.
7. Важіль призначений для повороту гвинта.
8. Механічна перевага домкрата досить висока, адже лише зробивши невелике зусилля, можна підняти важкий вантаж.
9. Інші види машин включають такі як катапульта, кран, насос, бігова доріжка, турбіна.
10. Важливо знати назви деталей машини, як-от підшипник, манометр, шестерня, регулятор, храповик і запобіжний клапан.

Taken from World Book Encyclopedia (International)

LISTENING

26. **Before watching the video, check if you know the meaning of the words. Use the dictionary if necessary.**

Output force, input force, overcome, array, equal, amount, due to, researched, proven, standards-based, outline.

27. **Watch the video about mechanical advantage and efficiency of simple machines (https://www.youtube.com/watch?v=y_AfvpW-kbc). Then match adjectives (1-5) with nouns (a-e).**

1) total	a) efficiency
2) greater	b) amount
3) better	c) array
4) comprehensive	d) job
5) animated	e) presentations

28. **Watch the video again and complete the following sentences.**

1. In an ideal situation, the total amount of work done by a machine should _____ the amount of work put onto it.
2. However, due to friction, the output force is usually _____ that the input force.
3. Machines with greater efficiency do a better job at overcoming the force of _____.
4. For example, a pulley with 90% of the work input to _____ a load, while the other 10% is used to overcome friction.
5. To access a comprehensive array of complete multimedia lessons, as well as the most up-to-date, standards-based curriculum content that's

researched, _____ and teacher-approved, visit us at newpathlearning.com.

6. Each multimedia lesson includes animated presentations, interactive activities, _____ labs, vocabulary exercises and standards-based assessments.

29. **Your teacher has given you a list of the following questions. Which questions are answered in the video (ex. 27)? How are they answered?**

1. What could be an ideal situation regarding mechanical efficiency?
2. Why is the output force usually less than the input force?
3. Which machines do a better job of overcoming the force of friction?
4. Can you think of an example used a pulley with 80% mechanical efficiency?
5. Can you think of an example used a pulley with 90% mechanical efficiency?
6. What should you do to create your free outline learning account?
7. What does each multimedia lesson include?

SPEAKING

30. **Your professor asked you to briefly inform the students about the efficiency of machines and mechanical advantage. Create a mini-presentation. Begin the sentences as suggested below.**

1. *It is important for an engineer to understand the notions of efficiency of machines and ……..*
2. *The efficiency of machines may be defined as……..*
3. *It is known that mechanical advantage is….*
4. *Simple machines include ……..*
5. *The most important among them are ……..*

31. **Worl in small groups. Talk about different classifications of simple machines. What is common and different about them? Use the information from the table below.**

Types of Lever	Types of Pulleys
First class of Lever. It has fulcrum located between the input force and the output force.	Fixed pulley. The pulley is fixed with support. It has MA = 1 since used to change direction of force.
Second class lever. The fulcrums at one end of the arm and input force is applied to the other end.	Movable single pulley. The pulley is not fixed with support, the load is shared by two sections of rope pulling upward.
Third class of lever. The input force is in between fulcrum and output force.	Multiple pulleys or a Block and tackle. All of the sections of rope are pulling up against the downward force of the weight.

Taken from https://slideplayer.com/slide/8136075/

32. **Compete the quiz to test your knowledge of machinery and manufacturing. Create your own quizzes in pairs, change over, complete them and compare your scores.**

Question 1. Which is not a cycle in a four-cycle engine?

a. intake

b. combustion

c. compression

d. depression

Question 2. Which company does not produce automobiles?

a. Ford

b. Audi

c. BMW

d. Apple

Question 3. What is related to mass production?

a. assembly line

b. landline

c. timeline

d. washing line

Question 4. Which is not used for running engines?

a. kerosene

b. gasoline

c. cocoa

d. diesel

Question 5. Which is a simple machine?

a. coffee machine

b. truck

c. screw

d. oven

Question 6. Which item consist of a wheel and a rope?

a. lever

b. pulley

c. wedge

d. drum

Question 7. What is the efficiency of a typical car engine?

a. 55%

b. 45%

c. 25%

d. 15%

Taken from https://www.britannica.com/quiz/machinery-and-manufacturing#

33. **In groups, look at the examples of the use of simple machines in everyday life. Fill in the gaps using the words below. Add at least three more examples of your own in each line. Compare the results in groups.**

Car jack, end of a hose, jar lid, bicycle gears, door hinge, electric fan, office chair wheels, slanted roof, stairs, clothesline, window blinds, dog run, fork, knife, nail, needle, pliers, handheld garlic press, scissors.

1. The lever: any machine with a bar turning about a fixed point like a stapler, fishing rod, seesaw, ….., ……., ……
2. The wheel and axle: any machine with one or more wheels attached to a shaft like a pizza cutter, doorknob, analog clock, ….., ……., ……
3. The pulley: any machine with a wheel and rope in a grooved rim like a flag pole, garage door, well, ….., ……., ……
4. The inclined plane: any surface at an angle against a horizontal surface like a ladder, wheelchair ramp, slide, ….., ……., ……. .
5. The wedge: any machine with two edges that meet at a point like an ax, cheese grater, knife, ….., ……., ……. .
6. The screw: any machine with a spiral inclined plane like a bolt, drill, faucet, ….., ……., ……. .

Taken from https://examples.yourdictionary.com/simple-machine-examples-from-around-the-house.html

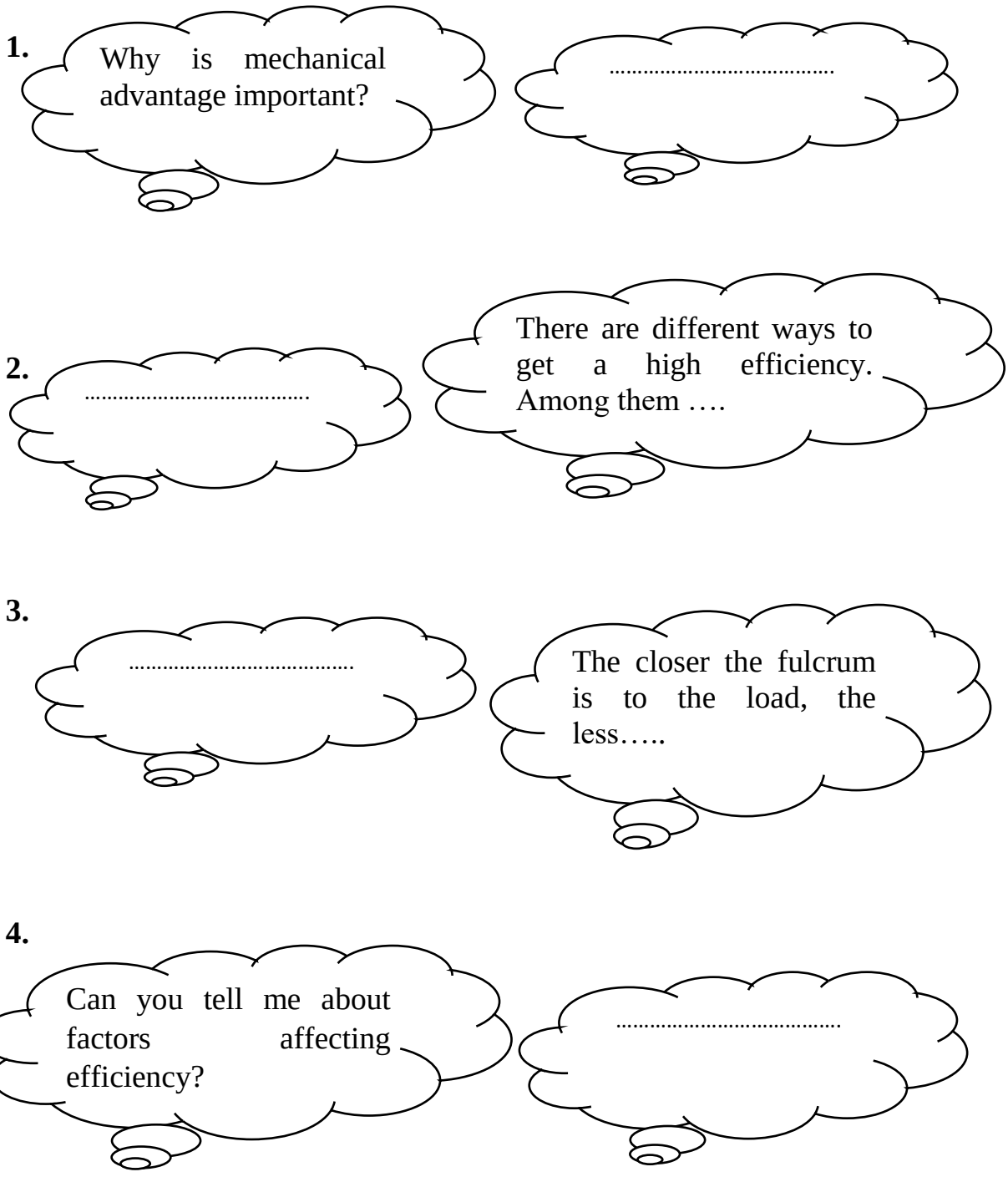
34. **As an engineering student, you are going to prepare a presentation about simple machines. Choose one of the following topics. Follow the structure: introduction, main body, conclusions. After the presentation answer the questions below.**

1. A brief overview of first machines.
2. Building simple machines at home.
3. How to calculate the efficiency of a machine.
4. Factors that affect the efficiency of a machine.
5. Conservation of energy vs mechanical advantage.

35. **In pairs, choose three machines you use on a daily basis and discuss how to make them more efficient. Use the expressions below.**

- ✓ *According to / in accordance with ……*
- ✓ *To start with ……*
- ✓ *For example, ……*
- ✓ *I see your point but ……*
- ✓ *The thing is that ……*
- ✓ *That's why ……*
- ✓ *But in fact ……*
- ✓ *What improves the efficiency of ……?*
- ✓ *How can we increase the efficiency of ……?*
- ✓ *What reduces the efficiency of ……?*

36. **In pairs, talk about the efficiency and mechanical advantage of machines. Complete and role play the dialogue below.**



WRITING

37. **Write a personal profile for an online course "Mechanical Advantage Effectiveness" (80-100 words). Follow the instructions:**

- state your full name, age and home country;
- provide some basic information about your educational background;
- explain why you are interested in this course;
- share your hobbies and interests;
- use the suggested phrases: in response to, to begin with, furthermore, nevertheless, I would like to, I am sure that, in conclusion;
- proofread and edit your profile.

38. **You are asked to create a poster on the topic "Simple Machines for Kids" for a children magazine. Follow the instructions:**

- create a catchy heading consisting of 3-4 words;
- add pictures, drawings or other visuals;
- use simple language;
- add links to supplementary material.

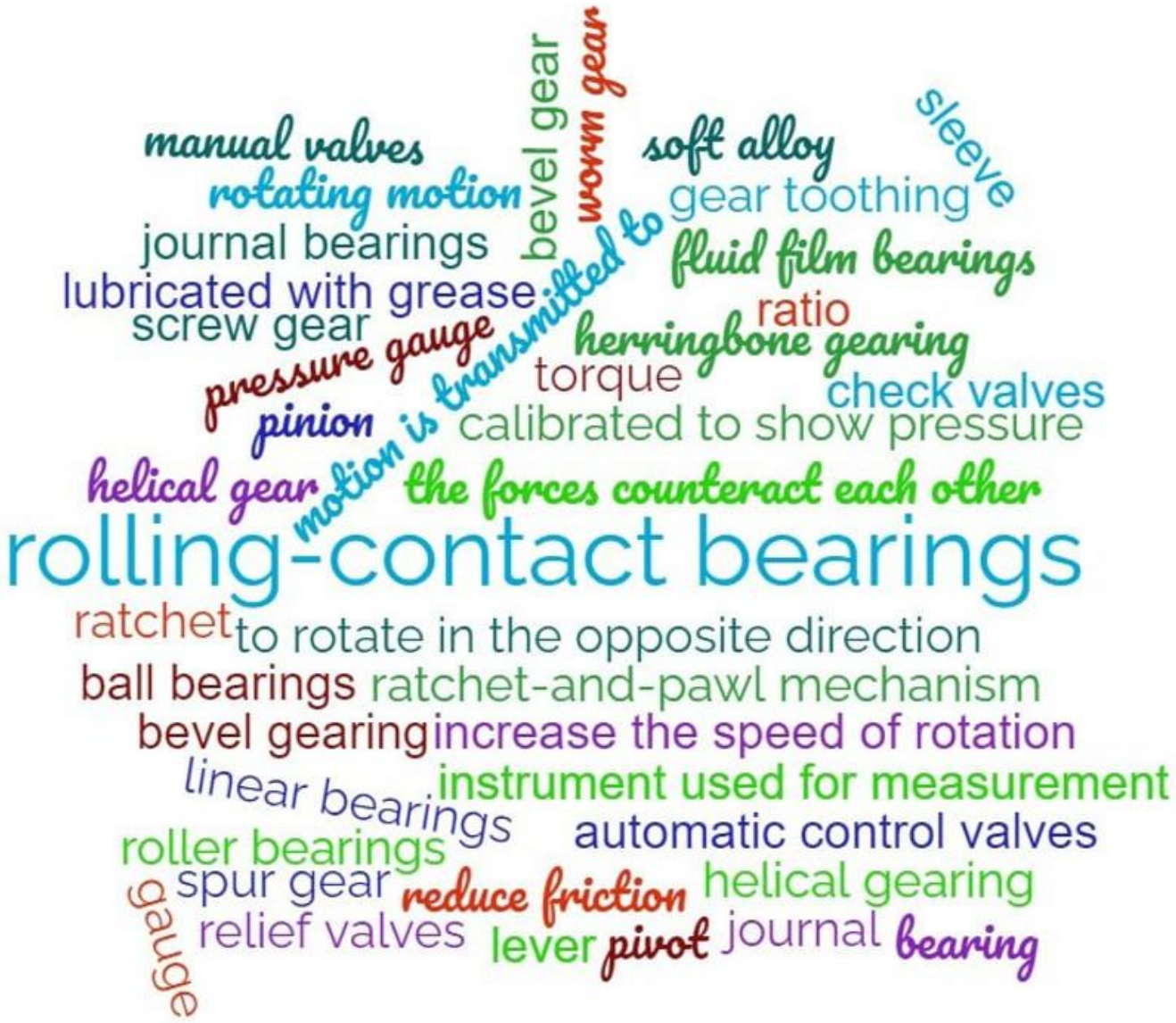
Show your work to your groupmates. Compare the posters and choose the most informative, attractive and clear one.

39. **Write a post for the university website about Archimedes who was the first to describe simple machines 2,000 years ago. Use the outline:**

- the most amazing facts about the life of Archimedes;
- the names and short description of the machines he described;
- which impact the simple machines had on the lives of people;
- choose the one which had the biggest significance in the history of humanity.

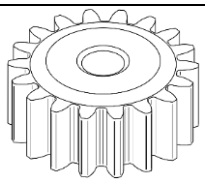
Show your work to your groupmates. Choose the most informative and attractive post for the university website.

Unit 2. Machine Parts: Bearings, Gears, Valves, Ratchet, Gauge



LEAD-IN

1. **Match the pictures with the words.**

1	bearing	**a**	*Taken from https://bit.ly/3fDaCp5*
2	gear	**b**	*Taken from https://bit.ly/3BYGZ9j*
3	ratchet	**c**	 *Taken from https://bit.ly/3RtFo10*
4	valve	**d**	*Taken from https://bit.ly/3RAapQB*
5	gauge	**e)**	*Taken from https://bit.ly/3M3XqWj*

2. **In groups, discuss the following questions.**

1. What parts of a machine do you know?
2. Why are bearings used in engineering applications?
3. What functions do valves provide?
4. What are gears and their function?
5. What materials are most gears made of?
6. What types of gear do you know?

3. **Explain the quotations.**

1. Improve a mechanical device and you may double productivity. But improve man, you gain a thousandfold.

   Khan Noonien Singh

2. Building a mechanical device for its appearance is like putting lace on a bowling ball.

   Andrew Vachss

3. Winning requires reaching inside of yourself for that extra gear to accelerate challenges.

   Orrin Woodward

4. All knowledge which ends in words will die as quickly as it came to life, with the exception of the written word: which is its mechanical part.

   Leonardo da Vinci

READING

4. **Underline the stressed syllable. Practise reading the words.**

Pressure, bearing, journal, multiplying, lever, engine, turbine, generator, smoothly, propeller, rotate, intersecting, determine, opposite, relative, direction, calibrate, container, centimetre, external, measurement.

5. **Explain the meaning of the words and phrases. Check in the dictionary.**

Bearing, ratchet, gear, torque, alloy, axle, gauge, vessel, pawl, engine, turbine, smoothly, linear bearings, journal bearing, reduce friction, ball bearings, roller bearings, ratchet-and-pawl mechanism, pinion, the forces counteract each other, bevel gear, helical gear, spur gear, worm gear, manual valves, pressure gauge.

6. **Read the text and fill in the blanks with proper sentences.**

1. When the power axle turns, its gear turns and causes the second gear to rotate in the opposite direction.
2. A second pawl may be used to prevent the wheel from turning backward while the lever is being returned to begin another stroke.
3. But pressure on the other side pushes the disc into the seat, preventing flow.
4. The gear and pinion mesh at a right angle to transmit power between axles that are not parallel and do not intersect.

BEARING

Bearing is a part of a machine that holds or guides moving parts. Bearings reduce friction and wear by enabling rotating and sliding parts to move smoothly. Bearings are used in a wide variety of machines, including

car engines, turbines, generators, and electric motors. Bearings are often classified according to their function. For example, *thrust bearings* keep a shaft from moving back and forth along the direction of its axis. *Linear bearings* guide objects along a track. *Journal bearings* keep a *journal* (shaft) turning smoothly.

There are two major types of journal bearings – *rolling-contact bearings* and *plain bearings*. They differ in the way they reduce friction.

Rolling-contact bearings change the sliding motion of a journal into a rolling one, thus producing less friction. Rolling-contact bearings include *ball bearings* and *roller bearings*. Ball bearings have several steel balls that roll between two grooved steel rings called races. In most ball bearings, the balls are separated and held in place by a cage or spacer made of bronze or soft steel. Roller bearings use cylindrical or tapered rollers instead of balls.

Plain bearings are sometimes called *fluid film bearings*, because they use a fluid to reduce friction. They form a sleeve around a journal but are separated from it by the fluid. Many plain bearings are lined with a soft alloy called babbitt metal and are lubricated with grease or oil.

Ratchet

Ratchet is a wheel or bar that can move in only one direction. It often consists of a notched wheel and a pawl (metal bar hung from a pivot). The pawl is attached to a lever. As the lever is moved, the free end of the pawl locks into a tooth of the wheel, causing the wheel to rotate. **(1)** _____ A mechanical counter is a simple device that uses the ratchet-and-pawl combination. A ratchet-and-pawl mechanism locks a machine such as a hoisting winch so that it does not slip.

Gear

Gear is a mechanical device that transfers rotating motion and power from one part of a machine to another. Gears are produced in a wide range of sizes, and they vary greatly in use. They range from the tiny

gears that drive the hands of a watch to the huge gears that turn the propeller of a supertanker.

A simple gear consists of a metal wheel or disc with slots called teeth around the edge. Gears always work in pairs. The teeth of one gear mesh (fit together) with the teeth of the other gear. Each gear has a metal axle in its centre. The axle of one gear is connected to a power source, such as an electric motor. **(2) _____** This action powers the axle of the second gear to do useful work.

Most gears are made of steel, but such materials as bronze, plastic, and nylon are also used. Metal gears are usually lubricated with oil or grease to keep them cool while they rotate. Gear teeth are specially constructed with curves to lessen wear, vibration, and noise.

How gears work. Gears may be used to increase or decrease the speed of rotation. One gear in every pair is smaller than the other. This small gear, called a *pinion,* has fewer teeth than the large gear. The ratio of the number of teeth on the pinion to the number of teeth on the large gear determines the relative speeds of the two gears and also the amount of *torque* (rotational force) transmitted from one to the other.

Types of gears include *spur gears, helical gears, bevel gears, warm gears, planetary gears, and rack and pinion gears*. Spur gears are simple gears that have straight teeth and axles that are parallel to each other. Helical gears have teeth that are set at an angle to the axle. This design makes the gears quieter at high speeds, but it tends to make the gears generate a sideways force, making them less efficient. Helical gears called *herringbone gears* solve this problem. They have two rows of teeth which generate opposite forces. The forces counteract each other, and the gears run smoothly.

Bevel gears usually mesh at a right angle to transmit power between intersecting axles. Worm gears have a large gear similar to a spur gear, and a pinion that is an endless screw around an axle. **(3) _____** .

Valve

Valve is a term used for various mechanical devices which open and close to control the flow of fluids in pipes and vessels. Mechanical valves include *check valves, relief valves, manual valves*, and *automatic control valves*. Check valves and relief valves allow flow in one direction only. In a check valve, a gate or disc covers an opening called the seat. Gravity or a spring holds the disc in place. Pressure on one side of the disc forces the valve open. **(4) _____** In a relief valve, the disc is held closed by a compressed spring on one side. It opens only when pressure against the other side of the disc is greater than that of the spring.

Gauge

Gauge, also called gage, is an instrument used for measurement. Gauges are used to measure such quantities as pressure, temperature, water level, and thickness. Two of the most common types of gauges are pressure gauges and water-level gauges. But people working in a great many different fields commonly use other kinds of specialized gauges in their work.

Pressure gauges measure pressure in enclosed vessels or containers, such as boilers or pipes. Pressures below that of the atmosphere are usually measured in centimetres or inches of mercury. *Vacuum gauges* measure pressure below the pressure of the atmosphere. *Water-level gauges* usually consist of a glass tube connected to the side of a container.

Taken from World Book Encyclopedia (International)

7. **Read the text again and decide whether the following statements are *True* (*T*) or *False* (*F*).**

1. Bearings reduce friction and wear by enabling rotating and sliding parts to move smoothly.
2. Bearings are often classified according to their materials.
3. There are two major types of journal bearings – rolling-contact bearings and plain bearings.
4. Most gears are made of plastic.
5. Gear is used to measure such quantities as pressure, temperature, water level, and thickness.
6. Check valves and relief valves allow flow in one direction only.
7. Mechanical valves include check valves, relief valves, manual valves, and automatic control valves.
8. Spur gears have teeth that are set at an angle to the axle.
9. Worm gears usually mesh at a right angle to transmit power between intersecting axles.
10. Two of the most common types of gauges are pressure gauges and water-level gauges.

USE OF ENGLISH

8. **In the text (ex. 6), find the opposites of the following words.**

Reduce – _____, noise – _____, thickness – _____,

curve – _____, lock – _____, external – _____.

9. **Work in pairs. Give Ukrainian equivalents to the words and phrases below.**

1.	gauge	17.	direction
2.	ratchet	18.	alloy
3.	smoothly	19.	axle
4.	journal bearings	20.	wear
5.	race	21.	pinion
6.	ball bearings	22.	torque
7.	roller bearings	23.	spur gear
8.	rolling-contact bearings	24.	helical gears
9.	linear bearings	25.	bevel gears
10.	ratio	26.	warm gears
11.	ratchet-and-pawl mechanism	27.	relief valves
12.	pawl	28.	relief valves
13.	pivot	29.	angle
14.	gear	30.	to intersect
15.	edge	31.	rows of teeth
16.	to rotate	32.	to reduce

10. **Match the words with similar meanings.**

1	reduce	**a**	fit together
2	motion	**b**	turn
3	prevent	**c**	decrease
4	vessel	**d**	liquid
5	fluid	**e**	small
6	tiny	**f**	container
7	intersect	**g**	restrain
8	rotate	**h**	cross
9	torque	**i**	movement
10	counteract	**j**	rotational force

11. **Work in small groups. Solve the word search puzzle.**

Mechanical devices

M O G P E O R L S P F P D J F
U N R W E R B Q T Y A S K Z C
M C M C J Y N E I W C B E A K
Y N L J P C T R L D H K V P K
K P I N I O N Y N A R N Y Q N
X B P K R E N G I N E I P N F
J X E Q W P G B I E O V F I X
A V U A Z Q C M K E Z C P X A
R E V E R B N T U K Q I O X Y
A F R L B I G F B I D B L W G
T Y U R I A N X M A E E F L G
C L B B U Z G G I I E O I W Y
H F X G D P E V A L V E B L A
E O E J W F A Q N S N C G D N
T W A Y S L R Q Q T O X N L W

12. **In pairs, create your own word search puzzles on the topic "Machine parts". Exchange and solve them.**

13. **Using the information from the text (ex. 6), choose the odd word in each line.**

1) car engine, generator, valve, electric motor;
2) ball bearing, roller bearing, fluid film bearing, control bearing;
3) spur gear, square gear, helical gear, bevel gear;
4) warm gear, planetary gear, pinion, rack and pinion gear;
5) check valve, relief valve, vacuum, manual valve;
6) to construct, to transmit, friction, to determine;

7) machine, valve, gauge, bearing;

8) compressed, pressure, measured, separated;

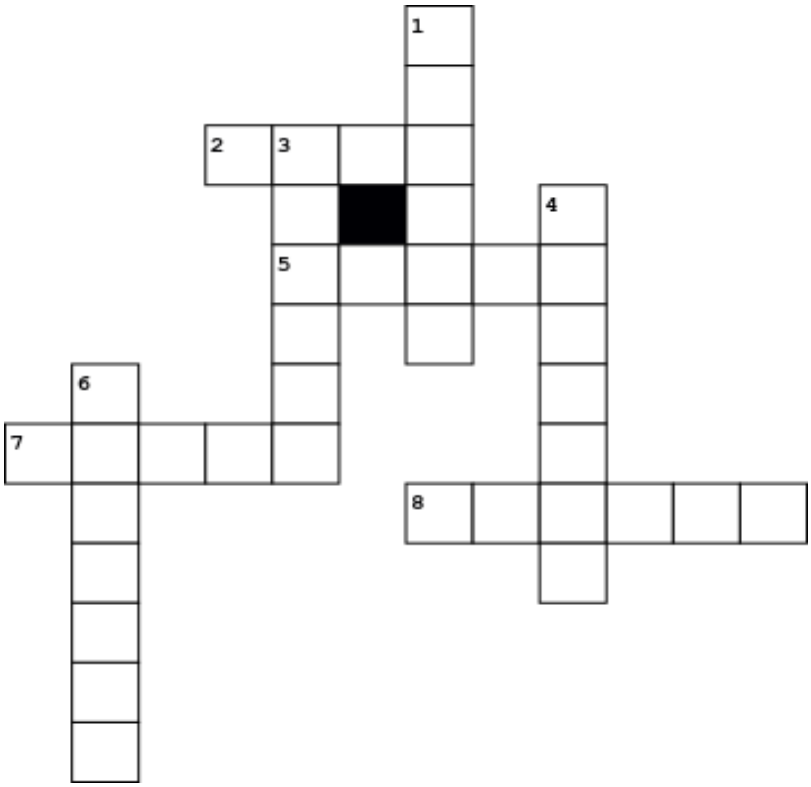
9) torque, pinion, teeth, gauge;

10) bronze, steel, iron, artificial.

14. Fill in the table with words derived from the given ones.

Noun	Verb	Adjective
rotation	.....	.....
.....	.....	productive
movement	.....	.....
.....	.....	constructive
.....	.....	transmissive
determination	.....	.....
.....	intersect	.....
.....	compress	.....
.....	measure	.....
pressure	.....	.....
.....	.....	relative
combination	.....	.....
separation	.....	.....

15. **Solve the crossword puzzle. You can also do it using the Crossword Lab platform at this link.**



Across

2. a device, often consisting of connecting sets of wheels with teeth around the edge, that controls how much power from an engine goes to the moving parts of a machine

5. a device for measuring the amount or size of something

7. a device that opens and closes to control the flow of liquids or gases

8. a small wheel with teeth-like parts around its edge that fit against similar parts on a larger wheel or a rack

Down

1. a force that causes something to rotate

3. a machine that uses the energy from liquid fuel or steam to produce movement

4. a part of a machine that supports another part that turns around

6. a part of a machine that allows movement in one direction only. It is usually a wheel with teeth-like parts that either slide over or lock against the free end of a bar

16. **Work in pairs. Using the information from the text (ex. 6), match 1-10 with a-j to make phrases. Then choose any three and make sentences.**

1	six basic types of metal	**a**	decrease the speed of rotation
2	the ratchet-and-pawl	**b**	transfers rotating motion and power
3	to transfer	**c**	to keep them cool while they rotate
4	to measure such quantities as	**d**	removal processes
5	have teeth that are set at	**e**	rotating motion
6	the number of teeth on the pinion to the number of teeth on the large gear	**f**	combination
7	to increase or	**g**	an angle to the axle
8	lubricated with oil or grease	**h**	wheel or disc
9	device that	**i**	of teeth on the large gear
10	to consist of a metal	**j**	pressure, temperature, water level, and thickness

17. **Revise words and phrases on the topic "Machine parts". Use Quizlet flashcards.**

18. **Fill in the gaps with the appropriate words from the list below.**

A hydrodynamic film, higher, friction, sliding bearings, needles, advantages, oil, failure, rolling bearings.

A bearing is a connector that permits the connected members to rotate or to move relative to one another. Often one of the members is

fixed, and the bearing acts as a support for the moving member. Most bearings support rotating shafts against either transverse (radial) or thrust (axial) forces. To minimize **1) _____**, the contacting surfaces in a bearing may be partially or completely separated by a film of liquid (usually **2) _____**) or gas. These are **3) _____** and the part of the shaft that turns in the bearing is the journal. Under certain combinations of force, speed, fluid viscosity, and bearing geometry, a fluid film forms and separates the contacting surfaces in a sliding bearing, and this is known as **4) _____**. An oil film can also be developed with a separate pumping unit that supplies pressurized oil to the bearing, and this is known as a hydrostatic film.

The surfaces in a bearing may also be separated by balls, rollers, or **5) _____**; these are known as **6) _____**. Because shaft speed is required for the development of a hydrodynamic film, the starting friction in hydrodynamic bearings is **7) _____** than in rolling bearings. To minimize friction when metal-to-metal contact occurs, low-friction bearing materials have been developed, such as bronze alloys and babbitt metal.

They have the following **8) _____** over bearings with sliding contact: they maintain accurate shaft alignment for long periods of time; they can carry heavy momentary overloads without **9) _____**; their lubrication is very easy and requires little attention; and they are easily replaced in case of failure.

Rolling bearings have the following **10) _____**. The shaft and house design and processing are more complicated; there is more noise for the higher speeds; the resistance to shock forces is lower; the cost is higher.

19. **Work in pairs. Write five questions about the usage of bearings, gears and valves in modern engineering and ask your partner to answer them. Then change roles. Use the Vocabulary (Appendix 1) if necessary.**

20. **Fill in the verbs in brackets in the Past Simple.**

The history of engineering is the record of human ingenuity through the ages. Even in prehistoric times, people **1)** _____ **(to adapt)** basic engineering techniques from things that **2)** _____ **(to be)** available in nature. For example, sturdy sticks **3)** _____ **(to become)** levers to lift large rocks, and logs were used as rollers to move heavy loads. The development of agriculture and the growth of civilization **4)** _____ **(to bring)** about a new wave of engineering efforts. People **5)** _____ **(to invent**) farming tools, **6)** _____ **(to design)** elaborate irrigation networks, and **7)** _____ **(to build)** the first cities. The construction of the gigantic Egyptian pyramids at Giza during the 2500's B.C. **8)** _____ **(to be)** one of the greatest engineering feats of ancient times. In ancient Rome, engineers **9)** _____ **(to build)** large aqueducts and bridges and vast systems of roads.

Taken from World Book Encyclopedia (International)

21. **Watch the video "Learn English Tenses: Past Simple, Past Continuous, Past Perfect, or Present Perfect" and answer the questions of the quiz. You will get the answers and your score at the end of the quiz.**

22. **Choose the correct option.**

1. He **(has been building / has built)** a house for 5 years. Now he needs more materials.
2. When I **(was coming in / came in)**, they **(discussed / were discussing)** two major types of journal bearings.
3. When **(did they start / were they starting)** a new project?
4. While I **(wrote / was writing)** a letter to my colleague, my brother **(was reading / read)** an engineering book.
5. By the time I **(decided / had decided)** to complete the task, my colleagues **(had already done / already did)** it.
6. They **(were researching / had been researching)** material properties for five years before they **(had started / started)** a project.
7. The role of engineers **(expanded / had expanded)** rapidly during the Industrial Revolution.
8. Early engineers **(used / were using)** such simple machines as the inclined plane, wedge, and wheel and axle.
9. I was disappointed because I **(had been waiting / was waiting)** for my supervisor for three hours yesterday.
10. I **(used to speak / used to speaking)** Italian in my childhood.

23. **Choose the correct item to fill in the blanks.**

Distinct branches of engineering **1)** _____ **(begin / began)** to develop during the Industrial Revolution. The term *civil engineer* was first used about 1750 by John Smeaton, a British engineer. Mechanical engineers **2)** _____ **(emerge / emerged)** as specialists in industrial machinery, and mining and metallurgical engineers were needed to supply metals and fuels. By the late 1800's, the development of electric

power and advances in chemical processing **3) _____ (had created / created)** the fields of electrical and chemical engineering. Professional schools **4) _____ (began / have begun)** to be founded as the demand for engineers steadily increased.

Since 1900, the number of engineers and engineering specialties **5) _____ (has expanded / was expanding)** dramatically. Artificial hearts, aeroplanes, computers, lasers, nuclear energy, plastics, space travel, and television are only a few of the scientific and technological breakthroughs that engineers **6) _____ (have helped / had helped)** bring about in this century. Because science and technology **7) _____ (are / is)** progressing and changing so rapidly, today's engineers **8) _____ (must studies / must study)** throughout their careers to make sure that their knowledge and expertise **9) _____ (do not become / had not become)** obsolete. They **10) _____ (were facing / face)** the challenging task of keeping pace with the latest advances while working to shape the technology of the future.

Taken from World Book Encyclopedia (International)

24. **Translate the sentences from Ukrainian into English in written form.**

1. Що ви робили після того як відвідали виставку сучасних механізмів?
2. «Деталі машин» – це найкраща книга, яку я мав, коли проводив власне дослідження сучасних типів підшипників.
3. Ми подивилися презентацію про види клапанів та їх використання у сучасному обладнанні, а потім поїхали на завод.
4. Наразі я розробив тип обробки за допомогою комп’ютерного цифрового керування, і тепер я працюю над її точністю та повторюваністю.

5. Я закінчив Оксфордський університет у 2018 році і отримав диплом інженера.
6. Коли професор увійшов до лабораторії, він побачив деталі машин, які студенти виготовили минулого тижня на заводі.
7. Вони зрозуміли, що не купили достатньо обладнання для проведення дослідження.
8. Багато років тому верстати були автоматизовані системою, що називається числовим програмним керуванням.
9. У Сполучених Штатах верстатобудівна промисловість почала розвиватися приблизно в 1800 році.
10. Використання ЧПК, обробних центрів, комп'ютерів і мікропроцесорів надало промисловості нову швидкість і ефективність.

25. **Use the information about the Present Perfect Tense and the Past Simple Tense (Appendix 2) and choose the correct option.**

1. Our mechanical engineers paid considerable attention to the spindle design three weeks (**ago / before)**.
2. I went there to check the corrosion resistance of the bearings (**on Friday / this week)**.
3. We've accomplished the speed reduction **(so far / last month)**.
4. He's called three times **(yesterday / in the last)** five hours to inform us that machine tool spindle bearings must provide the following requirements.
5. She reported on the topic "Efficiency and mechanical advantage" **(last week / so far)**.
6. Our designers have worked at the enterprise **(in 2016 / since 2016)**.
7. Jim has been an engineer **(for many years / in 2019)**.

8. They have created the design of machine elements **(last month / this month)**.
9. These titanium and nickel alloys were first used **(in 2001 / lately)**.
10. Have you seen our project manager **(today / yesterday)**?

26. **Do the following interactive tasks. Revise the use of the Past Simple Tense, the Past Continuous Tense and the Past Perfect Tense.**

TRANSLATION

27. **Translate the sentences from English into Ukrainian in written form.**

Gears are toothed elements that transmit rotary motion from one shaft to another. Gears are generally rugged and durable and their power transmission efficiency is as high as 98%. Gears usually cost more than chains and belts. The American Gear Manufacturers Association (AGMA) has established standard tolerances for various degrees of gear manufacturing precision. Spurs gears are the simplest and most common type of gears. They are used to transfer motion between parallel shafts, and they have teeth that are parallel to the shaft axes.

Gears may be used to increase or decrease the speed of rotation. They thus enable various parts of machines to operate at different speeds. One gear in every pair is smaller than the other. This small gear, called a *pinion*, has fewer teeth than the large gear. The ratio of the number of teeth on the pinion to the number of teeth on the large gear determines the relative speeds of the two gears and also the amount of *torque* (rotational force) transmitted from one to the other. For instance, if the pinion has 20 teeth and the large gear has 60 teeth, the ratio is 1 to 3, and the large gear will turn once in the time the pinion turns three times. Therefore, if the pinion drives the large gear, it reduces the speed of rotation by two-thirds but triples the torque. In such cases, the pinion

is known as the *reducing gear*. When the large gear drives the pinion, however, it serves as a *multiplying gear*. It increases the speed of rotation but reduces the torque.

Taken from The World Book Encyclopedia (International)

28. Translate the excerpt from Ukrainian into English in written form.

Призначення підшипника — підтримувати навантаження, одночасно дозволяючи відносний рух між двома елементами машини. Термін «підшипники кочення» відноситься до різноманітних підшипників, у яких використовуються сферичні кульки, циліндричні ролики або інший тип роликів між нерухомими та рухомими елементами. Більшість підшипників використовуються при обертанні.

Навантаження, що прикладається до підшипника кочення, проходить через зовнішнє кільце до тіл кочення, а потім до внутрішнього кільця, в результаті чого зусилля діють на дуже маленькі ділянки. Щоб витримувати такі високі навантаження, кульки, ролики та диски зазвичай виготовляються з дуже твердої високоміцної сталі або кераміки. Інші металеві матеріали включають деякі сплави титану / нікелю. Там, де зустрічаються менші навантаження або коли потрібна стійкість до корозії певних матеріалів, можна використовувати пластикові підшипники. Деякі підшипники, які піддаються впливу корозійних середовищ, виготовлені з нержавіючої сталі.

У порівнянні зі звичайними підшипниковими сталями, ці матеріали мають набагато нижчу щільність і вищу твердість, що призводить до меншої ваги та меншого зношування. Зазвичай вони мають кращу стійкість до корозії та можуть працювати при значно вищих температурах. Їх застосування: верстати, залізничне обладнання, виробництво напівпровідників, аерокосмічні пристрої та будь-яке обладнання, що працює при високих температурах.

Стандартні підшипники доступні в декількох класах. Конструкції відрізняються розміром і кількістю елементів (кульок або роликів) в підшипнику. Номер підшипника зазвичай вказує на клас і розмір отвору підшипника.

LISTENING

29. **Before watching the video, check if you know the meaning of the words and word combinations. Use the dictionary if necessary.**

Journal bearings, a metal sleeve, shaft, brass, fibrous, Babbitt, alloy, tin, copper, antimony, thickness, bushing, strength, advantage, a split journal bearing, a solid journal bearing, to remove, to replace.

30. **Watch the video "Journal Bearing Working Principle" (https://youtu.be/_cN1E8KUvmk) and answer the following questions.**

1. What do journal bearings typically consist of?
2. Can journal bearings be made out of nonmetallic materials?
3. Why is Babbitt usually bonded to a shell of harder metal?
4. Why are bearings generally made out of material that is softer than the metal of the shaft?
5. What two basic types of journal bearings are discussed?
6. How is a solid journal bearing sometimes called?
7. What does the term "sleeve bearing" generally refer to?
8. What is the advantage of a split journal bearing over a solid journal bearing?

31. **Watch the video again and complete the following sentences.**

1. Journal bearings typically consist of a metal sleeve that fits around _____.

2. Journal bearings can be made out of _____ or _____ materials.
3. Babbitt is a soft alloy comprised of _____, _____ and antimony.
4. Bearings are generally made out of material that is _____ than the metal of the shaft.
5. A solid journal bearing is sometimes called a bushing or _____ depending on its thickness.
6. The _____ of a split journal bearing over a solid journal bearing is that it can be separated into two halves.

32. **Write a blog entry (80-120 words) about the working principle of journal bearings and their application, using the information from the video (ex. 30) and other internet resources.**

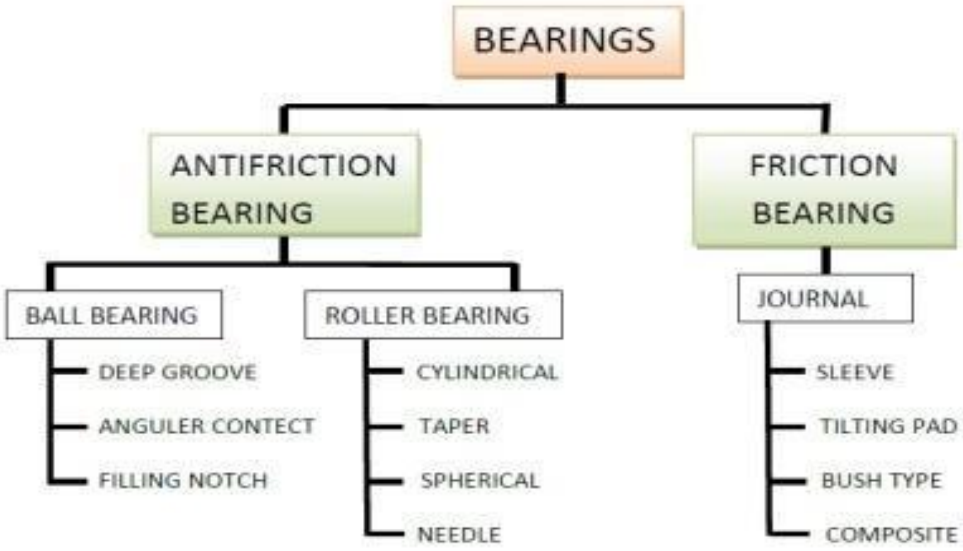
SPEAKING

33. **Watch the video and, in groups, prepare small presentations about different types of gears. Talk about their application, advantages and disadvantages. Then compare your ideas with the rest of the group.**

Taken from https://i.ytimg.com/vi/rRW-mNLIPxA/maxresdefault.jpg

34. **You are preparing a presentation about bearings. The lay out and the commonly used industrial bearing classification are given below. Search for more information on the Internet. Be ready to deliver your presentation.**

1) the importance of bearings;
2) their application;
3) classification;
4) bearing number identification;
5) different types of bearing materials;
6) bearing fits.

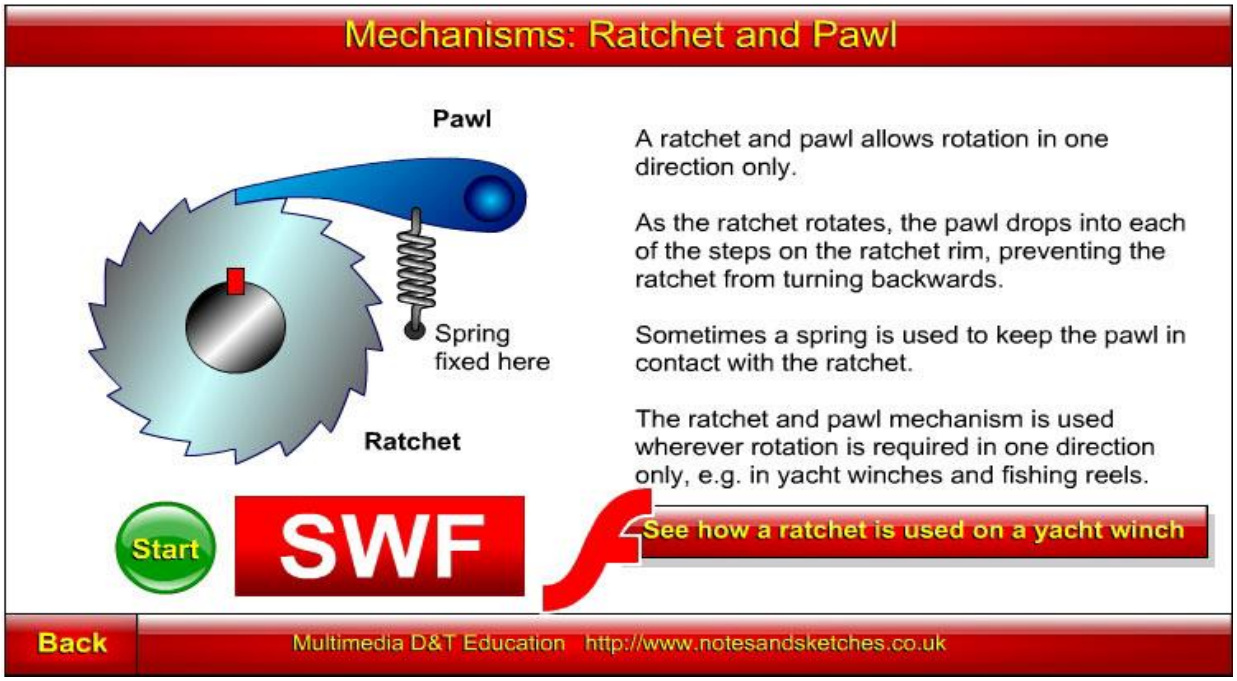


Taken from https://madetechnical.blogspot.com/2019/01/how-to-identify-types-of-bearing.html

35. **Work in groups of three. Use the link to choose one of the machine elements. Find the information about its classification, make a small presentation and deliver it. Follow the structure: definition, classification, application, and further improvement. Ask the other students at least one question after their talk.**

36. **In pairs, discuss the ratchet and pawl mechanism. Use the information from the article and the presentation. Find additional information on the Internet if necessary. Talk about:**

- how it works;
- materials it is made of;
- specifications;
- components of the mechanism;
- practical application of the ratchet mechanisms.



Taken from https://www.notesandsketches.co.uk/Ratchet.html

WRITING

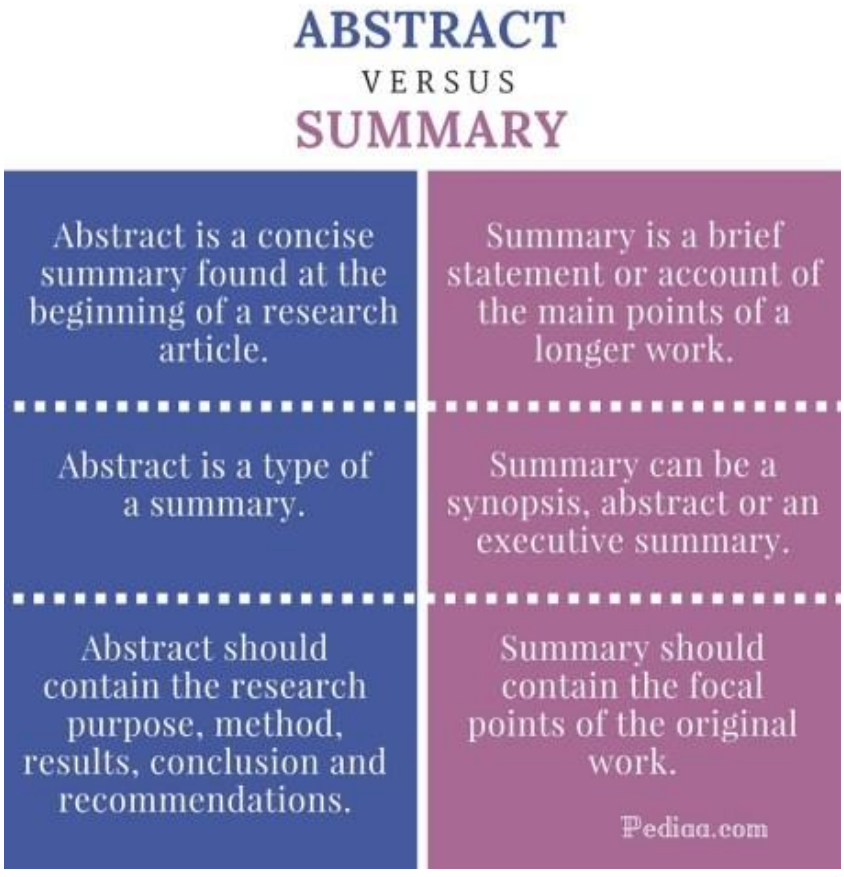
37. **Work in small groups. Watch the video "How to write a summary" and answer the test questions. Then draft the guidelines on writing a good summary using the plan.**

- ✓ tips for writing a successful and effective summary;
- ✓ a good paragraph structure;
- ✓ features of a good summary.

38. **When studying parts of machines you have been given the task to explore different types of bearings. Watch the video and write a summary on the topic "Assembly of a micro bearing". Use the words and phrases in the box below.**

dimension	shield	balls
millimetre	a plastic cage	to replace
to reassemble	to lubricate	uncommon

39. **Read the article "Review of Journal Bearing Materials and Current Trends" and write a summary. Remember the difference between an abstract and a summary.**



Taken from https://pediaa.com/difference-between-abstract-and-summary/

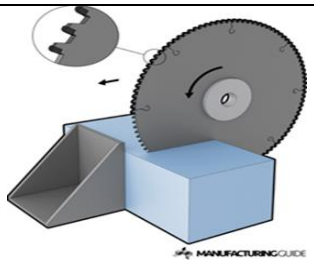
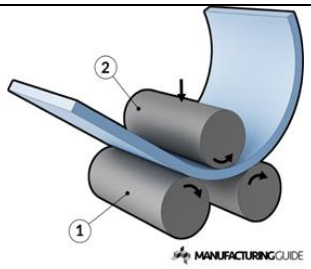
40. **Read the text "Machine Parts: gears, bearings, valves, ratchet, gauge" (ex. 6) and write a summary. These sites may help you to find useful phrases for your writing:**

- ✓ *https://www.kfmaas.de/summary1.html*
- ✓ *https://www.mpc.edu/home/showdocument?id=28714*
- ✓ *http://explainwell.org/index.php/table-of-contents-synthesize-text/writing-the-summary/*

UNIT 3. Machine Tools Operations

LEAD-IN

1. **Match the pictures with the words.**

1	sawing	**a**	*Taken from shorturl.at/bPUV4*
2	laser cutting	**b**	*Taken from shorturl.at/hHLT5*
3	grinding	**c**	*Taken from shorturl.at/fPRTW*
4	bending	**d**	 *Taken from shorturl.at/nuvBG*
5	forging	**e**	 *Taken from shorturl.at/npvJT*

2. **Work in pairs. Discuss the following questions.**

1. What does the notion of "machine tool operation" stand for?
2. What machine tool operations do you know?
3. What machine operations have you ever tried?
4. What precautions should be taken when you work with machines?
5. What new machine tool operations would appear in future?
6. What advanced machine tool operations do you know?
7. What facts do you know from the history of machine tool operations?

3. **Explain the quotations. Do you agree or disagree with them? Why/why not?**

1. The real problem is not whether machines think but whether men do.

   B. F. Skinner
2. People are more difficult to work with than machines. And when you break a person, he can't be fixed.

   Rick Riordan
3. I have little patience with scientists who take a board of wood, look for its thinnest part, and drill a great number of holes where drilling is easy.

   Albert Einstein
4. We think too much and feel too little. More than machinery, we need humanity. More than cleverness, we need kindness and gentleness. Without these qualities, life will be violent and all will be lost.

   Charlie Chaplin
5. The tendency of philosophers who know nothing of machinery is to talk of man as a mere mechanism, intending by this to imply that he is without purpose. This shows a lack of understanding of machines as well as of man.

   Arthur Young

READING

4. **Underline the stressed syllable. Practise reading the words.**

Grinding, broaching, abrasive, reaming, spindle, various, cylindrical, workpiece, beneath, sawing, forging, honing, abrasive, dimension, lapping, maximum, accuracy, stationary, aeroplane, toolholder.

5. **Explain the meaning of the words and phrases. Check in the dictionary if necessary.**

Machine tool operation, metal removal, metal forming, against the rotating workpiece, removing metal shavings from the hole, abrasive process, lathe, grinding, workpiece, turning, milling, spindle, machinist, accuracy, forging machine.

6. **Read the text about basic machine tool operations and answer the questions that follow.**

BASIC MACHINE TOOL OPERATIONS

Metal removal. There are two chief kinds of machine tool operations: (1) metal removal and (2) metal forming. Basic metal removal operations involve either the cutting away or the abrasion of part of the workpiece. In metal forming, the workpiece is shaped without the removal of any material from it.

Metal forming operations include forging, pressing, bending, and shearing. There are four main types of forming machines: (1) forging machines, (2) presses, (3) press brakes, and (4) shears.

There are six basic types of **metal removal** processes. They are (1) turning; (2) hole machining; (3) milling; (4) sawing; (5) planing, shaping, and broaching and (6) abrasive processes.

Turning is used chiefly to cut metal into round shapes. Turning machines are the most common machine tools in use. The *lathe* is the basic

turning machine. On a lathe, the workpiece is fastened to a rotating spindle, and the cutting tool is mounted at the side of the workpiece. The tool moves against the rotating workpiece, peeling metal until the workpiece has the desired shape. A turret lathe has several kinds of cutting tools mounted on a revolving toolholder called a turret. This lathe can perform various cutting operations, one after the other.

Some turning machines have several spindles and cutting tools that operate at the same time. Such multi-spindle machines perform various operations at once on several workpieces. The machine moves each workpiece from one cutting tool to the next until all the operations have been performed.

Hole machining includes drilling, boring, reaming, and tapping. In *drilling*, round holes up 7.5 centimetres in diameter are cut in a piece of metal. These holes, cut by a rotating *twist drill*, may be as small as a thousandth of a centimetre in diameter.

In most machine shops, twist drills are mounted on large machines called *drill presses*. The machinist places the workpiece on a table beneath the drill and lowers the drill into the metal. The bit of the drill has several sharp cutting edges. Two or more spiral grooves along the bit help remove metal shavings from the hole.

In *boring*, round holes greater than 7.5 centimetres in diameter are cut. Boring is also used to enlarge and *finish* (smooth) holes already drilled. Boring machines have a cutting tool with only one sharp edge. On small boring machines, the tool revolves and the workpiece remains stationary. On large machines, the tool is stationary and the workpiece revolves.

The process of *reaming* consists of smoothing the inside of a hole. *Tapping* involves the cutting of a screw thread inside a hole.

To cut deep holes, machinists use special processes in which a single- or multiple-edged tool mounted at the end of a bar is driven into the workpiece. These processes involve the rotation of the tool, the workpiece,

or both. During the operation, a fluid is forced into the hole to flush out shavings cut from the workpiece.

Milling. In this operation, a round tool with several cutting edges rotates against a workpiece. The cutting tool of most milling machines looks like a wheel with teeth projecting out of it. This tool makes flat surfaces on metal. Machinists use special milling tools to cut such shapes as those of bevels, gear teeth, and slots. *Special contour milling machines* produce aeroplane wing sections as long as 24 metres.

Sawing consists of machining a piece of metal with a cutting tool that has sharp teeth along one edge. There are two types of machine-tool sawing, *cutoff sawing* and *contour sawing*. Machinists use cutoff sawing to cut metal bars to a certain length. Contour sawing cuts flat pieces of metal into the desired shape.

Planing, shaping and broaching. Planing smooths flat surfaces of large pieces of metal. It resembles smoothing wood with a hand plane. But the cutting tool is stationary as the metal moves back and forth beneath it. The cutting tool moves back and forth over a stationary workpiece. Broaching shapes holes in a piece of metal. For example, it can change round holes to square ones. A broach is a long metal bar with rows of teeth on it. Each tooth cuts a little deeper than the one before. A broach is pulled or pushed through a hole, and the teeth cut the metal to the desired shape.

Abrasive processes include grinding, lapping, and honing. In *grinding*, metal is removed from the surface of a workpiece to make it smooth. A grinding machine has a *grinding wheel* that spins at high speed against the workpiece. This wheel is made of an abrasive material similar to that on sandpaper.

In *lapping*, an abrasive paste or other substance is used to remove metal. Lapping provides an extremely smooth surface when only a small amount of metal must be removed. A lapping machine has a metal plate covered with an abrasive. *Honing* assures maximum accuracy in finishing

holes to precise dimensions. In this process, an abrasive paste is applied to cylindrical parts called heads, which are inserted into the hole. The heads rotate while moving up and down.

Taken from the World Book Encyclopedia (International)

1. What are the two chief kinds of machine tool operations?
2. What do machinists use to cut deep holes?
3. How does the cutting tool of most milling machines look like?
4. State the working principle of the milling machine.
5. What operations can be done on a drilling machine?
6. Define the following terms used in a drilling operation:
   - cutting speed;
   - twist drill;
   - drill presses.
7. What operations does metal forming include?
8. What machine is used in grinding?
9. What is a broach? How does it work?
10. Choose three processes and define them.

7. **Give the definitions of these terms. Use the dictionary if necessary.**

Milling machines, lapping, a lathe, hole machining, broaching, grinding, drilling, cutoff sawing, an abrasive material, metal forming, planing.

8. **Read the text again and:**

1) summarize the information about basic machine tool operations (metal removal and metal forming);

2) talk about some other advanced machining operations you know.

USE OF ENGLISH

9. **Work in pairs. Give Ukrainian equivalents to the words and phrases.**

1.	machine tool operations	17.	grinding
2.	metal removal	18.	lapping
3.	metal forming	19.	beneath
4.	reaming,	20.	sandpaper
5.	abrasion	21.	accuracy
6.	workpiece	22.	accuracy
7.	turning	23.	to precise dimensions
8.	hole machining	24.	toolholder
9.	milling	25.	forging
10.	sawing	26.	pressing
11.	planing	27.	bending
12.	shaping	28.	shearing
13.	broaching	29.	forming machines
14.	spindle	30.	forging machines
15.	dimension	31.	presses
16.	lathe	32.	honing

10. **Write the opposites of the following words. Use the dictionary if necessary.**

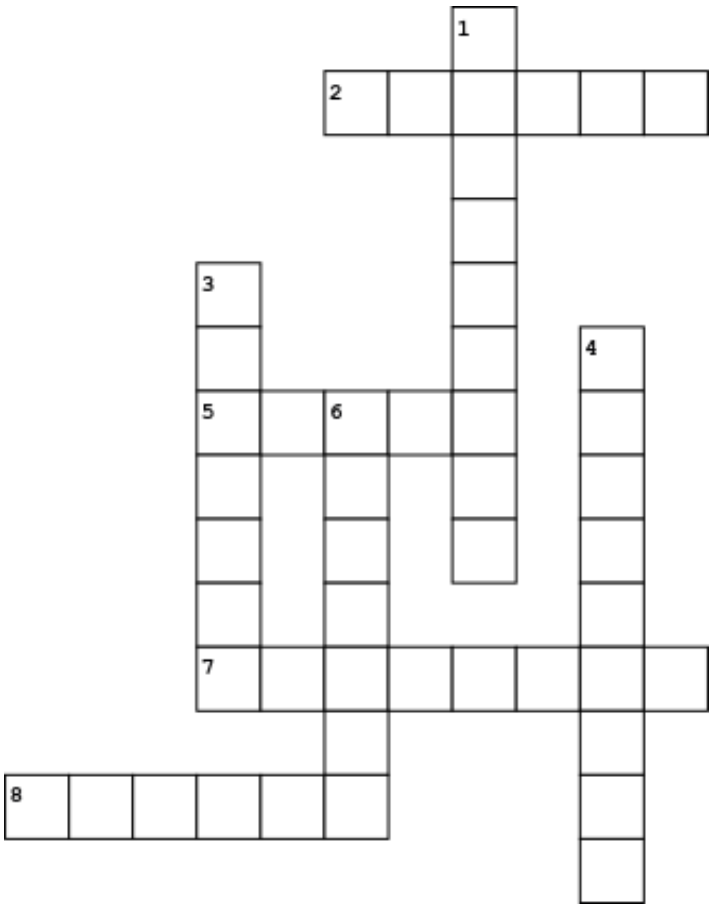
1) to remove;
2) to mount;
3) beneath;
4) to enlarge;
5) fluid;
6) stationary;
7) smooth.

11. **Match the words with similar meanings.**

1	revolve	**a**	extend
2	abrasive	**b**	form
3	smooth	**c**	cavity
4	enlarge	**d**	accurate
5	shape	**e**	go round
6	beneath	**f**	lathe
7	amount	**g**	rough
8	precise	**h**	below
9	hole	**i**	polished
10	turning machine	**j**	number

12. **Solve the crossword puzzle below. You can also do it using the Crossword Lab platform at this link.**

Machine tools operations



Across	Down
2. a long metal bar with rows of teeth on it	**1.** a piece of metal or other material that is in the process of being worked on or made or has actually been cut or shaped by a hand tool or machine
5. a machine for changing the shape of a piece of wood, metal, etc. that works by turning the material while a sharp tool is pressed against it	**3.** the activity of cutting metal or making it into particular shapes using a special machine
7. metal is removed from the surface of a workpiece to make it smooth	**4.** a person whose job is operating a machine
8. used to enlarge and finish (smooth) holes already drilled	**6.** used chiefly to cut metal into round shapes

13. **Match the words in column A with the words in column B to form meaningful phrases. Then choose any three and make sentences.**

1	basic metal	**a**	thread inside a hole
2	shaped without the removal of	**b**	in diameter
3	the tool moves against the rotating	**c**	removal operations
4	mounted on a revolving toolholder called	**d**	from the hole
5	round holes up 7.5 centimetres	**e**	reaming
6	remove metal shavings	**f**	forth over a stationary workpiece
7	the cutting of a screw	**g**	any material from it
8	planing, shaping and	**h**	workpiece
9	drilling, boring,	**i**	contour sawing
10	to cut such shapes as those of bevels,	**j**	broaching
11	cutoff sawing and	**k**	a turret
12	to move back and	**l**	gear teeth, and slots

14. **Work in small groups. Solve the word search puzzle.**

Machine tools operations

T H E R A N D K S F A Q V K W
S T Q I Z W R Q P K Q K L Y W
A C N C L I I T C Q V G G G P
W K H Q P Y L E Q F C N N R M
I O S G Y K L H I O U I I I I
N B D O T L I P P A U N N N L
G F O D Q Q N C W O C R I D L
H K X R S S G T U V B U H I I
O K T V I S M V K T L T C N N
N Y U U V N J G R O T R A G G
I D R H B S G B R M R I M C F
N H B R O A C H I N G I N U K
G N W Q S G K D W C L D C G H
O U V Q G H X J S X R U L X Z
N A N G T H K A F R I Q P S U

15. **Using the information from the text (ex. 6), choose the odd word in each line.**

1) drilling, boring, grinding, reaming;
2) planing, milling, shaping, broaching;
3) grinding, lapping, honing, drilling;
4) forging, pressing, bending, turning;
5) lathe, forging machines, presses, press brakes;
6) lathe, milling machine, engine, drill press machine;
7) turning, milling, hole machining, welding;
8) electrical discharge machining, milling, electrochemical machining, chemical machining;
9) drilling, abrasive process, grinding wheel, lapping;
10) strain, drill, broach, planer.

16. **Work in pairs. Using the information from the text (ex. 6), match 1-10 with a - j to make sentences.**

1	There are six basic types of metal	**a**	7.5 centimetres in diameter are cut.
2	Turning is used chiefly to	**b**	removal processes.
3	The lathe is the basic	**c**	a grinding wheel that spins at high speed against the workpiece.
4	Hole machining includes	**d**	accuracy in finishing holes to precise dimensions.
5	In boring, round holes greater than	**e**	cut metal into round shapes.
6	Tapping involves	**f**	forging, pressing, bending, and shearing.
7	Abrasive processes include	**g**	the cutting of a screw thread inside a hole.
8	A grinding machine has	**h**	turning machine.
9	Metal forming operations include	**i**	drilling, boring, reaming, and tapping.
10	Honing assures maximum	**j**	grinding, lapping, and honing.

17. **Fill in the gaps with the appropriate words from the list below.**

Electricity, forces, workpiece, spark, machining, smooth, tool, liquid, magnetism, negatively.

ADVANCED MACHINE TOOL OPERATIONS

Advanced machine tools cut extremely hard metals into complex shapes by means of electrical or chemical energy, heat, **1)** _____, or other **2)** _____. Advanced machine tool operations are used chiefly to make large steel dies for the manufacture of car parts and other parts. These methods include (1) electrical discharge machining, (2) electrochemical machining, (3) chemical machining, and (4) high-energy rate forming.

Electrical discharge machining (EDM) cuts holes in extremely hard metals, including steel alloys that cannot be cut by traditional methods. EDM produces **3)** _____, accurate holes, some of which have extremely complex shapes. It is the most widely used machining process.

Electrochemical 4) _____ **(ECM)** uses **5)** _____ to create a chemical reaction that erodes metal from a workpiece. In this method, electricity flows from a positively charged workpiece to a **6)** _____ charged cutting tool. An electrolyte is pumped between the workpiece and the cutting tool and conducts current between them. This causes an electrochemical reaction that erodes metal from the workpiece. The finished workpiece takes the shape of the face of the cutting **7)** _____.

Chemical machining. In this operation, the **8)** _____ is covered by a chemically resistant mask. The mask has holes cut in it of the shape of those to be cut in the workpiece. The workpiece is dipped into a strong chemical solution, which dissolves the metal from the workpiece sections not covered by the mask.

High-energy rate forming (HERF) involves transmitting pressure through a **9)** _____, usually water, to force sheet metal into the contours of a die. In most cases, the pressure is created by setting off an explosive in the liquid or by discharging an electric **10)** _____ in it. HERF is used chiefly to make large metal parts that have an unusual shape, such as a dish-shaped radar aerial.

Taken from from the World Book Encyclopedia (International)

18. **Revise words and phrases on the topic "Machine tool operations". Use Quizlet flashcards.**

19. **Using the information about the future forms (Appendix 2), choose the correct option to complete the sentences.**

1. I hope cutting tools **(will perform / are going to perform)** more machining operations in future.
2. I'll **(have been / be)** waiting there for seven hours.
3. Look! The grinding machine **(will be falling / is going to fall)**.
4. Tomorrow at 2 p.m. **(I'm making / I will make)** a report about metal forming processes.
5. **(I'll have been / I'll have been waiting)** there for seven hours.
6. **(Will you have finished / Will you be finishing)** developing some guidelines for a successful product design and manufacture by Thursday?
7. I think **(you'll incorporate / you are incorporating)** all new safety measures needed in the machine shop.
8. Do you think you'll have finished all your planning for industrial safety **(by / after)** 6 p.m.?
9. It's all booked! **(We're going to fly / We're flying)** to Kyiv on Sunday.
10. The timetable says the bus **(leaves / will leave)** at 8.00 p.m.

20. **Translate the excerpt from Ukrainian into English in written form.**

ФАБРИКА МАЙБУТНЬОГО

В сучасних галузях промисловості тенденція до автоматизованого виробництва здається неминучою. Інтеграція багатьох нових технологій, таких як ЧПУ, обробні центри, роботи, транспортно-розвантажувальне обладнання та автоматичні склади, разом із програмним забезпеченням CAD, CAM зробить фабрику майбутнього ближчою до реальності.

Усе виробництво, обробка матеріалів, складання та перевірка будуть здійснюватися машинами та обладнанням з комп'ютерним керуванням. Подібним чином, такі дії, як обробка вхідних замовлень, планування та розклад виробництва, облік витрат і різні процеси прийняття рішень виконуватимуться автоматично за допомогою комп'ютерів. Роль людей буде обмежуватися такими видами діяльності, як загальний нагляд; профілактичне обслуговування; модернізація машин і обладнання; прийом матеріалів і відвантаження готової продукції; забезпечення безпеки об'єктів заводу; програмування, модернізація та моніторинг комп'ютерних програм; обслуговування та оновлення комп'ютерного обладнання.

Важливим моментом повної автоматизації заводу є ступінь його впливу на зайнятість. Незважаючи на те, що прогнози вказують, що кількість операторів верстатів і робітників, що займаються виготовленням інструментів, скоротиться, кількість фахівців, таких як програмісти та електрики, значно збільшиться. Таким чином висококваліфіковані працівники, які необхідні на виробництві, будуть працювати в таких видах діяльності, як комп'ютерне програмування, обробка інформації, впровадження CAD/CAM тощо. Розробка більш сучасного програмного забезпечення значно полегшить ці завдання.

21. **Revise the Present Continuous Tense (Appendix 2) and write a short paragraph about the arrangements that have been made for the Vice President of a Manufacturing Company to open a new plant in Poland.**

12 October	**10.00** Arrival at Lublin Airport
	11.00 Meeting with Chief Executive
	2.00 Lunch with officials from the Department of Industry
	4.00 Official opening of a new factory
	5.00 Speech: "Plant and Machine Shop Layout"
	6.00 Dinner at the City Hall
13 October	**9.00** Return flight to London

The Vice President of Manufacturing Company is arriving at Lublin Airport at 10.00, and _____ .

22. **You are the manager of an engineering projects. Write what you will be doing at each phase of the project and what you will have done by a certain period of time.**

Project Phases	**Period**
Planning	September – October
Design	November – December
Tendering	January – February
Construction	March – April
Implementation	May – June

Example:

In September, I will be creating a guide for project-decision making.

By the end of December, I will have developed a product design for economical machining.

23. **Watch the video "4 ways to talk about the future" and answer the questions of the quiz. You will get the answers and your score at the end of the quiz.**

TRANSLATION

24. **Translate the excerpt from English into Ukrainian in written form.**

NUMERICAL CONTROL OF MACHINE TOOLS

Numerical control is a system of automating machine tools. In some systems, instructions are given by means of a control tape. This tape, which is made of paper or plastic, contains the instructions in the form of a number code. The numbers are represented on the tape by holes or by magnetized spots. The tape is fed into the machine, which has a control unit that reads the code. This process creates electric signals that correspond to the code. The signals control the direction and speed of the machine as it moves across the workpiece.

In some other machining systems, computers have replaced control tapes. A system known as computer numerical control has a number of machine tools, each of which is directed by its own computer. In a system called direct numerical control, a single computer controls more than 100 machine tools.

A more highly automated machining system, called adaptive control, involves the use of a microprocessor. A microprocessor is a tiny electronic device that performs the work of a large computer. The microprocessor regulates certain variables in the machining process, such as the speed of

a spindle, to make the process as efficient as possible. It also receives information from sensors that measure force, temperature, and other variables. It uses this information to operate the system at a level that is safe for the machine tool and the workpiece.

Taken from World Book Encyclopedia (International)

25. **Translate the excerpt from Ukrainian into English in written form.**

Верстати займають важливе місце у виробництві майже всіх металевих виробів. Механіки використовують верстати для виготовлення деталей для таких виробів, як велосипеди, автомобілі, радіоприймачі, холодильники, телевізори. Багато інших речей, включаючи книги, меблі та текстиль, виготовляються машинами, які були виготовлені верстатами.

Існує близько 500 видів верстатів. Деякі виконують одну операцію, наприклад шліфування або свердління. Інші, які називаються обробними центрами, виконують декілька видів завдань. Обробні центри мають автоматичну зміну інструментів і можуть використовувати більше 100 інструментів. Багато верстатів автоматизовано системою, яка називається числовим програмним керуванням.

Верстати можна об’єднати разом, щоб утворити гнучку виробничу систему. Кожен інструмент виконує різну операцію обробки металу. Метал, що обробляється, називається заготовкою, переміщується від одного інструменту до іншого за допомогою конвеєрів, роботів та іншого автоматичного обладнання.

Taken from World Book Encyclopedia (International)

LISTENING

26. **Before watching the video, check if you know the meaning of the words and word combinations. Use the dictionary if necessary.**

Forging, swords, dies, a hammer, workpiece, rolling, structure beams, rollers, extrusion, bulk deformation, cylindrical billet or rectangular bars, shape changes.

27. **Watch the video about metal forming (https://www.youtube.com/watch?v=RP4Y_aSBoNw) and complete the following sentences.**

1. Forging is when you put the workpiece in between _____.
2. In_____, the work material is placed in a die where a ram will then push the material through and create _____ for the work material.
3. An example of a product that would be created using the extrusion process would be solid _____.
4. _____ takes work material and feeds it in between two rollers.
5. These types of processes are in a class called _____.
6. The starting work _____ are usually cylindrical billet or _____ but in the end, the final shape is drastically different.

28. **Watch the video again and decide if the following statements are *True* (*T*) or *False* (*F*).**

1. Forging has come a long way from making just swords.
2. Forging is a process that can use much heavier forces than a hand in a hammer.
3. The dies apply force on both sides of the workpiece.
4. In milling, the material gets continually fed into the rollers until the desired shape is achieved.

5. One example of using rolling is to make a lathe.
6. Bulk deformation processes usually have significant deformations and massive shape changes.

29. **You are going to talk about forging at a students' scientific conference. Work in pairs. Discuss the information you are going to present. Use the video (ex. 27) and additional resources if necessary.**

SPEAKING

30. **Work in pairs. Watch the video "Lathe Machine: Parts, Function, Working, Operations & Types" and describe the working principle of the lathe. Name the different types of lathes available in the machine shop. Define the following terms used in lathe operation:**

- **cutting speed;**
- **feed;**
- **depth of cut;**
- **machining time.**

31. **Read the article and explain the difference between hot and cold working. What is cold working of metals? What are its advantages and disadvantages? Use the words and phrases in the box below.**

recrystallization	*strength and hardness*	*ductility*	*recovery of the product*
dislocation	*plastic deformation*	*permanent defects*	*internal and residual stresses*
extrusion	*defects-free grains*	*grain growth*	*a finished product*
strengthening	*surrounding atmosphere*	*to maintain the appropriate temperature*	*uniformity*

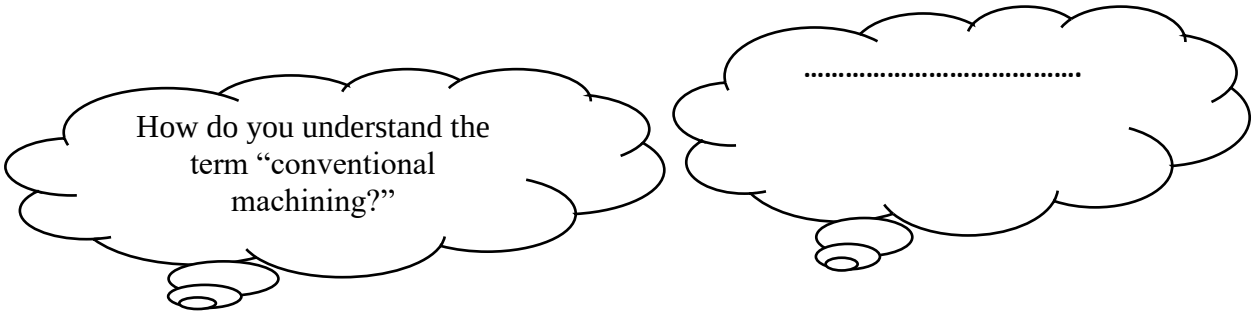
32. **Work in groups of three. Choose one of the processes mentioned in the text (ex. 6), find the information about its advantages and disadvantages, make a presentation and deliver it to your groupmates. Use the plan: introduction, main body, and conclusions. Ask the other students at least one question after their talk.**

33. **Choose a machine tool operation you know well. In pairs, discuss its application, tools, advantages and disadvantages. Complete the table.**

Machine tool operation	***Application***	***Advantages***	***Disadvantages***	***Tools***
Milling				
Drilling				
Turning				
Grinding				
Sawing				
Forging				
Your choice				

34. **Work in pairs. Watch the video, complete the dialogue about the differences between milling and turning and role play it.**

1.



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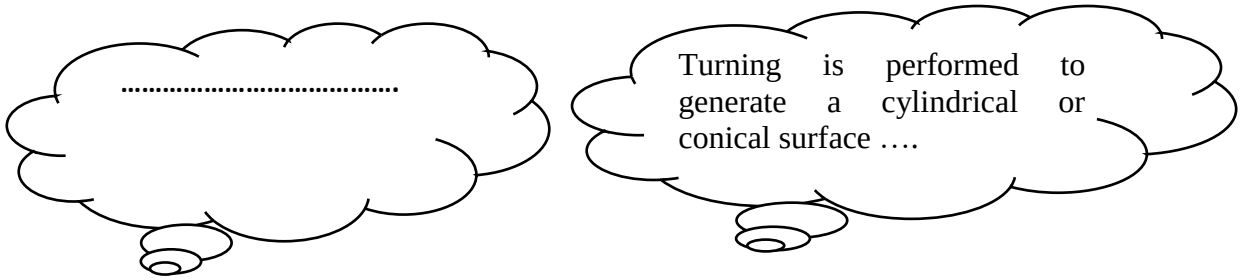

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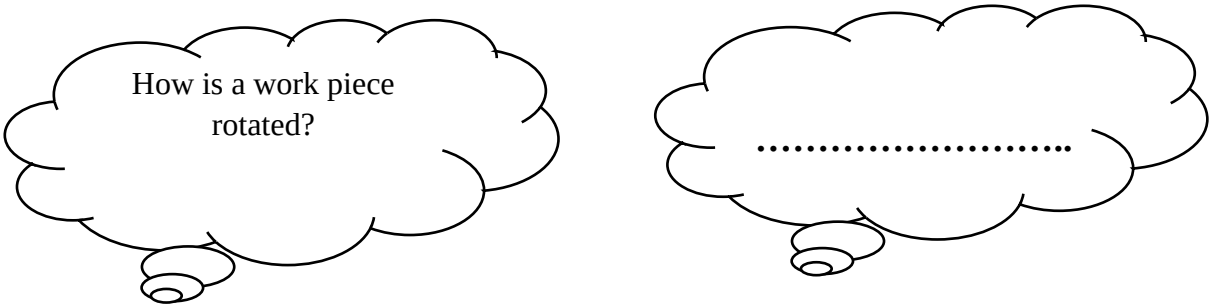

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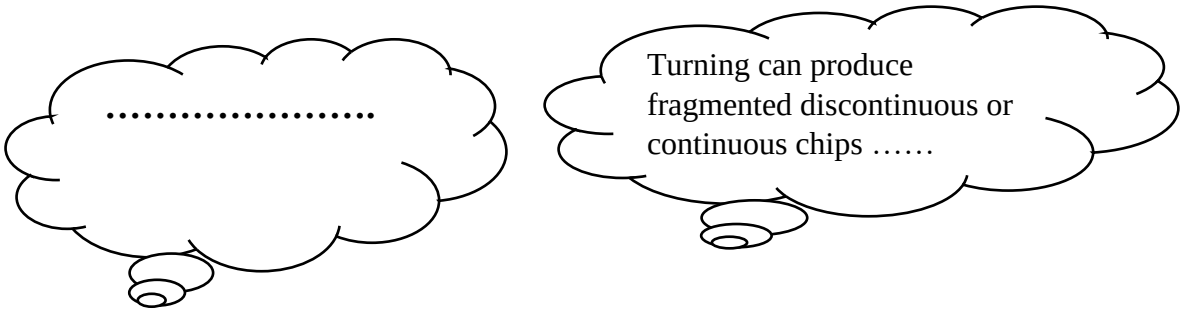


WRITING

35. **Choose a machine tool operation that you know well and describe its possible improvement (160-180 words). Use the words and phrases in the box below.**

tool life	*right maintenance*	*capacity*	*versatility*
cutting tools	*smart machining technology*	*efficiency and productivity*	*optimal cutting techniques*
to ensure machine shop safety	*CNC machine shop*	*operator training*	*to train employees and machinists*

36. **Work in small groups. You are going to create a website devoted to mechanical cutting tool machines. Describe the machines below (200-250 words) using the following plan:**

- ✓ **application;**
- ✓ **machine tool operation;**
- ✓ **properties;**
- ✓ **cutting tool materials.**

Alligator shear

Abrasive saw

Milling machines

Drill press machine

Bandsaw

Lathe machine

Diamond saw

https://engineeringlearn.com

Taken from https://engineeringlearn.com/types-of-mechanical-cutting-tools/

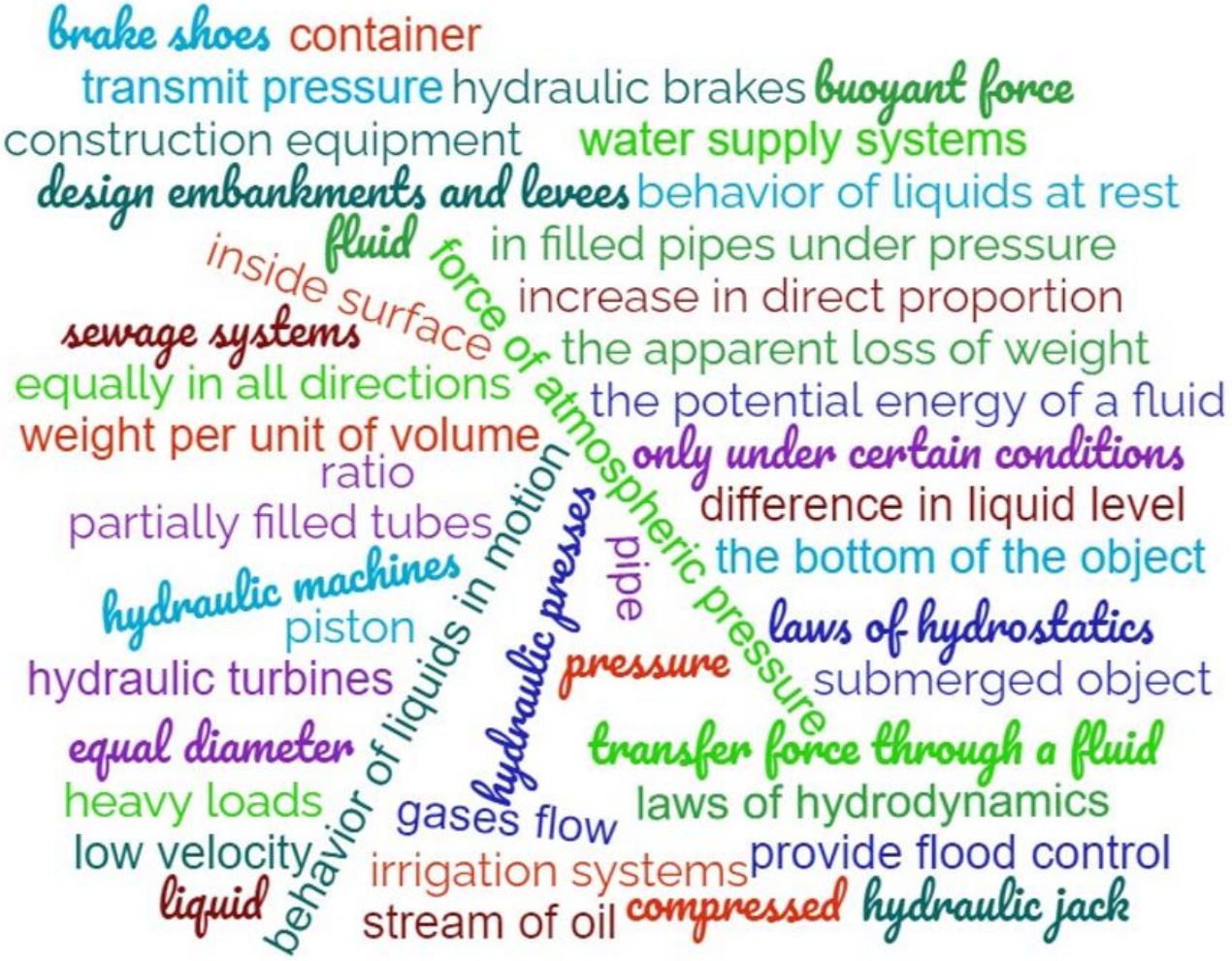
37. **Write a paragraph (80-120 words) about the future of the machine tools.**

38. **Choose a machine tool operation. Describe the main stages of the process (160-180 words) using the plan below.**

1. *Analysis and approval of technical drawings of the workpiece.*
2. *Modeling or prototyping the part to be manufactured.*
3. *Selecting the machining techniques to be used.*
4. *Choosing the right machine tool to use.*
5. *Machining of the part by the machinist.*
6. *Quality control.*

Taken from https://braidwoodgear.com/en/machining-steps/

Unit 4. Application of Hydraulics in Mechanical Engineering



LEAD-IN

1. **In groups, discuss the following questions.**

1. What is a hydraulic system?
2. What hydraulic systems do you know?
3. What are the main parts of the hydraulic system?
4. How does a hydraulic system work?
5. How many types of hydraulic machines do you know?

2. **Work in pairs. Match the following components of the hydraulic system (1-10) and their functions (a-j).**

1	fluid	**a**	power source for the pump
2	accumulator	**b**	removes contaminants from fluid
3	reservoir	**c**	receives the fluid and converts the energy to do work
4	filter	**d**	create different pressure zones throughout the system
5	pump / compressor	**e**	controls the direction and flow rate of the fluid
6	piston	**f**	holds excess fluid
7	motor	**g**	allows the pressurized fluid to travel from one place to another
8	control valve	**h**	oil that moves throughout the system (typically petroleum)
9	piping / tubing	**i**	pumps the fluid through the system (can be manual or electric)
10	actuator / cylinder	**j**	stores energy with pressurized gas

Taken from https://examples.yourdictionary.com/how-do-hydraulic-systems-work-examples-explainedcreate

3. **Explain the quotations.**

1. It is very sad for a man to make himself servant to a single thing; his manhood all taken out of him by the hydraulic pressure of excessive business.

Theodore Parker

Taken from https://www.morefamousquotes.com/topics/hydraulic-quotes/

2. Every inch of that thing is taken up with electronics, and hydraulics.

Mike Hill

Taken from http://www.quotehd.com/quotes/words/hydraulics

3. When you try to explain the behavior of water, remember to demonstrate the experiment first and the cause next.

Leonardo da Vinci

Taken from https://todayinsci.com/QuotationsCategories/H_Cat/Hydraulics-Quotations.htm

READING

4. **Underline the stressed syllable. Practise reading the words.**

Hydraulics, behaviour, conditions, hydrostatics, hydrodynamics, categories, specialty, partially, embankments, irrigation, sewage, potential, measured, submerged, buoyant, exerted, mathematician, equipment, liquid, mercury.

5. **Explain the meaning of the words and phrases. Use the dictionary if necessary.**

Behaviour of liquids, under certain conditions, at low velocity, categories, hydrostatics and hydrodynamics, concerned with, specialty fields of engineering, partially filled, hydraulic machines, heavy load, atmospheric pressure, piston, buoyant force.

6. **Read the text and decide if the statements are *True (T)* or *False (F)*.**

APPLICATION OF HYDRAULICS IN MECHANICAL ENGINEERING

Hydraulics is the branch of physics that studies the behaviour of liquids at rest and in motion. Some laws of hydraulics apply to both gases and liquids. But they apply only under certain conditions, such as when gases flow at low velocity and are not compressed. Scientists sometimes divide the study of hydraulics into two categories – hydrostatics and hydrodynamics. Hydrostatics describes the behaviour of liquids at rest. Hydrodynamics is concerned with the behaviour of liquids in motion.

Hydraulics is studied and applied in two of the specialty fields of engineering: civil engineering and mechanical engineering. Civil engineers use the principles of hydraulics mainly to study the flow of water in open or partially filled pipes. They design embankments and levees that provide flood control along rivers, as well as canals, irrigation systems, and sewage systems. They also plan water supply systems for cities and towns.

Mechanical engineers are usually more concerned with the flow of fluids in filled pipes under pressure. They use the principles of hydraulics to design hydraulic machines. These machines include hydraulic turbines, hydraulic brakes, power steering for cars, controls for aeroplanes and spacecraft, and construction equipment.

Pressure from water or some other fluid supplies the power that runs hydraulic machines. Some hydraulic machines, including turbines, operate by the force of a flowing fluid. Turbines are large wheels that change the potential energy of a fluid into work that can be used to power an electric generator or perform some other type of work. Steam or gas powers other kinds of turbines.

Other hydraulic machines, called hydraulic presses, increase and transfer force through a fluid from one piston to a larger piston. Industry uses hydraulic presses for such jobs as lifting heavy loads and pressing metal parts. One form of hydraulic press is called a hydraulic jack.

Laws of hydrostatics describe the behaviour of liquids at rest.

One principle of hydrostatics states: *The pressure caused by the weight of a column of fluid is determined by the height of the column.* The shape of the column does not affect the pressure that is exerted by the fluid.

Suppose that a pipe extends in a zigzag pattern from the ceiling to the floor. Another pipe of equal diameter extends straight down from the ceiling to the floor. The second pipe is, of course, shorter than the first. If both pipes are filled with water, the longer one will hold more water. But the water pressure at the bottom of both pipes will be equal because the height of both columns of water is equal.

An illustration of the above principle is the buoyant force exerted by a fluid on an object submerged in it. The bottom of an object submerged in water is deeper than the top of the object. Therefore, the column of water pressing on the bottom of the object is taller than the column pressing on the top of the object. Thus, the water exerts an upward force on the object called a buoyant force. Buoyant forces act to keep boats afloat.

Archimedes' principle comes from the principle discussed above. It states: *An object placed in a fluid seems to lose an amount of weight equal to the weight of the fluid it displaces.* A buoyant force exerted on the object by the fluid causes the apparent loss of weight. Archimedes, a Greek mathematician, developed this principle during the 200s B. C.

To illustrate this principle, imagine that a 1-liter metal can is placed in water. If the can weighs 3 kilograms, it will displace 1 liter of water, which weighs 1 kilogram. Thus, the buoyant force equals 1 kilogram. The can will then seem to weigh only 2 kilograms – that is, 1 kilogram less than its original weight.

Pascal's law states: *A fluid in a container transmits pressure equally in all directions.* Blaise Pascal, a French scientist and mathematician, developed this law during the A. D. 1600's.

To illustrate Pascal's law, take a bottle with a neck opening of 10 square centimeters and fill it with water. Put a plug in the neck so that the plug seals the top of the bottle and moves freely in the neck. Place a 1 kilogram weight on the plug. The pressure of the water will increase by 1 kilogram over each square centimeter of the inside surface of the bottle.

Taken from World Book Encyclopedia (International)

1. Hydraulics is the branch of chemistry that studies the behaviour of gases at rest and in motion.
2. All laws of hydraulics apply only to liquids.
3. Some laws of hydraulics apply only under certain conditions.
4. The energy increases in direct proportion to the ratio of the area of the larger cylinder to the area of the smaller cylinder.
5. Hydrodynamics describes the behaviour of liquids in motion, hydrostatics describes the behaviour of liquids at rest.
6. Engineers use the principles of hydraulics to study the stream of oil in open or partially filled tubes.
7. The fluid in the manometer must have the same weight per unit of volume as the liquid whose pressure is to be measured.
8. A barometer is used to forecast weather and to measure heights of mountains.
9. Mechanical engineers use the principles of hydraulics to design hydraulic machines.
10. The top of an object submerged in water is deeper than the bottom of the object.
11. A buoyant force exerted on the object by the liquid causes the apparent loss of weight.
12. Pascal's law states that a fluid in a tank transmits pressure equally in all directions.

7. **Read the text again and:**

1) **summarize the information about hydraulics and its application in engineering;**
2) **add some examples to illustrate Archimedes' principle and Pascal's law.**

USE OF ENGLISH

8. **Work in pairs. Give the Ukrainian equivalents to the words and phrases.**

1.	behaviour of liquids at rest	17.	construction equipment
2.	only under certain conditions	18.	laws of hydrostatics
3.	behaviour of liquids in motion	19.	weight per unit of volume
4.	submerged object	20.	increase in direct proportion
5.	pressure	21.	transfer force through a fluid
6.	difference in liquid level	22.	laws of hydrodynamics
7.	heavy loads	23.	piston
8.	the bottom of the object	24.	equal diameter
9.	ratio	25.	low velocity
10.	hydraulic jack	26.	exert an upward force
11.	gases flow	27.	piston
12.	inside surface	28.	stream of oil
13.	force of atmospheric pressure	29.	equally in all directions
14.	the apparent loss of weight	30.	buoyant force
15.	brake shoes	31.	transmit pressure
16.	pipe	32.	partially filled tubes

9. **Fill in the table with the words derived from the given ones.**

Noun	Verb	Adjective
liquid	X	.....
.....	X	heavy
.....	.....	forceful forceless
.....	.....	energetic
mechanic mechanics	.....	.....
.....	.....	systematic
.....	pressurize	X
tube	.....	X
.....	X	hydraulic
machine machinery	.....	.....
flow	.....	X
.....	.....	motional motionless
compression compressor	.....	.....

10. **In the text (ex. 6), find the opposites of the following words.**

Entirely – _____, light – _____, put down – _____, whole – _____, solid – _____, closed – _____.

11. **Match the words wih similar meaning. You can also do it using the Learning.Apps platform at this link.**

1 weight	**a** tube
2 fluid	**b** machinery
3 force	**c** tool
4 energy	**d** stream
5 equipment	**e** liquid
6 instrument	**f** mechanism
7 motion	**g** degree
8 machine	**h** load
9 flow	**i** operation
10 pipe	**j** strength
11 action	**k** movement
12 level	**l** power

12. **Find 10 words related to the topic *Hydraulics*, then choose any three and make sentences.**

p	i	p	e	f	t	o	f	o	r	c	e
s	a	w	d	p	i	f	l	o	w	l	o
l	i	q	u	i	d	d	u	g	u	o	p
o	d	j	m	e	m	r	i	f	s	g	r
a	g	o	o	s	t	u	d	l	n	a	e
d	n	s	b	u	o	s	y	m	n	e	s
s	m	l	v	h	l	y	d	b	v	c	s
l	g	e	n	e	r	a	t	o	r	g	u
v	n	e	q	u	i	p	m	e	n	t	r
d	s	o	m	s	l	y	h	t	a	s	e
h	y	d	r	a	u	l	i	c	s	o	n

13. **Work in pairs. Using the information from the text (ex. 6), match 1-13 with a-m. Then choose any three phrases and make sentences.**

1	the branch	**a**	at rest and in motion
2	transfer force	**b**	under certain conditions
3	lifting	**c**	in open or partially filled pipes
4	operate by the force	**d**	of a fluid into work
5	studies the behaviour of liquids	**e**	heavy loads
6	from the ceiling	**f**	of physics
7	apply only	**g**	through a fluid
8	pressing	**h**	to the floor
9	pipe extends	**i**	of a flowing fluid
10	to study the flow of water	**j**	supply systems
11	plan water	**k**	metal parts
12	change the potential energy	**l**	gases and liquids
13	apply to both	**m**	in a zigzag pattern

14. **Using information from the text, choose the odd word in each line.**

1) power, force, energy, liquid;
2) load, stream, task, job;
3) motion, movement, level, action;
4) flow, motor, engine, machine;

5) water, fluid, liquid, steam;

6) weight, height, mass, kilogram;

7) device, pipe, hose, tube;

8) air, oil, steam, gas;

9) equipment, load, machinery, machine;

10) tool, instrument, fluid, device.

15. **Match the words in column A with the words in column B to form meaningful phrases. Translate them into Ukrainian.**

Column A	Column B
1 heavy	**a** machines
2 electric	**b** engineering
3 hydraulic	**c** energy
4 certain	**d** fluid
5 sewage	**e** equipment
6 hydrostatic	**f** force
7 mechanical	**g** generator
8 flowing	**h** systems
9 potential	**i** conditions
10 construction	**j** principles
11 atmospheric	**k** loads
12 buoyant	**l** pressure

16. **Fill in the words from the list below. Use each word only once.**

Directions, liquids, ratio, loads, force, metal, apparent, pressure, conditions, flow, level, object.

1) _____ increases in direct proportion;
2) behavior of _____ at rest;
3) gases _____ at low velocity;
4) lifting heavy _____;
5) only under certain _____;
6) equally in all _____;
7) difference in liquid _____;
8) direct proportion to the _____;
9) bottom of the _____;
10) _____ loss of weight;
11) pressing _____ parts;
12) force of atmospheric _____.

17. **Match the key terms on the topic "Application of hydraulics in mechanical engineering" with their definitions.**

Pressure, turbine, flow, force, pump, wheel, energy, piston, load, steam, cylinder, tube.

1. Measurement of a power that changes or may produce change of movement in a body on which it acts or presses.
2. The amount of work that must be done by a machine.
3. The power which can do work, such as drive machines or provide heat.
4. A part of an engine consisting of a short solid pipe-shaped piece of metal that fits tightly into a cylinder, it is moved up and down by means of pressure.
5. A hollow round pipe of metal, glass, rubber, etc. used especially for carrying or holding liquids.

6. The action of putting force or weight onto something; the strength of this force.
7. The tube within a piston moves backwards and forwards in an engine or piece of machinery.
8. An engine or motor in which the pressure of a liquid or gas, usually at very high temperatures, drives a special wheel, producing a circular movement.
9. Water in the state of a gas produced by boiling.
10. A smooth steady movement or supply.
11. A circular object with an outer frame which turns round an inner part to which it is joined.
12. A machine for forcing liquids, air or gas into or out of something.

18. **Fill in the gaps with the appropriate words from the list below. You can also do it using the Learning.Apps platform at this link.**

Distance, barometer, arm, pressure, force, atmospheric, to measure, liquid, mercury, atmosphere, falls, tube, column, weight, level.

A manometer measures the **1)** _____ created by a liquid or a gas. The simplest kind of manometer is a U-shaped **2)** _____ with open ends. The tube contains a **3)** _____, usually mercury or water, which fills the bottom of the U and rises a short **4)** _____ in each arm. The liquid in the manometer must have a different **5)** _____ per unit of volume than the substance whose pressure is to be measured. One **6)** _____ is connected to the place where the pressure is to be measured. The other arm remains open to the **7)** _____. The difference in liquid **8)** _____ in the arms indicates the pressure compared to **9)** _____ pressure.

A **10)** _____ measures atmospheric pressure. It is used primarily to forecast weather and **11)** _____ heights of mountains. One type of barometer consists basically of a tube containing mercury. At sea level a

12) _____ of mercury about 75 centimeters high equals in weight the **13)** _____ of atmospheric pressure on that column. The level of **14)** _____ in the tube rises or **15)** _____ as the atmospheric pressure changes.

Taken from World Book Encyclopedia (International)

19. **Work in small groups. Make up crosswords. Exchange and solve them.**

20. **Revise words and phrases on the topic "Application of hydraulics in mechanical engineering". Use Quizlet flashcards.**

21. **Revise the information about the Passive Voice (Appendix 2) and fill in the gaps with the correct form of the verbs in brackets.**

1. As the rod _____ **(to pull out)**, air passes through the piston and fills the areas between the piston and the outlet valve.
2. The centrifugal pumps _____ **(not to develop)** until the late 1600's, when Denis Papin, a French-born inventor, made one with straight vanes.
3. Axial-flow compressors _____ first _____ **(to use)** on turbojet engines in the 1940's.
4. Manual valves _____ **(to control)** by hand.
5. Automatic control valves have become important in industry because hundreds of them can _____ **(to operate)** from a central location by a computer or a device called a controller.
6. In a relief valve, the disc _____ **(to hold)** closed by a compressed spring on one side.
7. Some water turbines _____ **(to submerge)** in rivers, and the normal flow of water provides power.
8. Water pressure created by the dam _____ **(to use)** to speed up the water when it enters the turbine.

9. The velocity at which a gas flows from a container depends on the pressure under which the gas _____ **(to confine)** in the container.
10. Bernoulli's principle _____ **(to use)** in the design of aeroplane wings.
11. Some water turbines _____ **(to locate)** at the bases of dams.
12. Automatic control valves _____ **(to control)** by some external power source, such as electricity or compressed air.

Taken from World Book Encyclopedia (International)

22. **Read this paragraph about Hydraulic *Engines.* Choose the correct option to fill in the gap.**

Hydraulic engine, or fluidic engine, **1) _____ (is / was)** a machine that **2) _____ (producing / produces)** motion by means of pressure from water or some other fluid. This type of engine **3) _____ (can be used / can used)** to drive machinery or **4) _____ (move / to move)** heavy loads. Examples of hydraulic engines **5) _____ (are included / include)** jacks, hoists, the power steering and brake mechanisms of cars, and the control systems of aircraft.

There **6) _____ (are / were)** two basic types of hydraulic engines – reciprocating engines, such as hydraulic lifts and suction pumps, and turbines, such as those that **7) _____ (are turned / turn)** electric generators. Reciprocating engines **8) _____ (operate / are operated)** at slow speeds. Turbines usually **9) _____ (are functioned / function)** at higher speeds.

Early hydraulic engines **10) _____ (were used / used)** water to produce power. Today, engines that **11) _____ (used / use)** water **12) _____ (are / is)** rare except for water turbines in hydroelectric plants. Modern hydraulic engines **13) _____ (use / used)** fluids that **14) _____ (do not freeze / not freeze)** at low temperatures. Such fluids **15) _____ (included / include)** oil, certain silicones, and some gases. The fluid in some hydraulic engines **16) _____ (is put / put)**

under pressure mechanically. In other engines, the pressure **17) _____ (comes / came)** from the weight of the fluid stored on a reservoir above the engine.

Taken from World Book Encyclopedia (International)

23. Choose the appropriate verb to fill in the gap.

1. The nonautomatic gate and globe valves _____ to turn on or shut off the flow of liquids.
   a) are used b) used c) are using
2. Most water pipes larger than 8 centimetres in diameter _____ of cast iron, reinforced concrete steel, or a mixture of asbestos and cement.
   a) made b) is making c) is made
3. Smaller water pipes in buildings may _____ of galvanized steel, copper, wrought iron, or plastic.
   a) is made b) be made c) made
4. The term valve _____ also _____ in physiology for natural growths in the body which serve much the same purpose as mechanical valves.
   a) used b) is used c) is using
5. Gas and oil pipelines _____ of steel pipe.
   a) are built b) built c) is built
6. Irrigation systems may have light aluminum pipe that can _____ easily _____.
   a) be moved b) be move c) to move
7. Pipe may _____ in several ways, depending on the material and type of pipe desired.
   a) to make b) be made c) made

8. When the piston _____, the air above it flows to the bottom of the pump.

   a) raises b) is raising c) is raised

9. When the piston moves down, air _____ out the hose.

   a) is forced b) forces c) forced

10. As the rod _____ in, the inlet valve closes and the piston forces air through the outlet valve.

    a) pushed b) pushes c) is pushed

11. When the piston moves toward the closed end, the fluid _____ out the outlet valve.

    a) forced b) is forced c) is forcing

12. Pipes _____ in many different sizes from a variety of materials.

    a) are made b) are making c) made

TRANSLATION

24. Translate the excerpt about *Pipes* into Ukrainian in written form.

Pipe is a tube used to transport liquids and gases from one place to another. People made pipe of clay thousands of years ago to carry water. The Romans used lead pipe to connect their public fountains to aqueducts. American pioneers made water systems from logs with holes bored through their centres. Later, they made pipes from hoops and wooden staves in much the same way that barrels are made.

Pipelines compare in importance with highways and railways as a means of transporting materials useful to people. Huge pipes bring water to the city from wells, lakes, or other sources of supply. A vast network of pipes then distributes the water to every home, and to each sink, toilet and other water fixtures in the house. Another network of pipes carries the waste water away from these fixtures through drains and sewer pipes. Long pipelines buried in the ground transport and distribute natural gas in some

countries in the same way water is distributed. Similar pipelines transport crude oil from wells to refineries.

Taken from World Book Encyclopedia (International)

25. **Translate the excerpt about *Liquids at rest* into English in written form.**

РІДИНИ В СТАНІ СПОКОЮ

Використання гідростатичних принципів є фундаментальним для проєктування багатьох машин і інструментів. Конструкція гідравлічних пресів і робота таких приладів як манометри і барометри залежать від законів гідростатики. Простий гідравлічний прес складається з циліндра, який містить два поршні, один менший за інший. Циліндр заповнений рідиною. Сила, прикладена до меншого поршня, передається через рідину на більший поршень. Сила зростає прямо пропорційною відношенню площі більшого поршня до площі меншого поршня. Гальма автомобіля працюють за принципом гідравлічного преса. Тиск, прикладений до педалі гальма, через рідину передається на гальмівні колодки, які тиснуть на колеса автомобіля.

LISTENING

26. **Before watching the video, check if you know the meaning of the following words. Use the dictionary if necessary.**

Hydraulics, pressure, jet, liquid, heavy machinery, powerful, plunger, entire surface, container, Pascal's law, tube, hydraulic machines, piston, force.

27. **Watch the video about hydraulic machines (https://www.youtube.com/watch?v=KEs_h-ucJEs) and complete the following sentences.**

1. Hydraulics move _____ _____ around using trapped liquid.
2. Who is Pascal? You may ask. Well, he was a French mathematician, physicist, _____ _____ and master of prose.
3. It says that any pressure on a trap fluid is _____ _____ throughout the fluid.
4. _____ _____ are used to lift cars, building materials or even people.
5. Construction vehicles, _____ _____ and elevators utilize the power of hydraulics.

28. **Work in pairs. You and your partner are going to make a presentation about hydraulic machines at a scientific forum. Discuss the information you are going to talk about. Use the video (ex. 27) and additional resources if necessary.**

SPEAKING

29. **Work in small groups. Choose one of the areas of application of hydraulics mentioned in the text (ex. 6), find more information about it on the Internet, make notes and prepare a short report for your groupmates. Follow the structure: introduction, main body, and conclusions. Ask the other students at least one question after their talk.**

30. **Work in pairs. Discuss the application, advantages and disadvantages of using hydraulic machines. Then compare your ideas with the rest of the group. Use the following phrases.**

- ✓ *In my opinion, …*
- ✓ *As far as I am concerned, …*

- ✓ *I should say that, …*
- ✓ *I rather think that …*
- ✓ *I don't think that, …*
- ✓ *I suppose that, …*
- ✓ *As a matter of fact, …*

31. **Your teacher asked you to inform the students about *Hydraulics and its application.* Create a brief presentation. Use the phrases below.**

- ✓ *It is important for an engineer to know hydraulics …*
- ✓ *Hydraulic system …*
- ✓ *Liquids at rest …*
- ✓ *Liquids in motion …*
- ✓ *Hydraulic machines include …*

32. **Think of a hydraulic machine you know well. In pairs, discuss its application, advantages, disadvantages and complete the table.**

Hydraulic machines	***Application***	***Advantages***	***Disadvantages***
Hydraulic Press			
Hydraulic Lift			
Hydraulic Pump			
Hydraulic Brakes			
Hydraulic Engines			
Turbines			

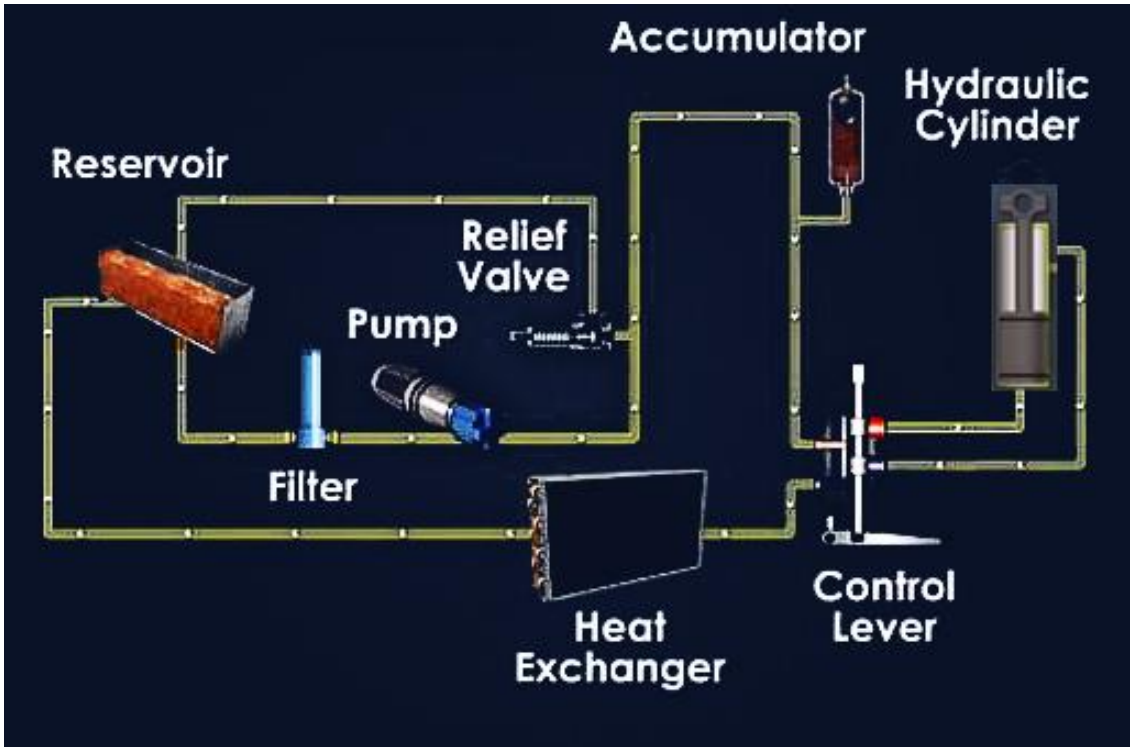
33. **As an engineering student, you are preparing for an international scientific conference. Use the Internet resources and vocabulary of this unit to prepare a short presentation about "Environmental Hydraulics". Follow the structure: introduction, main body, and conclusions.**

34. **Imagine our world without hydraulic machines. What difficulties could people meet? Compare your list with those of your classmates. Use the phrases from the table.**

Expressing Certainty:	***Expressing Uncertainty:***
Yes, I am certain. I'm a hundred percent certain … I'm absolutely sure. I have no doubt about it. I'm sure about it. I don't think there can be any doubt about …. Of course. I'm positive. I'm quite sure about it. I'm no doubt about it. I'm absolutely certain that…	I'm not sure about it. I doubt it. I'm not really sure about… I don't know for sure… It's very unlikely. I have my own doubts. I don't think so. I don't believe this is true. There's some doubt in my mind that … I'm not a hundred percent sure. I don't know yet.

Taken from https://basicenglishspeaking.com/expressing-certainty-uncertainty-english/

35. **In a Hydraulics class, talk with your groupmates about the main components of the hydraulic system and their functions. Use the information from the diagram and the text (ex. 6).**



Taken from http://www.airandhydraulic.com/2020/10/basic-hydraulic-system.html

WRITING

36. **Write a summary (80-120 words) of the text "Application of Hydraulics in Mechanical Engineering" (ex. 6).**

37. **As an engineering student, you are asked to write a discriptive essay about the hydraulic equipment (150-180 words). Use the plan:**

1. Name of the hydraulic machine.
2. Main parts.
3. Principle of work.
4. Practical application in engineering.

38. **You are creating a web page on hydraulics. Write a post (160-180 words). Use the following plan.**

1. Introduction.

   Hydraulics is …

2. Main body.

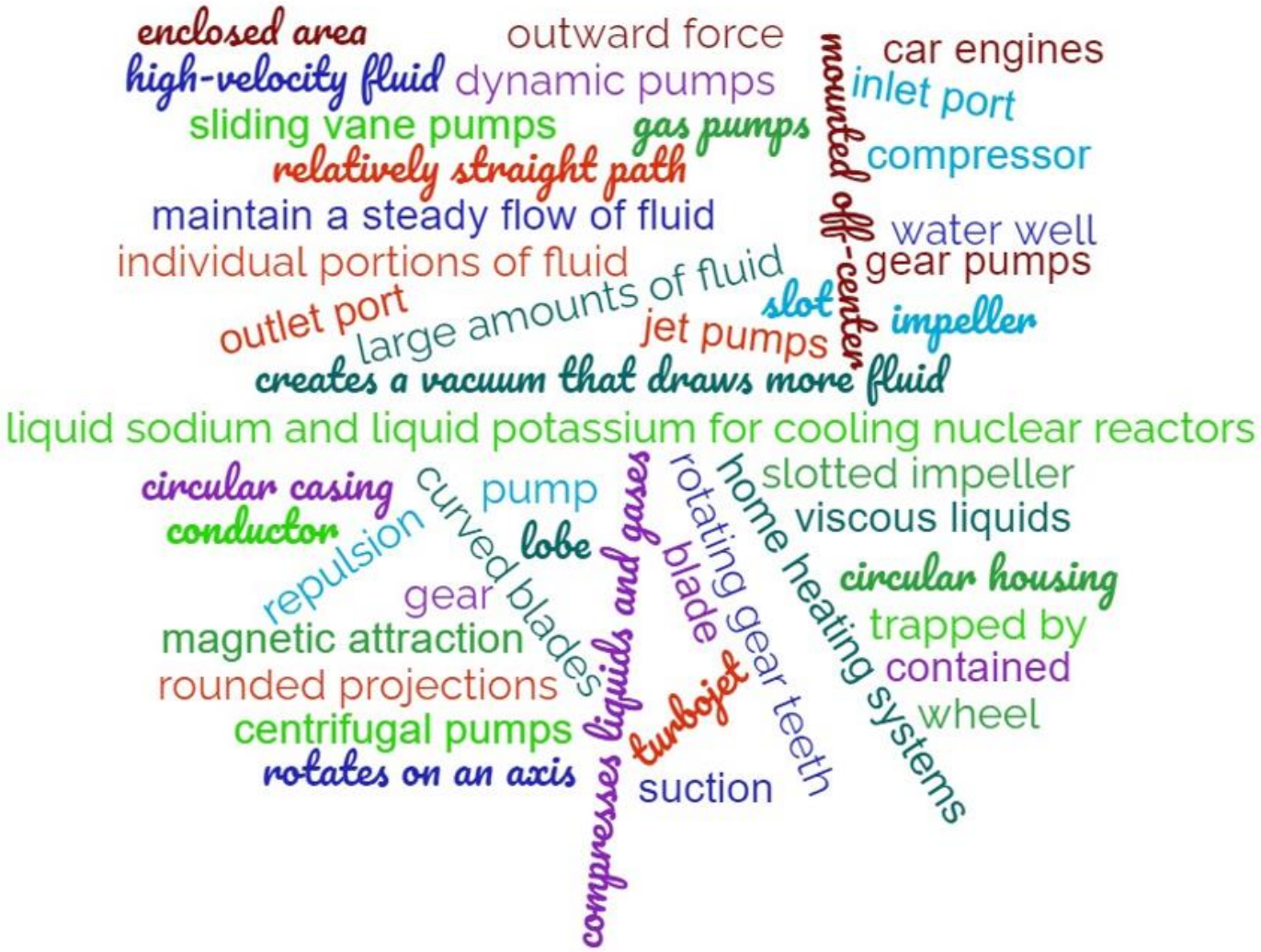
   Hydraulic machines …

   Liquids at rest …

   Liquids in motion …

3. Conclusions.

Unit 5. Types of Pumps



LEAD-IN

1. **In groups, discuss the following questions.**

1. What is pump?
2. What are the main parts of the pump?
3. How many types of pumps do you know?
4. What do you know about dynamic pumps?
5. What do you know about positive displacement pumps?

2. **Explain the quotations.**

1. Whitewashing the pump won't make the water pure.

Dwight L. Moody

2. Press the button, pump the water, build the pressure, push the piston, press the button. It's the perfect job.

Tori Amos

3. [The artist] is like a pump; he has inside him a great pipe that reaches down into the entrails of things, the deepest layers. He sucks up what was lying there below, dim and unnoticed, and brings it in great jets to the sunlight.

Gustave Flaubert

4. Why don't those damn oil companies fly their own flags on their personal property-maybe a flag with a gas pump on it.

Smedley Butler

Taken from https://www.azquotes.com/quotes/topics/pumps.html?p=2

3. **Work in pairs. Match different pumps (1-10) with their characteristics (a-j).**

1	Piston Pumps and Plunger Pumps	**a**	are centrifugal pumps with long cantilever design used in sump pump applications.
2	Axial Flow Pumps	**b**	are medium flow, medium pressure pumps which push fluid out away from the pump shaft at an angle greater than 90°.
3	Jet Pumps	**c**	use linear rather than rotary motion to move fluids.
4	Diaphragm Pumps	**d**	are centrifugal pumps that use pressure in combination with a rotary mechanism with numerous small impellers and vanes to transfer energy to a fluid.
5	Radial Flow Pumps	**e**	consist of a flexible, squeezable bladder encased in a rigid outer casing.
6	Turbine Pumps	**f**	use a diaphragm that moves back and forth to transport liquids from one place to another
7	Bladder Pumps	**g**	are high flow, low pressure pumps which lift fluid in a direction parallel to the impeller shaft.
8	Mixed Flow Pumps	**h**	use plungers or pistons to push media through a cylinder chamber.
9	Cantilever Pumps	**i**	are kinetic pumps with an ejector attached at the discharge outlet, utilizing the Venturi effect and motive fluid to generate pumping pressure.
10	Reciprocating pumps	**j**	are high pressure, low flow pumps which accelerate fluid along the impeller blades perpendicular to the shaft.

Taken from https://www.globalspec.com/pfdetail/pumps/types

READING

4. **Underline the stressed syllable. Practise reading the words.**

Refrigerator, inflating, bicycle, sodium, potassium, dynamic, displacement, maintain, individual, portion, centrifugal, circular, curved, suction, refineries, vacuum, diffusion, collide, pressurized, reciprocating, magnetized, leakage.

5. **Explain the meaning of the words and phrases. Use the dictionary.**

Heating system, oil well, turbojet, nuclear reactor, compressor, dynamic pump, positive displacement pump, maintain a steady flow of fluid, centrifugal pump, impeller, curved blades, axis, suction, inlet pipe, outlet port, rotor, pressure, diffusion.

6. **Read the text and decide if the following statements are *True (T)* or *False (F)*.**

TYPES OF PUMPS

Pump is a device that moves or compresses liquids and gases. Pumps are used in a variety of machines and other devices, including home heating systems, refrigerators, oil wells and water wells, and turbojet and car engines. The fluids (gases or liquids) moved by pumps range from air for inflating bicycle tires to liquid sodium and liquid potassium for cooling nuclear reactors. Most pumps are made of steel but some are made of glass or plastic. Gas pumps are also called compressors, fans or blowers.

There are two major types of pumps – dynamic pumps and positive displacement pumps. Dynamic pumps maintain a steady flow of fluid. Positive displacement pumps, on the other hand, trap individual portions of fluid that are in an enclosed area before moving them along.

Dynamic pumps

Centrifugal pumps consist of a motor-driven propeller like device, called an impeller, which is contained within a circular housing. The impeller is a wheel of curved blades that rotates on an axis. Before most centrifugal pumps can start pumping liquid, they must be primed (filled with liquid). As the impeller rotates, it creates suction that draws a continuous flow of fluid through an inlet pipe. Fluid enters the pump at the center of the impeller and travels out along the blades due to centrifugal (outward) force. The curved ends of the blades sweep the fluid to an outlet port.

Centrifugal pumps are inexpensive and can handle large amounts of fluid. They are widely used in chemical processing plants and oil refineries. A centrifugal pump consists of a rotating device called an impeller within a circular casing. Fluid enters the pump near the center of the impeller, which sweeps it to an outlet pipe.

Axial-flow pumps have a motor-driven rotor that directs fluid along a path parallel to its axis. The fluid thus travels in a relatively straight path from the inlet pipe through the pump to the outlet pipe.

Jet pumps get their name from the way they move fluid. They operate on the principle that a high-velocity fluid will carry along any other fluid it passes through. Most jet pumps send a jet of steam or water through the fluid that needs to be moved. The jet carries the fluid with it directly into the outlet pipe and, at the same time, creates a vacuum that draws more fluid into the pump. The amount of fluid carried out of most jet pumps is several times the amount in the jet itself.

Electromagnetic pumps are used chiefly to move liquid sodium and liquid potassium, which serve as coolants in nuclear reactors. These pumps consist of electrical conductors and magnetized pipes. The conductors send current through the fluid, which thereby becomes an electromagnet. The fluid is then moved by the magnetic attraction and repulsion (pushing away) between the fluid’s magnetic field and that of the pipes. The fluid is

therefore moved in an electromagnetic pump in much the same way as an armature is moved in an electric motor.

Positive displacement pumps

Rotary pumps are the most widely used positive displacement pumps. They are often used to pump such viscous (sticky) liquids as motor oil, syrup, and paint. There are three main types of rotary pumps. These types are: (1) gear pumps, (2) lobe pumps, and (3) sliding vane pumps.

Gear pumps consist of two gears that rotate against the walls of a circular housing. The inlet and outlet ports are at opposite sides of the housing, on line with the point where the teeth of the gears are fitted together. Fluid that enters the pump is trapped by the rotating gear teeth, which sweep the fluid along the pump wall to the outlet port.

Lobe pumps operate in a manner similar to gear pumps. However, instead of gears, lobe pumps are equipped with impellers that have lobes (rounded projections) fitted together. Lobe pumps can discharge large amounts of fluid at low pressure.

Sliding vane pumps consist of a slotted impeller mounted off-center in a circular housing. Sliding vanes (blades) move in and out of the slots. As the vanes rotate by the inlet port, they sweep up fluid and trap it against the pump wall. The distance between the impeller and the pump wall narrows near the outlet port. As the fluid is carried around to this port, the vanes are pushed in and the fluid is compressed. The pressurized fluid then rushes out the outlet port.

Taken from World Book Encyclopedia (International)

1. Most pumps are made of iron but some are made of glass or plastic.
2. The curved ends of the blades sweep the liquid to an outlet port.
3. Centrifugal pumps are expensive and can handle large amounts of fluid.
4. Electromagnetic pumps are used chiefly to move liquid sodium and liquid potassium, which are used as coolants in nuclear reactors.
5. The amount of liquid carried out of most jet pumps is several times the amount in the jet itself.
6. Rotary pumps are often used to pump such viscous (sticky) liquids as motor oil, syrup, and paint.
7. Centrifugal pumps are also used as compressors in turbojet engines, but axial-flow pumps are more efficient.
8. The distance between the impeller and the pump wall narrows near the inlet port.
9. Rotary pumps consist of a piston that moves back and forth within a cylinder.
10. In all reciprocating pumps, the inlet valve or the outlet valve is on the piston.
11. Lift pumps, force pumps, and bicycle tire pumps are common reciprocating pumps.
12. A lift pump cannot raise water that is deeper than about 7.5 meters because of high pressure.

7. **Read the text again and summarize the information about different types of pumps.**

USE OF ENGLISH

8. **Work in pairs. Give Ukrainian equivalents to the words and phrases. You can also do it using Quizlet flashcards.**

1.	axial-flow pump	17.	maintain
2.	positive displacement pump	18.	connecting rod
3.	gear pump	19.	reciprocating pump
4.	sliding vane pump	20.	circular housing
5.	lobe pump	21.	sliding blades
6.	inlet port	22.	rotary pump
7.	pressurized fluid	23.	inlet valve
8.	rounded projections	24.	coolant in nuclear reactor
9.	slotted impeller	25.	force pump
10.	lift pump	26.	centrifugal pump
11.	rotating gear teeth	27.	jet pump
12.	outlet port	28.	outlet valve
13.	sticky liquids	29.	bicycle tire pump
14.	electrical conductor	30.	leakage
15.	repulsion	31.	resistance
16.	dynamic pump	32.	slot

9. **Fill in the table with the words derived from the given ones.**

Noun	Verb	Adjective
pump	.....	X
.....	reciprocate	X
conductor conductivity	.....	.....
.....	.....	cool
fluid	X	.....
.....	supply	X
diffusion	.....	.....
displacement	.....	X
curve	.....	X
reaction	.....	.....
gear	.....	X
.....	.....	rotational
pipe	.....	X

10. **In the text, find the opposites of the following words.**

Shaky – _____, minor – _____, straight – _____, moving – _____, lower – _____, solid – _____.

11. **Match the words with similar meaning. You can also do it using the Learning.Apps platform at this link.**

1	engine	**a**	application
2	device	**b**	hole
3	load	**c**	reservoir
4	slot	**d**	mechanism
5	work	**e**	capacity
6	port	**f**	task
7	efficiency	**g**	motor
8	container	**h**	apparatus
9	gear	**i**	groove
10	use	**j**	lubricant
11	vacuum	**k**	productivity
12	oil	**l**	emptiness

12. **Find 10 words related to the topic *Pumps*, then choose any three and make sentences.**

p	u	m	p	s	g	h	l	r	c	i	r
i	h	l	r	v	e	l	o	c	i	t	y
s	h	r	c	i	a	c	r	l	r	c	o
t	l	i	o	r	r	s	s	t	e	a	m
o	r	s	c	h	m	r	o	b	c	k	l
n	o	e	f	f	i	c	i	e	n	c	y
r	l	h	d	i	l	c	o	i	o	b	r
s	l	o	t	o	s	u	c	t	i	o	n
l	i	s	b	r	d	i	l	s	h	m	s
c	w	h	e	e	l	s	o	r	b	r	i
h	l	o	r	i	c	h	m	d	o	i	l

13. **Work in pairs. Using the information from the text (ex. 6), match 1-13 with a-m, then choose any three and make sentences.**

1	moves or compresses	**a**	that rotates on an axis
2	creates suction that draws	**b**	are equipped with impellers
3	lobe pumps	**c**	are used chiefly to move
4	trapped by	**d**	liquids and gases
5	discharge large amounts	**e**	in nuclear reactors
6	slotted impeller mounted off-center	**f**	chemical processing plants
7	conductors send current	**g**	of most jet pump
8	serve as coolants	**h**	the rotating gear teeth
9	widely used in	**i**	a continuous flow of fluid
10	amount of fluid carried out	**j**	in a circular housing
11	wheel of curved blades	**k**	and other devices
12	used in a variety of machines	**l**	through the fluid
13	electromagnetic pumps	**m**	of fluid at low pressure

14. **Using the information from the text (ex. 6), choose the odd word in each line.**

1) compressor, container, tank, reservoir;
2) gear pumps, lobe pumps, sliding vane pumps, dynamic pumps;
3) lubricant, steam, grease, oil;
4) circular, curved, round, fluid;
5) glass, force, plastic, steel;
6) flow, productivity, efficiency, performance;
7) hole, impeller, groove, slot;
8) compressors, gears, fans, blowers;
9) cylinder, piston, valve, engine;
10) reciprocating, rotating, stream, straight.

15. **Match the words in column A with the words in column B to form meaningful phrases. Translate them into Ukrainian.**

Column A	*Column B*
1 dynamic	**a** engines
2 curved	**b** reactors
3 turbojet	**c** rotor
4 enclosed	**d** pumps
5 steady	**e** pipe
6 nuclear	**f** fluid
7 oil	**g** blades
8 inlet	**h** pressure
9 outlet	**i** flow
10 motor-driven	**j** port
11 high	**k** refineries
12 high-velocity	**l** area

16. **Fill in the words from the list below. Use each word only once.**

Propeller, heating, flow, jet, vane, fluid, coolants, vacuum, displacement, rotors, straight, amounts.

1) continuous _____ of fluid;
2) positive _____ pumps;
3) home _____ systems;
4) individual portions of _____;
5) sliding _____ pump;
6) motor-driven _____;
7) relatively _____ path;
8) alternating rows of _____;
9) _____ diffusion pumps;
10) large _____of fluid;
11) _____in nuclear reactors;
12) supplies water for a_____.

17. **Match the key terms on the topic "Types of pumps" with their definitions.**

Displacement, air, gas, machine, device, compressor, suction, liquid, valve, leakage, resistance, pipe.

1. A type of substance like air, which is not solid or liquid and usually cannot be seen.
2. The act of removing air or liquid from a container or from the space between two surfaces so that another gas or liquid enters.
3. A tube used for carrying liquids or gas, often underground.
4. A substance which is not a solid or a gas, which flows, is wet and has no fixed shape.
5. An instrument or apparatus which uses power, such as electricity, to perform work.

6. The mixture of gases which surrounds the earth and which we breathe.
7. A door like part of a pipe or tube which opens and shuts so as to control the flow of liquid, air, gas, etc. through it.
8. A part of a machine, for compressing gas or air.
9. A piece of equipment intended for a particular purpose.
10. The stated force opposed to anything moving.
11. The act of displacing or process of being displaced.
12. An example of something leaking; something which has leaked in or out.

18. **Fill in the gaps with the appropriate words from the list below. You can also do it using the Learning.Apps platform at this link.**

Air, valve, pumps, piston, water, blades, axial-flow, pressure, cylinder, well, compressors, inlet, meters, lift, outlet.

Axial-flow **1)** _____ are most often used as compressors in turbojet engines. Centrifugal pumps are also used for this purpose, but **2)** _____ pumps are more efficient. Axial-flow **3)** _____ consist of alternating rows of rotors and stationary blades. The **4)** _____ and rotors produce a pressure rise in the **5)** _____ as it moves through the axial-flow compressor. Air then leaves the compressor under high **6)** _____.

Lift pumps draw water from wells. In a **7)** _____ pump, the inlet valve is at the closed end of the **8)** _____ and the outlet valve is on the piston. As the **9)** _____ is raised, water is drawn up through the inlet valve. As the piston moves down, the **10)** _____ valve closes, forcing water through the outlet valve and up above the piston. As the piston is raised again, the **11)** _____ valve closes and the **12)** _____ is lifted to an opening, where it leaves the pump. At the same time, more

water is drawn through the inlet **13) _____**. It is theoretically possible for a lift pump to raise water in a **14) _____** almost ten **15) _____**.

Taken from World Book Encyclopedia (International)

19. **Work in small groups. Make up crosswords. Exchange and solve them.**

20. **Revise words and phrases on the topic "Types of pumps". Use Quizlet flashcards.**

21. **Revise the information about the Articles (Appendix 2) and fill in the gaps with the correct options.**

1. **(The / -)** atomic power plants have **(the / -)** stainless steel piping.
2. Pipe production include moulding, casting, welding, and drawing or pushing **(the / a)** material over **(the / a)** sharp point to make **(the / a)** centre hole.
3. **(The / -)** pipes transport liquids and gases from **(the / -)** one place to another.
4. **(The / A)** bicycle tyre pump has **(the / a)** piston that moves up and down.
5. **(The / -)** force pumps are similar to **(the / -)** lift pumps.
6. In force pumps both **(the / -)** inlet valve and **(the / -)** outlet valve are at **(the / -) closed end of (the / a)** cylinder.
7. **(The / -)** check valves and **(the / -)** relief valves allow **(the / -)** flow in one direction only.
8. However, because of leakage and resistance, a lift pump cannot raise water that is deeper than about 7.5 meters.
9. Some simple bicycle tyre pumps have **(the / -)** inlet valve on **(the / a)** piston and **(the / an)** outlet valve at **(the / -) closed end of (the / a)** cylinder.

10. **(The / -)** air enters **(the / a)** pump near **(the / a)** point where **(the / a)** connecting rod passes through **(the / a)** cylinder.
11. **(The / -)** pumping devices have been **(the / an)** important means of **(the / -)** moving fluids for **(the / -)** thousands of years.
12. **(The / -)** ancient Egyptians used water wheels with **(the / -)** buckets mounted on them to move **(the / -)** water for **(the / -)** irrigation.

22. **Fill in the gaps with the proper articles.**

1. In _____ 200's B.C., Ctesibius, _____ Greek inventor, made _____reciprocating pump for pumping water.
2. About _____ same time, Archimedes, _____ Greek mathematician, invented _____ screw pump that was made up of _____ screw rotating in _____ cylinder.
3. This type of pump was used to drain and to irrigate _____Nile Valley.
4. _____ British inventor John Appold introduced _____ curved-vane centrifugal pump in 1851.
5. _____ common water tap is _____ manual valve.
6. As _____ piston moves away from _____ closed end, fluid enters _____ cylinder.
7. In _____ check valve, _____ gate or disc covers _____ opening called _____ seat.
8. Gravity or _____ spring holds _____ disc in place.
9. Pressure on one side of _____ disc forces _____ valve open.
10. But pressure on _____ other side pushes _____ disc into _____ seat, preventing flow.
11. It opens only when pressure against _____ other side of _____ disc is greater than that of _____ spring.

12. _____ bicycle tyre pumps differ in _____ number and location of _____ valves they have and in _____ way air enters _____ cylinder.

Taken from World Book Encyclopedia (International)

23. Choose the appropriate word.

1. The walls, floors, and basements of modern office buildings and hotels have _____ maze of pipes.
   a) the b) a c) no article
2. _____ pipes carry hot and cold water for general use, hot water or warm for heating, and refrigerants for air conditioning.
   a) the b) a c) no article
3. Chemical factories, refineries, and similar industries depend almost entirely on pipes to move their products about within _____ manufacturing plant.
   a) the b) a c) no article
4. Warships often have such a maze of pipes that sailors on _____ ships find it difficult to move about.
   a) the b) a c) no article
5. _____ pipes also serve other purposes than to carry fluids.
   a) the b) a c) no article
6. Pneumatic pipes transport _____ containers carrying messages.
   a) the b) a c) no article
7. Much of our electrical and telephone wiring runs through pipes known as conduits, which protect _____ wires from water and breakage.
   a) the b) a c) no article
8. _____ check valve allows a liquid to flow in one direction.
   a) the b) a c) no article

9. The automatic valve closes shut to stop flow in _____ opposite direction.

   a) the b) a c) no article

10. _____ mechanical valves include check valves, relief valves, manual valves, and automatic control valves.

    a) the b) a c) no article

11. Valve is a term used for various mechanical devices which open and close to control _____ flow of fluids in pipes and vessels.

    a) the b) a c) no article

12. Cast iron, glazed tile, and concrete are among _____ materials used for drain and sewer pipe.

    a) the b) a c) no article

TRANSLATION

24. **Translate the excerpt about *Pumps* into Ukrainian in written form.**

Jet pumps can be used to raise water from wells deeper than 60 meters. In such cases, a centrifugal pump at ground level supplies water for a jet at the bottom of the well. The jet carries well water with it back up to ground level. Jet pumps are also used in high vacuum diffusion pumps to create a vacuum in an enclosed area. In high vacuum diffusion pumps, a high-velocity jet of mercury or oil vapor is sent into the enclosed area. The vapor molecules collide with the molecules of air and force them out the outlet port.

Reciprocating pumps consist of a piston that moves back and forth within a cylinder. One end of the cylinder has an opening through which the connecting rod of the piston passes. The other end of the cylinder, called the closed end, has an inlet valve or an outlet valve, or both, depending on the type of pump. In some reciprocating pumps, the inlet

valve or the outlet valve is on the piston. Common reciprocating pumps include lift pumps, force pumps, and bicycle tire pumps.

Taken from World Book Encyclopedia (International)

25. **Translate the excerpt about *Liquids in motion* into English in written form.**

РІДИНИ В РУСІ

Використання гідродинамічних принципів є основою гідротехніки та проектування деяких машин. Інженери використовують гідродинаміку при проєктуванні систем водопостачання, каналів та іригаційних систем. Вони також застосовують гідродинамічні принципи до проектування літаків і деяких гідравлічних машин, таких як водяні турбіни.

Інженери враховують багато факторів щоб визначити належний тиск у системі водопостачання. Наприклад, висота резервуара або контейнера впливає на тиск у потоків води з резервуара і цей тиск визначає швидкість потоку, яку можна отримати. Більшість резервуарів мають довгий ряд труб, які з'єднують джерело води з її місцем призначення. Такі фактори, як розмір труби та тертя між водою та трубами, впливають на потік води.

LISTENING

26. **Before watching the video, check if you know the meaning of the words. Use the dictionary if necessary.**

Centrifugal pump, impeller, curved vanes, rotate, fluid, centrifugal force, mechanical energy, pressure, kinetic energy, suction, stream, rotation, nozzle, flow, velocity, overcome resistance, cavitation, shaft, leakage, clearance.

27. **Watch the video about centrifugal pumps (https://www.youtube.com/watch?v=BaEHVpKc-1Q) and complete the following sentences.**

1. The impeller is _____ _____ in water.
2. Reduction in flow velocity will result in increase of _____ _____ which is required to overcome resistance of pumping system.
3. Water will start to boil forming _____ _____ and spoil impeller materials over time.
4. Careful _____ _____ is required to avoid the problem of cavitation.
5. _____ _____ of centrifugal pump is always challenging.

28. **Watch the video again and decide if the statements are *True (T)* or *False (F)*.**

1. Rotary pumps are the most preferred pumping devices in the hydraulic world.
2. When the impeller is made to rotate, it makes the liquid surrounding it also rotate.
3. Such a high pressure helps in sucking freshwater stream into the system again and this process continues.
4. More the suction head, more should be the pressure at the suction side to lift the water.
5. The current impeller type is enclosed, semi-open and open impellers are also in use depending upon the usage.

29. **In the course of studying Hydraulics, you have been given the task to describe the work of centrifugal pumps. Use the video (ex. 27) to complete the task.**

SPEAKING

30. **Work in small groups. Choose one type of pumps mentioned in the text (ex. 6), find more information about it on the Internet, make notes and prepare a short presentation for your groupmates. Follow the structure: introduction, main body, conclusions. Ask the other students at least one question after their talk.**

31. **Work in groups. Discuss the advantages and disadvantages of using different types of pumps. Then compare your ideas with the rest of the group. Use the following phrases.**

- ✓ *In my opinion, …*
- ✓ *As far as I am concerned, probable / improbable …*
- ✓ *In fact, very true.*
- ✓ *I should say that, quite correct / incorrect.*
- ✓ *To tell the truth … entirely feasible.*
- ✓ *I rather think that … perfectly possible / impossible.*
- ✓ *I must say that, certain / uncertain …*
- ✓ *I dont think that, necessary / unnecessary …*
- ✓ *I suppose that, …*
- ✓ *As a matter of fact, …*

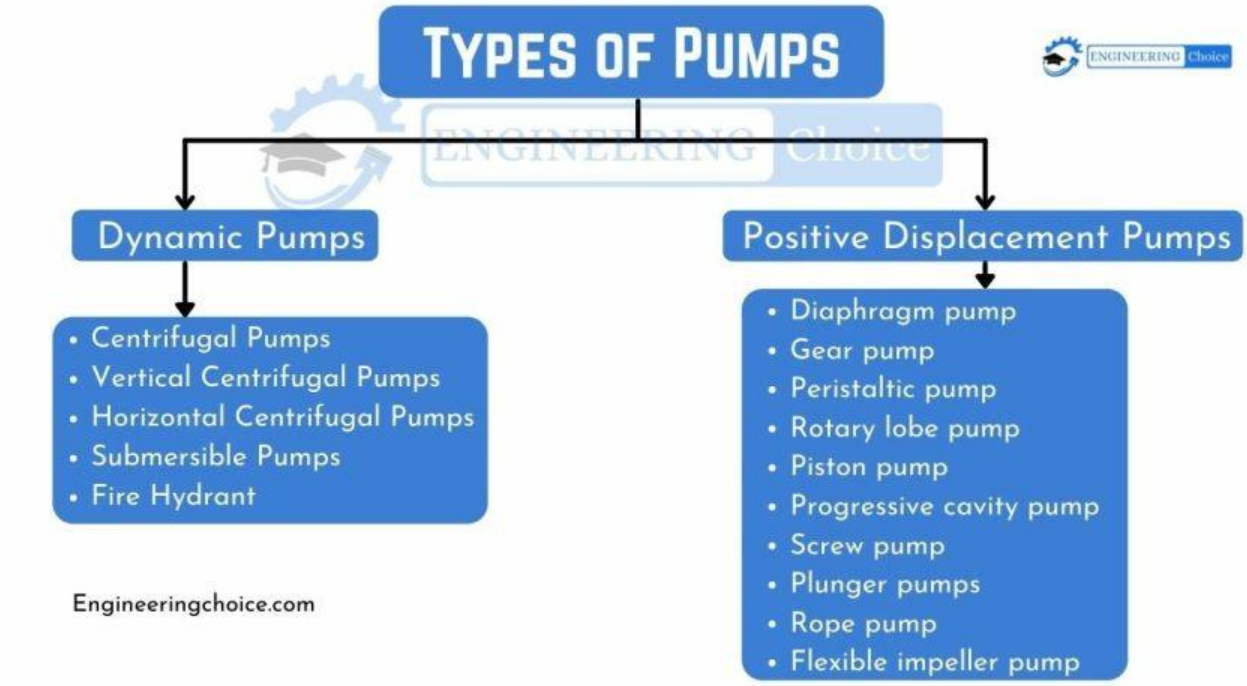
32. **Your teacher asked you to inform the students about *types of pumps.* Create a brief presentation. Use the phrases below.**

- ✓ *It is important for an engineer to know types of pumps …*
- ✓ *There are two major types of pumps …*
- ✓ *Dynamic pumps …*
- ✓ *Positive displacement pumps …*
- ✓ *Main parts of the pump …*

33. **Think of the pump you know well. In pairs, discuss its application, advantages, disadvantages and complete the table.**

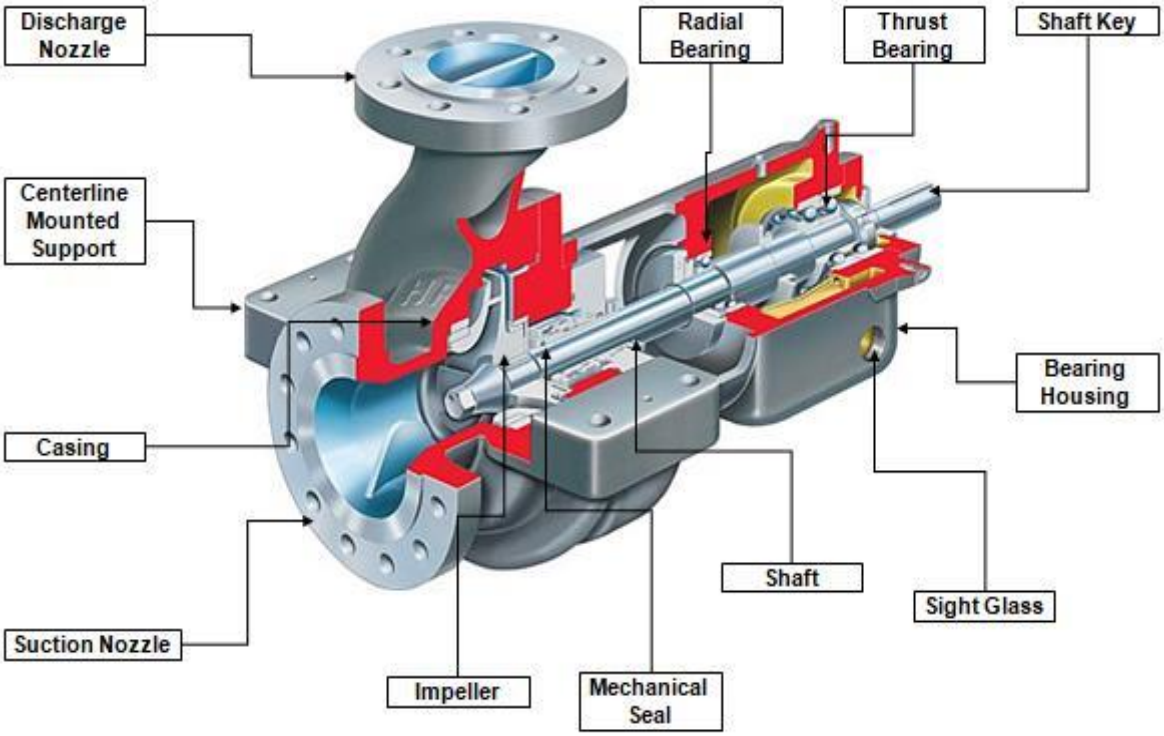
Type of Pump	***Sub-type of Pump***	***Application***	***Advantages***	***Disadvantages***
Dynamic pump				
Positive displacement pump				

34. **Make a short presentation about types of pumps and their features for a Hydraulics class. Use the diagram below.**



Taken from https://www.engineeringchoice.com/what-is-pump/

35. **Use the diagram below and describe the main components of the centrifugal pump and their functions.**



Taken from https://cceonlinenews.com/2020/02/20/how-centrifugal-pumps-work-with-video/

36. **Work in groups. Discuss the advantages, disadvantages, environmental audit and maintenance of different pumps. Then compare your ideas with those of your groupmates.**

WRITING

37. **You are creating a site "Frequently Asked Questions about Hydraulic Pumps". Make up a list of questions and answers and put it onto the site.**

38. **You are creating a web page about types of pumps and their application in engineering. Choose one type of pumps and write a post (150-160 words) about it. Use the following plan.**

1. Introduction.
   Pump is …
2. Main body.
   Dynamic pumps …
   Positive displacement pumps …
3. Conclusions.

39. **Write a "for and against essay" about "Advantages and disadvantages of different types of pumps" (160-180 words).**

Unit 6. Engineering Material Properties

LEAD-IN

1. **In groups, discuss the following questions.**

1. How important is the material science to an engineer?
2. What classification of engineering materials do you know?
3. How important for engineers to know about the properties of materials?
4. What does the notion “material properties” stand for?
5. What properties of engineering materials do you know? Give examples of objects with such properties.
6. What material properties are the most important for mechanics? Give your reasons.

2. **Work in pairs. Match the classes (1-8) with the properties (a-h).**

Class		**Property**	
1.	Economic and environmental	**a)**	modulus, yield and tensile, strength, hardness fracture toughness, fatigue strength, creep strength, damping
2.	General physical	**b)**	oxidation, corrosion, wear
3.	Mechanical	**c)**	resistivity, dielectric constant, magnetic permeability
4.	Thermal	**d)**	price and availability, recyclability, sustainability carbon footprint
5.	Electrical and magnetic	**e)**	colour, texture, feel
6.	Environmental interaction	**f)**	ease of manufacture, joining, finishing
7.	Production	**g)**	density
8.	Aesthetic	**h)**	thermal conductivity, specific heat, thermal expansion coefficient

Some information was taken from the book written by D. R. Jones, M. F. H. Ashby.

3. **Explain the quotations.**

1. Engineering material properties restrict product performance.
2. Engineering material properties identify the device.

READING

4. **Underline the stressed syllable. Practise reading the words.**

Quantitatively, qualitatively, stimuli, constraints, yielding, failure, torsional strength, ductility, ductile, elasticity, resistance, malleability, malleable, brittleness, viscosity, lubricate, determine, curvature, corrosion.

5. **Explain the meaning of the words. Check in the dictionary.**

Constraints, strength, resistance, stress, to withstand, destruction, tenacity, ductility, malleability, elasticity, limit, stress, strain, hardness, brittleness, distortion, elongation, viscosity, to lubricate, to decrease, deterioration, corrosion.

6. **Work in groups of three: students A, B and C. Each of you has to read some information (Text A – Student A, Text B – Student B, and Text C – Student C) about engineering material properties. By asking each other, find out the answers to the questions below.**

Student A asks Student C about Text C

1. What is viscosity?
2. How do fluids with high viscosity and low viscosity behave?
3. Why is the degree of viscosity important?
4. What is the difference between viscosity of hot liquids and gases and viscosity of cold liquids and gases?
5. What are the specifics of dimensional properties?
6. Why are chemical properties of materials important?
7. What is corrosion?

8. What does corrosion resistance involve?

Student B asks Student A about Text A

1. What is the specific of strength?
2. What is stress?
3. What is ultimate strength?
4. What is the specific of ductility?
5. What term is used in place of ductility?
6. What metals have such a property as ductility?
7. What is the specific of elasticity?
8. How is stress related to strain?

Student C asks Student B about Text B

1. What is hardness?
2. What are the examples of minerals that have hardness property?
3. What is the specific of malleability?
4. What are the most malleable metals?
5. At what conditions do some metals gain malleability?
6. How are malleability and ductility connected?
7. What is the specific of brittleness?
8. What can be referred to brittle material?

ENGINEERING MATERIAL PROPERTIES

The important properties of an engineering material determine the utility of the material which influences quantitatively or qualitatively the response of a given material to imposed stimuli and constraints. The various engineering material properties are given as under.

1. Mechanical.
2. Chemical.
3. Physical.
4. Dimensional.

These properties of the material are discussed as under.

Text A for Student A

Mechanical Properties

Strength is defined as the ability of a material to resist the externally applied forces with breakdown or yielding. The internal resistance offered by a material to an externally applied force is called stress. The capacity of bearing load by metal and to withstand destruction under the action of external loads is known as strength. The stronger the material the greater the load it can withstand. This property of material therefore determines the ability to withstand stress without failure. Strength varies according to the type of loading. It is always possible to assess tensile, compressive, shearing and torsional strengths. The maximum stress that any material can withstand before destruction is called its ultimate strength. The tenacity of the material is its ultimate strength in tension.

Ductility is the ability of certain solids to undergo permanent changes in shape without breaking. For example, a piece of copper can be drawn to make a thin wire. But the shape of a brick cannot be permanently changed except by breaking it.

Ductility is a valuable property of many metals, including aluminium, gold, iron, nickel, and silver. These metals can be drawn into wire, hammered into various shapes, or rolled into sheet. The term malleability is often used in place of ductility to describe the property of metals that allows them to be hammered into thin sheets. Metals are not the only ductile substances and not all metals are ductile. For example, modelling clay is a ductile nonmetallic substance and impure tungstem is a nonductile metal.

Elasticity is the ability of a solid to return to its original shape and size after it has been deformed by a force. All solids have some elasticity. Familiar materials that have elasticity include the springs in cars and the rubber in tennis balls.

Solids return to their original shape and size if the deforming force was not too great. If the stress applied to a solid exceeds the solid's elastic limit, the solid will keep its new shape. In the metric system, pascals are used to measure stress.

Stress is related to strain. Strain is a measure of how much a given dimension of a solid changes under stress. In many solids, including metals, minerals, and salts, the stress below the elastic limit is in direct proportion to the strain. The greater the amount of stress there is on the material, the greater the amount of strain. The ratio of stress to strain, called the elastic modulus, is a measure of how well a solid resists deforming forces. A solid with a large elastic modulus has strong resistance to stress.

Text B for Student B

Mechanical Properties

Hardness is the ability of a material to scratch a mark on other substances, or to resist being scratched by them. Scientists measure the hardness of a material by comparing it with a table of 10 well-known minerals. The minerals are arranged in order from 1 to 10. Each mineral in the table scratches the ones with lower numbers, and can be scratched by all those with higher numbers. The standard scale of hardness follows:

1. Talc	6. Feldspar
2. Gypsum	7. Quartz
3. Calcite	8. Topaz
4. Fluorite	9. Corundum
5. Apatite	10. Diamond

Malleability is the ability of many metals to be pressed or hammered into thin sheets. A malleable metal can be squeezed into a thin sheet by pushing on it in opposite directions. The most malleable metals include copper, gold, and silver. For example, gold can be shaped into foils 10 times as thin as a sheet of paper. Some gold foils measure only 0.0025

millimetre thick. Certain metals are not malleable at room temperature, but they gain malleability when heated and kept at a high temperature.

Malleability metals also exhibit ductility – that is, they can be permanently stretched to a considerable degree without breaking. Malleability and ductility are closely related properties that indicate how solids change when subjected to opposing external forces. Solids regain their original shape if such deforming forces are not too great. This property is called elasticity.

Brittleness is the property of a material opposite to ductility. It is the property of breaking of a material with little permanent distortion. The materials having less than 5% elongation under loading behavior are said to be brittle materials. Brittle materials when subjected to tensile loads, snap off without giving any sensible elongation. Glass, cast iron, brass and ceramics, are considered as brittle material.

Text C for Student C

Physical Properties

Viscosity is a property of fluids that causes them to resist flowing. It is caused by internal friction from the fluid's molecules moving against each other. Fluids with high viscosity, such as molasses, flow more slowly than those with low viscosity, such as water.

All fluids, including liquids and gases, have some degree of viscosity. Some materials, such as pitch, that appear to be solid are highly viscous and can flow very slowly. The degree of viscosity is important in many applications. For example, the viscosity of motor oil determines how effectively it can lubricate the parts of a car engine.

The more strongly a fluid's molecules interact, the more viscous the fluid. Generally, the larger the size or length of a molecule, the greater the interaction. The temperature of a fluid also determines how strongly its molecules interact. Molecules in liquids interact more as the temperature decreases. Thus, hot liquids have lower viscosity than cold liquids.

However, gas molecules interact more strongly at high temperatures. Hot gases have higher viscosity than cold gases.

One way to increase a liquid's viscosity is to dissolve polymers (long-chain molecules) in it. These molecules become entangled and resist flowing. The addition of solid particles in suspension to a liquid also increases viscosity.

Dimensional Properties

Size and shape. Dimensions of any metal reflect the size and shape of the material. Length, width, height, depth, curvature diameter etc. determines the size. Shape specifies the rectangular, square, circular or any other section.

Chemical Properties

The study of chemical properties of materials is necessary because most of the engineering materials, when they come in contact with other substances with which they can react, suffer from chemical deterioration of the surface of the metal. Some of the chemical properties of the metals are corrosion resistance, chemical composition and acidity or alkalinity. **Corrosion** is the gradual deterioration of material by chemical reaction with its environment.

Taken from the book "Introduction to Basic Manufacturing Processes and Workshop Technology" written by R. Singh, World Book Encyclopedia (International)

7. **Read the text again and:**

1) **summarize the information about mechanical, chemical, physical and dimensional properties of engineering materials;**
2) **add some properties according to the classification of engineering material properties given in the text.**

USE OF ENGLISH

8. **Work in pairs. Give the Ukrainian equivalents to the words and phrases. You can also do it using Quizlet flashcards.**

1.	strength	17.	talc
2.	internal resistance	18.	apatite
3.	to withstand destruction	19.	fluorite
4.	to assess tensile, compressive, shearing and torsional strengths	20.	calcite
5.	failure	21.	gypsum
6.	ductility	22.	brittleness
7.	malleability	23.	permanent distortion
8.	elasticity	24.	sensible elongation
9.	viscosity	25.	pitch
10.	friction	26.	to lubricate
11.	to come in contact with other substances	27.	suspension
12.	curvature	28.	chemical deterioration
13.	corrosion resistance	29.	gradual deterioration
14.	liquid	30.	to snap off
15.	to dissolve polymers	31.	chemical composition and acidity or alkalinity
16.	deforming forces	32.	to measure the hardness of a material

9. **Fill in the table with the words derived from the given ones.**

Noun	Verb	Adjective
appliableness	.....	.....
destruction	.....	.....
tension	_____	.....
malleability	.....	.....
.....	elasticize	.....
.....	deform	.....
.....	.....	resisting
hardness	_____	.....
brittleness	_____	.....
.....	_____	elongated
.....	_____	viscous
.....	.....	lubricative
dissolvability	.....	.....

10. **In the text, find the opposites of the following words.**

High – _____, thin – _____, decrease – _____, hot – _____, liquid – _____, quantitatively – _____.

11. **Match the words with similar meaning. You can also do it using the Learning.Apps platform at this link.**

1	property	**a**	cope with
2	strength	**b**	friable
3	withstand	**c**	rubbing
4	ductility	**d**	flexibility
5	hammer	**e**	treat
6	subject	**f**	decline
7	brittle	**g**	quality, characteristic
8	elongation	**h**	sticky
9	friction	**i**	extension
10	viscous	**j**	toughness
11	deterioration	**k**	strike

12. **In small groups, find 10 names of engineering material properties, then choose any three and make sentences.**

s	t	r	e	n	g	t	h	t	t	r	l
a	b	b	l	d	e	n	p	s	k	l	m
g	m	h	a	r	d	n	e	s	s	k	g
t	y	k	s	l	l	m	n	g	i	a	i
d	u	c	t	i	l	i	t	y	z	n	m
c	b	r	i	t	t	l	e	n	e	s	s
r	c	m	c	d	l	b	t	r	k	s	h
t	s	v	i	s	c	o	s	i	t	y	a
g	s	l	t	m	d	r	k	v	x	p	p
d	k	k	y	a	c	i	d	i	t	y	e
m	a	l	l	e	a	b	i	l	i	t	y

13. **Work in pairs. Using the information from the text (ex. 6), match 1-13 with a-m, then choose any three phrases and make sentences.**

1	to withstand destruction	**a**	into wire
2	to undergo permanent changes in	**b**	at a high temperature
3	metals can be drawn	**c**	on other substances
4	the stress applied to	**d**	under the action of external loads
5	a solid changes under	**e**	10 times as thin as a sheet of paper
6	to scratch a mark	**f**	to opposing external forces
7	to be pressed or hammered	**g**	stress
8	to be shaped into foils	**h**	to a considerable degree
9	to keep	**i**	a solid
10	to be permanently stretched	**j**	into thin sheets
11	subjected	**k**	shape without breaking
12	to snap off	**l**	from chemical deterioration
13	to suffer	**m**	without giving any sensible elongation

14. **Using the information from the text (ex. 6), choose the odd word in each line.**

1) ductility, brittleness, elasticity, strength;
2) width, height, depth, circular;
3) corrosion resistance, length, chemical composition, acidity;
4) calcite, fluorite, quartz, material;
5) viscosity, hardness, malleability, brittleness;
6) mechanical properties, chemical properties, general properties; physical properties;
7) stress, strain, solid, minerals;
8) paper, copper, gold, silver;
9) gold, glass, cast iron, ceramics;
10) rectangular, square, depth, circular.

15. **Fill in the gaps with the appropriate words from the list below. You can also do it using the Learning.Apps platform at this link.**

Measure, endure, elasticity, ductile, regain, tensile property, yield point, deformation, permanent, steel, proportional limit, resistance, elastic limit, stress, increase in load.

1) _____ is defined as the property of a material to regain its original shape after deformation when the external forces are removed. It can also be referred to as the power of material to come back to its original position after **2)** _____ when the stress or load is removed. It is also called as the **3)** _____ of the material.

4) _____ is defined as the maximum stress under which a material will maintain a perfectly uniform rate of strain to **5)** _____. Though its value is difficult to **6)** _____, yet it can be used as the important applications for building precision instruments, springs, etc.

Many metals can be put under stress slightly above the proportional limit without taking a **7)** _____ set. The greatest stress that a material can **8)** _____ without taking up some permanent set is called **9)** _____. Beyond this limit, the metal does not **10)** _____ its original form and permanent set will occur.

At a specific stress, **11)** _____ metals particularly cease, offering **12)** _____ to tensile forces. This means, the metals flow and a relatively large permanent set takes place without a noticeable **13)** _____. This point is called **14)** _____. Certain metals such as mild **15)** _____ exhibit a definite yield point, in which case the yield stress is simply the stress at this point.

Taken from the book "Introduction to Basic Manufacturing Processes and Workshop Technology" written by R. Singh

16. **Work in small groups. Make up crosswords. Exchange and solve them.**

17. **Revise words and phrases on the topic "Engineering material properties". Use Quizlet flashcards.**

18. **Using information about the bare infinitive (Appendix 2), choose the correct option.**

The bare infinitive is used 1) after modal verbs: can, may, must, should, etc. (but: have to, ought to); 2) after let, make, see, hear and feel; 3) after would rather, had better, and would sooner.

Then give two examples of your own sentences with the bare infinitive.

1. A material having high dielectric strength can _____ **(withstand / to withstand)** for longer time for high voltage across it before it conducts the current through it.

2. You have _____ **(to explain / explain)** how scientists measure the hardness of a material.
3. Let us _____ (**talk / to talk**) talk about engineering material properties.
4. You had better _____ **(to explain / explain)** the difference between these classification of engineering material properties.
5. Frankie saw her lecturer _____ **(to clarify / clarify)** information about mechanical properties of materials.
6. Let us now _____ **(to shift / shift)** attention from what we use to what is widely available.
7. He advised me _____ **(read / to read**) this information attentively.
8. The maximum stress that any material can _____ **(to withstand / withstand)** withstand before destruction is called its ultimate strength.
9. Dimensional properties have _____ **(to be / be)** in the classification of engineering material properties.
10. I have never heard this professor _____ **(to explain / explain**) this topic.
11. I would sooner _____ **(solve / to solve)** this problem.
12. She has decided _____ **(do / to do)** her home assignment.

19. **Revise grammar (the Infinitive Constructions) in Appendix 2. Read the sentences with the infinitive constructions. Then translate them into Ukrainian in written form. Make up your own sentences using different infinitive constructions.**

1. It is important *for an engineer to know* the properties of materials.
2. *Viscosity* is considered *to be* a property of fluids that causes them to resist flowing.
3. *The materials having less than 5% elongation under loading behavior* are said *to be* brittle materials.

4. I want *you to participate* in this project.
5. Tom finds *such a classification of engineering material properties hard to accept.*
6. The study of thermal properties is essential *for students to know* the response of metal to thermal changes i.e. lowering or raising of temperature.
7. It was difficult *for her to answer* the question.
8. They wanted *you to generate* some interesting ideas.
9. The professor declared *him to be* the most talented student on this course.
10. I saw *Karen enter the chemical laboratory*.

20. **Revise the information about the Gerund (Appendix 2) and translate the sentences into English in written form.**

1. Крім вивчення хімічних і фізичних властивостей матеріалів, я мав знати також і механічні властивості.
2. Я пам’ятаю, що вивчав дисципліну «Матеріалознавство» минулого року.
3. Слід припинити сперечатися з приводу отриманих результатів експерименту.
4. Немає сенсу обговорювати це наукове питання.
5. Я розмірковував про використання різних властивостей матеріалів в цьому пристрої.
6. Я захоплююся вивченням фізики.
7. Джейн вже закінчила працювати над цим проєктом.
8. Френкі відклала проведення експерименту на наступний рік.
9. Мені було цікаво читати про 3D і багатовимірне матеріалознавство.
10. Зараз ви продовжуєте робити деякі зміни в цьому проєкті.

21. **Revise the information about the Participle (Appendix 2) and fill in the gaps with the correct options.**

1. The **(interesting / interested)** lecture caused a great deal of excitement.
2. It is a **(tiring / tired)** job to investigate chemical properties of materials.
3. Alloys **(basing / based)** on zirconium and palladium are very good glass formers, but amorphous metals **(basing / based)** on titanium, copper, magnesium, iron, and other metals have been made.
4. Karen is not **(interested / interesting)** in this issue.
5. The engineer presented the **(approving / approved)** plan in the company.
6. The home assignment **(doing / done)** by Frankie was full of mistakes.
7. The information **(presenting / presented)** in this paper is valuable.
8. Those **(worked / working)** students look tired.
9. The problem **(discussing / discussed)** about material science at the scientific conference was related to our faculty.
10. When **(questioned / questioning)** about mechanical properties of materials the student gave some explanation and interesting examples.

22. **Put the verbs in brackets into the correct infinitive form or -ing form.**

1. Malleability is the ability of the material _____ **(flatten)** into thin sheets under applications of heavy compressive forces without _____ **(crack)** by hot or cold working means.
2. It is a special case of ductility which permits materials _____ **(roll or hammer)** into thin sheets.

3. A malleable material should be plastic but it is not essential _____ **(be)** so strong.
4. The malleable materials commonly used in engineering practice in order of _____ **(diminish)** malleability are lead, soft steel, wrought iron, copper and aluminium.
5. This allows them _____ **(use)** in applications where high strength and unusual shapes are required, such as golf club heads and cell phone cases.
6. Polarized light _____ **(pass)** through an anisotropic material (e.g., a material under stress) leads to two _____ **(exit)** polarizations that can be separated by an analyzer.
7. The professor decided _____ **(accept)** the laboratory work.
8. Karen expects _____ **(begin)** studying next term.
9. They agreed _____ **(participate)** in the startup.
10. Tom is intent on _____ **(graduate)** from the university next year.

Some sentences are taken from works of R. Singh, M. A. White.

23. **Choose the appropriate words to fill in the gaps.**

1. This equation _____ the mechanical behavior of a material at low stress.
   a) describe b) describes c) is describing
2. Toughness is a measure of the energy _____ to break a material.
   a) required b) require c) requiring
3. It is different _____ strength: tensile strength is the maximum stress value on a stress–strain curve, and toughness is related to the area under the stress–strain curve at failure.
   a) on b) from c) with
4. Many materials with low values of Young's modulus _____, that is, reversibly deformed.

a) also are very elastic

b) are also very elastic

c) are very elastic also

5. As with many other properties of materials, this property can be _____ temperature dependent.

a) strong b) stronger c) strongly

6. Stiffness, tensile strength, and elastic properties are important in material applications as seemingly diverse as sound production _____ piano strings to the strength of dental porcelain to the protection of a bullet-proof vest.

a) since b) from c) then

7. We begin _____ relevant definitions.

a) on b) from c) with

8. The yield strength _____ as the stress at which the strain is 0.2% greater than predicted by Hooke's law.

a) defined b) defines c) is defined

9. Rapid quenching leads to thin samples of amorphous metals, but more recently, techniques _____ to produce bulk metallic glass.

a) have been developed

b) have developed

c) was developed

10. When linearly _____ light hits the sample, optical anisotropy leads to the production of two rays of light within the sample.

a) polarize b) polarizing c) polarized

11. For metallic and ceramic materials, the elastic region _____ shows a linear relationship between stress and strain, but for polymers such as rubber the relationship _____ can be nonlinear.
    a) is showing, can be
    b) shows, can be
    c) shows, must be
12. Rapid _____ leads to thin samples of amorphous metals, but more recently, techniques _____ to produce bulk metallic glass.
    a) quenching, have been developed
    b) quenched, have developed
    c) quenching, have developed
13. _____ strongly a fluid's molecules interact, the more viscous the fluid.
    a) The more b) More c) The most
14. The capacity of bearing load by metal and to withstand destruction _____ the action of external loads is known as strength.
    a) on b) under c) in

The sentences were taken from the book written by M. A. White, R. Singh

TRANSLATION

24. Translate the sentences from English into Ukrainian in written form.

1. The mechanical properties of materials are of great industrial importance in the design of tools, machines and structures.
2. These properties are structure sensitive in the sense that they depend upon the crystal structure and its bonding forces, and especially upon

the nature and behavior of the imperfections which- exist within the crystal itself or at the grain boundaries.

3. The mechanical properties of the metals are those which are associated with the ability of the material to resist mechanical forces and load.
4. Weldability is defined as the property of a metal which indicates the two similar or dissimilar metals are joined by fusion with or without the application of pressure and with or without the use of filler metal (welding) efficiently.
5. Metals having weldability in the descending order are iron, steel, cast steels and stainless steels.
6. When metal is subjected to hot working and cold working processes, plastic deformation occurs which is an important phenomenon.
7. Plastic deformation of metal distorts the crystal lattice.
8. Magnetic properties of materials arise from the spin of the electrons and the orbital motion of electrons around the atomic nuclei.
9. Specific gravity of any metal is the ratio of the mass of a given volume of the metal to the mass of the same volume of water at a specified temperature.
10. A material is called as porous or permeable if it has pores within it.

The sentences are taken from the book written by R. Singh.

25. Translate the sentences from Ukrainian into English in written form.

1. Відсутність пластичності – крихкість.
2. Твердість зазвичай визначається як стійкість матеріалу до проникнення.
3. Тверді матеріали стійкі до подряпин або зношування через тертя об інше тіло.
4. Пластичність – це здатність металу витримувати подовження або згинання.

5. Завдяки цій властивості проводи виготовляють шляхом витягування через отвір.
6. Матеріал демонструє значну пластичність під час пластичного подовження.
7. Фізичні властивості матеріалу – це ті, які можна спостерігати без зміни ідентичності матеріалу.
8. Фізичними властивостями металів є щільність, колір, розмір і форма, питома вага матеріалу, пористість тощо.
9. Теплові властивості – це ті властивості матеріалу, які пов'язані з його теплопровідністю.
10. Електричні властивості – здатність проводити електричний струм.

LISTENING

26. **Before watching the video, check if you know the meaning of the following words. Use the dictionary if necessary.**

Bendy, smooth, shiny, bumpy, rough, fabrics, flexible, to drip off, unique, flimsy.

27. **Watch the video about materials and their properties (https://www.youtube.com/watch?v=340MmuY_osY). Then match materials (1-5) with properties (a-e).**

1 wood	**a** flexible
2 plastic	**b** strong and resistant
3 fabrics and rubber	**c** hard
4 metal	**d** transparent
5 glass	**e** waterproof

28. **Watch the video again and complete the following sentences.**

1. Materials have specific _____ that help them do their job.
2. An umbrella handle is made of _____, shield is made of _____.
3. Hard materials support _____ of the umbrella while the plastic is _____.
4. Clothes are made of cotton, that is a _____.
5. It let us move _____ and stay _____.
6. To build houses it is necessary to use _____ materials: _____, _____, _____ and _____.

29. **In groups, make a list of the questions asked in the video (ex. 27) and discuss the properties of materials (mentioned in the video) that are mostly used in applied mechanics.**

SPEAKING

30. **Your teacher asked you to inform the students about mechanical properties of materials. Create a brief presentation. Use the phrases below.**

1. *It is important for an engineer to understand the properties of material.*
2. *The machine elements should be made of the materials that have properties acceptable for the operation conditions.*
3. *It is known that the mechanical property is ……..*
4. *The mechanical properties involve ……..*
5. *The most important among them are ……..*

31. **As an engineering student, you learn different classifications of engineering material properties. Look at the three classifications in the table below and say which of them is the most comprehensive in your opinion.**

Classification 1	Classification 2	Classification 3
1. Chemical 2. Mechanical 3. Magnetic 4. Electronic 5. Thermal 6. Optical 7. Processing	1. Chemical 2. Mechanical 3. Physical 4. Dimensional	1. Chemical 2. Mechanical 3. Physical 4. Magnetic 5. Electrical

32. **This is the classification of engineering material properties by R. Singh. Choose a group of properties and talk about it.**

1. Physical Properties:

- ✓ density,
- ✓ color,
- ✓ size and shape,
- ✓ specific gravity,
- ✓ porosity.

2. Chemical Properties:

- ✓ corrosion resistance,
- ✓ chemical composition,
- ✓ acidity or alkalinity.

3. Thermal Properties:

- ✓ thermal conductivity,
- ✓ thermal expansion,
- ✓ specific heat,
- ✓ melting point,
- ✓ thermal diffusivity.

4. Electrical Properties:

- ✓ conductivity,
- ✓ temperature coefficient of resistance,
- ✓ dielectric strength,
- ✓ resistivity,
- ✓ thermoelectricity.

5. Magnetic Properties:

- ✓ magnetic hysteresis,
- ✓ coercive force,
- ✓ absolute permeability.

6. Optical Properties:

- ✓ refractive index,
- ✓ absorptivity,
- ✓ absorption co-efficient,
- ✓ reflectivity,
- ✓ transmissivity.

7. Mechanical Properties:

- ✓ strength,
- ✓ stiffness,
- ✓ elasticity,
- ✓ plasticity,
- ✓ ductility,
- ✓ malleability,
- ✓ toughness,
- ✓ brittleness,
- ✓ hardness,
- ✓ formability,
- ✓ castability,
- ✓ weldability.

33. **Work in groups. The table below presents two types of physical properties. Continue creating the table. Then talk about the way the material properties affect the design of products.**

Intensive Properties	Extensive Properties
Hardness **……..** **……..** **……..** **……..**	**Length** **Size** **……..** **……..** **……..** **……..** **……..**

34. **As an engineering student, you are going to make a presentation at a students' scientific conference. Choose one of the following topics. Follow the structure: introduction, main body, conclusions. Be ready to answer the questions after your presentation.**

1. A brief history about material science.
2. Advanced materials processing and fabrication: 3D printing and additive manufacturing technologies.
3. Nanomaterials: structure, properties, processing and performance.
4. Extreme deformation of engineering materials.
5. Biomedical materials.
6. Ceramics.
7. Drug related materials.
8. Energy materials.
9. Electronic, optical and magnetic (EOM) materials.
10. Metals and alloys.
11. Polymers and plastics.
12. Properties of wood.
13. Magnetic materials.
14. Steel material properties.
15. Thermal properties of materials.
16. Growing use of polymers as biomaterials.
17. Emerging electronic properties of polymers.
18. Evolution of polymer theory with emphasis on computer modeling and simulation.
19. Growing use of polymeric materials for wide variety of military items.

35. **Work in pairs. Complete the dialogue about the material properties and role play it.**

1. Why are material properties important?

.....

2. .....

There are different engineering material properties. Among them ..

3. .....

Corrosion resistance, chemical composition, acidity or alkalinity.

4. Can you tell me about these properties?

.....

36. **Work in pairs. Using the information from the text (ex. 6), discuss the mechanical properties of engineering materials. You may use additional information on the Internet.**

WRITING

37. **Work in small groups. You are going to create a website about engineering material properties (200-250 words). Include the following information:**

1. **Name of property.**
2. **Description.**
3. **Practical application of engineering material property.**

38. **As an engineering student, you are studying the use of ceramics for developing engine components. The teacher asked you to write a "for and against" essay about advantages and disadvantages of ceramics (160-180 words). Complete the task using the following plan.**

1. Introduction.

   Ceramics is a good material for engine blocks.

2. Main body.

   A. Ceramics has some benefits compared to other materials:

   - is hard, lightweight, and chemically stable;
   - …….;
   - …….;
   - ……..

   B. Ceramics has some disadvantages:

   - …….;
   - …….

3. Conclusions.

39. **Your teacher asked you to analyse the properties of iron and aluminum engine blocks. Write an essay (180-200 words) on the topic "Pros and cons of iron and aluminum engine blocks".**

Unit 7. Strength of Materials

LEAD-IN

1. **Think of as many words as possible related to the topic "Strength of materials". Make a mind map using the following tool. Then, share your mind map with a partner. Finally, in pairs, discuss the similarities and differences between your mind maps.**

2. **Work in pairs. Discuss the following questions.**

1. Why is strength of materials important for an engineer?
2. Can you name the materials which are strong?
3. How do you find the strength of a material?
4. What are the applications of strength of materials in daily life?
5. What affects the strength of materials?

3. **Guess if the following facts about the strength of materials are *True* (*T*) or *False* (*F*).**

1. The strength of materials is described with units of pressure.
2. A wire made out of the same steel may have the same tensile strength but the thicker rod will require more force to break.
3. The strength of a material does not depend on its other properties.
4. The strength of a material does not change depending on the environment, such as temperature or humidity.
5. Many conditions can affect plastics by causing chemical changes: for example, many plastics are made softer and weaker by water.
6. Many plastics can be damaged and made brittle and weak by Ultraviolet radiation from the Sun.

READING

4. **Underline the stressed syllable. Practise reading the words.**

Various, machine, design, structural, aluminium, concrete, iron, withstand, fairly, tensile, layer, unite, laboratory, heavier.

5. **Explain the meaning of the words and phrases in bold. Check in the dictionary.**

6. **Work in pairs. Make notes to fill in *What I know* and *What I want to know* columns. Then, read the text and fill in *What I learnt* column. Compare your answers.**

What I know	What I want to know	What I learnt
_____ _____	_____ _____	_____ _____

STRENGTH OF MATERIALS

Strength of materials is a term used by engineers to describe how much force a material can resist. Engineers also use the term to describe how a material's **shape** and size change as a result of an applied force. In addition, strength of materials is the branch of engineering that deals with the study of various forces and of the properties of materials that enable them to resist such forces. When engineers design a building or a machine, they consult publications that list the strength of various materials. They may also conduct tests to determine the strength of these materials. Strength-of-materials engineers attempt to design structural and mechanical parts that **resist external forces** in a safe and economical manner.

How materials react to force. The strength of a material depends on its mechanical properties, which include elasticity, hardness, and stiffness.

Mechanical properties combine differently in every material. As a result, such materials as aluminium, concrete, and steel differ in their ability to resist a particular force. Also, each material differs in its ability to resist various types of force. A cast iron bar, for example, is better able to withstand compression (force that pushes it together) than tension (force that pulls it apart).

When an external force is applied to a material, a force inside the material resists the external force. This internal resistance of a material to such a force is called stress. A material subjected to an external force changes in shape and size. When a weight is put on the end of a rope, for example, the rope stretches. The actual change in shape of a material – in the above case, the stretching of the rope – is called deformation. Deformation per unit of length is called **strain**. The greater the amount of stress in a material is, the greater is the amount of strain that will occur in it. For most structures, such as buildings and bridges, the strain is so small that resulting changes in shape cannot be seen. An object like a rubber band, however, shows a significant change in shape even when subjected to fairly small forces. The **ratio** of stress to strain in a material, called the modulus of elasticity, is a measure of the material's ability to stretch when a force is applied to it.

Materials undergo three types of stress: tensile, compressive, and shearing. Tensile stress causes a material to stretch, as with the rope. Compressive stress causes a material to push together. The pillars that support a building undergo compressive stress because the weight of the structure pushes down on them. Shearing stress causes a material to separate into layers by a sliding action. Such an action resembles that of the cards in a deck, which slide apart when they are tilted so the edges are at an angle.

The stresses in a material may combine to resist force. Combined stresses cause flexure (bending) and torsion (twisting). For example,

various stresses unite in a **springboard** when a person stands on it. The person's weight causes tensile stress in the top section of the board, and the fibres there stretch. At the same time, the weight of the individual causes compressive stress in the bottom section of the board. As a result, the fibres there push closer together. This combination of stresses resists the weight that is applied and makes the board bend.

How strength is determined. Technicians measure the strength of a material by using special machines that apply force to a sample of the material. First, they determine the material's elastic limit, the amount of force it can resist without changing shape **permanently**. If the applied force is lower than the elastic limit, the material will return to its original shape and size after the force is removed. But if the force exceeds the elastic limit, the material will change permanently.

Technicians also measure the ultimate strength of a material – that is, the maximum force it can resist without breaking. Engineers consider **ultimate** strength in terms of the number of kilograms of force per square centimetre that a material can withstand. For example, a bar of cast iron can withstand about 2,110 kilograms per square centimeter of a pulling force without breaking. Laboratory tests for strength are not exact. The results are affected by a material's age, composition, and moisture. In constructing a building or a machine, engineers use a material strong and stiff enough to resist a heavier load than the one expected. This policy helps ensure that the material will not fail when it is in actual use in a structure or machine.

The text is taken from World Book Encyclopedia

7. **Read the text again and answer the following questions.**

1. What does the term *strength of materials* mean?
2. Why do engineers consider the strength of various materials when they design a building or a machine?
3. Why do materials differ in their ability to resist a particular force?

4. When does stress occur in a material?
5. Explain the difference between stress and strain.
6. Describe different types of stress.
7. What happens when various stresses unite in a springboard when a person stands on it?
8. How is strength determined?
9. What is ultimate strength?
10. Why are laboratory tests for strength not exact?

USE OF ENGLISH

8. **Give the Ukrainian equivalents to the words below. You can also do it using Quizlet flashcards.**

1)	hardness	7)	stress
2)	stiffness	8)	springboard
3)	concrete	9)	fibres
4)	strain	10)	withstand
5)	ratio	11)	tensile
6)	angle	12)	shearing

9. **In the text, find the opposites of the following words.**

Yield – _____, weakness – _____, internal – _____, dangerous – _____, exclude – _____, disability – _____, compression – _____, insignificant – _____ .

10. **Fill in the table with the words derived from the given ones.**

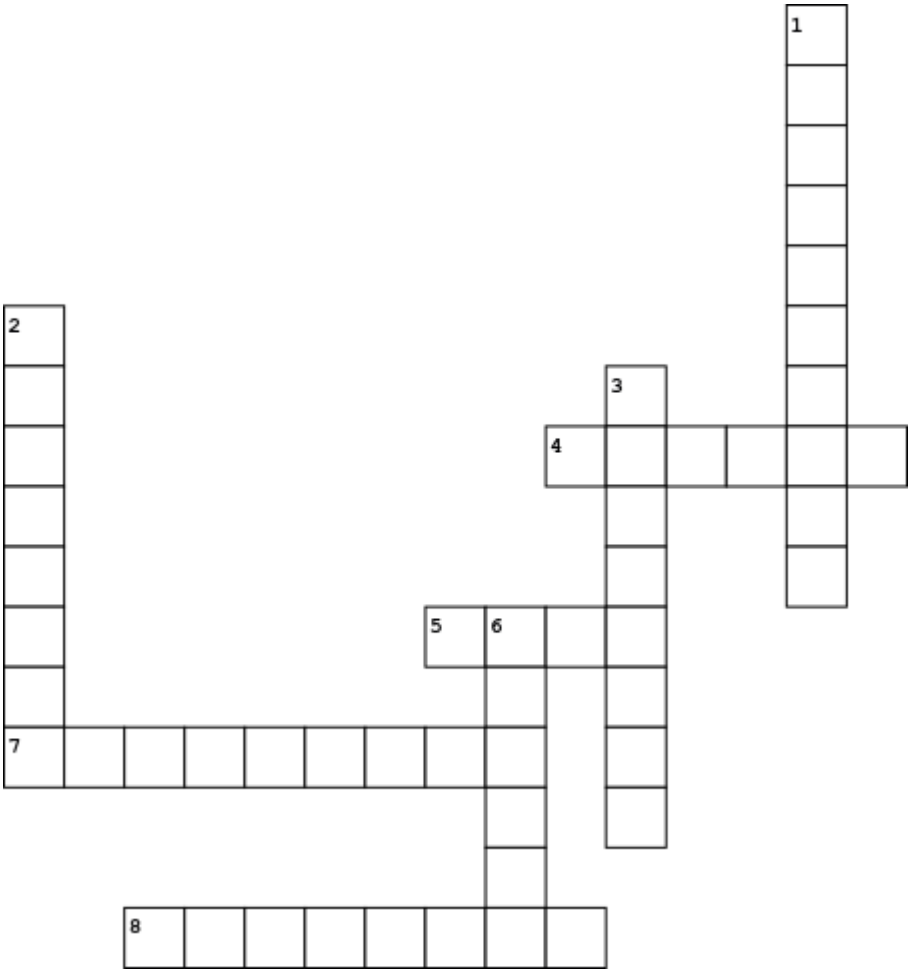
Noun	Verb	Adjective
strength	.....	.....
.....	.....	various
.....	resist	.....
.....	.....	structural
.....	.....	mechanical
.....	.....	economical
.....	depend	.....
elasticity	_____	.....
hardness	.....	.....
stiffness	.....	.....
deformation	.....	.....
.....	.....	significant
stress	.....	.....

11. **Match the words with similar meaning. You can also do it using the Learning.Apps platform at this link.**

1	change	**a**	try
2	branch	**b**	distinct
3	attempt	**c**	respond
4	particular	**d**	outline
5	ratio	**e**	alter
6	apply	**f**	employ
7	react	**g**	rather
8	shape	**h**	subdivision
9	occur	**i**	appear
10	fairly	**j**	proportion

12. **Solve the crossword puzzle below. You can also do it using the Crossword Lab platform at this link.**

Strength of materials



Across

4. a force or influence that stretches, pulls, or puts pressure on something, sometimes causing damage

5. a chemical element that is a common greyish-coloured metal. It is strong, used in making steel, and exists in very small amounts in blood

7. the quality of being firm, hard, or unable to bend

8. a quality in a substance or material, especially one that means that it can be used in a particular way

Down

1. the ability to stretch

2. the quality of being difficult to bend, cut, or break

3. physical, especially violent, strength, or power

6. to refuse to accept or be changed by something

13. **Work in pairs. Using the information from the text (ex. 6), match 1-10 with a - j to make phrases, then choose any three and make sentences.**

1	the branch of engineering that	**a**	in the ability to resist various types of force
2	differ	**b**	subjected to an external force
3	conduct	**c**	in shape of a material
4	a material	**d**	on its mechanical properties
5	change	**e**	deals with the study of various forces
6	the strength of a material depends	**f**	the elastic limit
7	apply force	**g**	tests to determine the strength of these materials
8	the ratio	**h**	of stress to strain in a material
9	if the force exceeds	**i**	to a sample of the material

14. **Using the information from the text (ex. 6), choose the odd word in each line.**

1) strength, elasticity, force, hardness;
2) building, shape, machine, bridges;
3) react, resist, withstand, describe;
4) flexure, bending, building, torsion;
5) aluminium, concrete, steel, branch;
6) compression, tension, property, stress;
7) workplace stress, tensile stress, compressive stress, shearing stress;

8) material's age, material's property, material's composition, material's moisture;

9) soft, week, brittle, safe.

15. **Fill in the gaps with the appropriate words from the list below.**

Fiberglass, layers, element, composite materials, aluminium, withstand.

DEVELOPMENT OF NEW MATERIALS

During the late 1960s, scientists began the extensive development of composite materials. Such a material contains two or more materials. Many **1)** _____ contain a large amount of one substance combined with fibres, flakes, or **2)** _____ of another. Composite materials have greater strength than many single materials. For example, glass fires combined with plastics form **3)** _____ reinforced plastics. This material has greater strength than either the glass or the plastics alone. Fibreglass re-inforced plastics are used to make such products as boat hulls, building panels, and truck parts.

Since the 1970s, scientists have increased the development of composite materials that contain fibres. Two of the strongest fibres consist of boron, a chemical **4)** _____, and graphite, a form of carbon. Boron fibres and graphite fibres can **5)** _____ intense force and high temperatures. These lightweight fibres, as well as light-weight metals, such as **6)** _____, are used in some spacecrafts.

The text is taken from World Book Encyclopedia

16. **Work in small groups. Solve the word search puzzle.**

Strength of materials

K L S L D D M J E B K K E F H E B H O X
J S T I F F N E S S W I T H S T A N D W
F I Z P R O P E R T I E S V S H Q E W G
M C N W Q V P M Y A Q J V N B A W Z O G
F B E H S X J A X G D Q I S Y W B F K U
X Q B J C O N C R E T E Q W W S N Q X G
A R J S Q K O P M N S H A P E N Q S N E
G A P E G E V K M Z X J Q I R I Q S B L
B T G C F G U D O J I G W S V G H E C A
P I S L G C L V I L X J E G U W S N H S
Y O O K Z L M Q S H E D Z Z A O T D A T
L U G L F H J W T N M J Q D Q C I R V I
V N Y Q C D G S U C K F H U Z Z M A E C
J E M E T E N B R F K T X N V K U H U I
F A H L E I I F E W S S Q M X X O W A T
O L I J S L R U B T J J V S R C C F W Y
C F V R C N A U H N B O V J I G R S X Z
S T R A I N E K W D G B Q U O C H W J D
I D X X B B H W B V V H Y A H L H T O D
M K J X R V S V N I Q K X O P B A Q G W

1. shape **2.** properties **3.** elasticity **4.** hardness **5.** stiffness **6.** concrete **7.** withstand
8. strain **9.** ratio **10.** shearing **11.** moisture

17. **In pairs, make up your own word search puzzles. Exchange and solve them.**

18. **Drag the letters into their correct positions to unscramble the words. Each word is a name of a material property. The first two letters in each word are already in the correct positions. You can also do it using Wordwall.net platform at this link.**

1) **st**hgtenr
2) **el**siacitty
3) **ha**dresns

4) **st**ffessin
5) **du**citytli
6) **ma**lalitbiyle
7) **br**esstlneit
8) **vi**otyscsi

19. **Revise the information about comparative and superlative adjectives (Appendix 2) and choose the correct option.**

1. A cast iron bar is ***better / more better*** able to withstand compression than tension.
2. Special machines determine the material's elastic limit, the amount of force it can resist without changing shape ***permanently / permanent***.
3. Compounds consist of two or more elements that are ***chemically / chemical*** bound – that is, combined by a chemical reaction.
4. In an alloy, the percentage of an alloying metal is ***the biggest / the most big***.
5. Our Internet connection is ***really / real*** slow. Quite often, it takes us several minutes to download a small document.
6. Concrete is one of the ***most widely / more widely*** used construction materials at present.
7. City planners try to find ***more efficient / the most efficient*** ways of developing public transport.
8. Air travel is ***quicker / more quick*** than travelling by car.
9. It's not fair. Nick didn't work ***as hard as me / harder as me***, but he got a better mark in the exam.
10. It's ***most dangerous / more dangerous*** travelling by car than by train.

20. **Choose the correct options.**

1. Annealed metal is generally _____ and _____ (much) elastic.
   a. softest / most b. softened / much c. softer / more

2. Quenched metal is _____, but tends to be more brittle.
   a. harder b. hardest c. hardened

3. The problem of creep is made _____ by heat, so is a major issue in engines, where both loads and temperatures are high.
   a. badder b. worse c. worst

4. Generally, hard materials are _____ durable than soft materials, because they are _____ at resisting wear – progressively worsening damage – to their surfaces.
   a. more / better b. most / best c. much / good

5. This machine isn't working very _____.
   a. good b. well c. bad

6. Manufacturers are searching for practical solutions to make _____ cars, _____ personal computers, or _____ pens.
   a. fastest / smallest / best
   b. more fast / more small / more good
   c. faster / smaller / better

7. The results of school exams in the UK have improved significantly in recent years, because exams _____ they used to be.
   a. aren't as difficult as
   b. aren't as difficult than
   c. are as difficult as

8. My new mobile phone was _____ my computer.
   a. almost expensive than
   b. almost as expensive as
   c. almost as expensive than

9. It is difficult to choose a new phone, because they all look _____.
   a. same b. the same c. the same as

10. Flight prices for low-cost airlines are getting _____.
    a. more lower b. more low c. lower

21. Fill in the blanks using the proper forms of the words in brackets.

1. The tensile strength of materials is usually _____ **(low)** than their compressive strength.
2. Some materials can extend _____ **(significant)**, but still return to their original shape.
3. Some materials conduct heat _____ **(good)** than others.
4. The thermal conductivity of copper is approximately 40% _____ **(great)** than that of aluminium.
5. Due to its better thermal conductivity copper is much _____ **(effective)** than aluminium as a material for electric wires.
6. The coefficient of thermal expansion (it's change in size for a given change in temperature) of copper is about 40% _____ **(low)** than that of aluminium, which means that copper is _____ **(little)** susceptible to movement.
7. Plates are flat pieces of metal that are wide, but _____ **(thick)** than sheets.
8. Powder particles are _____ **(small)** than pellets.
9. Pellets do not require _____ **(far)** processing.
10. Steel is much _____ **(strong)** than concrete, not just in tension, but also when it's compressed.

22. **Put the words in the correct order to form sentences.**

1. horizontally / The height / the towers / measured / of / is
2. contain / or / iron / 90% / more / Low alloy steels
3. contain / more iron / than / Low alloy steels / chromium
4. is /added / to make / softer / it / Tungstem / to steel
5. than / harder / is / tempered metal / Precipitation-hardened metal
6. is / car / our range / This model / the heaviest / in
7. is / a much better / Maglev technology / way / people and goods / than / to move / existing models
8. service life / are / and / Maglev trains / have / a far longer / a lot cheaper, faster
9. are / more / and / you / work / can /now / Computer programs / sophisticated / much more efficiently
10. takes / to produce aluminium / than / It / more energy / to produce copper

23. **Choose the correct option.**

1. He suggested _____ a course at college.
   a. to take b. take c. taking

2. The engine power for tractors _____ over the years.
   a. increased b. will increase c. have increased

3. The stronger the material the _____ the load it can withstand.
   a. greater b. greatest c. great

4. When a body _____ to tensile force its length increases and the diameter decreases.
   a. will subject b. is subjected c. was subjected

5. The mechanical properties of materials _____ of great industrial importance in the design of tools, machines and structures.
   a. are b. have been c. is

6. Melting temperature _____ on the nature of inter-atomic and intermolecular bonds.
   a. depend b. depends c. is depending

7. _____ in the library this week to revise for my exams.
   a. I'm studying b. I'm study c. I study

8. When I was at university nobody _____ a mobile phone.
   a. had got b. did have c. had

9. When I was at school, my favourite subject _____.
   a. was physics b. were physics c. was physic

10. My brother works as _____ for British Aerospace.
    a. the engineer b. engineer c. an engineer

TRANSLATION

24. **Translate the sentences from English into Ukrainian in written form.**

1. The definition of strength is the capability of a substance to withstand external forces without fracturing or deforming.
2. When an external force is exerted on a material, the resistance that the material provides is known as stress.
3. Strength refers to the ability of a metal to endure the stress caused by external forces without breaking and to withstand the weight it bears.
4. The stronger the material the greater the load it can withstand.

5. The ability of a material to endure stress without collapsing is determined by its property of strength. The magnitude of strength depends on the type of load applied to the material.
6. The evaluation of tensile, compressive, shear, and torsional strengths is always feasible.
7. The highest stress that a material can endure prior to failure is referred to as its ultimate strength.
8. The ultimate strength of a material under tension is commonly referred to as its tenacity.
9. The purpose of the V notch in a metal specimen is to ensure that it fractures under the impact load that it undergoes.
10. In the absence of the V notch, many alloys would merely deform rather than fracture, making it impossible to measure their energy-absorbing capacity.

25. **Translate the sentences from Ukrainian into English in written form.**

1. Металеві матеріали тестуються з метою оцінки їх поведінки при різних видах навантажень, таких як розтягнення, стиск, зсув, кручення, удар, циклічне навантаження, і для надання потрібної інформації розробникам виробів, проектувальникам обладнання, дизайнерам приладів та матриць і системним дизайнерам.
2. Інформація про поведінку матеріалу під навантаженням використовується розробниками для розрахунків та визначення можливості металу задовольняти необхідні функціональні вимоги створеного виробу або його компонентів.
3. Дуже важливо випробувати матеріал, щоб оцінити та порівняти його механічні характеристики, зокрема міцність.
4. Необхідно вдосконалити процедуру тестування для розробки стандартних специфікацій матеріалів.

5. Для цього необхідно проводити як руйнівний, так і неруйнівний контроль матеріалів.
6. Механічні випробування, такі як випробування на розтяг, стиск, твердість, удар, втому та повзучість, включаються до переліку руйнівних випробувань металу.
7. Метал, піддаючись раптовому навантаженню або стресу, може вийти з ладу.
8. Для оцінки здатності металу витримувати раптові удари використовується тест на зіткнення.
9. Випробування на удар визначає енергію, необхідну для зламу стандартного стержня з V-подібним зрізом за допомогою імпульсного навантаження, і служить показником ударної міцності матеріалу під впливом ударного навантаження.
10. Методи Ізода та Шарпі є стандартними методами випробування для визначення ударної міцності матеріалів.

LISTENING

26. **Before watching the video, check if you know the meaning of the following words. Use the dictionary if necessary.**

Impregnable, Pliny the Elder, millennia, topple, durable, concrete, decades, emissions, accounts for, gravel, sand, limestone, cement, fossil fuels, incentive, replicate.

27. **Watch the video about *the material that could change the world for a third time*. Then answer the following questions.**

1. When was the first concrete construction built?
2. Why was this construction remarkable?
3. Where is concrete used now?
4. How has concrete changed our lives?
5. Give examples of industrial processes that produce emissions into the atmosphere?
6. Why is it more difficult to reduce the emissions from concrete than from other building materials?
7. How can we make concrete more clear?

28. **Watch the video again and complete the following sentences.**

1. Today, our roads, sidewalks, bridges, and skyscrapers are made of a similar, though less _____, material called concrete.
2. Concrete has shaped our skylines, but that's not the only way it's changed our _____.
3. Refrigeration – along with other heating and cooling – makes up about 6% of total _____.
4. The problem is _____, one of the four ingredients in concrete.
5. Transporting and then storing the captured _____ can be expensive.
6. When the ash interacted with _____, the seawater strengthened it – making their concrete stronger and more long-lasting than any we use today.

29. **When studying the course of *Strength of Materials*, your teacher has given you the task to describe the applications of concrete. Use the video (ex. 27) to complete the task.**

SPEAKING

30. **Work in groups of three. Choose one of the materials mentioned in the text, find the information about its strength and other properties, make a small presentation and deliver it to your groupmates. Follow the structure: introduction, main body, conclusions. Ask the other students at least one question after their talk.**

31. **Work in pairs. Discuss the risks, advantages, disadvantages, application, possibilities, environmental issues and future prospects of using concrete. Then compare your ideas with the rest of the class. Use the words and phrases in the box below.**

I'm in favor of… *Certainly, one reason in favor of…* *One disadvantage of…*	*One argument against…* *I don't support…*

32. **Do a Webquest. Find out the information about one of innovative engineering materials used at present. Describe its main properties and applications, advantages and problems to the rest of the class. These sites may help:**

https://www.asme.org/topics-resources/content/9-material-discoveries-that-could-transform-manufacturing

https://www.re-thinkingthefuture.com/rtf-fresh-perspectives/a1072-10-innovative-construction-materials-used-around-the-world/

https://civiconcepts.com/blog/innovative-construction-materials

https://www.startus-insights.com/innovators-guide/top-10-materials-industry-trends-innovations-2020-beyond/

33. **Work in groups. Do a Webquest. Research one of these topics and report your findings to the rest of the class.**

1. Types of Loads / Forces.
2. Stresses and Strains.
3. Elastic limit.
4. Factor of safety.
5. Applications of strength of materials in the industry.
6. Applications of strength of materials in daily life.
7. How do properties like elasticity, ductility, and tensile strength of materials like metals, ceramics, polymers and composites compare with each other?
8. Famous scientists in the field of strength of materials.

34. **You work for a manufacturer of hand tools (hammers, saws, screwdrivers etc.) and have been asked to investigate using alternative materials in your products. In pairs, make notes and discuss the main properties required of the materials used to make the tools.**

35. **Think of a product you know well. In pairs, discuss the materials used in it and the properties that make the materials suitable. Discuss whether alternative materials could be used.**

WRITING

36. **You are going to create a blog devoted to engineering material properties. Think about the information you want to post on the blog. Then describe (180-200 words) the main material properties using this plan:**

1. Name of property.
2. Description.
3. Practical application of engineering material property.

37. **You are taking part in the international web exchange project. Write a post (180-200 words) about a famous person – Stepan Timoshenko, the founder of the field of the strength of materials and his career at Kyiv Polytechnic Institute.**

Use the outline:

1. Do a basic Internet search about Stepan Timoshenko.
2. Use libraries to gather more information.
3. Take notes.
4. Find your focus.
5. Keep track of all of your sources.

38. **Choose two widely used engineering materials. Study their properties and write a compare and contrast essay in which detail the similarities and differences between them.**

Use the plan:

1. Introduction.
2. At least one paragraph to explain the materials' similarities.
3. At least one paragraph to discuss differences.
4. Conclusion.

Unit 8. Automation

LEAD-IN

1. **In pairs, read the quotes, choose one of them and discuss what you think it means and whether you agree or disagree with it.**

1. The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency.

   Bill Gates

2. Automation is no longer just a problem for those working in manufacturing. Physical labor was replaced by robots; mental labor is going to be replaced by AI and software.

   Andrew Yang

3. Software is the language of automation.

   Jensen Huang

4. Advances in automation, artificial intelligence and robotics, while increasing productivity, will also cause major upheavals to the workforce.

   John Hickenlooper

5. Technology, through automation and artificial intelligence, is definitely one of the most disruptive sources.

   Alain Dehaze

2. **Work in pairs. Student A does a Webquest about the use of automation in manufacturing and student B does a Webquest about the use of automation in daily life (communications, transportation, service industries, consumer products etc.). Then, each student reports on his/her findings to the partner. These sites may help:**

https://www.britannica.com/technology/automation/Manufacturing-applications-of-automation-and-robotics

https://www.britannica.com/technology/automation/Computer-integrated-manufacturing

3. **Check how much you know about automation. Do the Quiz.**

READING

4. **Underline the stressed syllable. Practise reading the words.**

Auto***ma***tion, require, variety, assembly, repetitive, accurately, radioactivity, machine, environmental, routine, repetitive, machinery.

5. **Explain the meaning of the words and phrases in bold. Check in the dictionary if necessary.**

6. **Read the text and fill in the blanks with proper sentences.**

A They have difficulty maintaining the level of concentration necessary to do this type of work effectively over long periods of time.

B For example, since the 1960s, many cities have used automated systems to control their traffic lights in order to smooth the flow of traffic.

C In medicine, cardiac pacemakers regulate the heart rate of people with heart disorders.

D Since the late 1970s, however, the availability of inexpensive computers to run machines has greatly stimulated the development of automated systems.

Automation

Automation is the use of machines to perform tasks that require decision making. Automation is used for a wide variety of jobs that are too boring, complex, or dangerous for people to do.

Industrial robots on **assembly lines** perform a variety of repetitive tasks that many people would find boring. In some homes, thermostats control the temperature in automated heating and air-conditioning systems, in refrigerators, and in water heaters. **(1)** _____ Supermarkets, department stores, and **ware-houses** use computerized automated systems that handle record keeping, ordering, and stock control. In manufacturing, automated machines make certain products more quickly, accurately, and cheaply than human workers can. Automated equipment is used in sections of nuclear reactors where high levels of radioactivity would harm workers.

An automated system has devices called **sensors**, which provide information about the results of the machine's operation and about certain environmental conditions that affect its performance. This information is fed directly back to the system, allowing the machine to adjust its operation if necessary. Such a system of self-regulation is called **feedback**. The use of feedback to regulate machines distinguishes automation from mechanization. Mechanization is the use of mechanical power in place of the physical power of people or animals. An automated industrial robot uses feedback to recognize the particular model of car on which it is working. The robot can then decide how and where to weld different car parts. A mechanized robot has no feedback system and so cannot adjust its operation to changing conditions. Such a robot blindly **welds** each part in exactly the same place and can be used on only one model of car at a time.

Automated devices have been used for hundreds of years. **(2)** _____ Many people expect the growth of automation to cause increased unemployment as more workers are replaced by machines. Others believe that increased automation will stimulate industrial growth and create new jobs. Growing numbers of technical workers may be needed to build and maintain automated systems.

Uses of automation

Automated systems can perform tasks involving decisions that are too complex for people to make in a limited amount of time. Automation also is used for jobs that are so **routine**, boring, or degrading that people are not able to perform them effectively over long periods of time. Some automated machines are designed to operate in environments that are unsafe for people. In addition, many companies use automated equipment because it is more economical than using people or nonautomated machinery.

In making complex decisions. Automated systems can make decisions that are beyond the **capacity** of people to make. **(3)** _____ Sensors in the pavement determine the number of vehicles on the street and their speed and send the data to a central computer. The computer uses the data – and much other information – to decide how to time each traffic light in the area. It then sends the necessary signals to the lights. In busy office buildings, computers control the movement of the lifts to minimize and equalize the time people on each floor must wait for the lift to arrive.

Automated systems also can make decisions more quickly than people can. High-speed military aircraft sometimes fly at very low altitudes in order to avoid detection by enemy radar. To avoid hitting obstacles, these aircraft use radar-operated, automated guidance systems, which can react much faster than a pilot can.

In routine, boring jobs. Many people find repetitive, simple jobs, such as working on a factory assembly line, dull and **degrading**.

(4) _____ Automated machinery, however, is well suited to such routine tasks as assembling, inspecting, and packaging manufactured products.

In unsafe environments. Automated machinery can operate in environments that are unsafe for people. Automated systems have been developed for repairing underwater pipelines at extremely high pressures and for exploring other planets. Cars are painted by robots in spray booths containing high concentrations of **airborne** paint particles that are harmful to people. These robots measure the car's position, determine which colour to use, and repeat spraying patterns with great consistency. They work faster and more accurately at the job than people do and they waste much less paint.

The text is taken from World Book Encyclopedia

7. **Read the text again and answer the following questions.**

1. What is automation?
2. Give examples of the use of industrial robots.
3. Describe the function of sensors in automated systems.
4. Explain the difference between automation and mechanization?
5. What was the main stimulus for the development of automated systems?
6. What are the social consequences of the growth of automation?
7. Where are automated systems commonly used?
8. Give examples of the use of automation for making complex decisions.
9. Why is automated machinery well suited to routine, boring jobs?
10. How is automated machinery used in unsafe environments?

USE OF ENGLISH

8. **Give Ukrainian equivalents to the words below. You can also do it using Quizlet flashcards.**

1)	automation	7)	vehicle
2)	assembly line	8)	equalize
3)	mechanization	9)	altitude
4)	feedback	10)	obstacle
5)	weld	11)	airborne
6)	unemployment	12)	consistency

9. **Fill in the table with the words derived from the given ones.**

Noun	Verb	Adjective
variety	.....	.....
.....	.....	repetitive
reactor	.....	.....
sensor	.....	.....
.....	.....	necessary
.....	automate	.....
.....	depend	.....
employment	.....	.....
.....	stimulate	.....
decision	.....	.....
.....	minimize	.....
consistency	.....	.....

10. **In the text (ex. 6), find the opposites to the following words.**

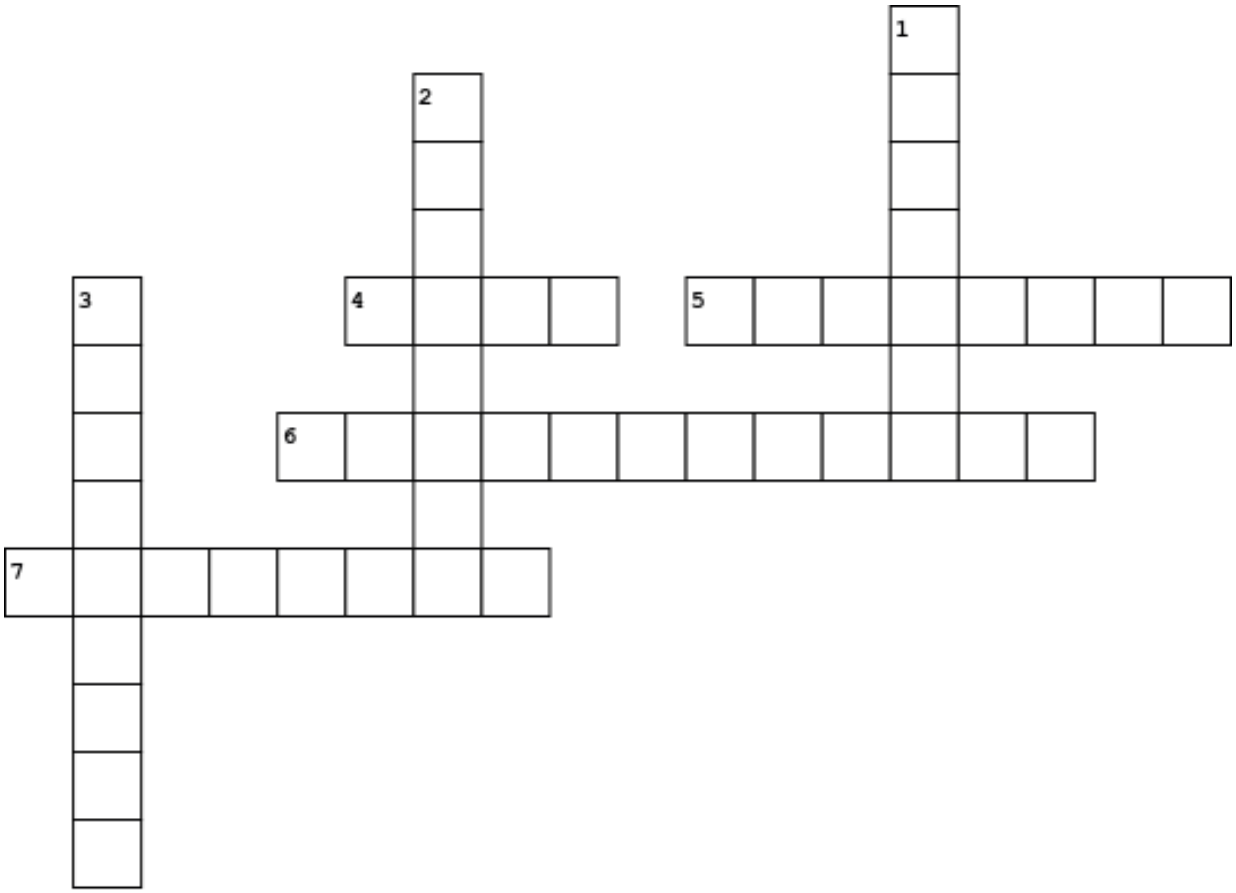
Interesting – _____, safe – _____, decline – _____, simple –_____, free – _____, depart – _____, useful – _____, similarity – _____, forbidding – _____.

11. **Match the words with similar meaning. You can also do it using the Learning.Apps platform at this link.**

1	perform	**a**	effectiveness
2	equipment	**b**	gadget
3	harm	**c**	influence
4	assembly lines	**d**	adapt
5	device	**e**	reaction
6	sensor	**f**	carry out
7	affect	**g**	damage
8	performance	**h**	detector
9	feedback	**i**	machinery
10	adjust	**j**	conveyor

12. **Solve the crossword puzzle below. You can also do it using the Crossword Lab platform at this link.**

Automation



Across

4. to join two pieces of metal together permanently by melting the parts that touch

5. height above sea level

6. the number of people who do not have a job that provides money

7. the total amount that can be contained or produced

Down

1. a usual or fixed way of doing things

2. a path with a hard surface on one or both sides of a road, that people walk on

3. causing people to feel that they have no value

13. **Work in pairs. Using the information from the text (ex. 6), match 1-10 with a-j to make phrases, then choose any three and make sentences.**

1	tasks that require	**a**	which provide information about the results of the machine's operation
2	computerized automated systems	**b**	industrial growth
3	devices called sensors,	**c**	decision making
4	This information is fed	**d**	automated systems
5	stimulate	**e**	that handle record keeping, ordering, and stock control
6	maintain	**f**	directly back to the system
7	decisions that	**g**	such routine tasks as assembling, inspecting, and packaging manufactured products
8	High-speed military aircraft sometimes fly	**h**	that are harmful to people
9	well suited to	**i**	are beyond the capacity of people to make
10	high concentrations of airborne paint particles	**j**	at very low altitudes

14. **Using the information from the text (ex. 6), choose the odd word in each line.**

1) require, need, dislike, depend on;
2) lively, boring, dull, monotonous;
3) exactly, accurately, precisely, absolutely;
4) performance, perfection, efficiency, effectiveness;

5) distinguish, differentiate, disintegrate, single out;
6) particular, specific, peculiar, pacific;
7) rusty, routine, regular, everyday;
8) avoid, escape, get away from, approve;
9) degrading, demanding, humiliating, demeaning;
10) vehicle, car, automobile, travelling.

15. **Fill in the gaps with the appropriate words from the list below.**

Hazardous, job, automated, versatility, manufacturer, record, equipment, run out of, registers, costs, single-task.

Use of Automation in Cost Saving

Automated systems often can do a particular **1)** _____ more cheaply than a person can. For many industrial operations, a simple robot costs about as much as one year's wages and benefits for the three shift workers it can replace. After the first year, a **2)** _____ should save money by using such a robot. The use of automation also allows companies to save money they otherwise would have to spend to make **3)** _____ work areas safe for human workers.

Many supermarkets and department stores use **4)** _____ systems to perform several functions previously carried out by managers. Electronic cash **5)** _____ ring up each item as it is sold. This sales information is fed automatically to a computer that keeps a **6)** _____ of how much of each item remains in stock. The computer predicts when the store will **7)** _____ an item and can place orders to restock items before they are sold out. The computer can also evaluate the effect of advertising campaigns on sales. Such automation helps stores cut **8)** _____ and operate more efficiently.

Manufacturers may also save money by replacing older machines with automated **9)** _____. Many robots can be made to perform different tasks merely by changing their computer program. This capability enables manufacturers to use one robot to do the work of several **10)** _____ machines. The **11)** _____ of computerized robots allows producers to make small amounts of specialized items more economically. It also enables them to change styles, models, or types of products more cheaply and easily.

The text is taken from World Book Encyclopedia

16. **Work in small groups. Solve the word search puzzle.**

Automation

T N R F B I R X M B O D W M A E A O T Q
O H W P H K J Q B N W S Y S T E M D S I
Z A I Y G H O E J G E Q U I P M E N T A
I S P Y A B M A N U F A C T U R I N G W
C Y K N U M D O M P J D X M Z E Q Z X T
D M Q C M F I E Z S N V U B R J L C V G
R O U T I N E T B I D D I V T T C V N L
M G U M X D X W I S H Q Y M E L T L A F
Z J D E V I C E A R G S J L Z W B L Y Z
J A G F J G Q E A J P C R X P I V Q N U
E I U P A I Z D C Z G W O R C V G H T X
A Y U W N I X R Y T S Y S X R W C Y H J
T R N G X F W M E C H A N I Z A T I O N
S J P Q H E H O R Y L T E T O V L S B Q
U O X V I E O Q A Q W F S W J S U G L S
J Q I A B D K G A F C Z Y V J S A A I H
D L T C B B I Z O Q P P X G R C Q T T P
A Y F S L A M T O A R T G W L V V L E A
S I S R A C R X P C Y K F P K B R O O Y
G B I V U K H O S M R H T F S A Z Y X H

1. sensor **2.** feedback **3.** manufacturing **4.** equipment **5.** system **6.** mechanization **7.** adjust **8.** device **9.** routine

17. **In pairs, make up your own word search puzzles. Exchange and solve them.**

18. **Put the words in each sentence in the correct order. You can also do it using the Wordwall platform at this link.**

1. performance / systems / All / depend / on / automated / to control / their / feedback
2. room /is / temperature / purpose / of / heating / to keep / a / a / certain / at / a / system / The
3. output / heating / automated /involves / system / both / An / input / and
4. automated / needs / output / An / system / to measure / sensors / its
5. are / There / sensors / types / of / many
6. home / room / measure / in / Thermometers / the / temperature
7. on / thermostat / temperature / boiler / switches / the / to raise / The / the / room
8. decades / large / of / A few / were employed / numbers / in / workers / manufacturing / ago

19. **Complete the sentences with the prepositions below.**

By, on, from, in, with, over, for, of.

1. All automated systems depend _____ feedback to control their performance.
2. The basic elements of feedback can be illustrated _____ a home heating system.
3. Automated systems compare the actual output _____ the desired output.

4. If the actual output of the system differs _____ the desired output, the comparator sends an error signal to a controller.
5. By the early 1990's manufacturing workers in industrial countries accounted _____ a small part of the labour force.
6. Some fully automated systems, however, are designed to be taken _____ by a human controller during emergencies.
7. The use _____ feedback to regulate machines distinguishes automation from mechanization.
8. Longer life expectancy in many countries is contributing to an increase _____ the percentage of older people in the population.

20. **Choose the correct option.**

1. The earliest known example of automation is a water clock that existed in Alexandria, Egypt, _____ the 200's B.C.
   a. on b. in c. about

2. In this clock, a large elevated container filled _____ water had an opening near the bottom.
   a. by b. in c. with

3. Water flowed _____ the opening _____ a jar marked to show units of time.
   a. across / to b. through / into c. in / on

4. The level _____ water in the jar indicated the time of day.
   a. of b. over c. in

5. As the water level _____ the large container dropped, the water pressure decreased.
   a. of b. in c. at

6. Normally, the lower pressure would slow the flow of water _____ the jar.

   a. into b. on c. in

7. However, the large container in this clock had a float that was linked _____ a device that controlled the size of the opening.

   a. onto b. to c. in

8. As the water level in the container dropped, the opening became wider, thereby providing a more constant flow _____ water into the jar and making the clock more accurate.

   a. of b. in c. off

9. A float was also used _____ toilets invented by the ancient Romans.

   a. in b. by c. for

21. **Complete the sentences with prepositions.**

1. Automated systems can also be designed to learn _____ their experience by trial and error.
2. True automation exists when the system makes decisions without relying _____ a human controller.
3. Automated devices have been used _____ hundreds of years.
4. Many people expect the growth of automation to cause increased unemployment as more workers are replaced _____ machines.
5. Automation also is used for jobs that are so routine, boring, or degrading that people are not able to perform them effectively _____ long periods of time.
6. Automated systems can make decisions that are _____ the capacity of people to make.

7. High-speed military aircraft sometimes fly _____ very low altitudes in order to avoid detection by enemy radar.
8. Automated systems have been developed for repairing underwater pipelines _____ extremely high pressures and for exploring other planets.
9. Robots measure the car's position, determine which colour to use, and repeat spraying patterns _____ great consistency.

22. **Match the two parts of the sentences.**

1	Automation is used	**a**	on feedback.
2	The use of automated controls in chemical production and petroleum refining dates	**b**	without a human operator.
3	Improvements in radar and electronics led	**c**	about the results of the machine's operation.
4	Numerical control does not depend	**d**	for a wide variety of jobs
5	In automated factories of the future, all operations will be controlled	**e**	for the three shift workers it can replace.
6	In a numerical control system, machines can perform a variety of tasks	**f**	from mechanization.
7	An automated system has sensors, which provide information	**g**	to the introduction of automatically aimed antiaircraft guns in 1944.
8	The use of feedback to regulate machines distinguishes automation	**h**	on which it is working.
9	An automated industrial robot uses feedback to recognize the particular model of car	**i**	from the early 1900's.
10	For many industrial operations, a simple robot costs about as much as one year's wages and benefits	**j**	by computer.

23. **Fill in the blanks using the proper forms of the verbs in brackets.**

1. Students should consider _____ **(do)** a computer course.
2. The course involves _____ **(learn)** about the manipulation of digital images.
3. She succeeded in _____ **(find)** a post as a Research Engineer.
4. So far this year the industry _____ **(not to develop)** any new techniques.
5. Most bridges _____ **(build)** of concrete these days.
6. When cracks began to appear, the bridge _____ **(strengthen)**.
7. The rotor _____ **(to turn)** against the wind and _____ **(start)** the turbine.
8. I don't think the course _____ **(be)** very interesting.
9. The same principle _____ **(use)** in machines ever since.
10. The Golden Gate bridge _____ **(open)** in 1937.
11. We _____ **(do)** a Google search and _____ **(find)** the answer very quickly.
12. When he _____ **(work)** in Nigeria, there _____ **(be)** a serious accident on the oil rig.

TRANSLATION

24. **Translate the excerpt from English into Ukrainian in written form.**

All automated systems depend on feedback to control their performance. The basic elements of feedback can be illustrated by a home heating system.

The purpose of a heating system is to keep a room at a certain temperature. An automated heating system involves both input and output. In such a system, the input is the thermostat setting – that is, the desired room temperature – and the output is the actual temperature. The input tells the system what the output should be.

An automated system needs sensors to measure its output. There are many types of sensors. Thermometers in the home measure room temperature – a heating system's actual output. Sensors in other systems measure such variables as chemical composition, colour, pressure, size, and weight.

Automated systems compare the actual output with the desired output. Devices that make such comparisons are called comparators. In a heating system, the thermostat functions as the comparator. It compares the thermometer reading with the temperature for which the thermostat has been set.

The text is taken from World Book Encyclopedia

25. Translate the excerpt from Ukrainian into English in written form.

Якщо фактичний вихід продукції автоматизованої системи відрізняється від бажаного, компаратор посилає сигнал про помилку до контролера. Контролер вирішує, що робити, щоб виправити помилку на виході. Термостат в системі опалення функціонує і як контролер, і компаратор. У більш складних системах зворотного зв’язку контролером може бути комп’ютер.

Частина будь-якої автоматизованої системи, яка керується за допомогою зворотного зв’язку та змінює вихід продукції, називається процесом. Контролер керує процесом, щоб виправити вихід продукції. У системі опалення будинку процесом є котел. Термостат вмикає котел для підвищення температури в приміщенні.

Термометр (датчик) постійно вимірює кімнатну температуру (вихід продукції). Термостат (компаратор) може виявити, що кімнатна температура підвищилася достатньо, щоб відповідати налаштуванню термостата). Потім він діє як контролер і вимикає котел (процес), щоб у кімнаті не ставало занадто жарко.

LISTENING

26. **Before watching the video, check if you know the meaning of the words. Use the dictionary if necessary.**

Disruption, artificial intelligence, cutting edge, academia, unique, threaten, loan application, zip codes, breakthroughs, diabetic retinopathy, ophthalmologist, high-volume, tackling, novel, disparate, cross-pollination, boilerplate, pathbreaking, litigation.

27. **Watch the video about the jobs we will lose to machines and the ones we won't. Use the link:**

(https://www.ted.com/talks/anthony_goldbloom_the_jobs_we_ll_lose_to_machines_and_the_ones_we_won_t?utm_campaign=tedspread&utm_medium=referral&utm_source=tedcomshare).

Then answer the following questions.

1. How many jobs are at a risk of being automated by machines?
2. What is Machine learning?
3. When did the industry start using Machine learning?
4. Give examples of tasks that can be performed by Machine learning?
5. What are the advantages of machines over people in performing these tasks?
6. Why can't machines tackle novel situations?
7. What kinds of tasks are machines getting smarter and smarter on?
8. Who will develop a business strategy in the future: people or machines?

28. **Watch the video again and complete the following sentences.**

1. In 2013, researchers at _____ did a study on the future of work.
2. Machine learning started making its way into _____ in the early '90s.

3. We have no chance of competing against _____ on frequent, high-volume tasks.
4. He was able to connect his understanding of _____ with his knowledge of cooking in order to invent – any guesses? – the microwave oven.
5. On frequent, high-volume tasks, machines are getting _____.
6. The copy behind a marketing campaign needs to grab consumers' _____.

29. **You are taking part in a discussion club on the topic "The Future of Robotics". Use the information from the video and discuss possible consequences of the loss of human jobs due to automation.**

SPEAKING

30. **Work in groups of three. Choose one of the areas of the use of automation mentioned in the text, find the information about it on the Internet, make notes and prepare a short presentation for your groupmates. Follow the structure: introduction, main body, conclusions. Ask the other students at least one question after their talk.**

31. **Work in pairs. Discuss the application, advantages, disadvantages, risks, possibilities, economic and social issues of using robots. Then compare your ideas with your partner. Use the words and phrases in the box below.**

I'm in favor of… *Certainly, one reason in favor of…* *One disadvantage of…*	*One argument against…* *I don't support…*

32. **You are taking part in a discussion club. Choose one of the questions below and express your opinion on the problem.**

1. Robots are already an integral part of manufacturing in factories. Do you believe one day that there will be little need for humans in manufacturing? How are robots better than the human workforce?
2. If you could have a robot, what tasks would you use it for?
3. Police and the military use robots to sweep for landmines and bombs. What are the advantages of these practices? Do you see any other uses for robots in combat and police work?
4. Do you think that one-day robots will replace teachers?
5. What threat do robots present to mankind?
6. Do you believe robots will ever outsmart people and take over the planet?
7. Robotic surgery is a method to perform surgery using very small tools attached to a robotic arm and a surgeon controls the robotic arm with a computer. How beneficial do you think this is now and for the future of medicine?
8. Do you believe it's just a matter of time before fast-food workers are replaced by robots?
9. What do you think would happen to the world's economy if robots began replacing people in the workforce?
10. Did you ever have a favourite Sci-Fi films hero who was a robot?
11. Would you ever trust a robot to watch your children or walk your dog?

The questions are taken from (https://www.esltalkingpoints.com/discussion/intermediate-esl-conversation-questions/robots-3/)

33. **Do the Webquest. Find out the information about one type of robots and its applications. Make a presentation to the whole class.**

These sites may help you:

https://www.guardforce.com.hk/en/news/blog_115/Types-of-Robots-and-Their-Applications_1729
https://www.elprocus.com/robots-types-applications/
https://www.intel.com/content/www/us/en/robotics/types-and-applications.html
https://www.jabil.com/blog/ten-popular-industrial-robot-applications.html
https://builtin.com/robotics
https://www.howtorobot.com/expert-insight/industrial-robot-applications
https://www.genesis-systems.com/blog/robots-automotive-manufacturing-top-6-applications
https://www.geeksforgeeks.org/top-10-applications-of-robotics-in-2020/

34. **Work in groups. Imagine that you have entered a competition to design one of these robots:**

1) a robot helper for old people;
2) a robot pet animal;
3) a robot fruit picker.

Decide together:

a) the actions the robot should be able to perform;
b) how it will move from place to place;
c) the power source it will use;
d) the sensors it will need;
e) its approximate size and weight.

You can look for ideas on the Web.

https://www.nature.com/articles/d41586-022-00072-z
https://roboticsandautomationnews.com/2022/07/22/robotic-pets-how-to-choose-and-what-you-should-know-about-them/53341/
https://www.theguardian.com/us-news/2022/may/28/robot-agriculture-farming-artificial-intelligence

35. **As a group, present your proposals (see ex. 34) to the other groups. Give reasons for your decisions. Be prepared to answer questions about your proposals. Use the phrases:**

1. *I'm going to talk about…*
2. *The purpose of my talk is…*
3. *Let's look at…*
4. *We can see that…*
5. *We've looked at X, Y and Z…*
6. *It's my view that…*
7. *Thank you for your attention…*
8. *I'll be happy to answer any questions you may have…*

WRITING

36. **Write a paragraph (80-120 words) about the possibility that robots will take over our jobs.**

37. **Write a blog post (180-200 words) on the topic "The future of robots". In your post answer the following questions:**

1. What is the future of artificial intelligence (AI)?
2. Will robots become as intelligent as humans or more intelligent?
3. Will it be possible for robots to be autonomous? If so, when will that happen and will it be a good thing?

38. **Based on the information and ideas discussed above write a "for and against" essay (180-200 words) in which detail the advantages and disadvantages of the use of robots in different areas of life. Follow the plan:**

1. Introduction.
2. Body.
   - The first paragraph in which you should give your points for the topic along with justifications and examples.
   - The second paragraph in which you should give your points against the topic along with justifications and examples.
   - The third paragraph in which you should state your claim. You should take your stand and explain to the readers why you support the particular point of view on the topic.
3. Conclusion.

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Full links to the interactive activities used in the textbook

Unit 1

Task 2	https://learningapps.org/display?v=p50z6168a22
Task 8	https://dictionary.cambridge.org/
Task 10	https://dictionary.cambridge.org/thesaurus/
Task 12	https://crosswordlabs.com/embed/machine-tools-operations
Task 15	https://learningapps.org/display?v=p6ztjrvsj22
Task 16	https://wordsearchlabs.com/
Task 17	https://quizlet.com/726729486/unit-1-machines-efficiency-and-mechanical-advantage-flash-cards/?funnelUUID=53b387bb-8c9f-47fc-b0f8-e3c3440ad7e3
Task 27	https://www.youtube.com/watch?v=y_AfvpW-kbc

Unit 2

Task 5	https://dictionary.cambridge.org/
Task 11	https://wordsearchlabs.com/embed/275526
Task 12	https://wordsearchlabs.com/
Task 15	https://crosswordlabs.com/embed/mechanical-devices-2
Task 17	https://quizlet.com/734278242/machine-parts-flash-cards/?new

Task 21	https://www.engvid.com/learn-engish-tenses-past-tenses/
Task 26	https://test-english.com/grammar-points/b1/past-simple-past-continuous-past-perfect/
Task 30	https://youtu.be/_cN1E8KUvmk
Task 33	https://www.youtube.com/watch?v=rRW-mNLIPxA
Task 35	https://en.wikipedia.org/wiki/Machine_element
Task 36	https://www.globalspec.com/learnmore/motion_controls/power_transmission_mechanical/ratchets_pawls https://www.slideshare.net/SharKhan4/ratchet-and-pawl-mechanism
Task 37	https://edpuzzle.com/media/620153028e1bf542e9dc7a6d
Task 38	https://www.youtube.com/watch?v=tXlXjqvr8nU
Task 39	https://www.researchgate.net/publication/287157035_Review_of_Journal_Bearing_Materials_and_Current_Trends

Unit 3

Task 5	https://dictionary.cambridge.org/
Task 12	https://crosswordlabs.com/embed/machine-tools-operations
Task 14	https://wordsearchlabs.com/embed/275522
Task 18	https://quizlet.com/734970195/machine-tools-operations-flash-cards/?x=1qqt
Task 23	https://www.engvid.com/learn-english-tenses-4-ways-to-talk-about-the-future/

Task 27	https://www.youtube.com/watch?v=RP4Y_aSBoNw
Task 30	https://www.youtube.com/watch?v=oUmzSB9TVgY
Task 31	https://www.differencebetween.com/difference-between-hot-working-and-vs-cold-working/
Task 34	https://www.youtube.com/watch?v=VcYa05Qcc4o

Unit 4

Task 5	https://dictionary.cambridge.org/
Task 11	https://learningapps.org/display?v=p66mjoze322
Task 18	https://learningapps.org/display?v=p9voq6jsj22
Task 20	https://quizlet.com/_ccujy3?x=1jqt&i=2jcjgm
Task 27	https://www.youtube.com/watch?v=KEs_h-ucJEs

Unit 5

Task 5	https://dictionary.cambridge.org/
Task 8	https://quizlet.com/_cctnqv?x=1jqt&i=2jcjgm
Task 11	https://learningapps.org/display?v=pjhokjvdt22
Task 18	https://learningapps.org/display?v=po6xdvf3c22
Task 20	https://quizlet.com/232746286/pumps-flash-cards/
Task 27	https://www.youtube.com/watch?v=BaEHVpKc-1Q

Unit 6

Task 5	https://dictionary.cambridge.org/
Task 8	https://quizlet.com/_ccn43b?x=1qqt&i=2jcjgm
Task 11	https://learningapps.org/display?v=prf8aakd322

Task 15	https://learningapps.org/display?v=p2rrtbtdc22
Task 17	https://quizlet.com/_btvnpx?x=1jqt&i=4jpwi1
Task 27	https://www.youtube.com/watch?v=340MmuY_osY

Unit 7

Task 1	https://beta.plectica.com/
Task 5	https://dictionary.cambridge.org/
Task 8	https://quizlet.com/715313870/strength-of-materials-flash-cards/?x=1qqt
Task 11	https://learningapps.org/display?v=pbppzggxj22
Task 12	https://crosswordlabs.com/embed/strength-of-materials-7
Task 16	https://wordsearchlabs.com/view/262410
Task 17	https://wordsearchlabs.com/
Task 18	https://wordwall.net/resource/35953178
Task 27	https://www.youtube.com/watch?v=hRI0ymx_6aw

Unit 8

Task 3	https://quizizz.com/admin/quiz/5e1b72b8629b0c001b0a28c7/introduction-to-automation-and-robotics?source=quiz_share
Task 5	https://dictionary.cambridge.org/
Task 8	https://quizlet.com/717310105/automation-flash-cards/?x=1qqt
Task 11	https://learningapps.org/display?v=pjo3tuq8522

Task 12	https://crosswordlabs.com/view/automation-55
Task 16	https://wordsearchlabs.com/view/270088
Task 17	https://wordsearchlabs.com/
Task 18	https://wordwall.net/resource/35948060
Task 27	https://www.ted.com/talks/anthony_goldbloom_the_jobs_we_ll_lose_to_machines_and_the_ones_we_won_t?utm_campaign=tedspread&utm_medium=referral&utm_source=tedcomshare
Task 32	https://www.esltalkingpoints.com/discussion/intermediate-esl-conversation-questions/robots-3

APPENDIX 1. Vocabulary

UNIT 1. Machines: Efficiency and Mechanical Advantage

1.	the direction and the motion of force	напрям і рух сили
2.	mechanical motion	механічний рух
3.	the wheels of a turbine	колеса турбіни
4.	to drive a generator	приводити генератор в дію
5.	to transmit mechanical work	передавати механічну роботу
6.	efficiency	продуктивність
7.	mechanical advantage	механічна перевага
8.	the ratio between	співвідношення між
9.	the friction of	тертя
10.	perpertual motion	вічний двигун
11.	to put out the work	виконати роботу
12.	to use up / supply the energy	використовувати / забезпечувати енергією
13.	the force exerted by the machine	сила яку прикладає машина
14.	to apply to the machine	застосовувати до машини
15.	a gentle tapering	плавне звуження
16.	a spiral inclined plane	спіральна похила площина
17.	a crowbar	лом
18.	a lever	важіль
19.	under the weight	під вагою
20.	fulcrum / support	точка опори / опора
21.	to raise the load	підняти вантаж
22.	to push down on	натиснути на
23.	gears	шестерні
24.	ball bearings	шарикопідшипники
25.	the axle	вісь

26.	the pulley	шків
27.	the inclined plane	похила площина
28.	thin wedge	тонкий клин
29.	the screw	гвинт
30.	a grooved rim	рифлена оправа
31.	mallet	молоток
32.	sledgehammer	кувалда
33.	array	матриця
34.	slope	нахил
35.	manufacture	виробництво
36.	intake	поглинання
37.	combustion	горіння
38.	compression	стиснення
39.	depression	ослаблення, зменшення
40.	four-cycle engine	чотиритактний двигун
41.	pliers	плоскогубці
42.	pivotal part	стрижнева частина
43.	to perform entirely different tasks	виконувати зовсім інші завдання
44.	connecting rod	тяга. шатун
45.	flexible shaft	гнучкий вал

UNIT 2. Mechanical Devices: Gears, Bearings, Valves, Ratchet, Gauge

1.	bearing	підшипник
2.	to move smoothly	рухатися плавно
3.	shaft	вал
4.	moving back and forth along the direction of its axis	рухаючись вперед-назад уздовж напрямку своєї осі
5.	linear bearings	лінійні підшипники
6.	journal bearings	підшипники ковзання
7.	rolling-contact bearings	підшипники кочення
8.	to reduce friction	зменшити тертя
9.	ball bearings	шарикопідшипники
10.	roller bearings	роликові підшипники
11.	fluid film bearings	підшипники з рідинною плівкою
12.	sleeve	рукав
13.	journal	цапфа
14.	soft alloy	м’який сплав
15.	to be lubricated with grease	змащуються мастилом
16.	ratchet	храповик
17.	pivot	стрижень
18.	lever	важіль
19.	ratchet-and-pawl mechanism	храповий механізм
20.	rotating motion	обертальний рух
21.	to increase or decrease the speed of rotation	збільшити або зменшити швидкість обертання
22.	to rotate in the opposite direction	обертатися в протилежному напрямку
23.	pinion	шестерня
24.	ratio	співвідношення
25.	torque	крутний момент

26.	the forces counteract each other	сили протидіють одна одній
27.	bevel gear	конічна зубчаста передача
28.	gear toothing	зубчасте зачеплення
29.	helical gear	косозуба передача
30.	screw gear	гвинтова зубчаста передача
31.	spur gear	прямозуба циліндрична передача
32.	worm gear	черв’ячна передача
33.	bevel gearing	конічна зубчаста передача
34.	helical gearing	косозуба передача
35.	herringbone gearing	шевронна зубчаста передача
36.	check valves	зворотні клапани
37.	relief valves	запобіжні клапани
38.	manual valves	ручні клапани
39.	automatic control valves	автоматичні регулюючі клапани
40.	gauge	вимірювальний прилад
41.	pressure gauge	манометр
42.	instrument used for measurement	прилад, який використовується для вимірювання
43.	the tube has a tendency to curl	труба має властивість скручуватися
44.	to be calibrated to show pressure	відкалібровано для показу тиску
45.	motion is transmitted to	рух передається

UNIT 3. Machine Tool Operations

1.	machine tool operations	верстатні операції
2.	metal removal	видалення металу
3.	metal forming	обробка металу тиском
4.	cutting away	відрізання
5.	abrasion	стирання
6.	workpiece	заготовка
7.	turning	точіння
8.	hole machining	обробка отворів
9.	milling	фрезерування
10.	sawing	пиляння
11.	planing	стругання
12.	shaping	формування
13.	broaching	протягування
14.	spindle	шпиндель
15.	turning machines	токарні верстати
16.	lathe	токарний верстат
17.	to be fastened	закріплюється
18.	toolholder	інструментотримач
19.	cutting tool	ріжучий інструмент
20.	to be mounted	монтується
21.	turret lathe	револьверний верстат
22.	reaming	розсвердлювання
23.	multiple-edged tool	багатолезовий інструмент
24.	machinist	механік
25.	bevel	фаска
26.	to flatter uneven surfaces	вирівнює нерівні поверхні
27.	broach	протяжка

28.	planer	рубанок
29.	grinding	шліфування
30.	lapping	притирка
31.	honing	відточування
32.	sandpaper	наждачний папір
33.	to provide an extremely smooth surface	забезпечує надзвичайно гладку поверхню
34.	accuracy	точність
35.	to precise dimensions	до точних розмірів
36.	to be inserted into the hole	вставляються в отвір
37.	forging	кування
38.	pressing	пресування
39.	bending	згинання
40.	shearing	зсування
41.	forming machines	формувальні машини
42.	forging machines	ковальні машини
43.	presses	преси
44.	to mount	монтувати
45.	shears	ножиці

UNIT 4. Application of Hydraulics in Mechanical Engineering

1.	behavior of liquids at rest	поведінка рідин у спокої
2.	only under certain conditions	лише за певних умов
3.	behavior of liquids in motion	поведінка рідин при русі
4.	submerged object	занурений об’єкт
5.	pressure	тиск
6.	difference in liquid level	різниця в рівні рідини
7.	heavy loads	великі навантаження
8.	fluid	рідина
9.	the bottom of the object	нижня частина предмета
10.	ratio	співвідношення
11.	hydraulic jack	гідравлічний домкрат
12.	gases flow	потік газів
13.	inside surface	внутрішня поверхня
14.	liquid	рідина
15.	force of atmospheric pressure	сила атмосферного тиску
16.	the apparent loss of weight	явна втрата ваги
17.	brake shoes	гальмівні колодки
18.	pipe	труба
19.	construction equipment	будівельне обладнання
20.	laws of hydrostatics	закони гідростатики
21.	weight per unit of volume	вага на одиницю об’єму
22.	increase in direct proportion	збільшення прямо пропорційно
23.	to transfer force through a fluid	передавати силу через рідину
24.	laws of hydrodynamics	закони гідродинаміки
25.	piston	поршень
26.	equal diameter	рівний діаметр
27.	low velocity	низька швидкість
28.	the potential energy of a fluid	потенційна енергія рідини

29.	compressed	стиснутий
30.	stream of oil	потік масла
31.	equally in all directions	однаково в усіх напрямках
32.	buoyant force	виштовхувальна сила
33.	to transmit pressure	передавати тиск
34.	partially filled tubes	частково заповнені труби
35.	to design embankments and levees	проектувати насипи та дамби
36.	to provide flood control	забезпечити контроль за повенями
37.	irrigation systems	системи поливу
38.	sewage systems	системи каналізації
39.	water supply systems	системи водопостачання
40.	in filled pipes under pressure	в заповнених трубах під тиском
41.	hydraulic machines	гідравлічні машини
42.	hydraulic turbines	гідравлічні турбіни
43.	hydraulic brakes	гідравлічні гальма
44.	hydraulic presses	гідравлічні преси
45.	container	контейнер

UNIT 5. Types of Pumps

1.	pump	насос
2.	to move or compress liquids and gases	переміщує або стискає рідини та гази
3.	home heating systems	системи опалення будинку
4.	water well	колодязь
5.	turbojet	турбореактивний
6.	car engines	автомобільний двигун
7.	liquid sodium and liquid potassium for cooling nuclear reactors	рідкий натрій і рідкий калій для охолодження ядерних реакторів
8.	gas pumps	газові насоси
9.	compressor	компресор
10.	dynamic pumps	динамічні насоси
11.	to create a vacuum that draws more fluid	створює вакуум який втягує більше рідини
12.	to maintain a steady flow of fluid	підтримувати постійний потік рідини
13.	individual portions of fluid	окремі порції рідини
14.	an enclosed area	закрита територія
15.	centrifugal pumps	відцентрові насоси
16.	wheel	колесо
17.	impeller	робоче колесо
18.	contained within	міститься всередині
19.	curved blades	вигнуті лопаті
20.	to rotate on an axis	обертається на осі
21.	jet pumps	струминні насоси
22.	outward force	зовнішня сила
23.	conductor	провідник
24.	magnetic attraction	магнітне тяжіння

25.	repulsion	відштовхування
26.	circular casing	круглий кожух
27.	viscous (sticky) liquids	в’язкі (липкі) рідини
28.	the rotating gear teeth	обертові зуби шестерні
29.	relatively straight path	відносно прямий шлях
30.	gear pumps	шестерні насоси
31.	to be trapped by	затискається
32.	circular housing	круглий корпус
33.	inlet port	вхідний отвір
34.	gear	шестерня
35.	lobe	частка
36.	suction	всмоктування
37.	rounded projections	округлі виступи
38.	mounted off-center	встановлений не по центру
39.	sliding vane pumps	пластинчасті насоси
40.	slotted impeller	щілинне робоче колесо
41.	slot	паз, канавка
42.	blade	лопать
43.	large amounts of fluid	велика кількість рідини
44.	high-velocity fluid	високошвидкісна рідина
45.	outlet port	вихідний отвір

UNIT 6. Material Properties

1.	to withstand destruction	протистояти руйнуванню
2.	to undergo permanent changes	зазнавати постійних змін
3.	to apply to a solid	застосовувати до твердого тіла
4.	to change under stress	змінюватися під час стресу
5.	to heat and keep at a high temperature	нагрівати і зберігати при високій температурі
6.	to be stretched to a considerable degree	бути розтягнутим до значного ступеня
7.	to be subjected to opposing external forces	піддаватися дії протилежних зовнішніх сил
8.	to be pressed or hammered into thin sheets	пресований або збитий у тонкі листи
9.	to snap off without giving any sensible elongation	відламати без відчутного подовження
10.	to assess tensile, compressive, shearing and torsional strengths	оцінити міцність на розтяг, стиск, зсув і кручення
11.	to come in contact with other substances	вступати в контакт з іншими речовинами
12.	to measure the hardness of a material	вимірювати твердість матеріалу
13.	to dissolve polymers	розчиняти полімери
14.	to lubricate	змащувати
15.	to suffer from chemical deterioration	страждати від хімічного псування
16.	internal resistance	внутрішній опір
17.	strength	міцність
18.	ductility	гнучкість
19.	malleability	пластичність

20.	elasticity	еластичність
21.	viscosity	в’язкість
22.	friction	тертя
23.	curvature	викривлення
24.	corrosion resistance	стійкість до корозії
25.	quantitatively or qualitatively	кількісно чи якісно
26.	deforming forces	деформуючі сили
27.	talc	тальк
28.	apatite	апатит
29.	fluorite	флюорит
30.	calcite	кальцит
31.	gypsum	гіпс
32.	brittleness	крихкість
33.	permanent distortion	постійна деформація
34.	sensible elongation	відчутне подовження
35.	suspension	підвіска
36.	chemical deterioration	хімічне псування
37.	gradual deterioration	поступове погіршення
38.	chemical composition	хімічний склад
39.	acidity or	кислотність
40.	alkalinity	лужність
41.	the utility of the material	корисність матеріалу
42.	breaking	руйнування
43.	to be hammered into thin sheets	розбивати на тонкі листи
44.	ductile nonmetallic substance	пластична неметалева речовина
45.	spring	пружина

UNIT 7. Strength of Materials

1.	strength of materials	опір матеріалів
2.	resist	чинити опір
3.	applied force	прикладена сила
4.	properties of materials	властивості матеріалів
5.	to withstand	витримувати
6.	to conduct tests	проводити випробування
7.	material’s age, composition, and moisture	вік, склад і вологість матеріалу
8.	to attempt to design structural and mechanical parts	спробувати спроєктувати конструктивні та механічні частини
9.	to resist external forces	протистояти зовнішнім силам
10.	in a safe and economical manner	безпечним і економним способом
11.	elasticity	еластичність
12.	hardness	твердість
13.	stiffness	жорсткість
14.	to differ in their ability to resist a particular force	відрізняються здатністю протистояти певній силі
15.	cast iron bar	чавунний брусок
16.	compression	компресія
17.	tension	напруга
18.	concrete	бетон
19.	internal resistance of a material	внутрішній опір матеріалу
20.	stress	напруга
21.	changes in shape and size	зміни форми і розміру
22.	stretching	розтягування
23.	deformation	деформація
24.	strain	напруження

25.	significant change in shape	істотна зміна форми
26.	subjected to fairly small forces	піддається дії досить невеликих сил
27.	ratio	співвідношення
28.	modulus of elasticity	модуль пружності
29.	a measure of the material's ability to stretch	міра здатності матеріалу розтягуватися
30.	tensile stress	навантаження на розтяг
31.	compressive stress	стискаюча напруга
32.	pillars	стовпи
33.	shearing stress	напруга зсуву
34.	to separate into layers	розділяти на шари
35.	combined stresses	комбіновані напруги
36.	flexure	згинання
37.	torsion	кручення
38.	springboard	трамплін
39.	a sample of the material	зразок матеріалу
40.	without changing shape permanently	без остаточної зміни форми
41.	the force exceeds the elastic limit	сила перевищує межу пружності
42.	the ultimate strength of a material	граничний опір матеріалу
43.	material strong and stiff enough	матеріал досить міцний і жорсткий
44.	bending	згинання
45.	twisting	скручування

UNIT 8. Automation

1.	to perform tasks	виконувати завдання
2.	require decision making	вимагають прийняття рішень
3.	a wide variety of jobs	широкий вибір вакансій
4.	too boring, complex, or dangerous for people to do	надто нудно, складно або небезпечно для людей
5.	assembly line	конвеєр
6.	a variety of repetitive tasks	різноманітні повторювані завдання
7.	computerized automated systems	комп'ютеризовані автоматизовані системи
8.	to handle record keeping, ordering, and stock control	займатися веденням обліку, замовленнями та контролем запасів
9.	manufacturing	виробництво
10.	automated machines	автоматизовані машини
11.	automated equipment	автоматизоване обладнання
12.	sections of nuclear reactors	секції ядерних реакторів
13.	high levels of radioactivity	високий рівень радіоактивності
14.	certain environmental conditions	певні умови середовища
15.	to adjust operation	налаштувати на роботу
16.	system of self-regulation	система саморегуляції
17.	automation	автоматизація
18.	mechanization	механізація
19.	the use of mechanical power	використання механічної сили
20.	to weld	зварювати
21.	feedback system	система зворотного звя'зку
22.	changing conditions	зміна умов
23.	the availability of inexpensive computers	наявність недорогих комп'ютерів

24.	to run machines	запускати машини
25.	the development of automated systems	розвиток автоматизованих систем
26.	to cause increased unemployment	викликати зростання безробіття
27.	to stimulate industrial growth and create new jobs	стимулювати промислове зростання та створювати нові робочі місця
28.	numbers of technical workers	кількість технічних працівників
29.	to build and maintain automated systems	будувати та підтримувати в робочому стані автоматизовані системи
30.	to make in a limited amount of time	зробити за обмежений проміжок часу
31.	to perform effectively over long periods of time	ефективно працювати протягом тривалого часу
32.	nonautomated machinery	неавтоматизована техніка
33.	routine tasks	рутинні завдання
34.	assembling	складання
35.	inspecting	інспектування
36.	packaging manufactured products	пакування виробленої продукції
37.	data	дані
38.	equalize	зрівняти
39.	beyond the capacity of people	за межами спроможності людей
40.	to avoid hitting obstacles	щоб уникнути зіткнення з перешкодами
41.	environments that are unsafe for people	середовища небезпечні для людей
42.	at extremely high pressures	при надзвичайно високому тиску
43.	high concentrations of airborne	висока концентрація частинок

	paint particles	фарби в повітрі
44.	with great consistency	з великою послідовністю
45.	work faster and more accurately	працювати швидше і точніше

APPENDIX 2. Grammar

(Based on Dooley J., Evans V. Grammarway 2. Newbury, Berkshire: Express Publishing. – 152 p.)

The Article

An article is a part of speech that is used before a noun or an adjective followed by a noun. There are two articles in English: the indefinite article **a/an** and the definite article **the**. The indefinite article **a/an** comes from the numeral *one*. And the definite article **the** comes from the pronoun *that*. These meanings are partially preserved in the articles at present.

The indefinite article **a/an** is used with singular countable nouns. We use **a** when the next word starts with a consonant sound and **an** when the next word starts with a vowel sound.

The definite article **the** is used with uncountable nouns, as well as singular and plural countable nouns.

The Indefinite Article *A / An*

The indefinite article **a/an** is used:

- Instead of: “one”; “one of”; “some”; “any”; “someone’s”. E.g. This is a computer (one of computers).

The indefinite article **a/an** is not used:

- Before uncountable nouns and plural countable nouns. E.g. These are computers.

In these cases, you can often use **some** instead of **a/an**. E.g. Some oil leaked out of the tanker.

The Definite Article *The*

The definite article **the** is used:

- Instead of: “this”; “that”; or a possessive pronoun (“my”, “your”, etc.). E.g. This is the book you are looking for.

- To talk about a person or an object that is unique in its kind, or unique in a given situation: the sun, the moon, the earth, the sky, the president, the capital, etc.
- Before the superlative degree of an adjective or adverb and before an ordinal number. E.g. The fastest speed achieved by a Maglev train in 2003 was 501 km/h. He works the hardest of all. The second step in an internal combustion engine is called compression.
- Before the names of bodies of oceans, seas, rivers, mountain ranges, groups of islands, deserts: the Atlantic, the Black Sea, the Nile, the Alps, the Bahamas, the Sahara.

But: articles are not used before the names of individual islands and individual mountain peaks: Everest, Cuba.

- Before the names of countries which include a common noun ("states", "kingdom", "republic"): The United States of America.
- Before nationalities and surnames in the plural, when referring to the whole family: the Chinese, the Italians, the Smiths.

The articles are not used:

- Before proper names referring to people, countries, cities, as well as before the names of months and days of the week. E.g. Nick, France, Kyiv, May, Sunday.
- Before possessive or demonstrative pronouns, as well as before proper nouns in the possessive case. E.g. Look at *this* machine. Marie Curie and *her* husband Pierre Curie conducted pioneering research on radioactivity. *Newton's* laws of motion explain the relationship between a physical object and the forces acting upon it.
- Before a noun followed by a numeral: lesson 7.
- Before the names of meals (breakfast, lunch, dinner, etc.), sports and games. E.g. Tennis is an exciting sport.
- Before the names of diseases. E.g. He has got malaria.

But: flu/the flu, measles/the measles, mumps/the mumps.

The Adjective / Adverb

- **An adjective** describes a noun. It has the same form in the singular and plural. E,g. This is an electric car. These are electric cars.
- **Comparisons**

	Adjectives	*Comparative degree*	*Superlative degree*
One-syllable adjectives	cheap	cheap**er**	**the** cheap**est**
	large	larg**er**	**the** larg**est**
	big	big**ger**	**the** big**gest**
Two-syllable adjectives ending in –y, -w, -le, -er	noisy	nois**ier/more** noisy	**the** nois**iest/the most** noisy
	narrow	narrow**er/more** narrow	the narrow**est/the most** narrow
	clever	clever**er/more** clever	the clever**est/the most** clever
	gentle	gentl**er/more** gentle	the gentl**est/the most** gentle
The rest of two-syllable adjectives and multi-syllable adjectives	expensive	**more** expensive	**the most** expensive

- **Spelling**:
  - adjectives, ending in a **stressed vowel + consonant,** double the last consonant: fat – fat**ter** (than) – the fat**test** (of / in)
  - adjectives, ending in a **consonant + y,** change **–y** to **–ie**: nois**y** – nois**ier** (than) – the nois**iest** (of / in)
  - adjectives, ending in **–e,** add **–r** in the comparative and **–st** in the superlative degree: nice – nice**r** – the nice**st**

We can use **(not) as + adjective + as** to say that two people, places or things are / are not alike. E.g. This mechanism **is as simple as** that one. This mechanism is **not as complex as** that one.

- **An adverb** describes a verb. It shows **how, where, when,** or **how often** someone performs an action. An adverb is usually used after a verb. E,g. The results of the study were proved **experimentally.**
- **Formation** of adverbs:
  a. An adverb is usually formed by adding **–ly** to an adjective: slow – slow**ly**

b. Adjectives, ending in **–le**, drop the **–e** and add **–y**: simple – simpl**y**.

c. Adjectives, ending in a **consonant + y**, drop the **–y** and add **–ily**: angry – angr**ily**.

d. Adjectives, ending in **–l**, add **–ly**: careful – careful**ly**.

Some adverbs have either a completely different or the same form as the adjectives:

good – well	**hard – hard**
early – early	**fast – fast**
late – late	**long – long**
high – high	**straight – straight**
low – low	**deep – deep**
right – right	**near – near**
wrong - wrong	

- **Adverbs** form comparisons in the same way as adjectives, but with some differences:
  a. one-syllable adverbs and the adverb **early** add **–er, -est**: fast – fast**er** (than) – the fast**est** (of / in)
  b. two-syllable and multi-syllable adverbs form comparisons using **more/the most**: quickly – more quickly (than) – the most quickly (of / in)
- **the** following adjectives and adverbs form comparisons in a different way:

good/well	**better**	**the best**
bad/badly	**worse**	**the worst**
much/many/a lot of	**more**	**the most**
little	**less**	**the least**
far	**farther/further**	**the farthest / the furthest**

But:

Farther / further (adverb) = at a longer distance.

E.g. He lives **further/farther** away from the university than his friend.

Further (adjective) = following; additional.

E.g. Don't hesitate to ask me if you need any **further** information.

The Preposition

A preposition is a part of speech that connects words in a sentence. There are prepositions of time, place, direction, etc.

Prepositions of time

We use prepositions of time to say when something happened, is happening or will happen. The most common are **at, in** and **on.**

at	**time:** **holidays** **expressions:**	at 5 o'clock at Christmas, at Easter at the weekend, at the moment, at present, at dawn, at noon, at night, at midnight
in	**months:** **seasons:** **years:** **centuries:** **expressions:**	in April in winter in 1992 in the 20th century in the morning/afternoon/evening, in an hour, in a week
on	**days:** **dates:** **part of a particular day:** **adjective + day:**	on Friday, on New Year's Day on May 5th on Tuesday morning on a cold day

But: we use **from…to** to show the duration. E.g. She has classes from 9 am to 2 pm every day.

Prepositions of place

We use prepositions of place to talk about the location of people or things:

on –	on the surface
in –	in the pipes
under –	under the ground
in front of –	in front of the class
behind –	behind the schedule
beside / next to	next to the table
near –	near the window
at –	at the terminal
between –	between two chairs
among –	among the friends
opposite -	opposite the building

Prepositions of direction

We use prepositions of direction to show the direction in which someone or something is moving:

along –	International calls go along undersea optical fibre cables or via satellites high above the Earth.
across –	They are building a new bridge across the river.
up –	In the second stroke, the piston moves up.
down –	In the first stroke, the piston starts at the top and moves down.
into –	Corrosion in the pipes is extremely dangerous.
out of –	DrilIing mud is pumped into and out of the well during drilIing.
over –	You can buy a plastic cover to put over your computer if you’re worried about dust.
from…to	Signals pass from a telephone to the local exchange along copper cables.
round –	The earth goes round the sun.
through –	Light signals pass through optical fibers.

The Verb

In English, the verb has four forms, i.e. four endings.

Forms of the Verb

Infinitive	***Past Simple***	***Past Participle***	***Present Participle***
to do	**did**	**done**	do**ing**
to form	form**ed**	form**ed**	form**ing**

There are regular and irregular verbs. Regular verbs are those that have the ending **-ed** in the second and third forms. Irregular verbs are those that do not have the ending **-ed** in the second and third forms (See the table of irregular verbs). The fourth form of the verb is formed by adding the ending **-ing** to both regular and irregular verbs.

When adding the suffix **-ed**, the following spelling rules are followed:

- Verbs ending in **-e** only add **-d**: live – liv**ed**.
- Verbs ending in **a consonant + y** omit **y** and add **-ied**: carry – carr**ied**.
- Verbs ending in **a vowel + y** simply add **-ed**: enjoy – enjoy**ed**.
- Verbs ending in **one stressed vowel between two consonants** double the last consonant and add **-ed**: stop - sto**pped**.

When adding the suffix **-ing**, the following spelling rules are followed:

- Verbs ending in **-e** omit **-e** and add **-ing**: use – us**ing**.
- Verbs ending in one stressed vowel between two consonants double the last consonant and add **-ing**: plan – pla**nning**.
- Verbs ending in **-l** double **l** and add **-ing**: travel – trave**lling**.
- Verbs ending in **-ie** omit **-ie** and add **-y + -ing**: lie – l**ying**.

There are twenty-six verb tenses in the English language: sixteen tenses of the active voice and ten tenses of the passive voice.

TENSES OF THE ACTIVE VOICE

Aspects / Tenses	Simple	Continuous	Perfect	Perfect-continuous
Present	**I do** **It does**	**I am doing** **It is doing** **They are doing**	**I have done** **He has done**	**I have been doing** **He has been doing**
	Usually, sometimes, often, always, every day (week), etc.	*Now, at the moment, at present, these days, still, tonight, etc.*	*Ever, never, just, already, yet, since, for, lately, recently, always, how long, so far, today, this week.*	*For, since, all morning, how long (in questions), etc.*
Past	**It did**	**I was doing** **They were doing**	**I had done**	**I had been doing**
	Yesterday, last week, two days ago, in 1994, etc.	*At six o'clock yesterday, while when, as, all day, etc.*	*Before, after, just, already, till, until, when, by, by the time.*	*For, since, how long, before, until, etc.*
Future	**I will do**	**I will be doing**	**I will have done**	**I will have been doing**
	Tomorrow, the day after tomorrow, next year, in two days, soon, etc.	*At six o'clock tomorrow, this time next week, etc.*	*By, by the time, before, until, by then, etc.*	*By, by the time, until, before, etc.*
Future in the Past	**I would do**	**I would be doing**	**I would have done**	**I would have been doing**
	*He said that…**	*He said that…**	*He said that…**	*He said that…**

* The Future in the Past tenses are used instead of the corresponding Future tenses in object clauses, if the verb of the main clause is used in the past tense:
She **said** she **would do** his homework in the evening.
She **said** she **would be flying** to Lviv at that time the next month.
She **said** she **would have returned** home by Saturday afternoon.
She **said** she **would have been working** there for sthree years by the end of that year.

FORMATION OF THE TENSES OF THE ACTIVE VOICE

SIMPLE TENSES

Present Simple

I/You **work**.-He /She /It **works**.

Do you **work**? – **Does** he **work**? **Yes, I do. / No, he doesn't.**

I **do not (don't) work.** – He **doesn't work.**

Past Simple

I / He / She / We **knew.**

Did she **know**? – **Yes, she did. / No, she didn't.**

She **did not (didn't) know.**

Future Simple

He / They **will ('ll) fly.**

Will it / they **fly? – Yes, it will. / No, they** won't**.**

It / they **will not (won't) fly.**

Use

Simple tenses are used to talk about an action as a fact, a repetitive action or a permanent state in the present, past, or future.

*I **do** experiments in the university lab every day.*

*She **worked** with radioactive materials last year.*

*He **will test** a new component of the machine.*

*She said she **would be** busy next week.*

PRESENT SIMPLE

is used to talk about:

- Repeated actions or daily routines (often with adverbs: **always, never, usually, often**, etc.).

E.g. *She usually **starts** work at 8 am. She often **stays** at the office until late in the evening.*

- Permanent states. E.g. *Pamela **works** at college*.
- General truths or laws of nature. E.g. *The boiling point of water **is** 212°F*.
- Programs or schedules (films, trains, buses, etc.). E.g. *The train **leaves** in five minutes.*

Time expressions:

always, never, usually, often, seldom, rarely, sometimes, etc. (adverbs of frequency), every day/week/month/year, ma iн., on Mondays/Tuesdays, etc., in the morning/afternoon/evening, at night/the weekend, etc.

PAST SIMPLE

is used to talk about:

- Actions, which happened in the past and the time, is mentioned or implied. E.g. *A type of a machine gun **appeared** as early as 1500's*.
- Past habits or actions that repeated in the past but do not happen anymore. In this case, we can use adverbs of frequency (**always, never, usually, often**, etc.). E.g. *She often **played** computer games when she was a teenager*. (But: She ***doesn't play*** computer games anymore, she's too busy now.)
- Actions that happened one after the other in the past. E.g. *This machine tool **cut, drilled** and **squeezed** metal into any shape*.
- Actions performed by people who are no longer alive. E.g. *Hiram Maxim **developed** the first automatic machine gun.*

Remember:

- We use **used to** to talk about past habits, or actions that no longer occur. This expression has the same form in all persons, singular and plural. It is followed by the infinitive. E.g. *He **used to be** an explorer*. (*Now he is a lecturer at university*.)
- We can also use **Past Simple** instead of **used to**. E.g. *There used to be a small laboratory at my college. = There was a small laboratory at my college.*

Time expressions:

yesterday, last night/week/month/year/Monday, etc., two days/ weeks/months/years ago, then, when, in 1992, etc.

For more information about the Past Simple enter the links below, watch the video and do the quiz:

https://www.engvid.com/english-grammar-past-simple-time-markers/

FUTURE SIMPLE

is used for:

- Actions that may or may not occur in the future. E.g. *People **will fly** planes, not drive cars one day.*
- Predictions about the future based on what we think. E.g. *AI **will be** the most serious problem for our planet in the future.*
- Threats or warnings. E.g. *Stop using your mobile or I **will** write a report and send it to our supervisor*.
- Promises or spontaneous decisions. E.g. *I'll **help** you with this laboratory work.*
- Future actions and used with verbs **hope, think, believe, expect**, and others, expressions **I'm sure, I'm afraid**, and others, and adverbs **probably, perhaps**, and others. E.g. *I **don't think** the course **will be** very interesting. It **will probably take** two hours to fix.*

Remember:

We use **be going to** to express:

- Plans and intentions for the near future. E.g. ***I'm going to see*** *the manager.*
- Predictions about the future based on what we can see. E.g. *Look at those big grey clouds. **I'm going to** be late for work (my car is broken down).*

Note:

- We do not use Future Simple in conditional clauses and time clauses (after **when, while, before after, till, until, as soon as, if**). Instead we use present simple. E.g. *As soon as we have all the necessary documents, we **start** the experiment.*

Time expression:

tomorrow, the day after tomorrow, next week/month/year, tonight, soon, in a week/month/year, and others.

CONTINUOUS TENSES

Present Continuous

I **am ('m)** / You **are ('re)** / He **is ('s) working.**
Are you / **Is** he **working? – Yes, I am. / No, he isn't.**
I **am ('m) not** / He **is not (isn't)** / They **are not (aren't) working.**

Past Continuous

I /He /She **was** / We /They **were watching.**
Was he / **were** they **watching? – Yes, he was. / No, they weren't.**
He **was not (wasn't)** / They **were not (weren't) watching.**

Future Continuous

I /He / They **will be working.**
Will I / he / they **be working? – Yes, I / he / they will. No, I / he / they won't.**
I / He / They / **will not (won't) be working.**

Use

Present Continuous expresses an action that is in progress at the time of speaking, i.e. now; **Past Continuous** expresses an action that was in progress at a stated time or period of time in the past; **Future Continuous** expresses an action that will be in progress at a stated time or period of time in the future.

*He **is producing** a component now.*

*He **was developing** a 3D model when I came in.*

*This time tomorrow Tom **will be machining a workpiece**.*

PRESENT CONTINUOUS

is used for:

- Actions that are taking place now, at the time of speaking. E.g. *He **is creating a design** right now.*
- Temporary actions that occur around the moment of speaking, but not at the actual moment of speaking. E.g. *He **is studying** the properties of alloys these days.*
- Actions that occur too often and about which we want to express our irritation or criticism. (The word "always" is used in such sentences). E.g. *You **are always interrupting** me!*
- Fixed arrangements in the near future. E.g. *He **is meeting a production engineer** in an hour.*

Time expressions:

now, at the moment, these days, at present, always, tonight, still, and others.

Note:

Some verbs are not used in continuous tenses. They are called "stative verbs". They are:

- Verbs of senses: see**, hear, feel, taste**, **smell.** E.g. *Be careful when a gas leak smells.*

- Verbs of mental activity: **know, remember, forget**, **understand, notice, realise, think, believe, recognise, seem, sound**, and others. E.g. *I **don't remember*** the *laws of thermodynamics*.
- Verbs of likes and dislikes: **love, like, dislike, hate, enjoy, prefer,** and others. E.g. *Mechanical engineers know everything about machine tools.*
- Other verbs: include**, matter, need, belong, cost, mean, own, appear, want, have** (=**posses**), and others. E.g. *This engineering equipment **costs** a lot of money*.

For further information about the stative verbs enter the link below, watch the video and do the quiz:

https://www.engvid.com/stative-verbs-in-english/

For further information about the Present Continuous enter the link below, watch the video and do the quiz:

https://www.engvid.com/5-ways-to-use-the-present-continuous-verb-tense-in-english/

PAST CONTINUOUS

is used for:

- An action that was in progress at a stated time in the past. We do not know when this action started or finished. Eg. *At three o'clock yesterday afternoon, Mike **was testing** a gear system.*
- An action that was in progress when another action interrupted it. We use **Past Continuous** to denote an action that was in progress (longer action) and **Past Simple** to denote an action that interrupted it (shorter action). Eg. *As the workpiece **was turning**, the tool **broke down***. (was turning = longer action; broke down = shorter action).
- Two or more actions that occurred at the same time in the past. E.g. *While the wind **was blowing** the wind turbines **were working***.

- Actions in the background of a story or narrative. E.g. *The sun **was shining** and the birds **were singing**. Tom **was driving** his old truck through the forest.*

Time expressions:

when, while, as, all day/night/morning, and others.

as, when, while, + Past Continuous	*when + Past Simple*

FUTURE CONTINUOUS

is used for:

- An action that will be in progress at a stated time in the future.
  E.g. *This time next week **I'll be flying** to participate in the engineering conference.*
- An action that will definitely happen as a result of a routine or arrangement. E.g. *I **will be seeing** them at the machine shop at 2 p.m. tomorrow.*

For further information about Future Continuous enter the links below, watch the video and do the quizzes:

https://www.engvid.com/future-progressive-tense/

https://www.engvid.com/learn-to-make-plans-with-the-future-progressive-tense/

PERFECT TENSES

Present Perfect

I / You / **have ('ve) left / arrived.**

He / She / It **has ('s) left / arrived.**

Have you **left /arrived? – Yes, I have. / No, I haven't.**

You **have not (haven't) left / arrived.** He / She / It **has not (hasn't) left / arrived.**

Past Perfect

She **had arrived / gone.**

Had she **arrived/ /gone? – Yes, she had. / No, she hadn't.**

She **had not (hadn't) arrived / gone.**

Future Perfect

He / She / They **will ('ll) have left.** **Will** he /she / they **have left? - Yes, he / she / they will. No, he / she / they won't.** He/ She / They **will not (won't) have left.**

Use

Present Perfect denotes an action that finished before the moment of speaking;

Past Perfect denotes an action that finished before a moment or another action in the past;

Future Perfect denotes an action that will finish before a moment or another action in the future.

*He **has** already **tested** a tool prototype.*

*He **had tested** a tool prototype by nine o'clock yesterday.*

*He **will have tested** a tool prototype by nine o'clock tomorrow.*

PRESENT PERFECT

is used for:

- A past action, when the time of the action is not mentioned but the result is visible now.

  E.g. *Ted **has bought** new equipment.*

  *The company **has bought** new grinding machines.*

- An action that started in the past and is still going on.

  E.g. *He has been a mechanical engineer since 2010.*

  Manufacturers have made several improvements in the design of machine tools for the last three decades.

- An action that happened during a time period which is not yet finished: **today, this week, this morning / afternoon**, etc. E.g. *He **has made** three*

drafts ***this morning***. (It is still morning so this period of time is not finished.)

Time expressions:

ever, never, just, already, yet, since, for, always, so far, how long, lately, recently.

For further information about the Present Perfect Tense enter the link below, watch the video and do the quiz:

https://www.engvid.com/practice-the-present-perfect-tense-in-english/

https://www.engvid.com/english-grammar-how-to-use-since-and-for-with-the-present-perfect/

For further information about the difference between the Past Simple and the Present Perfect enter the links below, watch the videos and do the quizzes:

https://www.engvid.com/english-tenses-past-simple-present-perfect/

https://www.engvid.com/english-tenses-present-perfect-present-simple/

PAST PERFECT

is used for:

- An action that finished before a moment or another action in the past. E.g. *He* ***had manufactured*** *the tools by five o'clock in the afternoon. They* ***had developed*** *a new machine tool design before a chief engineer started a project.*

Time expressions:

before, after, already, just, till/until, when, by, by the time, and others.

For further information about the Past Simple, Past Continuous, Past Perfect and Present Perfect enter the link below, watch the video and do the quiz:

https://www.engvid.com/learn-engish-tenses-past-tenses/

FUTURE PERFECT

is used for:

- An action that will finish before a moment or another action in the future. E.g. *They **will have finished** their meeting by four o'clock this afternoon.*

Time expressions:

by, by the time, before, until, by then, and others.

Perfect Continuous Tenses

Present Perfect-Continuous

I / You **have been testing.**
He / She / It **has been testing.**
Have you **been testing? – Yes, I have. / No, I haven't.**
Has he / she / it **been testing?**
You **have not (haven't) been testing.**
He / She / It **has not (hasn't) been testing.**

Past Perfect Continuous

He **had been developing.**
Had he **been developing?- Yes, he had. / No, he hadn't.**
He **had not (hadn't) been developing.**

Future Perfect Continuous

I / you / we / **will ('ll) have been observing.**
Will I / you / we **have been observing? – Yes, I / we will. No, I / we won't.**
I / You / We / **will not (won't) have been observing.**

Use

Present Perfect Continuous expresses an action that was going on and finished before the moment of speaking; **Past Perfect Continuous** expresses an action that was going on and finished before a moment or another action in the past;

Future Perfect Continuous expresses an action that will be going on and finish before a moment or another action in the future.

*The engineer **has been checking** the pumps today.*

*She **had been testing** new engines for ten months before they went into production.*

*By the end of this month he **will have been working** on the project at the company for three years.*

*He told us that by the end of that month he **would have been evaluating** the physical and chemical characteristics of this product at the company for five years.*

PRESENT PERFECT CONTINUOUS

is used for:

- An action that began in the past and is still going on now. Eg. *He **has been conducting** scientific research for this organization for two months*. (He began working for this organization two months ago and he is still working there.)
- An action that began in the past and finished before now. E.g. *His hands are dirty. He **has been repairing** the equipment in the workshop.*

Note:

1. We use **Present Perfect** instead of **Present Perfect Continuous** with verbs that are not used in the continuous tenses (know, believe, like, and others). E.g. *I **have known** him since we developed the software at the company together.*

2. With the verbs **live, work, feel, teach** we can use **Present Perfect** or **Present Perfect Continuous** without difference in meaning. E.g. *He **has been recording/has recorded** the results of the experiments here since 2020*.

Time expressions:

since, for, all morning/afternoon/evening/week/day, how long (in questions).

For additional information about the **Present Perfect Continuous** (which is also called the **Present Perfect Progressive**) enter the links below, watch the videos and do the quizes:

https://www.engvid.com/present-perfect-progressive-challenge/
https://www.engvid.com/english-grammar-present-perfect-simple-continuous/

PAST PERFECT CONTINUOUS

is used for:

An action that was going on and finished before a moment or another action in the past. E.g. *She **had been waiting** for an hour before they carried out all the tests*.

Time expressions:

since, for, how long, before, until, and others.

FUTURE PERFECT CONTINUOUS

is used for:

- An action that will be going on and finish before a moment or another action in the future. E.g. *By the end of next month, we **will have been testing** laboratory equipment for two years. By the time she records the results, she **will have been carring out** the tests for two hours.*

Time expressions: *by…for.*

For further information about the future tenses enter the links below, watch the video and do the quiz:

https://www.engvid.com/using-the-future-tense-in-conversation-english-grammar/

PASSIVE VOICE

Aspect / Tense	Simple	Continuous	Perfect
Present	I **am tested** She **is tested** They **are tested**	I **am being tested** He **is being tested** You **are being tested**	I **have been tested** It **has been tested**
Past	I **was tested** We **were tested**	I **was being tested** They **were being tested**	I **had been tested**
Future	I **will be tested**	———	I **will have been tested**
Future in the Past	I **would be tested**	———	I **would have been tested**

The tenses of the Passive Voice are formed using the auxiliary verb **to be** and the main verb in the third form (**Past Participle**).

to be + past participle

Forms of the Passive Voice:

Present Simple: am/is/are + pp The pressure **is measured** twice a day.
Present Continuous: am/is are being + pp The pressure **is being measured** now.
Past Simple: was/were + pp The pressure **was measured** in the morning**.**
Past Continuous: was/were being + pp The pressure **was being measured** when the engineer came in.
Present Perfect: have/ has been + pp The pressure **has just been measured.**
Past Perfect: had been + pp The pressure **had been measured** before the engineer came in.
Future Simple: will be + pp The pressure **will be measured** in the evening.

Use

The tenses of the Passive Voice are used for the same actions as the corresponding tenses of the Active Voice. We use the Active Voice when the subject performs the action and the Passive Voice – when the action is performed to the subject

Changing Active to Passive

When we transform the Active Voice into the Passive Voice:

1) the object of the sentence in the Active Voice becomes the subject of the sentence in the Passive Voice;

2) the verb in the Active Voice is changed to the verb in the Passive Voice;

3) the subject of the sentence in the Active Voice becomes the agent of the sentence in the Passive Voice.

For example:

	subject	verb	object
Active Voice	We	receive	raw materials.

	subject	verb	agent
Passive Voice	Raw materials	are received	by us.

Passive Voice:

Present Simple	She **controls** them.	They **are controled**.
Present Continuous	She **is controling** them.	They **are being controled.**
Past Simple	She **controled** them.	They **were controled.**
Past Continuous	She **was controling** them.	They **were being controled**.
Present Perfect	She **has controled** them.	They **have been controled**.
Past Perfect	She **had controled** them.	They **had been controled**.
Future Simple	She **will control** them.	They **will have been controled**.
Modals (modal+be+pp)	She **can control** them.	They **can be controled**.

Only verbs which take an object can be used in the Passive Voice. E.g. Our mechanic ***has made*** routine maintenance of the equipment. The equipment ***has been made*** routine maintenance.

- **But:** *The mechanic works quickly.* (This sentence cannot be transformed into Passive because the verb does not take an object).

- If the verb can take two objects (**ask, bring, tell, send, show, teach, promise, offer, give, pay, lend,** and others), the Passive Voice can be formed in two ways, so that each of the two objects can become the subject of the sentence in the Passive.

Active:

He sent **me the results** of the scientific experiments.

Passive:

a. **I** was sent the results of the scientific experiments.

b. **The results** of the scientific experiments were sent to me.

- If the verb in the Active construction is followed by a preposition, this preposition remains in the same position after the verb in the Passive construction. E.g. *The chief engineer **looked through** the documents and signed them. The documents **were looked through** and signed.*

For further information about the **Passive Voice** enter the links below, watch the videos and do the quizes:

https://www.engvid.com/learn-english-grammar-active-passive/

https://www.engvid.com/passive-responsibility/

THE INFINITIVE, GERUND, PARTICIPLE

Forms of the Infinitive

Affirmative:	**Active**	**Passive**
Indefinite	to apply	to be applied
Continuous	to be applying	-
Perfect	to have applied	to have been applied
Perfect Continuous	to have been applying	-

Negative: we add particle ‘not’ before the infinitive: **not to apply, not to have been appying**.

The Infinitive is used without the Particle *to* after

auxiliary verbs	This solid **will keep** the new shape.
modal verbs (but: ought to)	Scientists **can measure** the hardness of a material.
had better, would rather, would sooner, cannot but, nothing but	I **would rather clarify** information about engineering material properties.
verbs that mean sense of perception: to hear, to see, to feel	She **saw** him **leave** the laboratory.

The Infinitive Constructions

The Objective Infinitive Construction	I want ***you to show*** the benefits of using ceramics.
The Subjective Infinitive Construction	***He*** is known ***to be*** an experienced engineer.
The For-to Infinitive Construction	It is easy ***for this student to solve*** this equation.

Forms of the Gerund

<u>Affirmative</u>:	**Indefinite**	**Perfect**
Active	subjecting	having subjected
Passive	being subjected	having been subjected

<u>Negative</u>: we add particle ‘not’ before the gerund: not subjecting, not being subjected.

WE USE INFINITIVE	WE USE GERUND
• **to express purpose.** *The term malleability is often used to describe the property of metals.* • **after the verbs: agree, appear, decide, expect, hope, plan, promise, refuse etc.** *I planned to do some changes in this project.* • **after certain adjectives (happy, glad, sorry etc).** *I was glad to clarify this information.* • **after I would like/would love/would prefer to express specific preference.** *I'd prefer not to participate in this project.* • **after certain nouns.** *It's such a challenge to create a new engine.* • **after too/enough.** *He has got enough books to give the students.* • **with: it + be + adjective (+ of + noun/ pronoun).** *It is effective to use ceramics for developing a new engine.* • **with "only" to express an unsatisfactory result.** *He came back to the laboratory only to discover that the door was locked.* • **after: be + the first/ second/ next/ last/ best, etc.** *J. Henry was one of the first to discover the essential mechanics for the electric telegraph invented by Samuel Morse a year later.* • **in the expression: for + noun/ pronoun + to -inf.** *It was a great challenge for him to combine different properties of materials in one engine.* • **in expressions such as: to tell you the truth, to begin with, to be honest etc.** *To be truth, this topic is rather interesting.*	• **as a noun.** *Studying material science is important for an engineering student.* • **after certain verbs (admit, anticipate, appreciate, avoid, consider, continue, delay, deny, discuss, enjoy, escape, excuse, fancy, finish, forgive, go (physical activities), imagine, involve, keep (=continue), mention, mind, miss, object to, postpone, practice, prevent, quit, recall, recollect, report, resent, resist, risk, save, stand, suggest, tolerate, understand, etc).** *They have spent the whole day discussing the material properties.* • **after: dislike, enjoy, hate, like, love, prefer to express general preference.** *I like reading interesting facts about material properties. (in general)* • **Note: like + to-inf** – it's a good idea *I like to practise ESP on English lessons.* • **after: I'm busy, it's no use, it's (no) good, it's (not) worth, what's the use of, can't help, there's no point (in), can't stand, have difficulty (in), in addition to, as well as, have trouble, have a hard/difficult time.** *There's no point in talking about this issue.* • **after: spend/waste (time, money etc).** *He wasted much time analysing this information.* • **after prepositions.** *He left the laboratory without saying goodbuy.* • **after: look forward to, be/get used to, be/get accustomed to, object to, admit (to) etc.** *I object to being told how to write this specification.*

The Participle

Forms of the Participle:

In case of transitive verbs

	Participle I	**Participle II**	**Perfect Participle**
Active	defining	-	having defined
Passive	being defined	defined	having been defined

In case of intransitive verbs

	Participle I	**Participle II**	**Perfect Participle**
Active	falling	fallen	having fallen

We use the Participle:

1. Instead of a relative pronoun and a full verb.	*e.g. The books used by students are about engineering material properties. (=The books that are used by students are about engineering material properties.)*
2. To express reason.	*e.g.* ***Compressing*** *gas, Tom turn it into liquid. (= Because we compress gas, we turn it into liquid)*
3. To express time.	*e.g.* ***Having finished*** *the project, we left the laboratory. (= After finishing the project…)*
4. To avoid repeating the past continuous in the same sentence.	*e.g. He was solving a problem* ***sitting*** *in the park. (= He was solving a problem and he was* ***sitting*** *in the park.)*

APPENDIX 3. Irregular Verbs

№	Infinitive	Past Simple	Past Participle	Ukrainian equivalent
1.	be [bJ]	was (were)[wɒz][wɛ:]	been [bJn]	бути
2.	bear [bɬq]	bore [bʟ]	born [bʟn]	народжувати
3.	beat [bJt]	beat [bJt]	beaten [bJtn]	бити
4.	become [bl'kʌm]	became [bl'kɐlm]	become [bl'kʌm]	ставати
5.	begin [bl'gln]	began [bl'gɤn]	begun [bl'gʌn]	починати
6.	bend [bɐnd]	bent [bɐnt]	bent [bɐnt]	згинатися
7.	bet [bɐt]	bet [bɐt]	bet [bɐt]	битися об заклад
8.	bite [bəlt]	bit [blt]	bitten [bltn]	кусати
9.	blow [blɛV]	blew [blɬl]	blown [blɛVn]	дути
10.	break [brɐlk]	broke [brɛVk]	broken [brɛVkn]	ламати
11.	bring [brlɴ]	brought [brʟt]	brought [brʟt]	приносити
12.	build [bll̩d]	built [bll̩t]	built [bll̩t]	будувати
13.	burn [bɛ:n]	burnt [bɛ:nt]	burnt [bɛ:nt]	горіти, палити
14.	burst [bɛ:st]	burst [bɛ:st]	burst [bɛ:st]	розбиватися, вибухати
15.	buy [bəl]	bought [bʟt]	bought [bʟt]	купувати
16.	can [kɤn]	could [kɬd]	been able to	могти
17.	catch [kɤC]	caught [kʟt]	caught [kʟt]	ловити
18.	choose [CɬIz]	chose [CɛVz]	chosen [CɛVzn]	вибирати
19.	come [kʌm]	came [kɐlm]	come [kʌm]	приходити
20.	cost [kɒst]	cost [kɒst]	cost [kɒst]	коштувати
21.	cut [kʌt]	cut [kʌt]	cut [kʌt]	різати
22.	deal [dJl]	dealt [dɐlt]	dealt [dɐlt]	мати справу, обходитися

23.	dig [dɪg]	dug [dʌg]	dug [dʌg]	копати
24.	do [dʉ]	did [dɪd]	done [dʌn]	робити
25.	dream [drJm]	dreamt [drɛmt] dreamed [drJmd]	dreamt [drɛmt] dreamed [drJmd]	мріяти
26.	draw [drɒ]	drew [drʉ]	drawn [drɒn]	тягти, малювати
27.	drink [drIɴk]	drank [drɤɴk]	drunk [drʌɴk]	пити
28.	drive [drəIv]	drove [drɐV̩v]	driven ['drIvn]	вести (машину)
29.	eat [Jt]	ate [ɛt]	eaten ['Jtn]	їсти
30.	fall [fɒl]	fell [fɛl]	fallen [fɒln]	падати
31.	feed [fJd]	fed [fɛd]	fed [fɛd]	годувати
32.	feel [fJl]	felt [fɛlt]	felt [fɛlt]	відчувати
33.	fight [fəIt]	fought [fɒt]	fought [fɒt]	боротися
34.	find [fəInd]	found [fəV̩nd]	found [fəV̩nd]	знаходити
35.	forget [fɑ'gɛt]	forgot [fɑ'gɒt]	forgotten [fɑ'gɒtn]	забувати
36.	forgive [fɑ'gIv]	forgave [fɑ'gɛIv]	forgiven [fɑ'gIvn]	пробачати
37.	freeze [frJz]	froze [frɐV̩z]	frozen [frɐV̩zn]	заморожувати
38.	get [gɛt]	got [gɒt]	got [gɒt]	діставати
39.	give [gIv]	gave [gɛIv]	given [gIvn]	давати
40.	go [gɐV̩]	went [wɛnt]	gone [gɒn]	їхати, іти
41.	grow [grɐV̩]	grew [grʉ]	grown [grɐV̩n]	рости, ставати
42.	hang [hɤɴ]	hung [hʌɴ]	hung [hʌɴ]	висіти, вішати
43.	have [hɤv]	had [hɤd]	had [hɤd]	мати
44.	hear [hIq]	heard [hɐ:d]	heard [hɐ:d]	чути
45.	hide [həId]	hid [hId]	hidden [hIdn]	ховати
46.	hit [hIt]	hit [hIt]	hit [hIt]	вдарити
47.	hold [hɐV̩ld]	held [hɛld]	held [hɛld]	тримати
48.	hurt [hɐ:t]	hurt [hɐ:t]	hurt [hɐ:t]	спричиняти біль

49.	keep [kJp]	kept [kɐpt]	kept [kɐpt]	тримати, зберігати
50.	know [nɘV]	knew [njʜ]	known [nɘVn]	знати
51.	lay [lɐl]	laid [lɐld]	laid [lɐld]	класти
52.	lead [lJd]	led [lɐd]	led [lɐd]	вести
53.	lean [lJn]	leant [lɐnt] leaned [lJnd]	leant [lɐnt] leaned [lJnd]	притулятися
54.	learn [lɘ:n]	learnt [lɘ:nt] learned [lɘ:nd]	learnt [lɘ:nt] learned [lɘ:nd]	вивчати
55.	leave [lJv]	left [lɐʃt]	left [lɐʃt]	залишати, покидати
56.	lend [lɐnd]	lent [lɐnt]	lent [lɐnt]	позичати (комусь)
57.	let [lɐt]	let [lɐt]	let [lɐt]	дозволяти
58.	lie [ləl]	lay [lɐl]	lain [lɐln]	лежати, класти
59.	light [ləlt]	lit [llt]	lit [llt]	освітлювати
60.	lose [lʜz]	lost [lPst]	lost [lPst]	губити
61.	make [mɐlk]	made [mɐld]	made [mɐld]	робити, виготовляти
62.	mean [mJn]	meant [mɐnt]	meant [mɐnt]	означати, значити
63.	meet [mJt]	met [mɐt]	met [mɐt]	зустрічати
64.	pay [pɐl]	paid [pɐld]	paid [pɐld]	платити
65.	put [pVt]	put [pVt]	put [pVt]	класти
66.	read [rJd]	read [rɐd]	read [rɐd]	читати
67.	ride [rəld]	rode [rɘVd]	ridden [rldn]	їхати верхи
68.	ring [rlɴ]	rang [rχɴ]	rung [rɅɴ]	дзвонити
69.	rise [rəlz]	rose [rɘVz]	risen [rlzn]	підніматися
70.	run [rɅn]	ran [rχn]	run [rɅn]	бігти
71.	say [sɐl]	said [sχd]	said [sχd]	сказати

72.	see [ʂi:]	saw [ʂɔ:]	seen [ʂi:n]	бачити
73.	seek [ʂi:k]	sought [ʂɔ:t]	sought [ʂɔ:t]	шукати
74.	sell [ʂɛl]	sold [ʂɛʊld]	sold [ʂɛʊld]	продавати
75.	send [ʂɛnd]	sent [ʂɛnt]	sent [ʂɛnt]	посилати
76.	set [set]	set [ʂɛt]	set [ʂɛt]	встановлювати, заходити (про сонце)
77.	sew [ʂɛʊ]	sewed [ʂɛʊd]	sewn [ʂɛʊn] sewed [ʂɛʊd]	шити
78.	shake [ʃɛlk]	shook [ʃʊk]	shaken [ʃɛlkn]	трясти
79.	shave [ʃɛlv]	shaved [ʃɛlvd]	shaven [ʃɛlvn]	голитися
80.	shine [ʃaIn]	shone [ʃɒn]	shone [ʃɒn]	сяяти, блищати
81.	shoot [ʃu:t]	shot [ʃɒt]	shot [ʃɒt]	стріляти
82.	show [ʃɛʊ]	showed [ʃɛʊd]	showed [ʃɛʊd] shown [ʃɛʊn]	показувати
83.	shut [ʃʌt]	shut [ʃʌt]	shut [ʃʌt]	закривати
84.	sing [sIŋ]	sang [sɤŋ]	sung [sʌŋ]	співати
85.	shrink [ʃrIŋk]	shrank [ʃrɤŋk]	shrunk [ʃrʌŋk]	скорочувати(ся), відступати
86.	sit [sIt]	sat [sɤt]	sat [sɤt]	сидіти
87.	sleep [sli:p]	slept [slɛpt]	slept [slɛpt]	спати
88.	smell [smɛl]	smelt [smɛlt] smelled [smɛld]	smelt [smɛlt] smelled [smɛld]	пахнути
89.	sow [sɛʊ]	sowed [sɛʊd]	sown [sɛʊn]	сіяти
90.	speak [spi:k]	spoke [spɛʊk]	spoken [spɛʊkn]	говорити
91.	spell [spɛl]	spelt [spɛlt]	spelt [spɛlt]	вимовляти (по буквах)
92.	spend [spɛnd]	spent [spɛnt]	spent [spɛnt]	тратити,

				проводити час
93.	spread [sprɛd]	spread [sprɛd]	spread [sprɛd]	розповсюджувати
94.	spring [sprlɴ]	sprang [sprɤɴ]	sprung [sprʌɴ]	стрибати
95.	stand [stɤnd]	stood [stu:d]	stood [stu:d]	стояти
96.	steal [sti:l]	stole [stƐVl]	stolen [stƐVln]	красти
97.	stick [stlk]	stuck [stʌk]	stuck [stʌk]	приклеїти
98.	strike [stralk]	struck [strʌk]	struck [strʌk]	вдарити
99.	string [strlɴ]	strung [strʌɴ]	strunk [strʌɴ]	натягувати
100.	swear [swfq]	swore [swO:]	sworn [swO:n]	клястися
101.	sweep [swi:p]	swept [swɛpt]	swept [swɛpt]	замітати, мести
102.	swim [swlm]	swam [swɤm]	swum [swʌm]	плавати
103.	take [tɛlk]	took [tuk]	taken [tɛlkn]	брати
104.	teach [ti:C]	taught [tO:t]	taught [tO:t]	вчити (когось)
105.	tell [tɛl]	told [tƐVld]	told [tƐVld]	сказати, розказати
106.	think [Tlɴk]	thought [TO:t]	thought [TO:t]	думати
107.	throw [TrƐV]	threw [Tru:]	thrown [TrƐVn]	кидати
108.	understand [ʌndq'stɤnd]	understood [ʌndq'stVd]	understood [ʌndq'stVd]	розуміти
109.	wake [wɛlk]	woke [wƐVk]	woken [wƐVkn]	прокидатись
110.	wear [wƐq]	wore [wO:]	worn [wO:n]	носити (одяг)
111.	weep [wi:p]	wept [wɛpt]	wept [wɛpt]	плакати
112.	win [wln]	won [wʌn]	won [wʌn]	перемагати
113.	write [ralt]	wrote [rƐVt]	written [rltn]	писати

APPENDIX 4. Audioscripts

UNIT 1

MACHINES: EFFICIENCY AND MECHANICAL ADVANTAGE

MECHANICAL ADVANTAGE AND EFFICIENCY

In an ideal situation, the total amount of work done by a machine should equal the amount of work put onto it. However, due to friction, the output force is usually less than the input force. Machines with greater efficiency do a better job at overcoming the force of friction. For example, a pulley with 90% of the work input to lift a load, while the other 10% is used to overcome friction.

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Taken from https://www.youtube.com/watch?v=y_AfvpW-kbc

UNIT 2

MACHINE PARTS:

BEARINGS, GEARS, VALVES, RATCHET, GAUGE

JOURNAL BEARING WORKING PRINCIPLE

Journal bearings typically consist of a metal sleeve that fits around a shaft. The sleeve is held in place within a housing. The journal is simply the place on the shaft that is surrounded and supported by the bearing.

Journal bearings can be made out of metallic or nonmetallic materials. Examples of common metallic bearing materials include bronze or brass. This example of a nonmetallic bearing material is called phenolic. This fibrous synthetic material is used in power-generating applications because it does not conduct electricity.

Another common bearing material is called Babbitt. Babbitt is a soft alloy comprised of tin, copper and antimony. Babbitt is usually bonded to a shell of harder metal to give the bearing strength. Bearings are generally made out of material that is softer than the metal of the shaft. This helps to protect the shaft by allowing the bearing material to wear out first. Journal bearings usually have a lubricant groove on the inside surface of the bearing. This groove generally runs parallel to the shaft and helps distribute oil or grease along the shaft where the shaft passes through the bearing.

There are two basic types of journal bearings: solid journal bearings and split journal bearings. Solid journal bearings consist of a solid one-piece sleeve mounted in a one-piece housing. A solid journal bearing is sometimes called a bushing or a sleeve bearing depending on its thickness. A bushing is a relatively thin solid journal bearing that gets most of its strength from the housing in which it is mounted. The term “sleeve bearing” generally refers to a thick-walled journal

bearing. A split journal bearing consists of a two-piece bearing mounted in a two-piece housing.

The advantage of a split journal bearing over a solid journal bearing is that it can be separated into two halves. A split journal bearing is easier to service since it can usually be separated and removed from around the shaft without removing the shaft itself. Solid journal bearings can be more difficult to replace than other types of journal bearings. Frequently they must be slipped on and off the end of the shaft or the shaft must be removed through the bearing.

Taken from https://youtu.be/_cN1E8KUvmk

UNIT 3

MACHINE TOOLS OPERATIONS

INTRODUCTION TO METAL FORMING

Let's start with forging. It has come a long way from making just swords. It is now a process that can use much heavier forces than a hand in a hammer. Forging is when you put the workpiece in between two dies. The dies then apply force on both sides of the workpiece and that is to form it to its desired shape.

In extrusion, the work material is placed in a die where a ram will then push the material through and create the desired shape for the work material. An example of a product that would be created using the extrusion process would be solid aluminium cylinders.

Then there's rolling. Rolling takes work material and feeds it in between two rollers. The material gets continually fed into the rollers until the desired shape is achieved. One example of using rolling is to make structure beams.

Let's move on to the drawing process. It is similar to extrusion when instead of getting pushed through the die it is pulled through. One product that is made using drawing is a metal pipe. These types of processes are in a class called bulk deformation processes. They usually have significant deformations and massive shape changes. The starting work shapes are usually cylindrical billet or rectangular bars but in the end, the final shape is drastically different.

Taken from https://www.youtube.com/watch?v=RP4Y_aSBoNw

UNIT 4

APPLICATION OF HYDRAULICS IN MECHANICAL ENGINEERING

HOW DO HYDRAULIC MACHINES WORK?

Have you ever seen a tennis ball get completely squashed? Well, it's pretty cool and it's made possible by the power of liquids also known as hydraulics.

What's the first thing that comes to your mind when you think about water? Is it ocean waves or raindrops rippling a pond? Or is it something a little more extreme? Yeah! This is definitely not the first thing that came to my mind, but I kind of wish it was! It's common to associate water with things that are serene or peaceful, but when pressure is applied like with these jets, water can be very powerful. One of the most useful ways to use water and other liquids like it is in hydraulics.

Hydraulics move heavy machinery around using trapped liquid. And what makes a trapped liquid so powerful is how it deals with pressure or something pushing off.

Here I'll show you with this syringe. Right now the syringe is filled with air, if I push the plunger, the air comes out. If I put my finger on the end, I can still push the plunger down even though I'm keeping the air from coming out. That's because the air becomes compressed. You can tell, it's compressed because when I let go of the plunger it springs back into place. Let's try it again but with water instead of air. If I block the end with my finger and push down, the plunger doesn't push down easily. That's because water is a liquid, so it doesn't easily compress. Instead, it transfers the pressure from my push to the entire surface of the container. If I keep pushing all that pressure comes rushing out. Oops! I'll clean that up later.

What you just witnessed is a principle called Pascal's law. Who is Pascal? You may ask. Well, he was a French mathematician, physicist, religious philosopher and master of prose. What didn't braise Pascal do? Okay. Back to his law. It says that any pressure on a trap fluid is transmitted equally throughout the fluid. So, if you press in on one end of the syringe that push goes through this whole tube and pushes the other end out like this. This is basically the same way hydraulic machines get their power. The pistons that make these machines move are like giant syringes. If you push on one part of the fluid that push is transmitted to all the other parts. If you set up the machine right, you can end up with a ton of force transmitted from just a tiny push and you can lift super heavy things. Hydraulic machines are used to lift cars, building materials or even people.

Remember the soon to be smashed tennis ball. That was the handiwork of a machine called the hydraulic press. These machines are used for crushing cars, thinning glass and making swords. There are a bunch of other types of machines that use hydraulics to get jobs done. Construction vehicles, ferrous wheels and elevators utilize the power of hydraulics. Even some animatronics in movies and at amusement parks use hydraulics to bring lifelike movements to these amazing machines.

Now that you know a little more about hydraulics, you can experiment with this science at home. With tinker crate you can build different types of hydraulic machines like this claw. Put your new knowledge to the test and let's see what you can create. If you want to get this crate, check out kiwico.com. and if you're itching to make a hydraulic machine with materials you might already have at home, watch our video here. We can't wait to see what you create!

Taken from https://www.youtube.com/watch?v=KEs_h-ucJEs

UNIT 5

TYPES OF PUMPS

HOW DOES A CENTRIFUGAL PUMP WORK?

Centrifugal pumps are the most preferred pumping devices in the hydraulic world. In this video, we will have a conceptual overview of working of centrifugal pumps.

At the heart of the system lies the impeller. It has got a series of curved vanes, fitted inside shroud plates. The impeller is always immersed in water. When the impeller is made to rotate, it makes the fluid surrounding it also rotate. This imparts centrifugal force to the water particles and the water moves radially out. Since rotational mechanical energy is transferred to the fluid at discharge side of the impeller, both pressure and kinetic energy of water will rise. At the suction site water is getting displaced, so a negative pressure will be induced at the eye. Such a low pressure helps in sucking freshwater stream into the system again and this process continues. This is the reason why priming is important for centrifugal pumps. If no water is present initially, the negative pressure developed by the rotating air at the eye of impeller will be negligibly small to suck fresh stream of water. Impeller is fitted inside a casing, so the water moving out will be collected inside it and will move in the same direction of rotation of impeller to the discharge nozzle. Here you can note one specialty of casing. It has got increasing area along the flow direction. Such increasing area will help in accommodating newly added water stream and will also help in reducing exit flow velocity.

Reduction in flow velocity will result in increase of static pressure which is required to overcome resistance of pumping system. Here you can see more details of vanes inside impeller. They are backward curved vanes with state-of-the-art eye configuration. This vane is extracted from a KIRLOSKAR pump

model. If pressure at suction side of the impeller goes below vapor pressure of water, a dangerous phenomenon could happen. Water will start to boil forming vapor bubbles and spoil impeller materials over time. This phenomenon is known as cavitation. More the suction head, lesser should be the pressure at the suction side to lift the water. This fact puts a limit to maximum suction head a pump can have. Careful pump selection is required to avoid the problem of cavitation. The current impeller type is enclosed, semi-open and open impellers are also in use depending upon the application. If the working fluid is cloggy in nature, it is preferred to use open kind of impeller, but they are slightly less efficient. Mechanical design of centrifugal pump is always challenging.

A shaft is used to connect the impeller and the motor. Since water pressure inside the casing is huge, a proper sealing arrangement is imperative in arresting water leakage through the shaft casing clearance. Mechanical seal or stuffing box based mechanism is used for this purpose. Impeller is mounted on bearings, but at the suction side of impeller it is not advisable to fit a bearing since it will block the flow. So bearings have to be fitted at the other end. This means impeller is mounted like a cantilever. For high flow rate pumps a bearing housing with cooling oil is necessary for improving the life of bearings. We thank KIRLOSKAR brothers for their technical support in creation of this video.

Taken from https://www.youtube.com/watch?v=BaEHVpKc-1Q

UNIT 6.

MATERIAL PROPERTIES

MATERIALS AND THEIR PROPERTIES

You use objects every single day. But have you ever thought about what they are made of? Why are some bendy and some are really hard? Why are some smooth and shiny, and some bumpy and rough?

When it comes to the objects around us, they can be very different from one another. Can you think of some materials you see in the classroom or at home?

You might have come up with materials like glass, wood, plastic, metal, paper, fabrics, or rubber.

Do you know what the properties of some of these materials are? You might know that wood is hard, plastic is waterproof, fabrics and rubber are flexible, mental is strong and resistant.

Do you know how some of these are used and why they are chosen to make objects with? Objects are made from materials that are specially chosen depending on the purpose. This is because materials have special properties that help them do their job.

Take the umbrella. For example, the handle is made from hard materials, while the umbrella shield is often made from plastic. The hard materials were used for the handle because it is strong and perfect for supporting the top of the umbrella. The plastic was chosen because it is waterproof and light which lets the rain drip off while allowing you to carry it easily.

Why do you think we use glass for windows and reading glasses? You've probably already guessed. It is because you can see through it. These objects wouldn't be much use if they were made of wood.

You may have noticed by now that our clothes are made out of special materials as well. And these materials also have unique properties. Can you guess what materials your clothes are made of? They might be cotton, which is a fabric that helps you stay cool on a hot day. Well, they might be made from that is very good at keeping you warm on those cold winter days.

What do you think would happen if you wore a t-shirt made from metal? That would just be silly, wouldn't it? You wouldn't even be able to move. Can you now see why we choose certain materials for our clothing? They let us move easily and stay comfortable because they are flexible. And they help us keep warm or cool depending on the weather.

Now, which of these houses is different from the others? Of course, it's the house made out of flimsy paper that is different. Have you ever seen a house built from paper? No way. When it comes to building houses, we need to use tough materials such as bricks, glass, wood, and cement. So that they stay standing for a long time and don't blow over in the wind.

Now you know about materials and their awesome properties.

Taken from https://www.youtube.com/watch?v=340MmuY_osY

UNIT 7

STRENGTH OF MATERIALS

THE MATERIAL THAT COULD CHANGE THE WORLD ... FOR A THIRD TIME

Thousands of years ago, the Romans invented a material that allowed them to build much of their sprawling civilization. Pliny the Elder praised an imposing sea wall made from the stuff as “impregnable to the waves and every day stronger.” He was right: much of this construction still stands, having survived millennia of battering by environmental forces that would topple modern buildings.

Today, our roads, sidewalks, bridges, and skyscrapers are made of a similar, though less durable, material called concrete. There’s three tons of it for every person on Earth. And over the next 40 years, we’ll use enough of it to build the equivalent of New York City every single month.

Concrete has shaped our skylines, but that’s not the only way it’s changed our world. It’s also played a surprisingly large role in rising global temperatures over the last century, a trend that has already changed the world, and threatens to even more drastically in the coming decades. To be fair to concrete, basically everything humanity does contributes to the greenhouse gas emissions that cause global warming. Most of those emissions come from industrial processes we often aren’t aware of, but touch every aspect of our lives.

Look around your home. Refrigeration – along with other heating and cooling – makes up about 6% of total emissions. Agriculture, which produces our food, accounts for 18%. Electricity is responsible for 27%. Walk outside, and the cars zipping past, planes overhead, trains ferrying commuters to work – transportation, including shipping, contributes 16% of greenhouse gas emissions. Even before we use any of these things, making them produces emissions – a lot of emissions.

Making materials – concrete, steel, plastic, glass, aluminum and everything else – accounts for 31% of greenhouse gas emissions. Concrete alone is responsible for 8% of all carbon emissions worldwide. And it's much more difficult to reduce the emissions from concrete than from other building materials. The problem is cement, one of the four ingredients in concrete. It holds the other three ingredients – gravel, sand, and water – together. Unfortunately, it's impossible to make cement without generating carbon dioxide. The essential ingredient in cement is calcium oxide, CaO. We get that calcium oxide from limestone, which is mostly made of calcium carbonate: CaCO3. We extract CaO from CaCO3 by heating limestone. What's left is CO2 – carbon dioxide. So for every ton of cement we produce, we release one ton of carbon dioxide. As tricky as this problem is, it means concrete could help us change the world a third time: by eliminating greenhouse gas emissions and stabilizing our climate. Right now, there's no 100% clean concrete, but there are some great ideas to help us get there.

Cement manufacturing also produces greenhouse gas emissions by burning fossil fuels to heat the limestone. Heating the limestone with clean electricity or alternative fuels instead would eliminate those emissions. For the carbon dioxide from the limestone itself, our best bet is carbon capture: specifically, capturing the carbon right where it's produced, before it enters the atmosphere. Devices that do this already exist, but they aren't widely used because there's no economic incentive. Transporting and then storing the captured carbon can be expensive. To solve these problems, one company has found a way to store captured CO2 permanently in the concrete itself.

Other innovators are tinkering with the fundamental chemistry of concrete. Some are investigating ways to reduce emissions by decreasing the cement in concrete. Still others have been working to uncover and replicate the secrets of Roman concrete. They found that Pliny's remark is literally true. The Romans used volcanic ash in their cement. When the ash interacted with seawater, the

seawater strengthened it – making their concrete stronger and more long-lasting than any we use today.

By adding these findings to an arsenal of modern innovations, hopefully we can replicate their success – both by making long lasting structures, and ensuring our descendants can admire them thousands of years from now.

Taken from https://www.youtube.com/watch?v=hRI0ymx_6aw&t=43s

UNIT 8

USES OF MACHINES: AUTOMATION

THE JOBS WE'LL LOSE TO MACHINES – AND THE ONES WE WON'T

So this is my niece. Her name is Yahli. She is nine months old. Her mum is a doctor, and her dad is a lawyer. By the time Yahli goes to college, the jobs her parents do are going to look dramatically different. In 2013, researchers at Oxford University did a study on the future of work. They concluded that almost one in every two jobs have a high risk of being automated by machines.

Machine learning is the technology that's responsible for most of this disruption. It's the most powerful branch of artificial intelligence. It allows machines to learn from data and mimic some of the things that humans can do. My company, Kaggle, operates on the cutting edge of machine learning. We bring together hundreds of thousands of experts to solve important problems for industry and academia. This gives us a unique perspective on what machines can do, what they can't do and what jobs they might automate or threaten. Machine learning started making its way into industry in the early '90s. It started with relatively simple tasks. It started with things like assessing credit risk from loan applications, sorting the mail by reading handwritten characters from zip codes.

Over the past few years, we have made dramatic breakthroughs. Machine learning is now capable of far, far more complex tasks. In 2012, Kaggle challenged its community to build an algorithm that could grade high-school essays. The winning algorithms were able to match the grades given by human teachers. Last year, we issued an even more difficult challenge. Can you take images of the eye and diagnose an eye disease called diabetic retinopathy? Again, the winning algorithms were able to match the diagnoses given by human ophthalmologists. Now, given the right data, machines are going to outperform humans at tasks like this. A teacher might read 10,000 essays over a 40-year career. An ophthalmologist might see 50,000 eyes. A machine can read millions

of essays or see millions of eyes within minutes. We have no chance of competing against machines on frequent, high-volume tasks.

But there are things we can do that machines can't do. Where machines have made very little progress is in tackling novel situations. They can't handle things they haven't seen many times before. The fundamental limitations of machine learning is that it needs to learn from large volumes of past data. Now, humans don't. We have the ability to connect seemingly disparate threads to solve problems we've never seen before. Percy Spencer was a physicist working on radar during World War II, when he noticed the magnetron was melting his chocolate bar. He was able to connect his understanding of electromagnetic radiation with his knowledge of cooking in order to invent – any guesses? – the microwave oven.

Now, this is a particularly remarkable example of creativity. But this sort of cross-pollination happens for each of us in small ways thousands of times per day. Machines cannot compete with us when it comes to tackling novel situations, and this puts a fundamental limit on the human tasks that machines will automate. So what does this mean for the future of work? The future state of any single job lies in the answer to a single question: To what extent is that job reducible to frequent, high-volume tasks, and to what extent does it involve tackling novel situations? On frequent, high-volume tasks, machines are getting smarter and smarter. Today they grade essays. They diagnose certain diseases. Over coming years, they're going to conduct our audits, and they're going to read boilerplate from legal contracts. Accountants and lawyers are still needed. They're going to be needed for complex tax structuring, for pathbreaking litigation. But machines will shrink their ranks and make these jobs harder to come by.

Now, as mentioned, machines are not making progress on novel situations. The copy behind a marketing campaign needs to grab consumers' attention. It has to stand out from the crowd. Business strategy means finding gaps in the market, things that nobody else is doing. It will be humans that are creating the copy

behind our marketing campaigns, and it will be humans that are developing our business strategy. So Yahli, whatever you decide to do, let every day bring you a new challenge. If it does, then you will stay ahead of the machines. Thank you.

Taken from

https://www.ted.com/talks/anthony_goldbloom_the_jobs_we_ll_lose_to_machines_and_the_ones_we_won_t?utm_campaign=tedspread&utm_medium=referral&utm_source=tedcomshare

APPENDIX 5. Further Reading

TEXT 1

Read the text and answer the questions.

1. What is the primary objective of robotics, and how does it encompass various engineering and scientific disciplines?
2. In what types of environments and for what purposes are robots commonly used today, as mentioned in the text?
3. How did the term "robotics" originate, and who are some of the key figures associated with its introduction to the public?
4. When and where was the term "robotics" first used in print, and what was the context in which it was used?
5. What significant development in the field of robotics occurred in 1961, and how did it impact the use of robots in various industries?

Robotics

Robotics is an interdisciplinary branch of electronics and communication, computer science and engineering. Robotics involves the design, construction, operation, and use of robots. The goal of robotics is to design machines that can help and assist humans. Robotics integrates fields of mechanical engineering, electrical engineering, information engineering, mechatronics engineering, electronics, biomedical engineering, computer engineering, control systems engineering, software engineering, mathematics, etc.

The field of **robotics** develops machines that can automate tasks and do various jobs that a human might not be able to do. Robots can be used in many situations for many purposes, but today many are used in dangerous environments (including inspection of radioactive materials, bomb detection and deactivation), manufacturing processes, or where humans cannot survive (e.g., in space, underwater, in high heat, and clean up and containment of hazardous materials and radiation). Robots can take any form, but some are made to resemble humans

in appearance. This is claimed to help in the acceptance of robots in certain replicative behaviors which are usually performed by people. Such robots attempt to replicate walking, lifting, speech, cognition, or any other tasks mainly performed by a human. Many of today's robots are inspired by nature, contributing to the field of bio-inspired robotics.

Certain robots require user input to operate, while other robots function autonomously. The concept of creating robots that can operate autonomously dates back to classical times, but research into the functionality and potential uses of robots did not grow substantially until the 20th century. Throughout history, it has been frequently assumed by various scholars, inventors, engineers, and technicians that robots will one day be able to mimic human behavior and manage tasks in a human-like fashion. Today, robotics is a rapidly growing field, as technological advances continue; researching, designing, and building new robots serve various practical purposes, whether domestically, commercially, or militarily. Many robots are built to do jobs that are hazardous to people, such as defusing bombs, finding survivors in unstable ruins, and exploring mines and shipwrecks. Robotics is also used in STEM (science, technology, engineering, and mathematics) as a teaching aid.

The word *robotics* was derived from the word *robot*, which was introduced to the public by Czech writer Karel Čapek in his play *R.U.R. (Rossum's Universal Robots)*, which was published in 1920. The word *robot* comes from the Slavic word *robota*, which means work/job. The play begins in a factory that makes artificial people called *robots*, creatures who can be mistaken for humans – very similar to the modern ideas of androids. Karel Čapek himself did not coin the word. He wrote a short letter in reference to an etymology in the *Oxford English Dictionary* in which he named his brother Josef Čapek as its actual originator.

According to the *Oxford English Dictionary*, the word *robotics* was first used in print by Isaac Asimov, in his science fiction short story *"Liar!"*, published in May 1941 in *Astounding Science Fiction*. Asimov was unaware that

he was coining the term; since the science and technology of electrical devices is *electronics*, he assumed *robotics* already referred to the science and technology of robots. In some of Asimov's other works, he states that the first use of the word *robotics* was in his short story *Runaround* (Astounding Science Fiction, March 1942), where he introduced his concept of The Three Laws of Robotics. However, the original publication of "Liar!" predates that of "Runaround" by ten months, so the former is generally cited as the word's origin.

In 1948, Norbert Wiener formulated the principles of cybernetics, the basis of practical robotics.

Fully autonomous robots only appeared in the second half of the 20th century. The first digitally operated and programmable robot, the Unimate, was installed in 1961 to lift hot pieces of metal from a die casting machine and stack them. Commercial and industrial robots are widespread today and used to perform jobs more cheaply, more accurately, and more reliably than humans. They are also employed in some jobs which are too dirty, dangerous, or dull to be suitable for humans. Robots are widely used in manufacturing, assembly, packing and packaging, mining, transport, earth and space exploration, surgery, weaponry, laboratory research, safety, and the mass production of consumer and industrial goods.

Taken from: https://en.wikipedia.org/wiki/Robotics

TEXT 2

Read the text and answer the following questions:

1. What are the three basic similarities that all robots share in terms of their construction, as mentioned in the text?
2. What are the three different types of robotic programs mentioned, and how do they differ in terms of how robots operate?
3. How is the classification of robots becoming more relevant as they are designed for specific tasks, and what are some examples of specialized

robots mentioned in the text?

4. What are some of the current and potential applications of robots mentioned in the text, particularly in fields like agriculture and medicine?
5. Can you provide examples of commercial and home automation in the kitchen mentioned in the text, and what role do these robots play in food preparation?

Robotic aspects

There are many types of robots; they are used in many different environments and for many different uses. Although being very diverse in application and form, they all share three basic similarities when it comes to their construction:

1. Robots all have some kind of mechanical construction, a frame, form or shape designed to achieve a particular task. For example, a robot designed to travel across heavy dirt or mud might use caterpillar tracks. Origami inspired robots can sense and analyze in extreme environments. The mechanical aspect of the robot is mostly the creator's solution to completing the assigned task and dealing with the physics of the environment around it. Form follows function.
2. Robots have electrical components that power and control the machinery. For example, the robot with caterpillar tracks would need some kind of power to move the tracker treads. That power comes in the form of electricity, which will have to travel through a wire and originate from a battery, a basic electrical circuit. Even petrol-powered machines that get their power mainly from petrol still require an electric current to start the combustion process which is why most petrol-powered machines like cars, have batteries. The electrical aspect of robots is used for movement (through motors), sensing (where electrical signals are used to measure things like heat, sound, position, and energy status), and operation (robots need some level of electrical energy supplied to their motors and sensors in order to activate and perform basic operations).
3. All robots contain some level of computer programming code. A program

is how a robot decides when or how to do something. In the caterpillar track example, a robot that needs to move across a muddy road may have the correct mechanical construction and receive the correct amount of power from its battery, but would not be able to go anywhere without a program telling it to move. Programs are the core essence of a robot, it could have excellent mechanical and electrical construction, but if its program is poorly structured, its performance will be very poor (or it may not perform at all). There are three different types of robotic programs: remote control, artificial intelligence, and hybrid. A robot with remote control programming has a preexisting set of commands that it will only perform if and when it receives a signal from a control source, typically a human being with remote control. It is perhaps more appropriate to view devices controlled primarily by human commands as falling in the discipline of automation rather than robotics. Robots that use artificial intelligence interact with their environment on their own without a control source, and can determine reactions to objects and problems they encounter using their preexisting programming. A hybrid is a form of programming that incorporates both AI and RC functions in them.

As more and more robots are designed for specific tasks, this method of classification becomes more relevant. For example, many robots are designed for assembly work, which may not be readily adaptable for other applications. They are termed “assembly robots”. For seam welding, some suppliers provide complete welding systems with the robot i.e. the welding equipment along with other material handling facilities like turntables, etc. as an integrated unit. Such an integrated robotic system is called a “welding robot” even though its discrete manipulator unit could be adapted to a variety of tasks. Some robots are specifically designed for heavy load manipulation, and are labeled as “heavy-duty robots”.

Current and potential applications include:

- Military robots.
- Industrial robots. Robots are increasingly used in manufacturing (since the

1960s). According to the Robotic Industries Association US data, in 2016 the automotive industry was the main customer of industrial robots with 52% of total sales. In the auto industry, they can amount for more than half of the "labor". There are even "lights off" factories such as an IBM keyboard manufacturing factory in Texas that was fully automated as early as 2003.

- Cobots (collaborative robots).
- Construction robots. Construction robots can be separated into three types: traditional robots, robotic arm, and robotic exoskeleton.
- Agricultural robots (AgRobots). The use of robots in agriculture is closely linked to the concept of AI-assisted precision agriculture and drone usage. 1996-1998 research also proved that robots can perform a herding task.
- Medical robots of various types (such as da Vinci Surgical System and Hospi).
- Robot-assisted surgery designed and used in clinics.
- Kitchen automation. Commercial examples of kitchen automation are Flippy (burgers), Zume Pizza (pizza), Cafe X (coffee), Makr Shakr (cocktails), Frobot (frozen yogurts), Sally (salads), salad or food bowl robots manufactured by Dexai (a Draper Laboratory spinoff, operating on military bases), and integrated food bowl assembly systems manufactured by Spyce Kitchen (acquired by Sweetgreen) and Silicon Valley startup Hyphen. Home examples are Rotimatic (flatbreads baking) and Boris (dishwasher loading).
- Robot combat for sport – hobby or sports event where two or more robots fight in an arena to disable each other. This has developed from a hobby in the 1990s to several TV series worldwide.
- Cleanup of contaminated areas, such as toxic waste or nuclear facilities.
- High temperature crucibles allow robotic systems to automate sample analysis.

- Domestic robots.
- Nanorobots.
- Swarm robotics.
- Autonomous drones.
- Sports field line marking.
- Educational robotics. Robots such as LEGO® Mindstorms are used to teach coding, mathematics, and creative skills.

Taken from: https://en.wikipedia.org/wiki/Robotics

TEXT 3

Read the text and answer the following questions:

1. What are some advantages of using military robots in warfare, according to Lieutenant General Richard Lynch and Major Kenneth Rose?
2. How do military robots contribute to the potential improvement of soldiers' survivability on the battlefield?
3. What concerns and risks have been raised by human rights groups and experts regarding the development of lethal autonomous weapons systems (LAWS)?
4. Who are some notable individuals who have called for a ban on autonomous weapons, and where was this call made?
5. How do soldiers in the military develop emotional bonds with robots, and what factors contribute to these bonds?

Military robots: advantages and risks

Military robots are autonomous robots or remote-controlled mobile robots designed for military applications, from transport to search & rescue and attack. Some such systems are currently in use, and many are under development.

Advantages

Autonomous robotics would save and preserve soldiers' lives by removing serving soldiers, who might otherwise be killed, from the battlefield. Lt. Gen.

Richard Lynch of the United States Army Installation Management Command and assistant Army chief of staff for installation stated at a 2011 conference:

As I think about what's happening on the battlefield today ... I contend there are things we could do to improve the survivability of our service members. And you all know that's true.

Major Kenneth Rose of the US Army's Training and Doctrine Command outlined some of the advantages of robotic technology in warfare:

Machines don't get tired. They don't close their eyes. They don't hide under trees when it rains and they don't talk to their friends ... A human's attention to detail on guard duty drops dramatically in the first 30 minutes ... Machines know no fear.

Increasing attention is also paid to how to make the robots more autonomous, with a view of eventually allowing them to operate on their own for extended periods of time, possibly behind enemy lines. For such functions, systems like the Energetically Autonomous Tactical Robot are being tried, which is intended to gain its own energy by foraging for plant matter. The majority of military robots are tele-operated and not equipped with weapons; they are used for reconnaissance, surveillance, sniper detection, neutralizing explosive devices, etc. Current robots that are equipped with weapons are tele-operated so they are not capable of taking lives autonomously. Advantages regarding the lack of emotion and passion in robotic combat is also taken into consideration as a beneficial factor in significantly reducing instances of unethical behavior in wartime. Autonomous machines are created not to be "truly 'ethical' robots", yet ones that comply with the laws of war (LOW) and rules of engagement (ROE). Hence the fatigue, stress, emotion, adrenaline, etc. that affect a human soldier's rash decisions are removed; there will be no effect on the battlefield caused by the decisions made by the individual.

Risks

Human rights groups and NGOs such as Human Rights Watch and the Campaign to Stop Killer Robots have started urging governments and the United

Nations to issue policy to outlaw the development of so-called “lethal autonomous weapons systems” (LAWS). The United Kingdom opposed such campaigns, with the Foreign Office declaring that “international humanitarian law already provides sufficient regulation for this area”.

In July 2015, over 1,000 experts in artificial intelligence signed a letter calling for a ban on autonomous weapons. The letter was presented in Buenos Aires at the 24th International Joint Conference on Artificial Intelligence (IJCAI-15) and was co-signed by Stephen Hawking, Elon Musk, Steve Wozniak, Noam Chomsky, Skype co-founder Jaan Tallinn and Google DeepMind co-founder Demis Hassabis, among others.

Psychology

American soldiers have been known to name the robots that serve alongside them. These names are often in honor of human friends, family, celebrities, pets, or are eponymic. The “gender” assigned to the robot may be related to the marital status of its operator.

Some affixed fictitious medals to battle-hardened robots, and even held funerals for destroyed robots. An interview of 23 explosive ordnance detection members shows that while they feel it is better to lose a robot than a human, they also felt anger and a sense of loss if they were destroyed. A survey of 746 people in the military showed that 80% either ‘liked’ or ‘loved’ their military robots, with more affection being shown towards ground rather than aerial robots. Surviving dangerous combat situations together increased the level of bonding between soldier and robot, and current and future advances in artificial intelligence may further intensify the bond with the military robots.

Taken from: https://en.wikipedia.org/wiki/Military_robot

APPENDIX 6. Tests

UNIT TEST 1

1. What does a machine produce?
   a) direction
   b) force
   c) energy
   d) motion
2. What is the efficiency of a machine?
   a) the energy used up by friction
   b) the sum of the energy it supplies and the energy put into it
   c) the ratio between the energy it supplies and the energy put into it
   d) the ratio of the force exerted by the machine to the force applied to the machine
3. What is the mechanical advantage?
   a) the distance from the load to the fulcrum
   b) the ratio of the force exerted by the machine to the force applied to the machine
   c) the sum of the efforts required to raise the load
   d) the ratio between the energy it supplies and the energy put into it
4. Which simple machine may be called a spiral inclined plane?
   a) the wedge
   b) the pulley
   c) the screw
   d) the wheel and axle
5. Which simple machine has a revolving circular object and a rope?
   a) the pulley
   b) the screw
   c) the wedge
   d) the lever
6. Which is not a simple machine?

a) lever
b) pulley
c) ratio
d) wheel

7. In order to lift a load, a person can conveniently _____ on a rope, using the weight of the body.
   a) pull down
   b) pick up
   c) break down
   d) turn up
8. The wheel-and-axle machine is used to transport heavy goods by _____ rather than by sliding.
   a) bending
   b) rolling
   c) lifting
   d) grinding
9. Machines with greater efficiency do a better job at overcoming the force of _____.
   a) friction
   b) nature
   c) energy
   d) motion
10. Due to friction, the output force is usually _____ that the input force.
    a) much more
    b) more
    c) the same
    d) less

UNIT TEST 2

1. This is a device that opens and closes to control the flow of liquids or gases.
   a) valve
   b) bearing
   c) gear
   d) ratchet
2. This is a small wheel with teeth-like parts around its edge that fit against similar parts on a larger wheel or a rack.
   a) mechanical advantage
   b) engine
   c) pinion
   d) gauge
3. This is a machine that uses the energy from liquid fuel or steam to produce movement.
   a) torque
   b) engine
   c) gauge
   d) roller bearing
4. It is a soft alloy comprised of tin, copper and antimony.
   a) copper
   b) aluminium
   c) Babbitt
   d) steel
5. Mechanical valves include _____.
   a) check valves
   b) relief valves
   c) manual valves and automatic control valves
   d) all of the above

6. Non-metallic gears have _____.
    a) low noise and high load-carrying capacity
    b) high noise and high load-carrying capacity
    c) high noise and low load-carrying capacity
    d) low noise and low load-carrying capacity
7. What is the function of bearings?
    a) They reduce friction and wear by enabling rotating and sliding parts to move smoothly.
    b) They are used to measure such quantities as pressure, temperature, water level, and thickness.
    c) They usually mesh at a right angle to transmit power between intersecting axles.
    d) They use the energy from liquid fuel or steam to produce movement.
8. Gauge is an instrument used for _____.
    a) measurement
    b) machining
    c) compression
    d) rotation
9. The surfaces in a bearing may also be separated by _____; these are known as rolling bearings.
    a) balls
    b) rollers
    c) needles
    d) all of the above
10. Ratchet often consists of a _____ and a pawl.
    a) journal bearings
    b) notched wheel
    c) herringbone gear
    d) water-level gauge

UNIT TEST 3

1 Which of the following processes is not grouped under the metal removal process?

a) turning
b) milling
c) rolling
d) boring

2 Advanced machine tool operations are used chiefly to make large steel dies for the manufacture of car parts and other parts. These methods include _____.

a) electrical discharge machining
b) electrochemical machining
c) chemical machining
d) all of the above

3 What operations does metal forming include?

a) forging
b) pressing
c) bending and shearing
d) all of the above

4 What are the main types of forming machines?

a) forging machines
b) presses
c) press brakes and shears
d) all of the above

5 This is a machine for changing the shape of a piece of wood, metal, etc. that works by turning the material while a sharp tool is pressed against it.

a) a bandsaw
b) a broach
c) a lathe
d) a grinding wheel

6 Choose the main parts of a lathe.

a) bed
b) tailstock
c) workpiece
d) carriage

7 Which of the following is the type of nontraditional machining?

a) turning
b) drilling
c) milling
d) none of the mentioned

8 High-energy rate forming involves _____.

a) transmitting pressure through a liquid, usually water, to force sheet metal into the contours of a die
b) smoothing wood with a hand plane
c) shaping without the removal of any material
d) producing aeroplane wing sections as long as 24 metres

9 What is CNC Machining?

a) This is a round tool with several cutting edges that rotates against a workpiece.
b) This is a piece of metal or other material that is in the process of being worked on or made or has been cut or shaped by a hand tool or machine.
c) In this operation, the workpiece is covered by a chemically resistant mask.
d) This is a manufacturing process in which pre-programmed computer software dictates the movement of factory tools and machinery.

10 The metal removal process, where the material is removed by particles.

a) turning
b) abrasive process
c) drilling
d) none of the mentioned.

UNIT TEST 4

1. What is hydraulics?
   a) Hydraulics is the branch of chemistry that studies the behavior of liquids at rest and in motion.
   b) Hydraulics is the branch of mathematics that studies the behavior of liquids at rest and in motion.
   c) Hydraulics is the branch of physics that studies the behavior of liquids at rest and in motion.
   d) Hydraulics is the branch of phylosophy that studies the behavior of liquids at rest and in motion.

2. What are two basic types of hydraulic engines?
   a) rotary engines and turbines
   b) reciprocating engines and turbines
   c) reciprocating engines and pumps
   d) turbines and pumps

3. What do the Laws of hydrostatics describe?
   a) the behavior of liquids at rest
   b) the behavior of liquids and gases at rest
   c) the behavior of liquids in motion
   d) the behavior of gases at rest

4. Some hydraulic machines, including turbines, operate by the _____ of a flowing fluid.
   a) load
   b) pressure
   c) force
   d) motion

5. Hydrostatics describes the behavior of liquids _____.
   a) under different conditions
   b) under pressure
   c) at rest
   d) in motion

6. Hydrodynamics is concerned with the behavior of liquids _____.
   a) in motion
   b) at rest
   c) in tubes
   d) under heavy loads

7. Hydraulics is studied and applied in two of the specialty fields of engineering:
   a) electrical engineering and mechanical engineering
   b) civil engineering and mechanical engineering
   c) civil engineering and chemical engineering
   a) chemical engineering and electrical engineering

8. One principle of hydrostatics states:
   a) The pressure caused by the shape of a column of fluid is determined by the height of the column.
   b) The pressure caused by the height of a column of fluid is determined by the height of the column.
   c) The pressure caused by the weight of a column of fluid is determined by the height of the column.
   d) The pressure caused by the form of a column of fluid is determined by the height of the column.

9. Archimedes' principle states:
    a) An object placed in a fluid seems to lose an amount of weight equal to the weight of the fluid it displaces.
    b) An object placed in a fluid seems to take an amount of weight equal to the weight of the fluid it displaces.
    c) An object placed in a fluid seems to return an amount of weight equal to the weight of the fluid it displaces.
    d) An object placed in a fluid seems to give an amount of weight equal to the weight of the fluid it displaces.

10. Pascal's law states:
    a) A fluid in a container transmits stress equally in all directions.
    b) A fluid in a container transmits motion equally in all directions.
    c) A fluid in a container transmits torque equally in all directions.
    d) A fluid in a container transmits pressure equally in all directions.

UNIT TEST 5

1. What is pump?
   a) Pump is a device that moves or compresses liquids and gases.
   b) Pump is a mechanism that moves or compresses liquids and gases.
   c) Pump is an engine that moves or compresses liquids and gases.
   d) Pump is a motor that moves or compresses liquids and gases.
2. What are two major types of pumps?
   a) dynamic pumps and displacement pumps
   b) centrifugal pumps and jet pumps
   c) rotary pumps and electromagnetic pumps
   d) dynamic pumps and positive displacement pumps
3. Most pumps are made of _____.
   a) steel
   b) plastic
   c) iron
   d) cast iron
4. _____ pumps maintain a steady flow of fluid.
   a) Positive displacement
   b) Electromagnetic
   c) Centrifugal
   d) Dynamic
5. _____ pumps are the most widely used positive displacement pumps.
   a) Gear
   b) Jet
   c) Rotary
   d) Centrifugal
6. Which is not a dynamic pump?
   a) centrifugal pump
   b) axial-flow pump

c) jet pump

d) gear pump

7. Which is not a positive displacement pump?

a) gear pump

b) lobe pump

c) sliding vane pump

d) centrifugal pump

8. Centrifugal pumps are inexpensive and can handle _____ amounts of fluid.

a) handle

b) maintain

c) pump

d) compress

9. Gas pumps are also called _____.

a) actuators

b) compressors

c) engines

d) jets

10. There are three main types of rotary pumps:

a) dynamic pumps, positive displacement pumps, jet pumps

b) electromagnetic pumps, centrifugal pumps, gear pumps

c) gear pumps, lobe pumps, sliding vane pumps

d) lobe pumps, centrifugal pumps, gear pumps

UNIT TEST 6

1. The properties of the material are: _____.
   a) mechanical and chemical
   b) physical
   c) dimensional
   d) all of the above
2. Strength is the ability of _____.
   a) a material to resist the externally applied forces with breakdown or yielding
   b) certain solids to undergo permanent changes in shape without breaking
   c) a solid to return to its original shape and size after it has been deformed by a force
   d) a material to carry an electrical charge
3. Ductility is a property of _____.
   a) aluminium and gold
   b) iron and nickel
   c) silver
   d) all of the above
4. Nonductile metal is _____.
   a) platinum
   b) silver
   c) zinc
   d) copper
5. _____ determines the size.
   a) rectangular
   b) curvature diameter
   c) square
   d) circular

6. Chemical properties of the metals involve _____.
    a) corrosion resistance
    b) chemical composition and acidity
    c) alkalinity
    d) all of the above
7. Hardness is the ability of _____.
    a) the ability of a solid to return to its original shape and size after it has been deformed by a force
    b) the ability of metals to be pressed or hammered into thin sheets
    c) the property of a material opposite to ductility.
    d) the ability of a material to scratch a mark on other substances, or to resist being scratched by them
8. _____ is considered as brittle material.
    a) Cast iron
    b) Transformation-toughened zirconia
    c) Silicon carbide
    d) Mercury
9. The opposite of brittle is _____.
    a) crisp
    b) fragile
    c) ductile
    d) friable
10. _____ is the ability of many metals to be pressed or hammered into thin sheets.
    a) Viscosity
    b) Malleability
    c) Corrosion
    d) Elasticity

UNIT TEST 7

1. The strength of a material depends on its _____ properties.
   a) mechanical
   b) chemical
   c) physical
   d) dimensional
2. This internal resistance of a material to such a force is called _____.
   a) force
   b) compression
   c) stress
   d) tension
3. The force that pushes a material together is called _____.
   a) compression
   b) stress
   c) tension
   d) torsion
4. The force that pulls a material apart is called _____.
   a) torsion
   b) compression
   c) stress
   d) tension
5. The change in shape of a material is called _____.
   a) compression
   b) deformation
   c) tension
   d) stress
6. Deformation per unit of length is called _____.
   a) torsion
   b) strain
   c) stress
   d) force

7. The ratio of stress to strain in a material is called _____.
    a) the modulus of elasticity
    b) measure of the material's ability to compress
    c) elasticity
    d) deformation
8. Materials undergo three types of stress: _____.
    a) tensile
    b) compressive
    c) shearing
    d) all of the above
9. Tensile stress causes a material _____.
    a) to stretch
    b) to compress
    c) to twist
    d) to deform
10. Combined stresses cause _____.
    a) flexure and bending
    b) torsion and twisting
    c) flexure and torsion
    d) none of the above

UNIT TEST 8

1. In manufacturing, automated machines make certain products _____ than human workers can.
   a) more cheaply
   b) more accurately
   c) more quickly
   d) all of the above
2. An automated system has devices called _____, which provide information about the results of the machine's operation and about certain environmental conditions that affect its performance.
   a) switches
   b) sensors
   c) systems
   d) assembly lines
3. The use of feedback to regulate machines distinguishes automation from _____.
   a) mechanization
   b) assembly lines
   c) robots
   d) automated guidance systems
4. A mechanized robot has no _____ system and so cannot adjust its operation to changing conditions.
   a) sensor
   b) power
   c) electrical
   d) feedback
5. Growing numbers of technical workers may be needed to build and maintain _____.
   a) automated systems

b) electrical systems
c) mechanical systems
d) none of the above

6. Automation also is used for jobs that are so _____ that people are not able to perform them effectively over long periods of time.
   a) routine
   b) boring
   c) degrading
   d) all of the above
7. Automated systems can make decisions that are beyond the _____ of people to make.
   a) work
   b) idea
   c) capacity
   d) none of the above
8. High-speed military aircraft sometimes fly at very low _____ in order to avoid detection by enemy radar.
   a) height
   b) altitudes
   c) level
   d) rise
9. Automated machinery, however, is well suited to such routine tasks as _____ manufactured products.
   a) assembling
   b) inspecting
   c) packaging
   d) all of the above

10. Cars are painted by robots in spray booths containing high concentrations of airborne paint _____ that are harmful to people.
    a) participles
    b) powder
    c) particles
    d) principles