

Formation of the concept of the structure of substance in general secondary school students on the basis of non-standard tasks

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Annotation: This article aims to improve the methodology of teaching the concept of substance structure in general secondary schools using non-standard assignments (problems and tests).

Keywords: Non-standard tasks, independent thinking, molecular physics, search for tests by one or two selective answers, structure of matter, molecule and its size, Brownian motion, dissociation in liquids and gases, mass, density, new approach to the topic, development of creative thinking, development of logical thinking observation.

The methodology for developing students' understanding of the structure of matter is based on the physical properties of bodies in various states (gaseous, liquid and solid), as well as on the thermal motion and interaction of microparticles (atoms, molecules, ions) that make up these bodies, studies the ongoing physical phenomena and processes ... The first ideas about the structure of matter belonged to the Greek scientist Democritus. Everything is made up of very small particles - "atoms", he said. It is believed that the smallest particle of matter cannot be broken into pieces. The word atom also means "indivisible particle" in Greek. Today the complex structure of the atom is fully established. An atom consists of a nucleus and an electron.

The smallest particle that retains the chemical properties of a substance is called a molecule. The word molecule means "small mass". For example, if a substance is divided into many parts, will it retain its properties? Experiments show that a particle of matter retains its properties only to a certain extent. Each molecule of a substance has a size and volume. All matter in nature consists of molecules and atoms, which are in constant and chaotic motion with gravity and repulsion between them. For example, if we take a water molecule, it has two hydrogen atoms and one oxygen atom. The molecules move under the influence of heat, and when the heater is turned on in the room, after a while the entire part of the room begins to heat up. This is due to the fact that molecules transfer heat, and gases, like liquids, conduct heat poorly. The first to observe the movement of particles was the English botanist Robert Brown. The continuous and chaotic movement of very small particles in a liquid or gas came to science under the name of Brownian motion. Diffusion is the transfer of one of the interrelated substances to another and the transfer of molecules to the first. The diffusion rate depends on the type of substance, the speed of the molecule and the temperature. As the temperature rises, the diffusion rate increases. Diffusion is faster in gases, slower in liquids, and much slower in solids. There are four types of aggregates of substances (gas, liquid, solid, plasma). Gas is a substance that does not have a specific volume or shape (oxygen, methane, carbon dioxide).

Liquids are substances that have a certain volume, but have no shape (water, gasoline, oil). Solids are substances of a certain size and shape (ice, iron, gold). Plasma is a highly ionized gas (fire, star, sun).

According to the structure of the article, we can give students the following tasks:

1) In everyday life, when we pour water into a kettle to make tea and start heating it, we see that steam starts to come out of it. After a while, the water will boil and, if the heater is not turned off, the water will completely evaporate.

Question: Does the water in the container boil quickly when the lid is open or closed?

Answer : When closed, it boils quickly

To which scientist does the following idea apply? "All matter consists of very small particles" A) L. Bolsman B) Democritus

Answer : Democritus.

3) Scientists who contributed to the development of the theory of molecular kinetics? Say at least three in fifteen seconds

J) (Lomonosov, Stern, Avogadro)

4) In the Universe, the Sun is in the center, and 8 planets move around it. The earth is also distinguished by the presence of life on earth. The sun is a huge source of energy, and light from it reaches the Earth in 8 minutes 20 seconds. There are many ionized gases in the sun.

Question : What state of matter can be found in the sun? What is the most common element in the sun?

Answer : Plasma and helium are the most common

5. The state of aggregation of substances is given (use the picture)



Question : What substances from the picture: table salt, gas, water, waterfalls have the property of flow and why does it flow?

Answer : In the picture, gas, waterfall and water in the flask are permeable. This is due to the action of the molecules that make up the substance. In this case, the speed of movement of gas molecules is high.

6) The mixing of the molecules of substances in the state of aggregation occurs very slowly, the slow mixing of the particles of the body indicates the force of

interaction, and what are these forces called in the molecule? Have you encountered this in your daily life? Substances in this state of aggregation have a certain size and shape.

Answer : Solids and metals call these forces molecular forces.

Molecule mass and size

1) During breathing, a person absorbs oxygen and emits carbon dioxide. The alveoli in the lungs are involved in gas exchange.

Question : What is the speed of movement of molecules in the state of aggregation, moving faster than the molecules of substances in the rest of the state of aggregation? How does the respiratory rate change with increasing temperature? (free)

Answer : When the temperature in gases rises, breathing becomes difficult and the speed of the gas molecules increases.

2) Most plants bloom in spring. After this, the plants must be pollinated in order for them to bear fruit. Pollination is subdivided into spontaneous pollination, external pollination, and artificial pollination. Wheat and other grains are blown by the wind.

Question: Wind pollination of wheat is an example of spreading, what is this movement? (motion touches solid molecules)

Answer : Brownian motion

3) What does the word "small mass" mean?

Answer : molecule

4) Arrange the following substances in order of increasing inertia.

H₂O 2) CO₂ 3) O₃ 4) H₃O

$\mu_1 = 18 \text{ g / mol}$, $\mu_2 = 44 \text{ g / mol}$, $\mu_3 = 48 \text{ g / mol}$, $\mu_4 = 19 \text{ g / mol}$

Answer: $\mu_3 > \mu_2 > \mu_4 > \mu_1$

5) If there is one oxygen atom for every two hydrogen atoms in a water molecule, how many oxygen atoms are there for every 10 hydrogen atoms? Find the answer depending on the reaction $2\text{H}_2\text{O} = 2\text{H}_2 + \text{O}_2$.

Answer : There are 5 oxygen atoms.

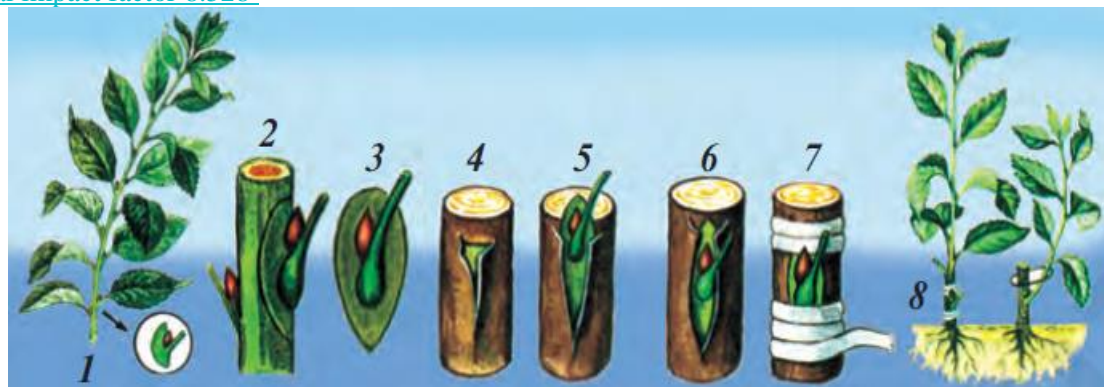
6) How much oxygen and hydrogen are involved in this reaction to form water?

Answer : The reaction $2\text{H}_2\text{O} = 2\text{H}_2 + \text{O}_2$ shows that you need 4 hydrogen atoms and 2 oxygen atoms.

7) What is the most abundant element in the following substances? N₂, O₂, O₃, CO₂, H₂O The atoms in these substances are as follows: oxygen-8, hydrogen-2, carbon-1, nitrogen-2.

Answer : The most common element is oxygen.

8) One of the wonders of nature is the existence of life in our homeland. Most of the land is made up of plants that reproduce in a variety of ways. One such method is welding.



Question: What kind of diffusion is an example of such a plant grafting method?

Answer : In this welding, the molecules of two solids join and begin to grow. An example is diffusion in solids. We observe physical and chemical processes in nature. We encounter these processes many times in our daily life. A physical process is a process in which the composition of a substance does not change. In a chemical process, the composition of a substance changes. For example, Rustam made sugar tea for breakfast and drank it. His mother cooked eggs for him on gas. When Rustam mixes sugar with tea to make sugar tea, the sugar dissolves in the boiling tea and does not react with it. His mother burns the gas while cooking the eggs, which changes the composition of the gas.

Question : 1) What process took place during the preparation of Rustam sugar tea and what kind of diffusion is formed?

2) What is the chemical process when boiling Rustam's mother's egg?

Answer : 1) A physical process is an example of diffusion in a liquid.

Examples of a chemical process are the gas that is burnt during the boiling of eggs.

9) Continuous and chaotic movement of atoms and molecules in a liquid or gas is called chaotic movement. The word chaotic means disorderly. We see this very often. For example, most cereals are wind-pollinated. Pollination is a preliminary fertilization process. Wind-pollinated plants include wheat, barley, and dill.

Question : What is an example of pollination of cereals?

Answer : Brownian motion is an example of the diffusion of solid molecules in liquids or gases.

10) The surfaces of gold and lead are polished and placed on top of each other with great stress. Five years later, when the loads on the metals were removed, they were observed to stick together. Gold atoms penetrated into lead, and lead atoms penetrated into gold atoms by about 1 mm. The mixture of gold and lead means that solids are also made of particles. Slow mixing of solids indicates that the interaction of metal particles is stronger than that of liquids or gases. This indicates that diffusion occurs in solids.

lead

lead



gold

1 mm



gold

a)

b)

Question: 1) In what state of aggregation of matter are gold and lead formed?

2) The inflow of gold and lead in 15 years is many times higher than in the first 5 years.

Answer: 1) Since gold and lead are solid, diffusion of solids is formed.

2) If in a year it drops to 1 mm, then in 15 years it will drop to 3 mm. This is three times more than 15 years and 5 years.

11) The body temperature of some animals is affected by changes in the outside temperature. That is, they are cold-blooded. When the temperature drops, the body temperature drops and prolonged sleep can be caused by discomfort from the outside air temperature and lack of food.

Question: Why do all the body functions of cold-blooded animals slow down with a decrease in temperature?

Answer: With a decrease in temperature, the speed of movement of molecules decreases, and as a result, all functions of the body (metabolism, blood circulation, etc.) slow down.

12) Sugar beet was developed by breeders in 1747 when European scientists discovered that fodder beets contain sugar. This was just over 1% and a lot of effort went into getting varieties suitable for industrial production.

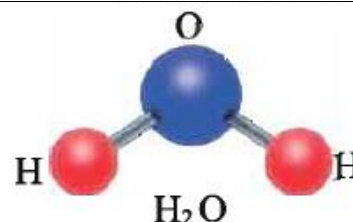
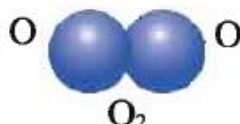
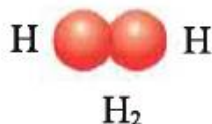
Question : What is the role of diffusion in sugar processing?

Answer : The sugar molecules get into the water beet. To enhance this process, sugar beets are crushed. The sugar then evaporates from the water.

13) What aggregate substances are found in nature without atoms? (One of them has a special shape and size, and the other does not have a special shape or size.)

Answer : metals, inert gases

hydrogen molecule	oxygen molecule	water molecule
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14. The figure shows the structures of substances (hydrogen $\mu_1 = 2 \text{ g / mol}$

Question : How do the compositions of drinking water differ from each other? (e.g. water in one country from other countries)

Answer : All substances obey the law of continuity. Therefore, the composition of all substances is the same everywhere.

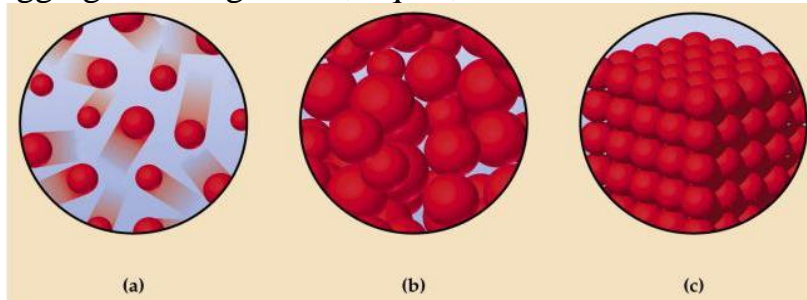
14) Is the mobility of a substance molecule lower than in task 14?

Answer : The reason for the appearance of a water molecule is that water moves more slowly because it is liquid.

Question : If you rub your cheeks with the leaves of a plant on a hot day, you may feel cold. Explain the reason for this.

Answer: The plant is constantly evaporating, so the internal energy and temperature of the leaf decrease.


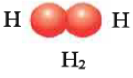


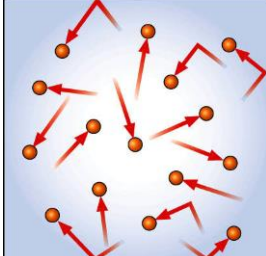
The state of aggregation of gaseous, liquid, solid substances is described.



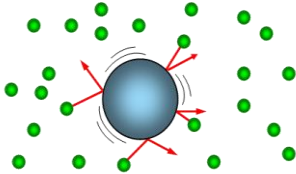


Question : In what order are the molecules of the aggregates in the order in which the molecules of such aggregates are in oscillatory motion and have the greatest gravitational force? (use the picture above).

Answer: In solid molecules, figure (c)

15) In this table, concepts are presented in the form of pictures. In this case, the student receives a selective answer. If the picture fits the concept, he says yes, and if it doesn't fit, he says no. This activity can be used for reinforcement during the lesson (as a handout).

№	CONCEPT	PICTURE
	Atom	
	Molecule	 <p style="text-align: center;">hydrogen molecule</p>
	Diffusion	
	Chaotic	
	Mass	

	Brown motion	
	Density	
	Size	

Answer : 1) 2) 3) 4) 5) 6) 7) 8)

This article focuses on "Concepts of the structure of matter" in physics. It was organized on the basis of non-standard tasks for teaching the structure of matter. At the same time, the formation of cognitive processes of free thinking, the formation of non-standard tasks with their use in a qualitative and rational manner. Non-standard tasks develop logical and creative thinking in schoolchildren. These questions and tests help increase student interest in science and life experiences.

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