

(Вакуумная техника)

Pre-reading Exercises

1. Read the following international words, define their meanings.

vacuum	television	operation	original
total	temperature	constant	photoelectric
perfect	cylinder	design	electron
method	radio	progress	chemical
gas	radar	vitamins	lift
theory	microscope	antibiotics	coffee

2. Match English and Russian equivalents.

- | | |
|---------------------------------|-----------------------------------|
| 1. perfect vacuum | a) химические изменения |
| 2. empty space | b) кофеварка |
| 3. lift pump | c) абсолютный вакуум |
| 4. high vacuum | d) космос |
| 5. boiling temperature | e) фармацевтические производители |
| 6. coffee maker | f) абсолютный вакуум |
| 7. chemical changes | g) термос |
| 8. hot filament | h) всасывающий насос |
| 9. pharmaceutical manufacturers | i) температура кипения |
| 10. vacuum bottle | g) высокий вакуум |
| 11. outer space | h) высокий вакуум |

3. Read the text carefully and translate it into Russian.

TEXT A. VACUUM – GENERAL SURVEY

A perfect vacuum would be a space from which all matter has been removed. This includes solids, liquids, gases (including air) or any other impurities. It would be a space that contains "nothing". Since there is no method or device that can remove all matter from an enclosed space, a perfect vacuum is unknown and has only theoretical meaning. It was once thought that a perfect vacuum might exist in outer space. Now scientists know that the apparently empty space between the stars contain a large mass of gas, which is mostly hydrogen.

An incomplete, or partial vacuum can be created with vacuum pumps. When a very high percentage of gas is removed from a space, it is called a high vacuum and is equal to a very low pressure. Partial vacuums are common. The vacuum bottle has a partial vacuum between double walls. The vacuum keeps liquids near their original temperatures by preventing heat conduction. A partial vacuum must be created in the cylinder of an automobile engine in order to form the air-gas mixture essential to combustion. The vacuum cleaner, vacuum coffee maker, and suction plunger depend upon partial vacuums for their operation. Electric-light bulbs have air removed so that the hot filament will not burn up in the oxygen in the air. The piston movement of a lift pump creates vacuum, allowing water to rise.

Industry has developed many profitable vacuum processes. Liquids under vacuum boil at a temperature lower than the normal boiling temperature. This fact has been useful to food and pharmaceutical manufacturers. Solutions of milk, sugar and fruit and vegetable juices are

concentrated under vacuum. This permits the water to boil off at a low temperature and prevents scorching of the product. Vitamins and antibiotics are processed under vacuum to avoid chemical changes that would occur at higher temperatures.

In 1906 evacuated glass tube was built that could increase the power of an electric signal by many times the original amount. It introduced the age of electronic communicating that gave us radio, television, radar. Vacuum tubes perform vital tasks in the operation of photoelectric cells, electron microscopes, and hundreds of other types of electronic equipment.

The scientists' interest on vacuum is constant. The history of progress in the study of vacuum is also the history of vacuum-pump design. At present there exist a great variety of vacuum pumps, compressors, chambers, devices, other types of equipment, and different technological processes in which vacuum is used.

Notes:

matter – материя *partial* – частичный *vacuum cleaner* – пылесос *apparently* – вероятно,
impurity – примесь, *suction plunger* – всасывающий поршень, *vacuum bottle* – термос, *lift pump* – всасывающий насос, *chamber* – камера, *oxygen* – кислород, *hydrogen* – водород

Comprehension Check

4. Decide whether these statements are true or false according to the text.

1. A perfect vacuum would be a space that contains "nothing".
2. A perfect vacuum is unknown and has only theoretical meaning.
3. Now scientist know that the apparently empty space between the stars contain a large mass of gas, which is mostly oxygen.
4. Partial vacuum can be created with vacuum pumps.
5. The piston movement of a lift pump creates vacuum, allowing dust to rise.
6. Liquids under vacuum boil at a temperature higher than the normal boiling temperature.
7. The scientists' interest on vacuum is constant
8. Vacuum is widely used.

5. Complete the sentences.

1. A perfect vacuum is unknown and...
2. The scientists say that the apparently empty space between the stars contains...
3. An incomplete, or partial vacuum can be created with...
4. The vacuum bottle has a partial vacuum between...
5. Vitamins and antibiotics are processed under vacuum to...
6. Vacuum tubes perform vital tasks....
7. The scientists' interest on vacuum is....

6. Answer the questions to the text.

1. What is vacuum?
2. Does perfect vacuum have a practical or theoretical meaning?
3. What gas is contained between the stars of an apparently empty space? 4. How can partial vacuum be created? 5. What examples of partial vacuum can you give? 6. In what way is vacuum useful? 7. What is the aim of vacuum tubes? 8. What is the attitude of scientists towards vacuum?

Vocabulary Practice

7. Study the following parts of derivatives. Transform as in the models below.

VERB	NOUN	ADJECTIVE	ADVERB
to contain	containment	theoretical	theoretically
to remove	removing/removal	apparent	apparently
to exist	existence	profitable	profitably
to create	creation	original	originally
to prevent	prevention	constant	constantly
to depend	dependence	chemical	chemically
to develop	development	historical	historically
to avoid	avoidance	usual	usually
to move	movement	most	mostly
to equip	equipment	clear	clearly

Model 1: to contain liquids – the containment of liquids

to remove all matter from an enclosed space, to create partial vacuum, to prevent heat conduction, to move the piston, to develop vacuum processes, to use vacuum

Model 2: a theoretical existence - to exist theoretically

an apparent containment, profitable vacuum processes, an original design, practical vacuum application

Lexical & Grammar Aspect

8. Choose the right word.

- A perfect vacuum would be a space from which all has been removed.
a) metal b) matter c) matt
- When a very high percentage of is removed from a space, it is called a high vacuum.
a) liquid b) solid c) gas
- A partial vacuum must be created in the of an automobile engine.
a) cylinder b) covering c) computer
- The piston movement of a lift pump creates vacuum, allowing..... to rise.
a) air plane b) water c) balloon
- Glass tube introduced the age of communicating.
a) commercial b) electronic c) language

9. Insert the right words.

- a) boil b) chemical c) vital d) common e) profitable
f) interest g) vacuum pumps h) constant

- Partial vacuums are
- Industry has developed many vacuum processes.
- Liquids under vacuum at a temperature lower than the normal boiling temperature.
- Vitamins and antibiotics are processed under vacuum to avoid changes.

- Vacuum tubes perform tasks in the operation of photoelectric cells, electron microscopes, etc.
- The scientists' on vacuum is constant.
- An incomplete, or partial vacuum can be created with....

10. Match the words and terms with their definitions.

- a) device b) vacuum c) gas d) piston e) design
- drawing or outline from which something may be made
 - something invented for a special purpose
 - space completely empty of substance
 - any air-like substance
 - plate or short cylinder used in engines, pumps, etc. to pas on motion

Summarizing

11. Make a short summary of the text. Do it according to the following plan.

- The title of the text is...
- The text is devoted to ...
- The text consists of (how many logical parts?)
- The first part deals with....
- The second (third, forth, etc.) part describes/underlines/states....
- The main idea of the text is ...
- The importance of ... is underlined.
- Attention is paid to....

TEXT B. MODERN VACUUM TECHNOLOGY APPLICATION

1. Skim the text and answer the questions below. Define the international words' meanings.

Our world is viewed in a very different way today than it was a hundred, fifty or even ten years ago, and not just in the types of products we manufacture but how we manufacture these products.

With more and more of today's technologies entering miniaturization and demand for precision reaching tolerance, which only can be read by an electron microscope, vacuum coatings and thin film technologies are rapidly branching out (расширяясь) to new industries every day.

There is a world-class family of vacuum products to meet the evolving challenges of the markets. Engineers as well as common people have a deep understanding of the role that vacuum plays at every step. Fascinating vacuum pumping solutions are being found that reduce costs while enhancing performance. Collaborative engineering contribute to assessing customer applications with an expert eye, addressing requirements and adding value to the end product.

Vacuum Technology and Equipment are being developed in many parts of the planet, such as Africa, America, Belarus, Canada, China, Denmark, France, India, Italy, Russia, Taiwan, U.K. etc. Various vacuum pumps, compressors, portable equipment and stationary industrial vacuum systems are developed and produced there.

Vacuum systems and technologies aim to provide unrivalled customer service by being industry focused. Primarily, the industry segments can be divided into three divisions, which are Chemical, Industrial, Energy and Environmental.

1. *Pharmaceutical end products* in Chemical Division produce and package pharmaceuticals in the form of tablets, vials and ointments. Establishments in this industry may undertake one or more of several processes, including such as chemical synthesis, fermentation, distillation, solvent extraction and recovery, filling, freeze drying, separation, vacuum drying, etc.

2. *Food, drink and beverage industry in Industrial Division* means production process, which must meet high standards of purity to preserve the unique characteristics of the brand. Creating a soft drink's unique flavour and ensuring the purity of bottled water, stringent production and

quality standards are of importance. Typical throughput modes for this division are filling, distillation, degassing, cooling water, product transfer, cleaning, mixing, packaging, etc.

3. Power generation in Energy & Environmental Division comprises establishments primarily engaged in operating electric power generation facilities. These facilities convert other forms of energy, such as waterpower, fossil fuels, nuclear power and solar power into electrical energy. Typical applications in energy generation are boiler feed, condensate, water - cooling, heat transfer.

Vacuum technology and equipment are applied in various branches in Belarus: carpet production, beer production, soap production, poultry processing, textile industry, water purifying, tire production, jewelry and household appliances making, leather working, etc. Sputtering is quite a new technological process applied in Belarus though it is not very widely used because of its high cost.

Notes:

Tolerance – допустимый предел, vacuum coating – вакуумное покрытие, thin film – тонкая плёнка, meet the evolving challenge – соответствовать прослеживаемым тенденциям/притязаниям, collaborative engineering – совместные инженерные проекты/общее инженерное дело, performance – производительность/эффективность, unrivalled – не имеющий себе равных, solvent extraction – экстракция растворителем, recovery – восстановление/рекуперация, degassing – откачивание газа, throughput modes – режимы/способы производительности, end products – конечные продукты, sputtering – напыление, cost – стоимость

1. What is our world today? 2. What is necessary to take into account in manufacturing? 3. What is the main tendency in the market now? 4. Who shows interest to vacuum technology development? 5. What can you say about the application of vacuum in industry? 6. In what way is vacuum technology and equipment applied in Belarus? 7. How is the new technological process employed called? 8. Is sputtering widely used, why?

TEXT C. A BIT OF HISTORY

1. Scan the text and describe the major milestones of Otto von Guericke activity.

Otto von Guericke was born November 20, 1602 in Magdeburg, Germany, and died in May 11, 1686. But he managed to make a great contribution into the whole science and vacuum equipment, in particular. The German physicist, engineer, scientist, and natural philosopher, Otto von Guericke invented the first air piston pump and used to study vacuums and the role of the air in combustion and respiration processes. Thus, his major scientific achievement was the establishment of the physics of vacuum. The first piston type vacuum pump was invented by Otto von Guericke to pump water out of the mine as far back as 1640. His latter pump designs used lever-operated pumping systems. With his experiments Guericke proved that substances were not pulled by a vacuum, but were pushed by the pressure of the surrounding fluids.

In 1663, von Guericke also built the first machine to create an electric spark. Guericke applied the barometer to weather prediction and thus prepared the way for meteorology. His later works focused on electricity. He invented the first electrostatic generator.

The German scientist Otto von Guericke was the first to demonstrate the properties of vacuum in a practical way by his well-known "Magdeburg Experiment" in 1654. The scientist joined two small copper hemispheres (i.e., 20 inches [51 cm] in diameter) in an enclosed space. Then he pumped the air out of that enclosure and rigged a team of eight horses together to attempt to separate the hemispheres. The horses could not pull them apart. Later he used 16 horses. They were also unable to separate two evacuated copper hemispheres. Once the air was

allowed back into the container the spheres were easily moved apart. Thus, the power of the vacuum was realized.

Many researchers of the past made a contribution to the development of vacuum science, namely: Evangelista Torricelli, Ludwig Eduard Boltzmann, Michael Faraday, Thomas Edison, Amadeo Avogadro, John Dalton, Robert Boyle.

Robert Boyle (born January 25, 1627, in Ireland) was a chemist and a natural philosopher. He was noted for his pioneer experiments on the properties of gasses and investigated whether small animals survive in a vacuum. The idea of "empty space" has been an important notion of art. Thus, Boyle's experiment became part of the standard repertoire of the eighteenth-century so called "travelling scientists". A home theatre performance of this sort is shown in famous picture by Joseph Wright of Derby: "An Experiment on a Bird in the Air Pump", 1768. Nowadays there are also artists who pay attention to vacuum, for example, Igor Poyarkov.

In 2004 spectators in Germany were again impressed by the Otto von Guericke experiment made in the open air with the teams of draft horses. They say the most of the audience believed that present day draft horses would be able to separate the hemispheres, but their hopes were not justified.

Except being a physicist, scientist, engineer, natural philosopher Otto von Guericke was also the first showman.

Notes:

combustion and respiration – сгорание, окисление и дыхание, make a great contribution – вносить вклад, piston pump – поршневой насос, electric spark – искровой разряд, hemispheres – полушары, enclosure – камера, корпус, rig a team – приспособить упряжку, be impressed by – находиться под впечатлением, draft horse – упряжная лошадь, тяговая лошадь, repertoire – репертуар, спектр, design – модель, дизайн

2. Skim the text and answer the questions.

2.1. What is Otto von Guericke? 2.2. Where and how was the Otto von Guericke experiment made? 2.3. Who else made a contribution into vacuum technology? 2.4. What did Robert Boyle pay his special attention to? 2.5. Did only scientists study vacuum? 2.6. Which animals: tigers, rabbits, lions, cats, dogs or horses were used in Magdeburg experiment, why? 2.7. Was this experiment repeated? 2.8. Are you interested in arts?

TEXT D. PUMPS

1. Skim the text and answer the questions below. Define the international words' meanings.

A pump is the device that expends energy to raise, transport, or compress fluids—liquids and gases. Vacuum pump is a device for reducing the pressure of a gas in a vessel by removing the gas. The term pump is generally used for liquid-handling or hand-operated devices while the term compressor is used when the pressure of a gas is increased in a motor-driven machine. A gas pump is generally called a compressor. The German scientist Otto von Guericke was the first to demonstrate the properties of vacuums in a practical way. The scientist's first pumps were inverted pumps (for fire fighting) and could evacuate larger volumes of air than could be done using static methods.

The vacuum pump was originally invented to help chemists to study the properties of gases and the newly discovered phenomenon called electricity. The history of progress in the study of vacuum is the history of vacuum-pump design. Before 1900, most pumps were hand-operated ones. In the 20th century the rotary oil pump, the molecular pump, the vapor condensation pump, and the oil diffusion pump were developed. These pumps made a high vacuum possible. Now it is known that efficient pumps can reduce the pressure of the gas to between 100 and 0.1 Pascal.

Perhaps the best-known pump is the human heart. Blood enters the heart through a set of one-way inlet valves. As the fluid container – the heart contracts, pressure is increased and the blood is forced into the arteries through one-way outlet valves. In machines, only the fluid is compressed, rather than contracting the whole container. A vacuum pump removes air from a container to create a vacuum. Force pumps of many types are used for vacuum pumps including rotary pumps and piston pumps. In the 21st century the vacuum pump has become a major necessity for the progressive lifestyle.

Pumps can be classified on four main principles: on the working pressure region; on the principle of operation; on the number of stages (single stage, multistage); on service fluid. There are different pump types:

- Dry Pumps (non-lubricated) provide a clean vacuum over the entire vacuum range. Dry pumps require little maintenance and don't generate any waste material.

- Water-Lubricated Pumps provide a rough vacuum at low initial cost and are very simple to operate. These pumps are corrosion resistant but are not suitable for water vapor sensitive systems.

- Oil-Lubricated Pumps offer high capacities, high vacuum/pressure levels, and lower noise levels. Diffusion pumps feature an ultra-high vacuum. Oil-lubricated pumps, however, require routine maintenance and oil changes, and the oil may contaminate your vacuum. There are also Rotary-Vane Pumps and others.

Osmotic pumps are based on the principle of osmosis and find their practical application in medicine.

Some examples of the present day vacuum pump designs and their characteristics are in the table below.

Primary/Rough Vacuum



Dry Scroll Pumps Oil-free, for absolutely clean applications. From atmosphere to 10^{-2} mbar



Rotary-Vane Pumps Includes the new Smart Pumps. From atmosphere to 2×10^{-3} mbar

High and Ultra-High Vacuum



Diffusion Pumps High-performance, cost-effective process pumps. From 10^{-1} to 10^{-4} mbar.



Turbo-molecular Pumps Process pumps with monolithic rotors and high fore-pressure tolerance. From 10 to 10^{-10} mbar.



Ion Pumps Ultra-high vacuum pumps in diode, noble diode, and Star-Cell® versions. From 10^{-8} to 10^{-11} mbar.

Vacuum pumps are used in many industrial and scientific processes including:

- The production of most types of electric lamps, vacuum tubes, and CRTs where the device is either left evacuated or re-filled with a specific gas or gas mixture
- Semiconductor processing, notably ion implantation and sputtering
- Electron microscopy
- Medical processes that require suction
- Mass spectrometers to create an ultra high vacuum between the ion source and the detector
- Vacuum engineering
- Vacuum pumps are also used to produce a vacuum that may then be used to power mechanical devices. In gasoline-powered automobiles, a vacuum is produced as a side effect of the operation of the engine and the flow restriction created by the throttle plate
- In an aircraft, the vacuum source is often used to power gyroscopes in the various flight instruments. To prevent the complete loss of instrumentation in the event of an electrical failure, the instrument panel is deliberately designed with certain instruments powered by electricity and other instruments powered by the vacuum source.

Note: mbar is a pressure unit, Torr is also a pressure unit

- What is a pump? 2. Do you see the difference between the term "pump" and "compressor"? 3. Who was the first to demonstrate the properties of vacuum in a practical way? 4. Do you pay attention to vacuum pump designs or any design? 5. What is special about the previous centuries pumps? 6. In what century did high vacuum become possible? 7. How can pumps be classified? 8. Which is the best-known pump? 9. What are osmotic pumps used for? 10. What pressure units do you know or come across in scientific articles? 11. Would you like to have a hand in making new pumps?

Section II. Lexical-Grammar Tests

Для того, чтобы правильно выполнить контрольные работы, необходимо усвоить следующий грамматический материал:

- Существительное. Множественное число. Существительное в функции определения (перевод.)
- Имя прилагательное. Степени сравнения. Сравнительные конструкции.
- Местоимения: личные, притяжательные, вопросительные, указательные, неопределённые, относительные и отрицательные.
- Словообразование. Распространённые суффиксы существительных, прилагательных, глаголов и наречий; приставки; конверсия.
- Видо-временные формы глагола: активный залог – формы Indefinite, Continuous, Perfect (Present, Past, Future).
- Многозначность глаголов: to be, to have, to do.
- Оборот: There +to be.