НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ ЦИВІЛЬНОГО ЗАХИСТУ УКРАЇНИ

О.С. Рижченко

Англійська мова

Посібник

Рекомендовано до друку і використання в навчальному процесі
вченою радою НУЦЗ України

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Навчальне видання призначене для самостійної роботи здобувачів вищої освіти, які навчаються на першому (бакалаврському) рівні в галузі знань 16 «Хімічна та біоінженерія».

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UNIT ONE

Substances

VOCABULARY

Translate the following words and write them down!

aluminum (*n*)
application (*n*)
boiling point (*adj*+*n*)
carbon (*n*)
copper (*n*)
corrosive (*adj*)
crystalline (*adj*)
density (*n*)
fragile (*adj*)
fusible (*adj*)
hardness (*n*)
iron (*n*)
melting point (*adj*+*n*)
nylon (*n*)
oxygen (*n*)
poisonous (*adj*)
property (*n*)
protein (*n*)
soluble (*n*, *adj*)
starch (*n*)
substance (*n*)

Before you read answer the questions:

1. What is chemistry?

2. What does chemistry study?

READ the text!

SUBSTANCES

Iron, aluminum, copper, water, sugar, oxygen, carbon dioxide, starch, proteins are all substances. Now several million substances are known, but their number is growing all the time. Some of the substances are found in nature, others like capron and nylon are created artificially. Each substance has been studied and got its own name. Substances can be somewhat similar to each other, but each of them is necessarily different from the others, each has its own characteristics, its own properties.

One of the tasks of chemistry is to describe substances. To describe a substance is to enumerate its properties. For example, table salt is a colorless crystalline substance (white when ground), salty in taste, fragile, soluble in water. When describing substances, their properties that can be measured are also indicated, for example, melting and boiling points, density, etc. The properties of substances also include their effect on the body. Many substances are poisonous. Therefore, unknown substances cannot be tasted, you can get poisoned. Some substances are corrosive to the skin and should not even be touched.

It is necessary to know the properties of substances in order to find their application. This, our distant ancestors appreciated and used the extraordinary hardness of the silicon mineral to make the first weapons and tools from it. It is also necessary to know the properties of substances in order to handle them properly. For example, products made of capron and nylon should not be ironed with an iron that is too hot, as these substances are fusible and can melt under the iron. It is also necessary to know the properties of substances in order to recognize substances, to distinguish them from each other.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. Protein is not a substance.
2. Substances can be found only in nature, they can’t be created artificially.
3. Salt is a colorless crystalline substance, salty in taste, fragile and soluble in water.

4. Some substances which corrosive to the skin and can be touched.

5. Our distant ancestors made the first weapons and tools from silicon mineral because they appreciated its extraordinary hardness.

TASK 2. Fill in the **gaps** with appropriate words.

melting and boiling points *crystalline* *density*
artificial *properties* *soluble* *fusible*

1. Salt and sugar are _____ substances which are _____ in water.
2. Substances can be _____ by their nature.
3. The properties which can be measured are _____ and _____.
4. It is very important to know the _____ of the substances to work with them properly.
5. Capron and nylon are _____so they can melt under the iron.

TASK 3. **Match** the words in **the two columns**.

1. distant	**a)** substances
2. effect	**b)** points
3. unknown	**c)** ancestors
4. properties	**d)** artificially
5. melting and boiling	**e)** on the body
6. created	**f)** that can be measured

TASK 4. **Combine** the ***substances*** with ***proper characteristics***.

boiling point *melting point*
corrosive *crystalline* *density* *fragile* *fusible*
hardness *soluble* *poisonous*

substance	**property**	**substance**	**property**
water	*boiling point*	carbon	
protein		copper	
silicon		iron	
nylon		salt	
aluminum		starch	
sugar		capron	

TASK 5. **Translate** the following text **into English**.

Хімія - це наука про речовини: їх склад, будову, властивості й взаємоперетворення. Предметом хімії є хімічні елементи та їх сполуки, а також закономірності, відповідно до яких протікають хімічні реакції.

Хімія як і багато інших природничих наук вивчає матерію. Люди називають матерією або речовиною все, що існує у світі, а предмети.

Хімічні речовини мають різні фізичні властивості: температуру кипіння та плавлення, колір, смак.

Багато речовин є отруйними, тому треба обережно ними користуватися.

UNIT TWO

Pure substances and mixtures

VOCABULARY

Translate the following words and write them down!

amount (*n*)
to bond to (*v*)
cell (*n*)
to compose (*v*)
to consist of (*v*)
to contaminate with (*v*)
to depend on (*v*)
to dissolve (*v*)
to extract from (*v*)
foreign impurity (*n*)
gaseous (*adj*)
lump (*n*)
powder (*n*)
solid (*n*)
solution (*n*)
to suspend (*v*)
tissue (*n*)
vaporous (*adj*)
volume (*n*)

Before you read answer the questions:

1. What is substance?

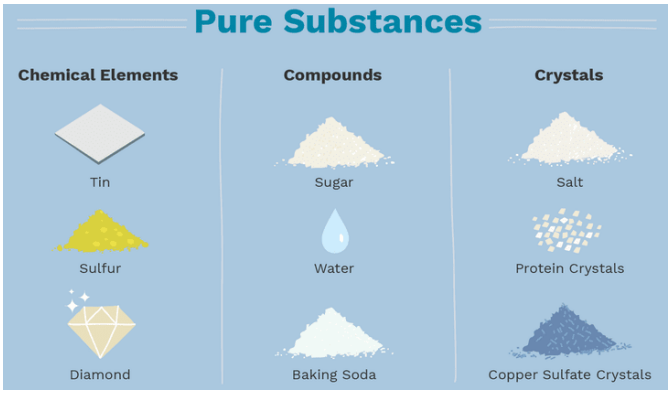
2. What kinds of substances do you know?

READ the text!

PURE SUBSTANCES AND MIXTURES

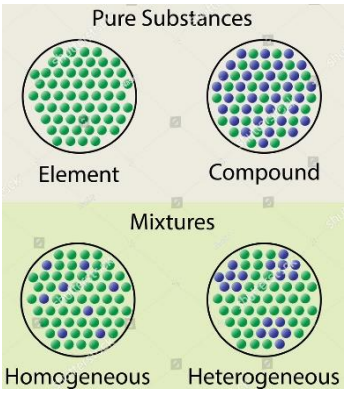
Whatever we study, the question always arises before us: what does the subject under study consist of? So, most living organisms consist of organs, organs of tissues, tissue of cells. And what are substances made of?

The smallest particle of water is a water molecule. The smallest sugar particle is a sugar molecule, etc.



Substances can have both molecular and non-molecular structure. In gaseous and vaporous form, all substances are composed of molecules. But the same cannot be said for solid crystalline substances. For example, a component in quartz crystals, in granite, etc. is silicon atoms, which are chemically bonded to oxygen atoms. There are no molecules in a quartz crystal. Many other substances, which look like large and small crystals, are also non-molecular in structure. For example, there are no molecules in the known crystalline substances - sodium chloride and soda.

All molecules of a given substance, for example, all water molecules are the same, but differ from the molecules of another substance. Therefore, the properties of different substances are different, but for the same substance they are the same. So, sugar is extracted from various plants and is sold in the form of granulated sugar, lump sugar, powdered sugar. But they are all the same substance, the same sugar with the same properties. Dissolving in water taken in equal volumes, the same amount of granulated sugar, lump sugar and powdered sugar, we get solutions of the same sweetness. A substance always has the same properties if it is not contaminated with foreign impurities or contains very little of them. This is, for example, distilled water (as opposed to river water). Therefore, distilled water everywhere in the world at normal atmospheric pressure (101.3 kPa) has the same boiling point of 100°C), the same crystallization temperature (0° C), the same density, equal to 1 g / cm3 at 4°C, etc. The properties of natural waters are not the same and depend on the impurities they contain.

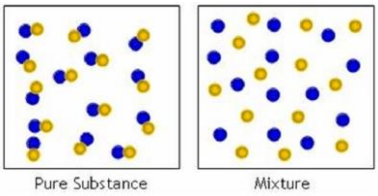


In practice, we do not find completely pure substances, and we have to be content with one degree or another of their purity.

In life, as a rule, we meet with mixtures of substances. So, air, as we know, is a mixture of several substances: oxygen, nitrogen, carbon dioxide, etc.

By shaking the chalk powder in water we get a mixture of water and chalk suspended in it; its particles are visible to the naked eye. However, in appearance it is not always possible to guess that we have a mixture in front of us. So, milk seems to us to be a homogeneous substance, but under a microscope it can be seen that it consists of drops of fat floating in a liquid, therefore, milk is a mixture of substances.

Solutions are a special case of mixtures. Shaking sugar in water, instead of a cloudy liquid, we get a transparent solution of sugar in water. It is impossible to see sugar in it, not only with the naked eye, but even with the strongest microscope. However, the presence of sugar in the solution is easily detected if the solution is tasted or, by placing a drop of the solution on a clean glass, let it dry. The sugar will remain on the glass in the form of crystals.



When dissolved in water, sugar is broken down into molecules, which are distributed between water molecules.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. Most living organisms consist of organs, organs consist of tissues and tissue consist of atoms.

2. It is known that substances can be of molecular and non-molecular structure.

3. All substances in gaseous and vaporous form are composed of molecules but substances in solid form are not.

4. Usually in nature we can find mixture of several substances but not completely pure substances.

5. A special case of mixtures is called solutions.

TASK 2. Fill in the **gaps** with appropriate words.

properties *impurities* *non-molecular* *pure* *transparent*

1. Many substances which look like large and small crystals are _____ in structure.

2. A substance always has the same properties if it is not contaminated with foreign _____ or contains very little of them.

3. When we shake sugar in water, we get a _____ solution of sugar in water.

4. We do not find completely _____ substances, and we have to be content with one degree or another of their purity.

5. The _____ of different substances are different, but for the same substance they are the same.

TASK 3. **Match** the words in **the two columns**.

1. living	**a)** water
2. vaporous	**b)** temperature
3. solid crystalline	**c)** atmospheric pressure
4. granulated	**d)** substances
5. foreign	**e)** organisms
6. distilled	**f)** sugar

7. normal	**g)** impurities
8. crystallization	**h)** form

TASK 4. **Choose** the appropriate **verb**.

to bond *to contaminate* *to dissolve* *to extract* *to suspend*

1. By shaking the chalk powder in water we get a mixture of water and chalk which is _____ in it; its particles are visible to the naked eye.

2. If we _____ the same amount of granulated sugar, lump sugar and powdered sugar in water taken in equal volumes, we will get solutions of the same sweetness.

3. A substance always has the same properties if it is not _____ with foreign impurities or contains very little of them.

4. Sugar is _____ from various plants and is sold in the form of granulated sugar, lump sugar, powdered sugar.

5. A component in quartz crystals, in granite, etc. is silicon atoms, which are chemically _____ to oxygen atoms.

TASK 5. **Translate** the following text **into English**.

Чисті речовини складаються з частинок однієї речовини і характеризуються постійними властивостями та складом, що не залежить від того, як її добували та де вона перебуває у природі. Наприклад, самородок золота, газоподібна речовина хлор у запаяній скляній ампулі, вода у склянці. Чисті речовини у природі зустрічаються набагато рідше та не існує абсолютно чистих речовин (без домішок).

Суміш – поєднання двох чи більше речовин. Існують природні суміші (повітря, ґрунт, граніт, морська вода, молоко, нафта, фруктові соки, природний газ) та штучні суміші, які створила людина (сталь, чавун, квас, будівельні суміші, бензин, фарби, пральні порошки, зубні пасти, кетчупи).

UNIT THREE

Chemical reactions

VOCABULARY

Translate the following words and write them down!

absorption (*n*)
to calcine (*v*)
combustible (*n*, *adj*)
explosion (*n*)
to facilitate (*v*)

finely ground (*adj*)
heating (*n*)
to ignite (*v*)
lime (CaO) (*n*)

occurrence (*n*)
odor (*n*)
precipitate (*n*)
release (*n*)
sediment formation (*n*)

Before you read answer the questions:

1. What is chemical reaction?

2. Is it easy to start a chemical reaction?

READ the text!

SIGNS AND CONDITIONS OF CHEMICAL REACTIONS

What external features do we use to distinguish chemical phenomena from physical ones? During chemical reactions, different substances are formed from one substance. By the disappearance of signs of the former and the appearance of signs of the latter, as well as by the release or absorption of energy, we conclude that a chemical reaction has taken place.

While calcining a copper plate a black coating appeared on its surface; while blowing carbon dioxide through lime water a white precipitate formed; when wood was burning, water droplets appeared on the cold walls of the vessel; when magnesium burned, a white powder was obtained.

Changes in color, odor, sediment formation, gas formation, release or absorption of energy are all signs of chemical reactions.

What needs to be done to start a chemical reaction?

To get it started, first of all, it is necessary to bring the reactants into contact. The more crushed the substances, the larger the surface of their contact with each other, the faster the reaction between them proceeds. A lump of sugar is difficult to ignite, and finely ground and sprayed in the air, sugar burns instantly, with an explosion.

You can break up a substance into tiny particles by dissolving. Therefore, the preliminary dissolution of the starting materials facilitates chemical reactions between the substances.

In some cases, contact of substances, such as iron with humid air, is sufficient for a reaction to occur. But often one contact of substances is not enough for this.

Thus, copper does not react with atmospheric oxygen at a low temperature of about 20-25°C. To cause the reaction of the combination of copper with oxygen, you need to resort to heating.

Heating affects the occurrence and course of chemical reactions in different ways. Some reactions require continuous heating. When heating stops, the chemical reaction stops. This can be seen in

the example of the decomposition of sugar.

In other cases, heating is required only for the occurrence of a reaction, it gives it a kind of impetus, and then the reaction flows by itself. This happened when burning magnesium, wood and other combustible substances.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. Different substances are formed from one substance when chemical reactions take place.

2. The release or absorption of energy shows that a chemical reaction has taken place.

3. The reaction between different substances starts faster if the surface of the substances in contact is small.

4. Copper reacts with atmospheric oxygen at a low temperature about 20-25°C.

5. Heating does not affect the occurrence and course of chemical reactions.

TASK 2. Fill in the **gaps** with appropriate words.

oxygen *coating* *powder* *droplets* *precipitate*

1. When we calcine a copper plate a black _____ appears on its surface.
2. When we blow carbon dioxide through lime water a white _____ forms.
3. When we burn wood, water _____ appear on the cold walls of the vessel.
4. When we burn magnesium, a white _____ is obtained.
5. When we heat copper, it reacts with _____.

TASK 3. **Match** the words in **the two columns**.

1. chemical	**a)** powder
2. water	**b)** of energy
3. white	**c)** formation
4. release or absorption	**d)** phenomena
5. sediment	**e)** substances
6. combustible	**f)** of sugar
7. decomposition	**g)** droplets

TASK 4. **Choose** the appropriate **verb**.

to blow *to ignite* *to calcine* *to facilitate* *to break up*

1. If you _____ a copper plate, you will find a black coating which appeared on its surface.

2. You can _____ a substance into tiny particles by dissolving.

3. It is difficult to _____ solid substances.

4. The preliminary dissolution of the starting materials _____ chemical reactions between the substances.

5. If you _____ carbon dioxide through lime water a white precipitate will be formed.

TASK 5. **Translate** the following text **into English**.

У природі зустрічаються такі явища, які приводять до творення інших, або одні речовини перетворюються на інші, змінюючи властивості. Явища,

які приводять до утворення одних речовин з інших із новими властивостями, називаються хімічними.

Хімічні явища називаються хімічними реакціями.

Умови, за яких відбуваються реакції:

- контакт речовини;

- подрібнення, перемішування;

- нагрівання.

Ознаками хімічних реакцій є зміна кольору, виділення газу, поява осаду та виділення теплоти.

UNIT FOUR

Elementary and complex substances

VOCABULARY

Translate the following words and write them down!

complex (*adj*)	homogeneous (*adj*)	to retain (*v*)
elementary (*adj*)	hydrogen (*n*)	sulfur (*n*)
to glow (*v*)	mixture (*n*)	test tube (*n*)
	red-hot (*adj*)	

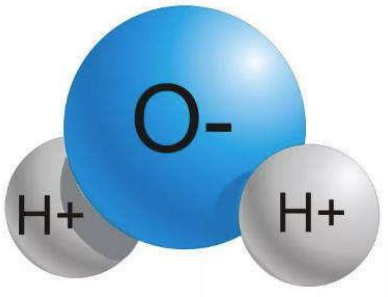
Before you read answer the questions:

1. What types of substances do you know?

2. How can substances change their properties?

READ the text!

ELEMENTARY SUBSTANCES AND COMPLEX SUBSTANCES



Some substances(matters) such as oxygen and hydrogen are composed of molecules formed by atoms of the same kind. Substances hydrogen and oxygen are classified as simple. Other substances such as water contain atoms of different types. Such substances are classified as complex.

Substances consisting of atoms of the same type are called elementary substances.

In addition to hydrogen and oxygen, the elementary substances from among the known include graphite, sulfur and all metals: iron, copper, magnesium, etc. Graphite consists of atoms of only one type - they are called carbon atoms; iron - also from atoms of one type - iron atoms; copper - only from copper atoms.

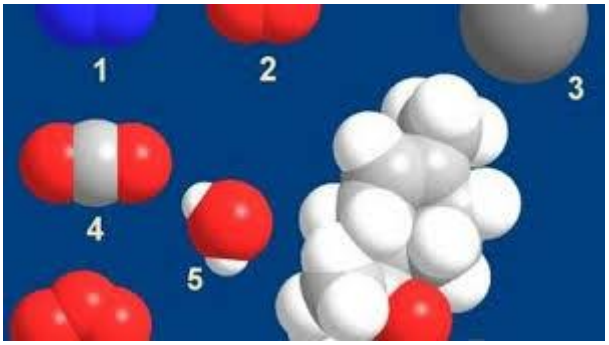
Substances consisting of atoms of different types are called complex substances.

Water, carbon dioxide, copper oxide are complex substances.

It is necessary to clearly understand the difference between elementary and complex substances. Let's make an experiment. Let's prepare a mixture of 4 g of sulfur and 7 g of iron. Pour this mixture into a test tube and heat it slightly. Soon the mixture will begin to heat up by itself without further heating and will glow red-hot. This means that a chemical reaction between iron and sulfur, accompanied by the release of heat takes place. If we examine the substance obtained, we will no longer see either iron particles or sulfur particles. We can see a homogeneous black powder. Let's bring a magnet to the powder. The powder is not attracted by a magnet, does not separate into sulfur and iron by water. It differs from both sulfur and iron in density, melting point, and all other properties.

Iron and sulfur have combined and formed another substance - iron sulfide.

Iron and sulfur are elementary substances. Iron consists only of iron atoms, sulfur - only of sulfur atoms, and iron sulfide is a complex substance, which consists of iron atoms and sulfur atoms. Crystals of iron and sulfur dissociate into atoms, which combine into crystals of iron sulfide - a substance of non-molecular structure.



A mixture of sulfur and iron differs from iron sulfide in the following features:

1) in the mixture sulfur and iron retain their properties, in iron sulfide their properties are not retained;

2) sulfur and iron can be separated from the mixture by physical methods, it is impossible to separate sulfur and iron from a complex substance by these methods.

Any mixture differs from a complex substance in that the properties of each substance in the mixture are retained.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. Substances consisting of atoms of different types are called simple substances.

2. Substances can be classified as elementary and complex.

3. Elementary substances are hydrogen, oxygen, graphite, sulfur, iron, copper, magnesium.

4. Iron sulfide is a substance of molecular structure.

5. We can separate sulfur and iron from a complex substance by physical methods.

TASK 2. Fill in the **gaps** with appropriate words.

complex *sulfide* *homogeneous*
elementary *dissociate*

1. Substances consisting of atoms of the same type are called _____ substances.

2. Water, carbon dioxide, copper oxide are _____ substances.

3. As a result of a chemical reaction between iron and sulfur takes place, we get a _____ black powder.

4. When iron and sulfur combine they form iron _____.

5. Crystals of iron and sulfur _____ into atoms

TASK 3. **Match** the words in **the two columns**.

1. make	**a)** tube
2. prepare	**b)** their properties
3. test	**c)** by a magnet
4. release	**d)** into atoms
5. attracted	**e)** an experiment
6. retain	**f)** of heat
7. dissociate	**g)** a mixture

TASK 4. **Choose** the appropriate **verb**.

to consist of *to be accompanied by* *to be composed of*
to attract *to retain*

1. Oxygen and hydrogen _____ molecules formed by atoms of the same kind.

2. When a chemical reaction between iron and sulfur takes place, it _____ the release of heat.

3. Substances which _____ atoms of different types are called complex substances.

4. In the mixture any substance_____ their properties.

5. A magnet can _____ metals.

TASK 5. **Translate** the following text **into English**.

Усі речовини діляться на прості і складні. Прості речовини складаються з атомів одного елемента (атомів одного виду).

Складні речовини (хімічні сполуки) складаються з атомів кількох елементів.

Хімічний елемент Оксиген утворює прості речовини, що відрізняються складом молекул: кисень O_2 і озон O_3. Кисень — газ без запаху, він є необхідним живим організмам для дихання. Озон має отруйний запах.

Хімічний елемент Фосфор утворює молекулярну речовину - білий фосфор P_4 і немолекулярну – червоний фосфор Р. Ці речовини відрізняються не лише будовою, а й властивостями. Білий фосфор має запах, самозаймається на повітрі. Червоний фосфор без запаху, горить лише при нагріванні.

Хімічний елемент Карбон утворює немолекулярні речовини алмаз і графіт. Вони позначаються однаковою формулою - С, але мають різну будову і відрізняються властивостями. Алмаз є прозорою, безбарвною, дуже твердою речовиною. Графіт - непрозорий, темно-сірий, м'який.

UNIT FIVE

Chemical elements

VOCABULARY

Translate the following words and write them down!

calcination (*n*)	constituent (*n*)	lack (*n*, *v*)
charcoal (*n*)	to crush (*v*)	luster (*n*)
to conduct (*v*)	to flatten out (*v*)	opaque (*adj*)
conductivity (*n*)		residue (*n*)

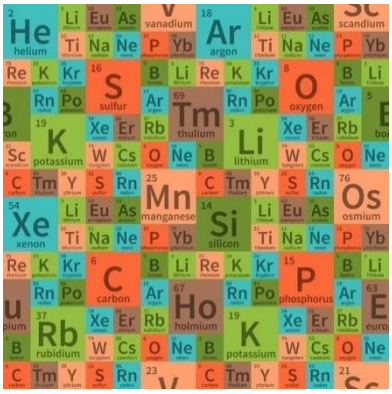
Before you read answer the questions:

1. What is a chemical element?

2. What groups of chemical elements do you know?

READ the text!

CHEMICAL ELEMENTS



The word “element”, which means a constituent part, passed into chemistry from ancient thinkers. The constituent parts of iron sulfide are iron and sulfur. Iron and sulfur in iron sulfide are not substances, but chemical elements.

A chemical element is a specific kind of atom. Oxygen atoms make up one kind of atoms, one chemical element which is called oxygen, mercury atoms are another kind of atoms, the chemical element is mercury, etc. Now we know 118 kinds of atoms - 118 chemical elements. Many of them make up the entire universe down to

the most distant stars and nebulae. Chemical elements form substances with which various transformations, studied by chemistry, occur.

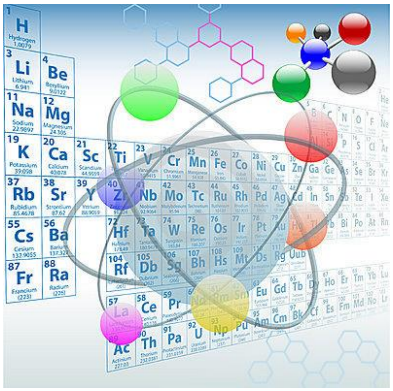
It is necessary to distinguish between the concepts: “chemical element” and “elementary substance”. Charcoal was found in the solid residue after the sugar calcination reaction. Thus we conclude that sugar contains carbon atoms. But it would be wrong to say that sugar (a colorless water-soluble substance) contains coal (an insoluble substance). Carbon atoms, in order to turn into coal, must free themselves from bonds with atoms of other elements and connect with each other. It happened during the decomposition of sugar by heating. The same thing happens with food left on the fire unattended, the food burns.

Coal and carbon are not the same thing. Carbon is a specific kind of atom, i.e. chemical element. The atoms of the element carbon can be part of complex substances, or they can form elementary substances, one of which is coal.

In the case under consideration, a chemical element (carbon) and its corresponding elementary substance (coal) are called differently. Most of the elements bear the same names as the corresponding elementary substances. Therefore, the words “oxygen”, “iron”, etc. can mean both a chemical element and an elementary substance with the same name.

Chemical elements are classified into two groups: metals and non-metals. Metal atoms form elementary substances - metals. Metals, as elementary substances, have a number of common properties. Metals are opaque and have a characteristic “metallic” luster, electrical conductivity and high thermal conductivity. They are plastic - they are not crushed under the blow of a hammer (like fragile substances,

such as glass), but flattened out. Metals include iron, copper, aluminum, mercury, gold, silver, etc.



The second group of chemical elements is made up of non-metals. They include carbon, oxygen, hydrogen, sulfur. Non-metal atoms also form elementary substances. Non-metals as elementary substances do not have such a pronounced external similarity as metals. Their common feature is the lack of metallic properties: they, as a rule, do not have a metallic luster, and they do not conduct electricity and heat.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. Usually a chemical element and its corresponding elementary substance have the same name.
2. Chemical elements are classified into metals and non-metals.
3. Non-metals have a metallic luster, conduct electricity and heat.
4. Metals are plastic as they are not fragile but they can flatten out.
5. Non-metals do not have a pronounced external similarity as metals.

TASK 2. Fill in the **gaps** with appropriate words.

solid *entire* *metallic* *corresponding* *common*

1. Many chemical elements make up the _____ universe down to the most distant stars and nebulae.
2. After the sugar calcination reaction charcoal can be found in the _____ residue.
3. Metals, as elementary substances, have a number of _____ properties.

4. The common feature of non-metals is the lack of _____ properties.

5. Most of the elements bear the same names as the _____ elementary substances.

TASK 3. **Match** the words in **the two columns**.

1. external	**a)** conductivity
2. an insoluble	**b)** part
3. metallic	**c)** reaction
4. electrical	**d)** conductivity
5. constituent	**e)** similarity
6. thermal	**f)** luster
7. calcination	**g)** substance

TASK 4. **Choose** the appropriate **verb**.

to conduct *to heat* *to make up* *to distinguish* *to form*

1. Oxygen atoms _____ one kind of atoms, one chemical element which is called oxygen.

2. It is necessary to _____ between the “chemical element” and “elementary substance”.

3. Metals _____ electricity and heat.

4. Chemical elements _____ substances which can be transformed in various ways.

5. Sugar can turn into coal when we _____ it.

TASK 5. **Translate** the following text **into English**.

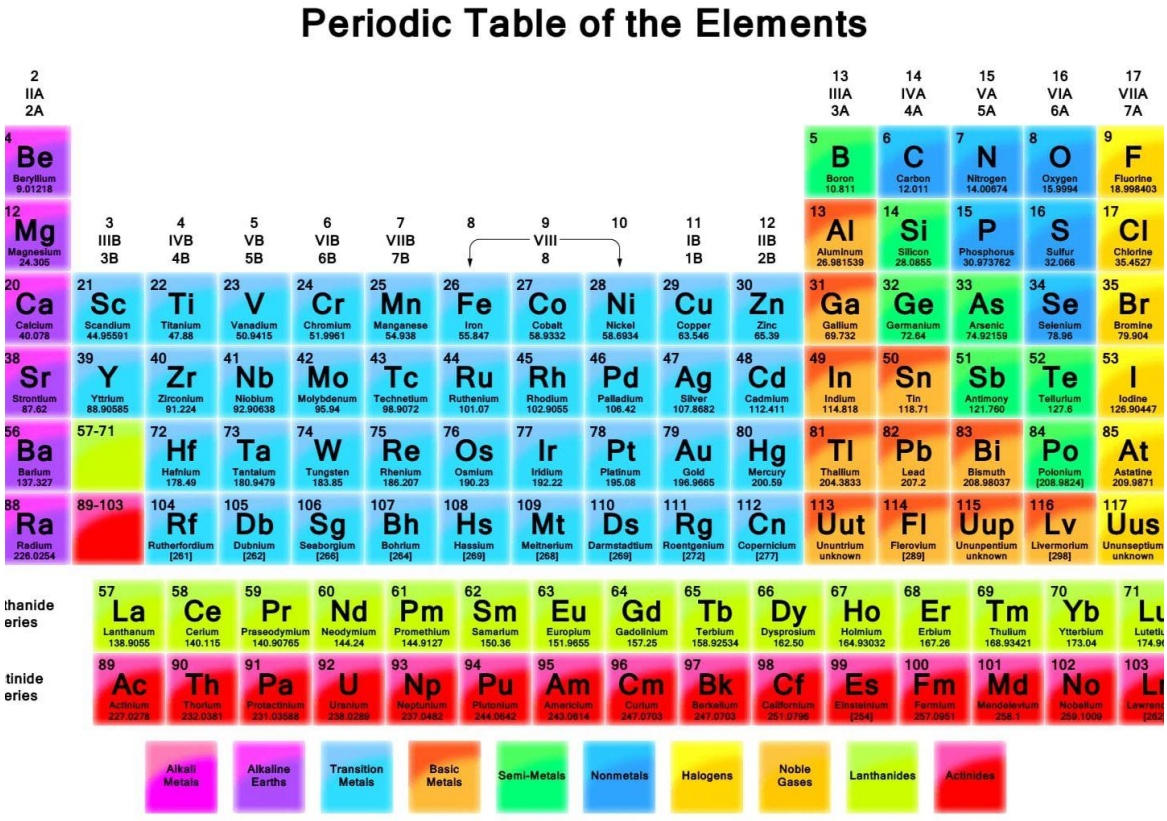
Атоми різних хімічних елементів відрізняються масою, розмірами, будовою і властивостями.

Кожен хімічний елемент має назву і позначається символом або хімічним знаком.

Символ хімічного елемента складається з однієї або двох літер. Як правило, використовуються перші літери його латинської назви.

Назви і символи 118 хімічних елементів наведено у періодичній таблиці. Більше 20 елементів отримані штучно за допомогою складних фізичних методів.

Атоми хімічних елементів з'єднуються один з одним у різних комбінаціях і утворюють величезну кількість природних і синтетичних речовин.



UNIT SIX

VOCABULARY

Translate the following words and write them down!

to calculate (*v*)	fraction (*n*)	quantitative (*adj*)
composition (*n*)	to multiply (*v*)	ratio (*n*)
to exhaust (*v*)	qualitative (*adj*)	relative (*adj*)

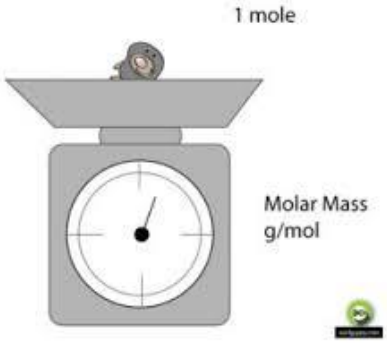
Before you read answer the questions:

1. What does chemical formula show?

2. How do we calculate molecular mass of a substance?

READ the text!

CHEMICAL FORMULAS.
MOLECULAR MASS OF A SUBSTANCE

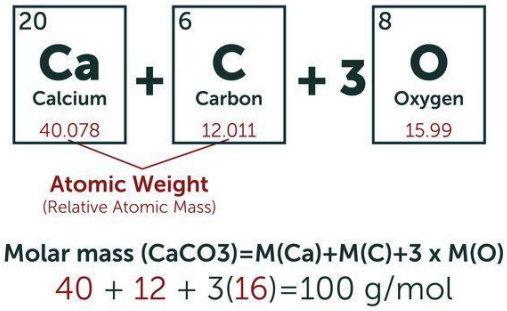


The composition of elementary and complex substances can be expressed by a chemical formula. To write the chemical formula of an elementary substance we need the chemical sign of the element and a number (assigned to it at the bottom right), indicating the number of its atoms in a molecule called an index. Thus, oxygen and hydrogen molecules consist of two atoms, so their composition is expressed by the formulas O_2 and H_2.

To write a formula of a complex substance you need to know what chemical elements the substance consists of (qualitative composition), and the number of

atoms of each element in its molecule (quantitative composition). We write the signs of chemical elements and the indices at the bottom right. So, a water molecule consisting of two hydrogen atoms and one oxygen atom is represented by the formula H_2O. Index 1 is not written.

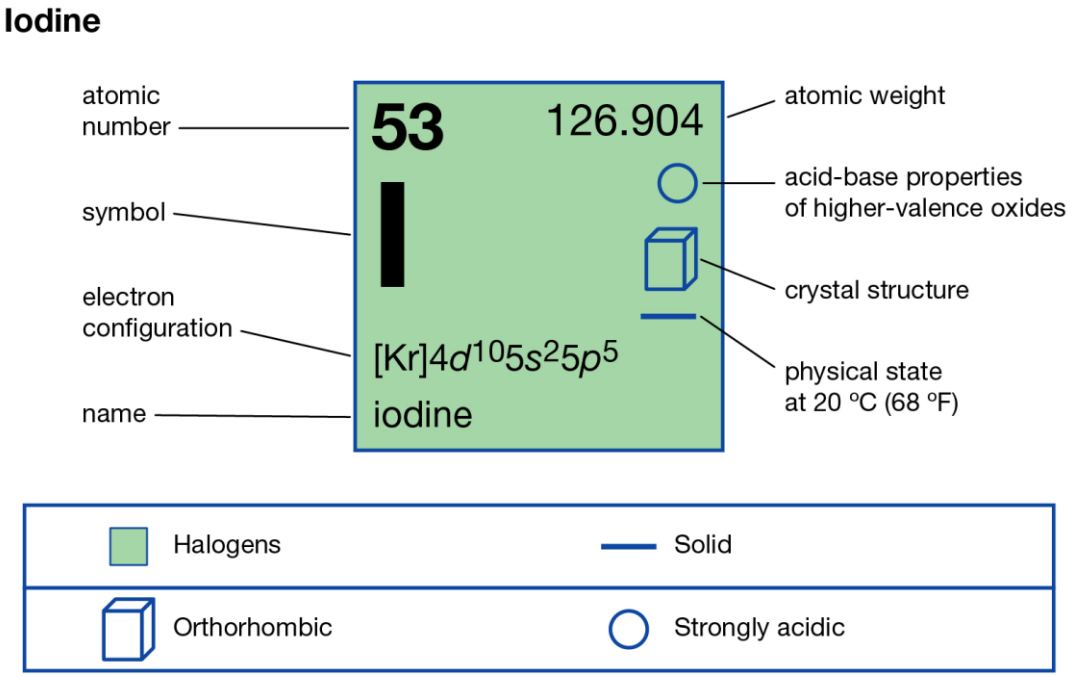
A chemical formula is a conditional record of the composition of a substance using chemical signs and (if necessary) indices.



What do we learn about a substance just by looking at its chemical formula?

We will immediately say whether this substance is elementary or complex, what elements it is formed of, and we will determine the number of atoms of one element per a certain number of atoms of another element. But this does not exhaust the information about the substance given by its chemical formula.

The chemical formula of a substance is used to calculate its relative molecular mass (M_r).



The relative molecular mass of a substance is a number that shows how many times the mass of its molecule is more than 1/12 of the mass of a carbon atom.

To calculate the relative molecular mass of a substance, you must add the relative atomic masses, taking into account the number of atoms of each element in the compound.

Thus,

$$M_r (H_2O) = 1 * 2 + 16 = 18.$$

The chemical formula can be used to calculate the mass fractions of elements in a substance. The mass fraction is denoted by the Greek letter ω – omega which shows how much of the relative molecular mass of a substance is the relative atomic mass of an element, multiplied by the index at the sign of the element in the formula.

Thus, the chemical formula expresses:

1) the qualitative composition of the substance - what chemical elements it consists of;

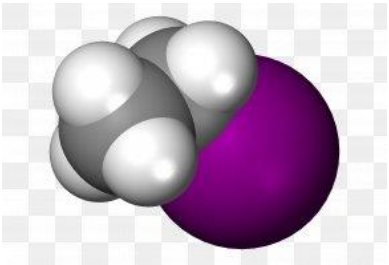
2) the quantitative or atomic composition of its molecule, i.e. the number of atoms of each element.

By the chemical formula, you can calculate:

1) the relative molecular mass of the substance;

2) mass fractions of elements in the substance;

3) the ratio of the masses of elements in a complex substance.



The number in front of the formula, called the coefficient, indicates the number of molecules of the given substance.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. To write a formula of a complex substance you need to know its qualitative composition and quantitative composition.

2. An index is a sign indicating the number of atoms in a molecule. It is written at the bottom right.

3. The relative molecular mass of a substance is a number that shows how many times the mass of its molecule is more than 1/12 of the mass of an atom.

4. The chemical formula can't be used to calculate the mass fractions of elements in a substance.

5. By the chemical formula you can calculate not only the relative molecular mass of the substance but also mass fractions of elements in the substance.

TASK 2. Fill in the **gaps** with appropriate words.

complex *formula* *indices* *qualitative*
elementary *quantitative* *composition*

1. A chemical formula shows if the substance is _____ or _____, what elements it is formed of and the number of atoms of one element per a certain number of atoms of another element.

2. Usually we write the signs of chemical elements and the at the _____ bottom right.

3. _____ composition shows what chemical elements the substance consists of and _____ composition shows the number of atoms of each element in its molecule.

4. A chemical formula is a conditional record of the _____ of a substance with the help of chemical signs indices.

5. A chemical _____ expresses the composition of elementary and complex substances.

TASK 3. **Match** the words in **the two columns**.

1. mass	**a)** formula
2. chemical	**b)** mass
3. the ratio	**c)** record
4. relative molecular	**d)** substance
5. atomic	**e)** fractions
6. complex	**f)** composition
7. conditional	**g)** of the masses

TASK 4. **Choose** the appropriate **verb**.

to exhaust *to consist* *to express* *to indicate* *to calculate*

1. The chemical formula of a substance is used to _____ its relative molecular mass.

2. Oxygen and hydrogen molecules _____ of two atoms, so their composition is expressed by the formulas O_2 and H_2.

3. The information about the substance given by its chemical formula does not _____ by elementary or complex substance and the number of atoms.

4. A number at the bottom right _____ the number of atoms in a molecule, it is called an index.

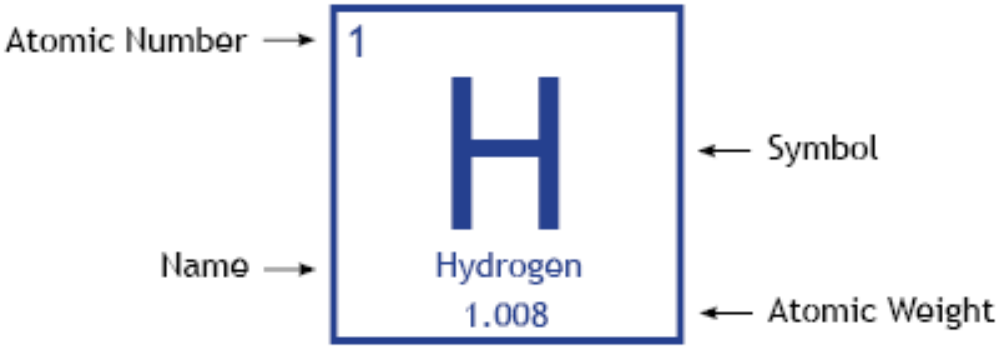
5. The chemical formula _____ the qualitative composition of the substance and the quantitative or atomic composition of its molecule.

TASK 5. **Translate** the following text **into English**.

Кожна складна або проста речовина складається з елементарних частинок – атомів і молекул, які мають однаковий атомний склад і структурну будову.

Хімічна формула – це зображення якісного і кількісного складу речовини за допомогою символів хімічних елементів, а також числових, літерних та інших знаків.

Хімічна формула дає наступну інформацію про речовину: які елементи входять до складу речовини і яке співвідношення атомів цих елементів.



UNIT SEVEN

VOCABULARY

Translate the following words and write them down!

to attach (*v*)	divalent (*adj*)	valence (*n*)
to consider (*v*)	to familiarize (*v*)	variable (*adj*)
constant (*adj*)	to link to (*v*)	
to depict (*v*)	monovalent (*adj*)	
to derive (*v*)	to represent (*v*)	

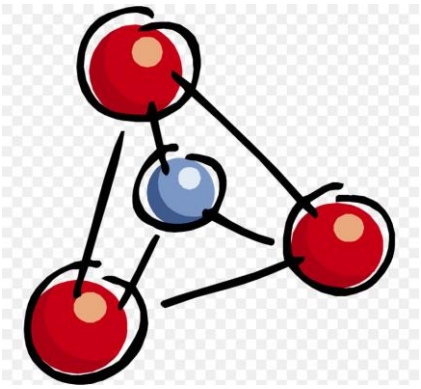
Before you read answer the questions:

1. How are the atoms in the molecule joined?

2. Can a number of atoms in the molecule be unlimited?

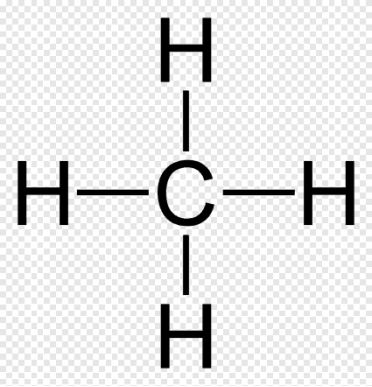
READ the text!

VALENCE OF ATOMS OF ELEMENTS



Chemical formulas are derived on the basis of data on the qualitative and quantitative composition of substances. Empirically, for example, it has been established that in any proportion of water there is 1 mass part of hydrogen per 8 mass parts of oxygen. Since the smallest number of oxygen atoms in a water molecule can be one atom, i.e. 16 [Ar H) = 16], then, consequently, there are two atoms of hydrogen in it; [Ar H) = 1]. It means that there is one oxygen atom and two hydrogen atoms in a water molecule. This method of

drawing up chemical formulas is used only in cases when the formula of a given substance is derived for the first time.



There are a lot of substances and if it was necessary to memorize their formulas, then the study of chemistry would be very difficult. It turns out that you can judge the composition of a substance and write its formula knowing the laws governing the combination of atoms. To do this you need to familiarize yourself with the property of atoms - valence.

Let us consider the composition of several substances: HCl, H_2O, NH_3, CH_4. From the above formulas it can be seen that the chlorine atom is connected to one hydrogen atom. Atoms of other elements - oxygen, nitrogen, carbon - are connected with a different number of hydrogen atoms - 2, 3, 4.

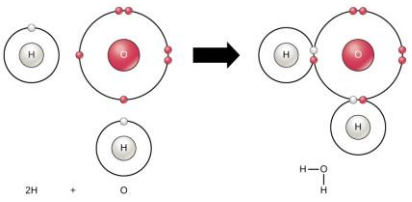
The behaviour of atoms of elements to attach a certain number of other atoms is called valence. The valence unit is taken as the valence of the hydrogen atom. A hydrogen atom does not attach more than one atom of other elements. It can be seen from the chemical formulas of the compounds, for example:

HBr, H_2S, PH_3, SiH_4

Let's represent these formulas like this:

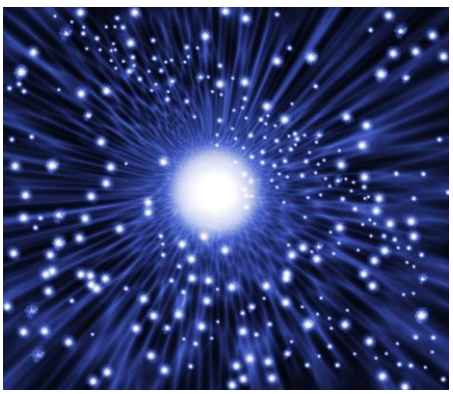
```
H
|
H – Br, H – S – H, H – P – H, H – Si – H
|          |
H          H
```

The dashes represent the bonds between atoms. Each dash represents one link. With this graphical way of depicting molecules, you can immediately see which atoms are connected to each other and which atoms are



not. So, the formula of water shows that in its molecule both hydrogen atoms are linked to an oxygen atom, but not linked to each other. From the above formulas it can be seen that the atoms of some elements (chlorine, bromine) attach one hydrogen atom to themselves - these elements are monovalent; atoms of other elements (oxygen, sulfur) attach two hydrogen atoms each - these elements are divalent, etc.

In a water molecule the sum of the valence units of two hydrogen atoms (2) is equal to the valence of an oxygen atom (also 2). In CH_4 methane the valence of a carbon atom (4) is equal to the sum of the valence units of four hydrogen atoms (also 4). In the molecules of the considered compounds, consisting of two elements, the total number of valence units of atoms of one element is equal to the total number of valence units of atoms of the other element. The valence of the hydrogen atom in all its compounds is 1, i.e. hydrogen is always monovalent; the valence of the oxygen atom is always 2, i.e. oxygen is always bivalent. Graphic formulas of simple substances of hydrogen and oxygen is: H - H and O = O.



By the formula of a substance consisting of two elements, it is possible to determine the valence of one element if the valence of the other is known. So, knowing that the valence of oxygen is always 2 it is easy to determine the valence of other elements by the formulas of their compounds with oxygen, for example, phosphorus by the formula P_2O_5. To do this, we find the total number of oxygen valence units by multiplying its valence (2) by the number of atoms in the molecule (5). We get 10. The same should be the total number of valence units for two phosphorus atoms. Therefore, the valence of phosphorus in phosphorus oxide is 10 : 2 = 5.

Some chemical elements show the same constant valence in all their compounds, others - different, variable valence. So, sodium, potassium in chemical

compounds are always monovalent; oxygen, zinc, magnesium, calcium are always bivalent. The valence of these elements is constant. Atoms with variable valence exhibit one or the other valence, depending on the elements and conditions their combination is formed.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. The valence unit is taken as the valence of the hydrogen atom which does not attach more than one atom of other elements.

2. Chlorine and bromine are monovalent elements but oxygen and sulfur are divalent elements.

3. If the formula of a substance consists of two elements it is impossible to determine the valence of one element if the valence of the other is known.

4. Some chemical elements show constant valence in all their compounds, other chemical elements show variable valence.

5. The formula of water shows that in its molecule both hydrogen atoms are linked not only to an oxygen atom but to each other as well.

TASK 2. Fill in the **gaps** with appropriate words.

bivalent *graphical* *composition*
valence *variable* *monovalent*

1. The behaviour of atoms of elements to attach a certain number of other atoms is called _____.

2. With _____ way of depicting molecules you can see which atoms are connected to each other and which atoms are not.

3. Atoms with _____ valence exhibit one or the other valence, depending on the elements and conditions their combination is formed.

4. The valence of the hydrogen atom in all its compounds is 1, i.e. hydrogen is always _____ ; the valence of the oxygen atom is always 2, i.e. oxygen is always _____.

5. You can judge the _____ of a substance and write its formula knowing the laws governing the combination of atoms.

TASK 3. **Match** the words in **the two columns**.

1. the combination	**a)** of a substance
2. the composition	**b)** number
3. a certain	**c)** formula
4. the bonds	**d)** chemical element
5. a graphic	**e)** valence
6. variable	**f)** between atoms
7. a divalent	**g)** of atoms

TASK 4. **Choose** the appropriate **verb**.

to represent *to multiply* *to attach*
to derive *to determine*

1. Monovalent elements _____ one atom to themselves and divalent elements _____ two atoms each.

2. If we know that the valence of oxygen is always 2 it is easy to _____ the valence of other elements by the formulas of their compounds with oxygen.

3. When we want to find the total number of oxygen valence units we should _____ its valence to the number of atoms in the molecule.

4. When we need to _____ a new chemical formula we should pay attention to the qualitative and quantitative composition of substances.

5. In a structural chemical formula the dashes _____ the bonds between atoms.

TASK 5. **Translate** the following text **into English**.

Атоми хімічних елементів зв’язуються між собою, утворюючи прості або складні речовини. Яким чином атоми зв’язуються між собою? Це відбувається тому, що атоми мають таку властивість, як валентність (від латинського слова «*valentia*», що означає «*сила*»).

Валентність – це здатність атома сполучатися з певним числом атомів того самого або інших хімічних елементів.

Валентність у формулах можна позначити римськими цифрами, які записують над символами хімічних елементів. Валентність має кількісну характеристику. За одиницю прийнято валентність атома водню. Атом водню не приєднує більше одного атома інших елементів. Отже, водень одновалентний.

Слід пам’ятати такі правила:

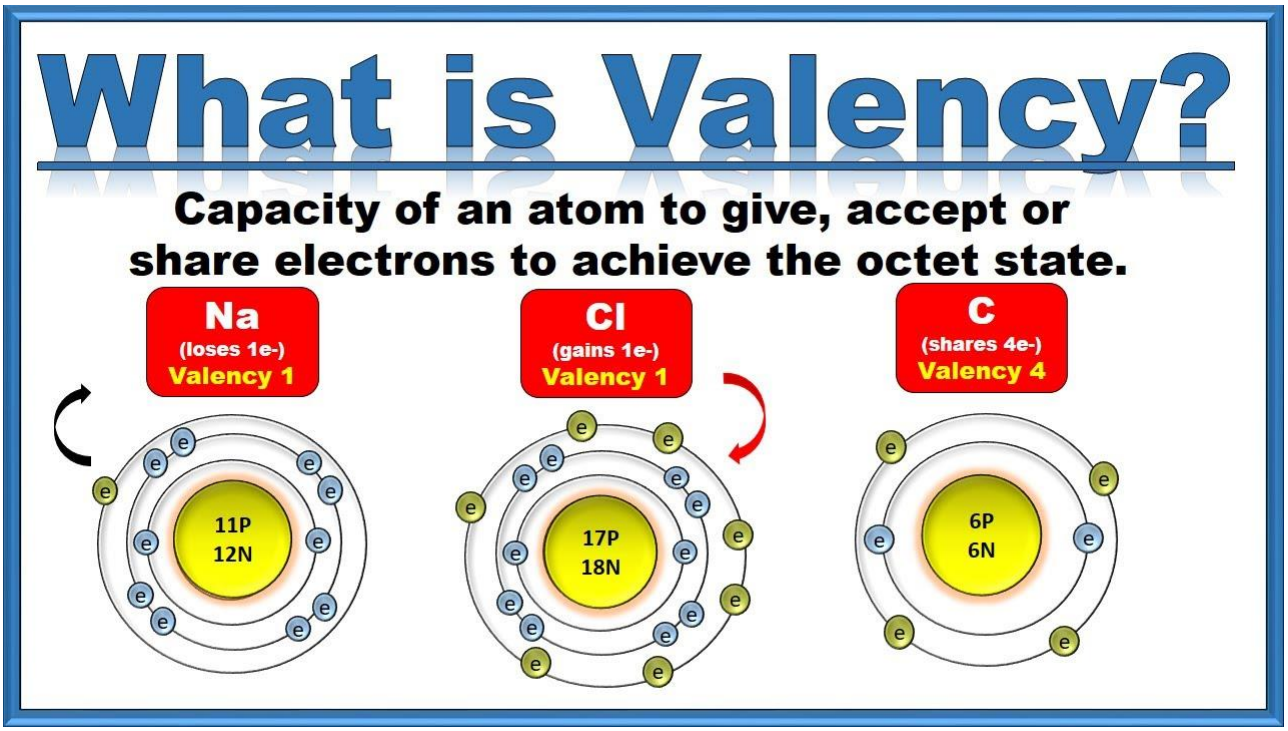
1. Валентність атомів водню у сполуках дорівнює одиниці (I), кисню – II, флору – I.

2. Валентність – число ціле – від одного до восьми. Більше восьми або дробовою валентність не буває.

3. У бінарних сполуках (складається з двох видів атомів) сумарна валентність усіх атомів одного елемента дорівнює сумарній валентності всіх атомів іншого елемента.

4. У назвах речовин, утворених елементом зі змінною валентністю, після назви цього елемента у дужках пишуть римську цифру, яка позначає його валентність. Наприклад: FeO – ферум (II) оксид; Fe_2O_3– ферум (III) оксид.

5. У формулах бінарних сполук на першому місці ставлять символи елементів, які у періодичній системі розміщені лівіше або нижче, на другому – які розміщені в періодичній системі правіше або вище.



UNIT EIGHT

Atomic-molecular theory

VOCABULARY

Translate the following words and write them down!

aid (*n*)	to involve (*v*)	to originate (*v*)
to destroy (*v*)	to join (*v*)	phenomenon (*n*)
essence (*n*)	to mix (*v*)	to preserve (*v*)
evaporation (*n*)	to move (*v*)	provision (*n*)
infinity (*n*)	to occur (*v*)	to separate (*v*)

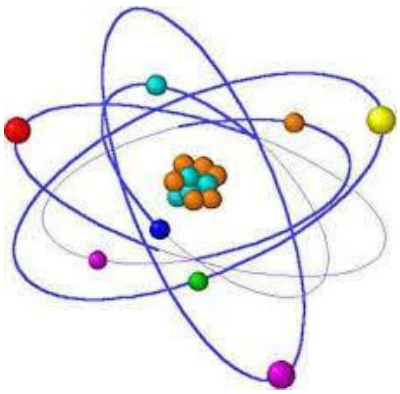
Before you read answer the questions:

1. What is the smallest item known in chemistry?

2. What do you know about M.V. Lomonosov?

READ the text!

ATOMIC-MOLECULAR THEORY IN CHEMISTRY



Molecular theory explains the physical phenomena that occur with substances. The study of atoms comes to the aid of molecular theory in explaining chemical phenomena. Both of these theories - molecular and atomic - are combined into atomic-molecular theory. The essence of this teaching can be formulated in the form of several provisions.

1. Substance is divisible not to infinity, but only to its molecules.

2. In physical phenomena molecules are preserved, in chemical ones they are destroyed.

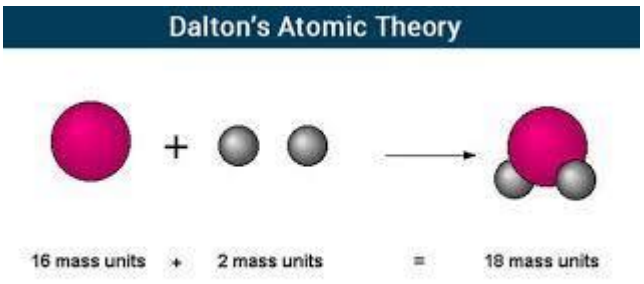
3. Molecules of substances are composed of atoms; in chemical reactions atoms, unlike molecules, are preserved.

4. The atoms of one element are similar to each other, but different from the atoms of any other element.

5. Chemical reactions involve the formation of new substances from the same atoms the original substances consisted of.

The theory of atoms originated in the works of ancient Greek philosophers long before the beginning of our era. Rejecting belief in gods and miracles, they tried to explain all the mysterious phenomena of nature by natural causes - joining and separating, moving and mixing invisible particles - eternally existing atoms. The theory of atoms, as godless, was persecuted by the ministers of the church for many centuries. Its followers were persecuted; their books were burned. But the philosophers of antiquity called atoms the things we now call molecules. Therefore, they were able to explain only physical phenomena: wind and storms, the spread of odors, the evaporation of water.

The basic principles of atomic-molecular theory were developed only in the middle of the 18th century by M.V. Lomonosov. He declared the study of the structure of substances to be the main task of chemistry. The atomic-molecular theory received universal recognition after the work of the English chemist D. Dalton. Chemistry really became a science only since chemical reactions began to be interpreted from the point of view of atomic-molecular theory.



TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. Molecular theory explains the chemical phenomena that occur with substances.

2. The atoms of one element are similar to each other and the atoms of any other element.

3. The principles of atomic-molecular theory were developed by M.V. Lomonosov but became known in the world after the work of the English chemist D. Dalton.

4. D. Dalton wanted the study of the structure of substances to be the main task of chemistry.

5. For many centuries the ministers of the church persecuted the theory of atoms as they believed it was godless.

TASK 2. Fill in the **gaps** with appropriate words.

formation *science* *theory* *atoms* *aid*

1. The study of atoms comes to the _____ of molecular theory in explaining chemical phenomena.

2. Chemical reactions involve the _____ of new substances from the same atoms the original substances consisted of.

3. Chemistry really became a _____ only since chemical reactions began to be interpreted from the point of view of atomic-molecular theory.

4. The _____ of atoms originated in the works of ancient Greek philosophers long before the beginning of our era.

5. The philosophers of antiquity called _____ the things we now call molecules.

TASK 3. **Match** the words in **the two columns**.

1. natural	**a)** particle
2. invisible	**b)** reaction
3. the evaporation	**c)** cause
4. chemical	**d)** recognition
5. universal	**e)** theory
6. physical	**f)** of water
7. atomic-molecular	**g)** phenomena

TASK 4. **Choose** the appropriate **verb**.

to destroy *to formulate* *to involve* *to originate* *to occur*

1. Chemical reactions _____ the formation of new substances from the same atoms the original substances consisted of.

2. Molecular theory explains the physical phenomena that _____ with substances.

3. In physical phenomena molecules are preserved, in chemical ones they are _____.

4. The theory of atoms _____ in the works of ancient Greek philosophers long before the beginning of our era.

5. The essence of atomic-molecular theory can be _____ in the form of several provisions.

TASK 5. **Translate** the following text **into English**.

Атомно-молекулярна теорія була створена в 1741 році видатним російським вченим М.В. Ломоносовим. Він вперше чітко розділив дві ступені в будові речовини: елементи (в нашому розумінні атоми) і корпускули (молекули). Основні положення даного вчення він виклав у книзі «Елементи математичної хімії».

Основні положення атомно-молекулярного вчення:

1. Речовини складаються з часток (структурних елементів речовин) – молекул, атомів або іонів.

2. Частки речовин (молекули, атоми або інші) безперервно безладно рухаються.

3. Між складовими частками речовини є відстані.

4. Молекули складаються з атомів. Молекули зберігаються під час фізичних явищ і руйнуються під час хімічних явищ (при хімічних реакціях).

5. Під час хімічних реакцій атоми зберігаються – при цьому відбувається їх перегрупування, що приводить до утворення нових речовин.

6. Молекули простих речовин складаються з однакових атомів, складних – з різних атомів.

Дж. Дальтон розвинув атомістичне вчення Ломоносова, він намагався встановити атомні маси відомих на той час елементів. Проте Дальтон заперечував існування молекул у простих речовинах.

UNIT NINE

VOCABULARY

Translate the following words and write them down!

brazier (*n*)	to increase (*v*)	scale (*n*)
brittle (*adj*)	to obtain (*v*)	sealed (*adj*)
to consume (*v*)	reacting substance (*n*)	to subtract (*v*)
to contradict (*v*)	resulted substance (*n*)	vessel (*n*)
to decrease (*v*)	retort (*n*)	

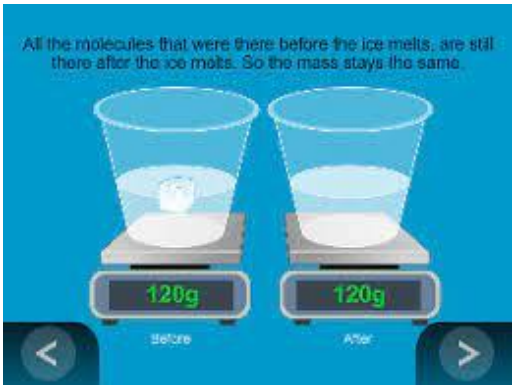
Before you read answer the questions:

1. What basic laws of chemistry do you know?

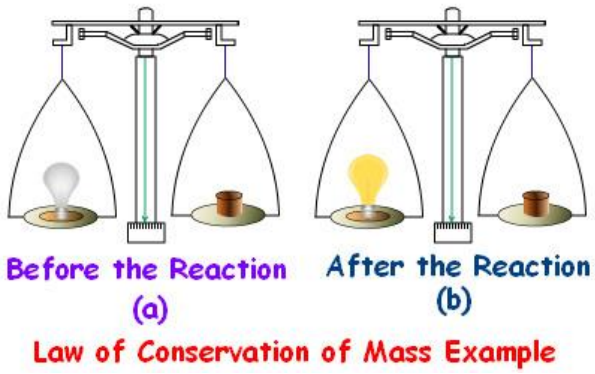
2. Can substances arise from nothing or turn into nothing?

READ the text!

THE LAW OF CONSERVATION OF THE MASS OF SUBSTANCES



The products of any chemical reaction are composed of the same atoms from which the basic substance consisted. Atoms are preserved during chemical reactions; it means that the mass of all atoms taken together must also be preserved. In this case, the products of any chemical reaction must have the same mass as the total mass of the basic substance.

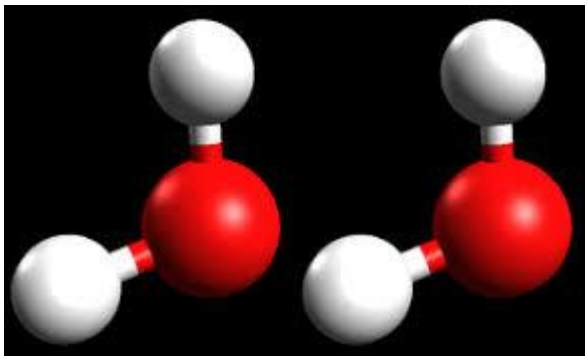


It would seem that experience sometimes contradicts this. Thus, when calcined in air, metals turn into brittle scales, the mass of which is always greater than the mass of metals before the experiment. May some particles from the air be attached to the metal? How can we be sure of it? A simple solution was found by M.V. Lomonosov. Instead of calcining metals in the open air, he calcined them in sealed retorts (vessels). The metal turned into scale, which means that the mass should increase. But the mass of the vessel after the experiment was the same as before the vessel was placed on the brazier. It means that the mass of the air contained in the vessel has decreased by as much as the mass of the metal has increased.

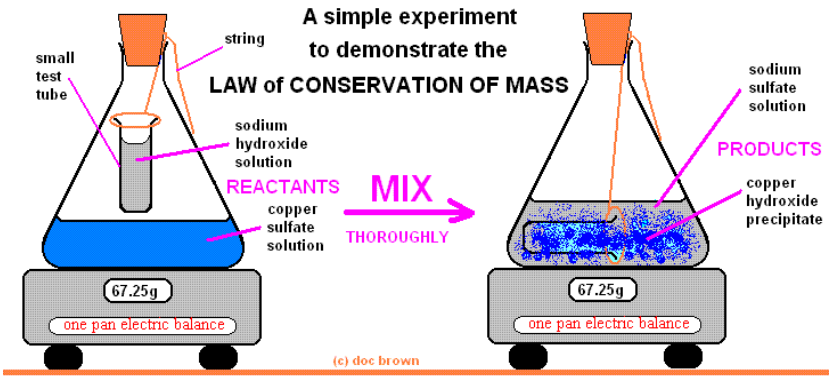
The mass of substances that have entered into a chemical reaction is always equal to the mass of the resulted substances.

This one of the basic laws of chemistry is called the law of conservation of mass. The law of conservation of mass was first formulated by M.V. Lomonosov.

From the law of conservation of mass, it follows that substances cannot arise from nothing or turn into nothing. Therefore, if it seems to us that during a chemical reaction a substance seems to be obtained from nothing or disappears without a trace, then this means that we have not taken into account all the substances participating in the reaction and resulted substances. For example, when wood burns, it seems to us that the substances that form it disappear without a trace. However, a more detailed study of the reaction shows that this is not



the case: the mass of substances consumed during the combustion of wood (the wood itself and oxygen of the air) is equal to the mass of water, carbon dioxide and ash obtained during combustion.



Using the law of conservation of mass, you can calculate the mass of either one of the reacting substances or one of the resulted substances if the masses of all the others are known. So, if you need to find out the mass of oxygen obtained during the decomposition of a certain portion of mercury oxide, then there is no need to collect oxygen and weigh it. It is enough to determine the mass of mercury oxide taken for the reaction and the mass of mercury obtained as a result of the reaction. According to the law of conservation of mass the sum of the masses of mercury and oxygen is equal to the mass of decomposed mercury oxide. Therefore, subtracting from the mass of mercury oxide the mass of the obtained mercury we find out the mass of the obtained oxygen.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. The products of any chemical reaction must have the same mass as the total mass of the basic substance.

2. M.V. Lomonosov found the solution to calcine metals in sealed retort vessels.

3. The mass of substances that have entered into a chemical reaction is different to the mass of the resulted substances.

4. One of the basic laws of chemistry called the law of conservation of mass was formulated by M.V. Lomonosov.

5. Using the law of conservation of mass it is possible to calculate the mass of the reacting substances or the resulted substances even if the masses of all the others are unknown.

TASK 2. Fill in the **gaps** with appropriate words.

brazier *nothing* *preserved* *resulted* *brittle*

1. Atoms are _____ during chemical reactions; it means that the mass of all atoms taken together must also be _____.

2. When metals are calcined in air, they turn into _____ scales, the mass of which is always greater than the mass of metals before the experiment.

3. The mass of the vessel after the experiment was the same as before the vessel was placed on the _____.

4. From the law of conservation of mass it follows that substances cannot arise from _____ or turn into _____.

5. All the substances participating in the reaction and _____ substances should be taken into account.

TASK 3. **Match** the words in **the two columns**.

1. a detailed	**a)** substance
2. a basic	**b)** study
3. brittle	**c)** retort
4. a resulted	**d)** law
5. a sealed	**e)** air
6. the open	**f)** scale
7. a chemical	**g)** reaction

TASK 4. **Choose** the appropriate **verb**.

to subtract *to decrease* *to obtain* *to consume*
to contradict *to increase*

1. The mass of the air contained in the vessel has _____ by as much as the mass of the metal has _____.

2. The mass of substances we _____ during the combustion of wood is equal to the mass of water, carbon dioxide and ash obtained during combustion.

3. If we need to find out the mass of oxygen we _____ during the decomposition of a certain portion of mercury oxide, we should determine the mass of mercury oxide taken for the reaction and the mass of mercury we _____ as a result of the reaction.

4. Sometimes our live experience _____ obvious facts.

5. The sum of the masses of mercury and oxygen is equal to the mass of decomposed mercury oxide so we need to _____ the mass of the of the obtained mercury to find out the mass of the obtained oxygen.

TASK 5. **Translate** the following text **into English**.

Під час хімічних реакцій одні речовини перетворюються в інші. А чи відбуваються якісь зміни з масою речовин в результаті реакції? З цього приводу вчені висловлювали різні думки. Видатний англійський хімік Р. Бойль, прожарюючи у відкритій реторті різні метали і зважуючи їх до і після нагрівання, виявив, що маса металів збільшується. Ґрунтуючись на цих дослідах, він дійшов неправильного висновку, що маса речовини в результаті хімічних реакцій змінюється.

М.В. Ломоносов, на відміну від Р. Бойля, прожарював метали в запаяних ретортах і зважував їх до і після прожарювання. Він довів, що маса речовин

до і після реакції залишається без змін. У 1748 році М.В. Ломоносов сформулював найважливіший закон хімії – закон збереження маси.

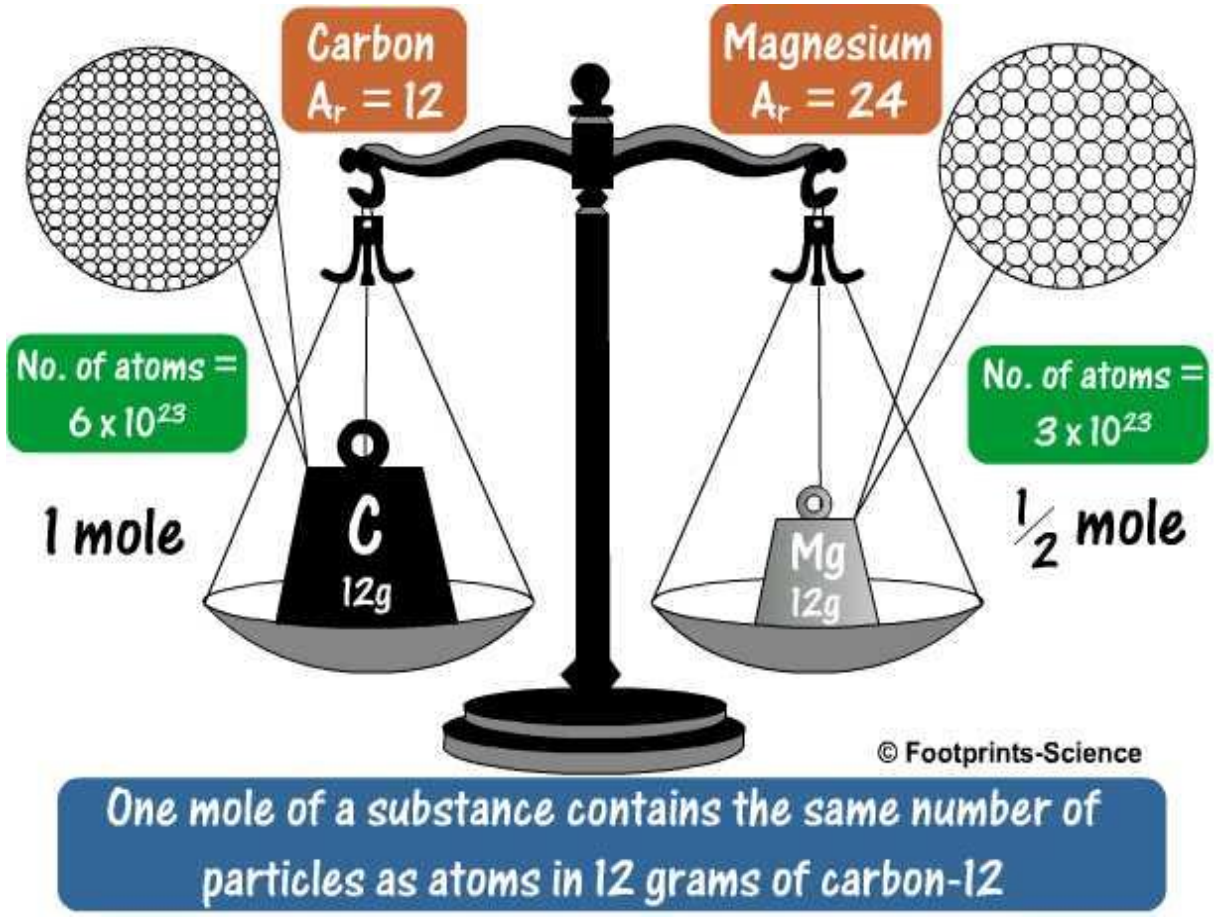
Такий же результат значно пізніше, не знаючи про дослідження М.В. Ломоносова, одержав французький учений А.Л. Лавуазьє, який сформулював закон збереження маси у 1789 р.

Закон збереження маси речовин можна пояснити так:

1. Під час хімічних реакцій атоми не виникають з нічого і не зникають, а лише перегруповуються. Суть хімічної реакції полягає у перегрупуванні атомів.

2. Загальна кількість атомів не змінюється.

3. Загальна маса атомів залишається сталою до і після реакції.



UNIT TEN

Chemical reactions

10

VOCABULARY

Translate the following words and write them down!

to cease (*v*)	to convert (*v*)	equation (*n*)
coating (*n*)	decomposition reaction (*n*)	stopper (*n*)
combination reaction (*n*)		substitution reaction (*n*)

Before you read answer the questions:

1. Are all chemical reactions similar or different?

2. What makes chemical reactions different?

READ the text!

TYPES OF CHEMICAL REACTIONS

Chemical reactions can be subdivided into several basic types according to such characteristics as the number and composition of the basic and resulted substances.

Decomposition reactions. Put the malachite powder (a green substance) in a test tube, close it with a stopper with a curved tube inserted, lower the end of the tube into a glass filled with lime water, and heat the malachite. When heated, the green powder turns to black. This is the familiar copper oxide CuO. Drops of water settle on the walls of the test tube and the solution in the glass becomes cloudy: it is a sign of the appearance of

carbon dioxide. What happened to malachite? Three new substances were formed from it - copper oxide, water and carbon dioxide:

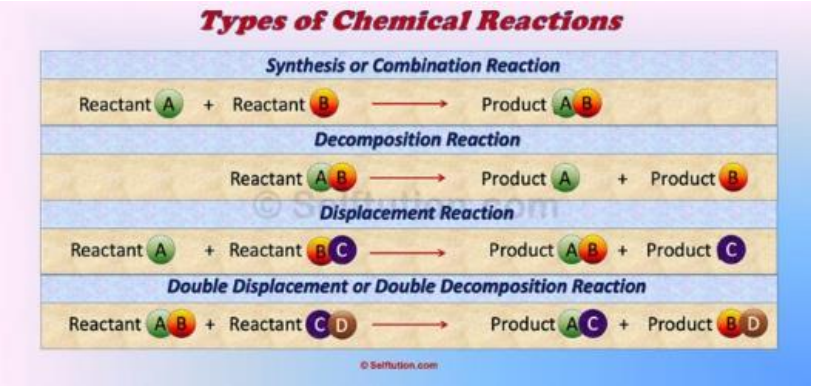
malachite → copper oxide + water + carbon dioxide

$Cu_2CH_2O_5 = 2CuO + H_2O + CO_2$

Let's recall the reaction:

water → hydrogen + oxygen

$2H_2O = 2H_2 + O_2$



The common thing in these reactions is that several elementary or complex substances are obtained from one complex substance.

Chemical reactions in which several other substances are obtained from one complex substance are called decomposition reactions.

Combination reactions. If only decomposition reactions occurred in nature, then all complex substances that can decompose would decompose and chemical phenomena would cease. But there are other types of reactions.

When copper is heated in air, it becomes covered with a black coating. Copper is converted to copper oxide (II):

copper + oxygen → copper oxide (II)

2Cu + O2 = 2CuO

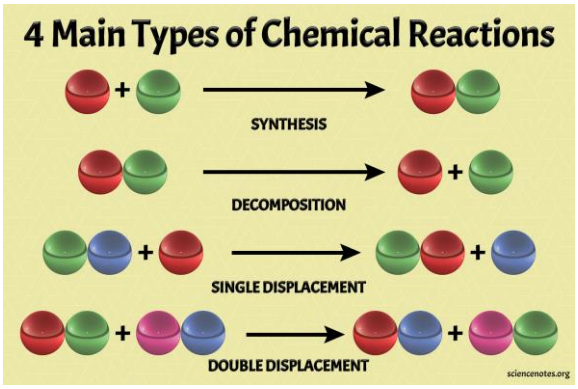
Let us now recall the reaction for obtaining iron sulfide (II):

iron + sulfur → iron sulfide (II)

Fe + S = FeS

In both cases, one new substance is obtained from several (in this case from two) substances.

Reactions in which one complex substance is obtained from several simple or complex substances are called combination reactions. Combination reactions are thus opposite to decomposition reactions.



Substitution reactions. Let's put an iron nail into a blue solution of copper chloride (II) - its chemical formula is $CuCl_2$. The nail will immediately start covering with copper released on its surface, and the solution by the end of the reaction turns from blue to greenish: it now contains iron chloride (II) instead of copper chloride (II). The chemical formula of iron chloride (II) is $FeCl_2$. The reaction is expressed by the equation:

iron + copper chloride (II) → copper + iron chloride (II)

$$Fe + CuCl_2 = Cu + FeCl_2$$

If instead of iron pieces of zinc Zn are thrown into a solution of copper chloride (II), copper will be released in the same way. The solution becomes colorless since the second product of the reaction is zinc chloride $ZnCl_2$, and the solution of this substance is colorless. The reaction is expressed by the equation:

zinc + copper chloride (II) → copper + zinc chloride (II)

$$Zn + CuCl_2 = Cu + ZnCl_2$$

The copper atoms in copper chloride (II) were replaced in the first case by iron atoms, and in the second - by zinc atoms. Thus, atoms can not only combine with each other, but also replace each other in complex substances.

Chemical reactions between elementary and complex substances in which the atoms that make up the elementary substance replace the atoms of one of the elements of the complex substance are called substitution reactions.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. Chemical reactions are subdivided into several basic types according to the composition of the resulted substances.

2. A decomposition reaction is a chemical reaction when several substances are obtained from one complex substance.

3. Combination reactions are chemical reactions when one complex substance is obtained from several simple or complex substances.

4. Combination reactions and decomposition reactions are similar.

5. In complex substances atoms can not only combine with each other but also replace each other.

TASK 2. Fill in the **gaps** with appropriate words.

decomposition appearance combination substitution solution opposite complex

1. A sign of the _____ of carbon dioxide is drops of water on the walls of the test tube and appearing of the cloudy _____.

2. Decomposition reactions are characterized by the obtaining of several elementary or complex substances from one _____ substance.

3. Combination reactions are _____ to decomposition reactions.

4. _____ reactions provide several elementary or complex substances from one complex substance and _____ reactions provide one complex substance from several simple or complex substances.

5. Chemical reactions between elementary and complex substances when the atoms of elementary substance replace the atoms of one of the elements of the complex substance are called _____ reactions.

TASK 3. **Match** the words in **the two columns**.

1. water → hydrogen + oxygen $2H_2O = 2H_2 + O_2$	**a)** an elementary substance
2. copper + oxygen → copper oxide 2Cu + O2 = 2CuO	**b)** a complex substance
3. iron + copper chloride→ copper + iron chloride Fe + $CuCl_2 = Cu + FeCl_2$	**c)** a mixture
4. copper chloride $CuCl_2$	**d)** a combination reaction
5. Zn + $CuCl_2 = Cu + ZnCl_2$	**e)** a decomposition reaction
6. sulfur S	**f)** a substitution reaction
7. milk	**g)** an equation

TASK 4. **Choose** the appropriate **verb**.

to decompose *to convert* *to settle* *to cease*
to subdivide *to obtain*

1. Chemical reactions can be _____ into several basic types according to the number and composition of the basic and resulted substances.

2. Drops of water _____ on the walls of the test tube and the solution in the glass becomes cloudy.

3. In decomposition reactions several elementary or complex substances are _____ from one complex substance.

4. If decomposition reactions occurred in nature all complex substances would _____ and chemical phenomena would _____.

5. When copper is heated in air, it becomes covered with a black coating and _____ to copper oxide.

TASK 5. **Translate** the following text **into English**.

Хімічна реакція – це явище, під час якого руйнуються сполуки і структури реагентів й утворюються нові сполуки продуктів реакції.

У світі, що нас оточує, постійно відбувається величезна кількість хімічних реакцій. У кожній з них беруть участь найрізноманітніші речовини з різними властивостями. Але, незважаючи на це, всі реакції можна згрупувати у кілька основних типів за низкою ознак. За основу класифікації хімічних реакцій найчастіше беруть зміни в кількості вихідних речовин та речовин, що утворилися внаслідок реакції.

Реакції розкладу – це реакції, в результаті яких з однієї речовини утворюється кілька нових речовин.

Реакції сполучення – це реакції, в результаті яких з двох або кількох вихідних речовин утворюється одна нова речовина.

Реакції заміщення – це реакції між простою і складною речовинами, у процесі яких атоми простої речовини заміщують атоми одного з елементів складної речовини, утворюючи нову просту і нову складну речовини.

UNIT ELEVEN

Oxygen

11

VOCABULARY

Translate the following words and write them down!

abundant (*adj*)	flame (*n*)	respiration (*n*)
blinding (*adj*)	handle (*n*)	smoldering (*adj*)
bottom (*n*)	to immerse (*v*)	splinter (*n*)
burner (*n*)	inanimate nature (*n*)	surface (*n*)
crust (*n*)	jar (*n*)	transparent (*adj*)
ember (*n*)	to make up (*v*)	wire (*n*)

Before you read answer the questions:

1. What properties of oxygen can you name?

2. What substances does oxygen combine with?

READ the text!

OXYGEN

Oxygen is the most abundant element on Earth; with its participation as an elementary substance, respiration and many important processes in inanimate nature and in technology occur.

The chemical sign of the element oxygen is O; the relative atomic mass is 16. The valence of oxygen in the compounds is two. The oxygen molecule consists of two atoms; its formula is O_2. The relative molecular mass of oxygen is 32.

Oxygen is the most abundant chemical element on the surface of the globe. In free form it is contained in the air. But most of all oxygen as a chemical element is found in water and in complex substances that make up rocks and minerals. Oxygen accounts for almost half of the mass of the earth's crust, hydrosphere and atmosphere. Oxygen is included in the chemical compounds that make up the organisms of plants, animals and humans.

OXYGEN PROPERTIES

Oxygen is a colorless gas, tasteless and odorless. It is slightly heavier than air, slightly soluble in water. At a pressure of 101.3 kPa and a temperature of 183°C oxygen turns into liquid. Liquid oxygen is a blue mobile liquid.

Let’s examine the chemical properties of oxygen, manifested in chemical reactions. We recognize oxygen by its ability to support the combustion of flammable substances: a smoldering splinter in it ignites. Let's get acquainted with several reactions of combining oxygen with elementary substances:

1. Pour some red phosphorus into an iron spoon. Red phosphorus is an elementary red substance, insoluble in water. Put a spoonful of phosphorus in oxygen. No reaction will happen. Let us now set fire to oxygen and again lower the spoon with burning phosphorus into oxygen. Phosphorus continues to burn in oxygen with a bright blinding flame. At the same time, the vessel is filled with thick white smoke so that a spoonful of burning phosphorus becomes invisible behind its veil. After some time, particles of white

smoke settle on the walls of the vessel in the form of a white powder. Let's add water to the vessel. At first we will get a cloudy liquid, but after a while the powder will dissolve and the liquid will become transparent again.

The red water-insoluble substance has turned into a white soluble substance with the release of heat and light, which means that a chemical reaction has occurred. How did oxygen take part in it? This is probably the reaction of the combination of phosphorus with oxygen. In this case oxygen should be consumed along with phosphorus.

To check this, let us burn phosphorus again in oxygen, but not in an open vessel, in a bell (vessel without a bottom) immersed in water. The wire handle of the phosphorus spoon is passed through the stopper. Having brought burning phosphorus into oxygen, we tightly close the neck of the bell with this stopper. As phosphorus burns, water rises higher and higher in the bell, which means that oxygen remains less and less - it is consumed.

Thus, in the above reaction, oxygen combines with phosphorus and a new substance is formed. This substance is called phosphorus oxide (V), its formula is P_2O_5.

2. Put the coal on an iron spoon into the flame of the burner and when the coal is hot take it out of the flame and hold it in the air. The coal smolders for a while and then goes out. Coal burns poorly in the air. Let's heat the ember again and bring it into the oxygen bank. Coal in oxygen does not go out, as in air, but becomes white-hot and burns without flame or smoke, gradually decreasing in size. BUT the coal went out. Let's bring

a burning splinter into the jar. It goes out. Let's add lime water to the jar. It grows cloudy. These are familiar signs of the presence of carbon dioxide CO_2, or carbon monoxide (IV).

A chemical reaction took place: oxygen combined with carbon. Reaction equation is: $C + O_2 = CO_2$

Like coal, sulfur, phosphorus and iron, most other non-metals and metals combine with oxygen. However, these reactions are not always accompanied with combustion. So, when heated in oxygen (as well as heating in air), copper combines with oxygen, turning into black powder - copper oxide CuO without combustion. The equation for the reaction of the compound of copper with oxygen is:

$$2Cu + O2 = 2CuO$$

Free oxygen is one of the most active elementary substances.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. Oxygen is the most abundant element on Earth because it is important for respiration and many important processes in inanimate nature.

2. The chemical sign of the element oxygen is O; the relative atomic mass and relative molecular mass of oxygen are 16.

3. Oxygen turns from gas into liquid (deliquesces) at a pressure of 101.3 kPa and a temperature of 183°C and becomes a colourless mobile liquid.

4. Oxygen is a colorless gas, tasteless and odorless, which is slightly heavier than air and slightly soluble in water.

5. Most non-metals and metals combine with oxygen and these reactions are always accompanied with combustion.

TASK 2. Fill in the **gaps** with appropriate words.

combustion *smoke* *blinding* *active* *soluble*

1. Phosphorus continues to burn in oxygen with a bright _____ flame.

2. The red water-insoluble substance has turned into a white _____ substance with the release of heat and light.

3. Coal in oxygen does not go out, as in air, but becomes white-hot and burns without flame or _____, gradually decreasing in size.

4. When heated in oxygen copper combines with oxygen, turning into black powder without _____.

5. Free oxygen is one of the most _____ elementary substances.

TASK 3. **Match** the words in **the two columns**.

1. a transparent	**a)** molecular mass
2. a mobile	**b)** in water
3. an abundant	**c)** nature
4. the relative	**d)** gas
5. soluble	**e)** element
6. inanimate	**f)** liquid
7. a colorless	**g)** substance

TASK 4. **Choose** the appropriate **verb**.

to support *to make up* *to account*
to manifested *to include*

1. Most of all oxygen as a chemical element is found in water and in complex substances that _____ rocks and minerals.

2. Oxygen is _____ in the chemical compounds that make up the organisms of plants, animals and humans.

3. Oxygen _____ for almost half of the mass of the earth's crust, hydrosphere and atmosphere.

4. The chemical properties of oxygen are _____ in chemical reactions.

5. Oxygen is able to _____ the combustion of flammable substances.

TASK 5. **Translate** the following text **into English**.

Оксиген - неметалічний елемент. Він може утворювати дві прості речовини - кисень O_2 і озон O_3. Валентність Оксигену є постійною і дорівнює II.

За звичайних умов кисень - безбарвний газ без смаку і запаху. Погано розчиняється у воді (в 1 л можна розчинити лише 0,04г кисню), але цього достатньо для існування у водоймах риб та різноманітних живих організмів, які дихають розчиненим у воді киснем. Кисень підтримує горіння. При температурі −183С° кисень зріджується (утворюється блакитна рідина), а при – 219С° - твердне, утворюючи кристали синього кольору.

Оксиген входить до складу більшості органічних сполук. Він становить 50 – 90% маси тканин рослин і тварин.

Озон O_3 утворюється з кисню під час грози, при окисненні смоли хвойних дерев і під дією сонячного випромінювання. У лабораторії його

отримують в озонаторах. За звичайних умов озон - безбарвний (у товстих шарах - блакитний) газ із запахом, важчий за повітря. Озон є отруйним. Він згубно діє на бактерії і застосовується для знезараження повітря і питної води.

У верхніх шарах атмосфери існує озоновий шар, який захищає все живе від згубного впливу ультрафіолетового випромінювання.

UNIT TWELVE

Oxidation

12

VOCABULARY

Translate the following words and write them down!

cloudy (*adj*)	oxidation (*n*)	to oxidize (*v*)
fractional (*adj*)	oxide (*n*)	wax (*n*)

Before you read answer the questions:

1. Can you call oxygen and active element and why?

2. What is the main quality of oxygen?

READ the text!

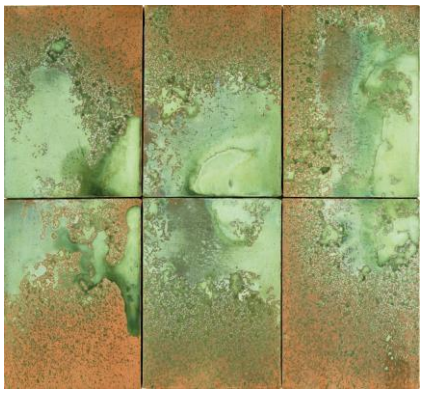
OXIDATION. OXIDES

Chemical reactions of oxygen with substances are referred to as oxidation reactions, and the resulting substances are referred to as oxides.

Oxide is a complex substance made up of atoms of two elements, one of which is oxygen.

Burning phosphorus is oxidized and phosphorus oxide(V) P_2O_5 is obtained. While burning coal, sulfur, iron oxidize and form oxides, namely: carbon dioxide CO_2 is carbon monoxide (IV), sulfur dioxide SO_2 is sulfur oxide (IV), iron scale Fe_2O_4 is iron oxides (II

and III).



Metal oxides like iron scale and copper oxide (II) are solids. Oxides of non-metals can be solid like phosphorus oxide (V), and liquid (water), and gaseous like sulfur dioxide and carbon dioxide (under normal conditions). Oxides are obtained by oxidation with oxygen not only of elementary substances, but also of some complex substances. Let's light a candle and put it in a jar of oxygen. A candle burns in oxygen with a bright flame. Water droplets are deposited on the walls of the can. Water is hydrogen oxide H_2O. Let's add lime water to the jar where the candle was burning. It will become cloudy, and this is a sign of carbon monoxide (IV) - carbon dioxide.

The candle is made of paraffin wax. The elements carbon and hydrogen are included in the composition of paraffin. When a candle burns, a compound of carbon with oxygen is formed - carbon monoxide (IV), and hydrogen combining with oxygen forms water:

$$\text{paraffin} + O_2 \rightarrow CO_2 + H_2O$$

Let us examine how to compose the equations for the oxidation of complex substances using the example of the combustion of acetylene:

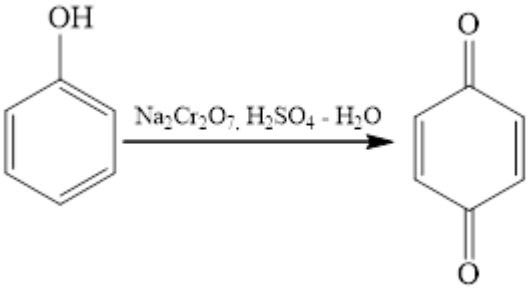
$$\text{acetylene} + \text{oxygen} \rightarrow \text{carbon dioxide} + \text{water}$$

$$C_2H_2 + O_2 \rightarrow CO_2 + H_2O$$

Let's first calculate: a) how many molecules of carbon dioxide and b) how many water molecules are formed during the oxidation of one acetylene molecule. The C_2H_2 molecule has two carbon atoms, and the CO_2 molecule has one. This means that one molecule of acetylene will produce two molecules of carbon

dioxide. There are two hydrogen atoms in the C_2H_2 molecule, and there are also two in the H_2O molecule. This means that one molecule of acetylene will produce one molecule of water:

$$C_2H_2 + O_2 \rightarrow 2CO_2 + H_2O$$



Let us now determine how many oxygen atoms will be used to form two molecules of carbon dioxide and one molecule of water. Oxygen atoms will go as many as they are contained in these molecules, i.e. five oxygen atoms. Five oxygen atoms make up two and a half of its molecules. Equation coefficients are found:

$$C_2H_2 + 2\ ½\ O_2 = 2CO_2 + H_2O$$

But fractional coefficients in chemical equations, as a rule, are not written. To get rid of the fractional number (2 ½), multiply all the coefficients by 2 and get the following reaction equation:

$$2C_2H_2 + 5O_2 = 4CO_2 + 2H_2O$$

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. Oxide is an elementary substance made up of atoms of two elements, one of which is oxygen.

2. Metal oxides are solids and oxides of non-metals can be solid, liquid, and gaseous.

3. Oxides are obtained by oxidation with oxygen only of elementary substances but not complex substances.

4. There are two hydrogen atoms in the C_2H_2 molecule and it means that one molecule of acetylene will produce one molecule of water.

5. As a rule, fractional coefficients in chemical equations are not written.

TASK 2. Fill in the **gaps** with appropriate words.

water *metal* *solid* *paraffin*
liquid *cloudy* *gaseous*

1. Oxides of non-metals can be _____ like phosphorus oxide, and _____ like water, and _____ like sulfur dioxide and carbon dioxide.

2. If we add lime water to the jar where the candle was burning it will become _____.

3. The elements carbon and hydrogen are included in the composition of _____.

4. _____ oxides like iron scale and copper oxide (II) are solids.

5. When a candle burns, a compound of carbon with oxygen is formed - carbon monoxide, and hydrogen combining with oxygen forms _____.

TASK 3. **Match** the words in **the two columns**.

1. oxidation	**a)** coefficient
2. resulting	**b)** reaction
3. paraffin	**c)** droplets
4. fractional	**d)** substance
5. bright	**e)** water
6. water	**f)** wax
7. lime	**g)** flame

TASK 4. **Choose** the appropriate **verb**.

to include *to obtain* *to deposit* *to refer* *to oxidize*

1. Chemical reactions of oxygen with substances are _____ to as oxidation reactions, and the resulting substances are _____ to as oxides.

2. When a candle burns in oxygen with a bright flame, water droplets are _____ on the walls of the can.

3. While burning sulfur _____ and forms sulfur dioxide SO_2 which is sulfur oxide (IV).

4. Oxides are _____ by oxidation with oxygen not only of elementary substances, but also of some complex substances.

5. The candle is made of paraffin wax so the elements carbon and hydrogen are _____ in the composition of paraffin.

TASK 5. **Translate** the following text **into English**.

Горіння в повітрі відбувається повільніше, ніж у кисні, оскільки в повітрі кисень дуже розбавлений азотом, і з поверхнею речовини, що горить, стикається менше молекул кисню, ніж під час горіння в чистому кисні. Крім того, температура горіння в повітрі не така висока, бо теплота, котра при цьому виділяється, витрачається на нагрівання не тільки продуктів згоряння, а й на нагрівання азоту повітря.

Взаємодія речовин з киснем не завжди може супроводжуватися горінням, однак при цьому завжди вивільняється теплота. Подібні процеси звуться повільним окисненням. В кам'яновугільних шахтах, незважаючи на досить посилену вентиляцію, завжди спостерігається підвищений уміст вуглекислого газу, котрий утворюється там в результаті повільного окислення вугілля. Різні металеві вироби із часом значно темнішають, тому що

більшість металів повільно окислюється під впливом повітря навіть при стандартних умовах.

В разі повільного окиснення речовини й матеріалу на виробництві, коли теплота не відводиться, підвищується температура так, що трапитися може самозаймання, так як повільне окиснення переходить в процес горіння, й здатне спричинити пожежу.

UNIT THIRTEEN

Flame

13

VOCABULARY

Translate the following words and write them down!

to accompany (*v*)	fuel (*n*)	soot (*n*)
adjacent (*adj*)	fume (*n*)	volatile (*adj*)
to char (*v*)	luminous (*adj*)	whitish (*adj*)
combustion (*n*)	molten (*adj*)	wick (*n*)
	shell (*n*)	

Before you read answer the questions:

1. Can you give definition to a flame?

2. What parts does the flame consist of?

READ the text!

FLAME

Combustion of various fuels is usually accompanied by the appearance of a flame. To study the structure of the flame, we will use a paraffin candle. Paraffin is a mixture of carbon and hydrogen compounds.

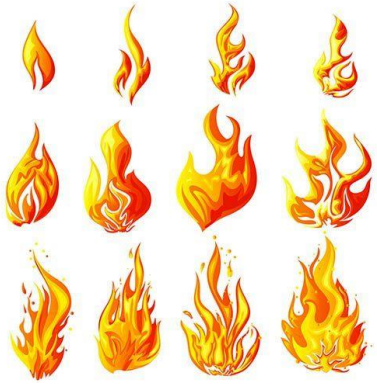
Let's light a candle and examine the flame. Three parts are found in it: the inner, dark part adjacent to the wick, a luminous cone around it, and a barely noticeable shell outside. The wick itself does not burn (only the bent end of it burns). It serves to supply molten paraffin to the combustion zone.

Let's examine the composition of each part of the flame. If the end of a glass tube is inserted into the inside of the flame, a whitish smoke which can be ignited will come out through it. These are paraffin fumes. So, the inner, dark cone of flame is formed by paraffin vapor.

Let’s introduce a cold object (for example, a porcelain cup) into the middle of the flame - a glowing cone - for a short time. The cup will be smoked and covered with soot. This means that the luminous cone contains free carbon in the form of small particles of soot coal. We know the composition of the outer cone of the paraffin flame: these are the end products of the combustion of paraffin — water vapor and carbon dioxide. Bring a splinter into the flame for a short time.

The splinter will be charred only in those places that are in the outer cone. This means that the flame temperature in it is the highest.

Where does the coal in the middle of the flame come from? When a lighted match is brought to the wick, the paraffin melts and begins to evaporate. The vapors rising from the wick ignite. Due to the high temperature in the middle of the flame, the paraffin vapor decomposes. This produces the smallest particles of coal, hydrogen and volatile carbon-hydrogen compounds. The hydrogen burns in the air leaking to the flame from below. From the heat of combustion, particles of coal are heated, so the flame glows. In the outer part of the flame, particles of coal are burned, carbon dioxide is formed. Here the flame temperature rises even more in comparison with the middle part, but the glow disappears.



If air is blown into the candle flame through a glass tube, the flame becomes almost non-luminous, and soot does not settle on the object introduced into it. This

is due to the fact that with sufficient air flow, coal particles burn quickly and do not stay in the flame. Flames are also formed in the furnaces of the stoves.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. The flame consists of three parts: the inner, dark part adjacent to the wick, a luminous cone around it, and a barely noticeable shell outside.

2. The inner, dark cone of flame is formed by paraffin vapor and the outer cone of the paraffin flame is formed by water vapor and carbon dioxide.

3. Due to the low temperature in the middle of the flame, the paraffin vapor decomposes and it produces the smallest particles of coal, hydrogen and volatile carbon-hydrogen compounds.

4. In the outer part of the flame the temperature rises even more in comparison with the middle part and the glow appears.

5. If air is blown into the candle flame through a glass tube, the flame becomes luminous and soot settles on the object introduced into it.

TASK 2. Fill in the **gaps** with appropriate words.

luminous *mixture* *shell* *combustion* *vapor* *match*

1. A soft white substance used for making candles called paraffin is a _____ of carbon and hydrogen compounds.

2. The inner, dark cone of flame is formed by paraffin _____.

3. When a lighted _____ is brought to the wick, the paraffin melts and begins to evaporate.

4. When we light a candle and examine the flame, we will see a dark part adjacent to the wick, a _____ cone around it, and a barely noticeable _____ outside.

5. We know the composition of the outer cone of the paraffin flame: these are the end products of the _____ of paraffin.

TASK 3. **Match** the words in **the two columns**.

1. a whitish	**a)** fumes
2. paraffin	**b)** smoke
3. a porcelain	**c)** fuels
4. various	**d)** cup
5. combustion	**e)** coal
6. soot	**f)** paraffin
7. molten	**g)** zone

TASK 4. **Choose** the appropriate **verb**.

to evaporate *to char* *to accompany* *to ignite*
to supply

1. Combustion of various fuels is usually _____ by the appearance of a flame.

2. The wick itself does not burn but it serves to _____ molten paraffin to the combustion zone.

3. The splinter will be _____ only in those places that are in the outer cone and it means that the flame temperature in it is the highest.

4. When a lighted match is brought to the wick, the paraffin melts and begins to _____.

5. If the end of a glass tube is inserted into the inside of the flame, a whitish smoke which can be _____ will come out through it.

TASK 5. **Translate** the following text **into English**.

Якщо запалити свічку та уважно подивитися на полум'я, можна помітити, що полум'я не є однорідним. Зверни увагу на існування декількох зон, які відрізняються за кольором.

У нижній, темнішій частині полум'я, температура є невисокою. Через нестачу повітря, у цій частині майже не відбувається горіння.

У середній частині полум'я, температура є вищою. Саме тут згоряє частина речовин, а решта — перетворюється на гази і часточки сажі. Якщо у цю ділянку полум'я помістити шпатель, можна спостерігати утворення кіптяви на ньому.

У верхній частині полум'я температура є найвищою. Саме у цій ділянці речовини повністю згоряють. Під час горіння утворюються вуглекислий газ і водяна пара.

UNIT FOURTEEN

14

VOCABULARY

Translate the following words and write them down!

to collide (*v*)	to flood (*v*)	rapid (*adj*)
decisively (*adv*)	greenhouse (*n*)	to rotate (*v*)
to dilute (*v*)	inverse (*adj*)	spark (*n*)
to extinguish (*v*)	manure (*n*)	tarp (*n*)

Before you read answer the questions:

1. Can oxidation be dangerous and why?

2. Is there any connection between the oxidation and combustion?

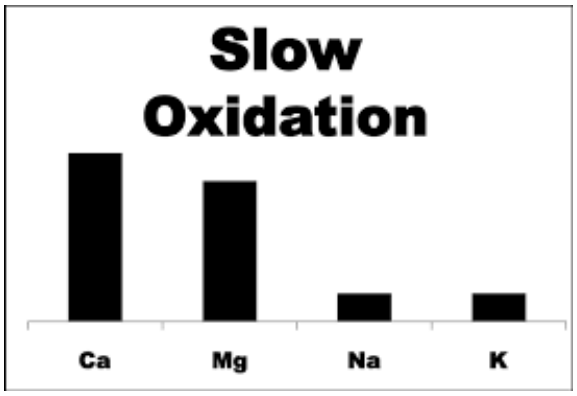
READ the text!

COMBUSTION AND SLOW OXIDATION

Oxidation reactions, accompanied by the release of heat and light, are called combustion.

Combustion in air is slower than in oxygen, because oxygen in air is highly diluted with nitrogen and fewer oxygen molecules collide with the surface of the burning substance. And the temperature during combustion in air is less high, since the released heat is spent not only on heating the initial substances, but also on heating nitrogen.

Phosphorus, burning in air, forms phosphorus oxide (IV), as well as burning in oxygen, coal forms carbon monoxide (IV) CO_2 and sulfur - sulfur oxide (IV) SO_2. The sparks bursting from under the knife, which is sharpened on a rapidly rotating stone, are red-hot particles of the same iron scale that is obtained when iron burns in oxygen.

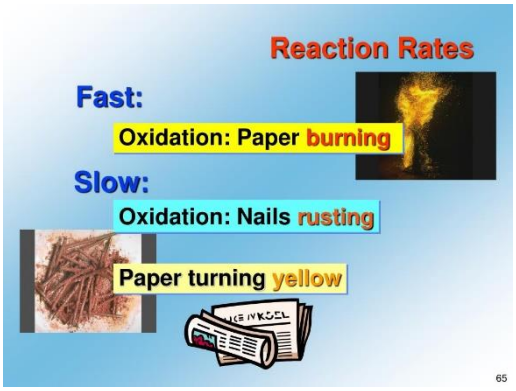


To ignite a substance in air, it must be preheated to a certain temperature, which is called the ignition temperature of this substance. The ignition temperature of sulfur and wood is about 270°C, coal - 350°C. If air has access to an ignited substance, then it continues to burn, because due to the heat released during combustion, the temperature of the substance is maintained above the temperature of its ignition.

Thus, in order to cause combustion, it is necessary: a) to heat the substance to the ignition temperature and b) to provide access to oxygen.

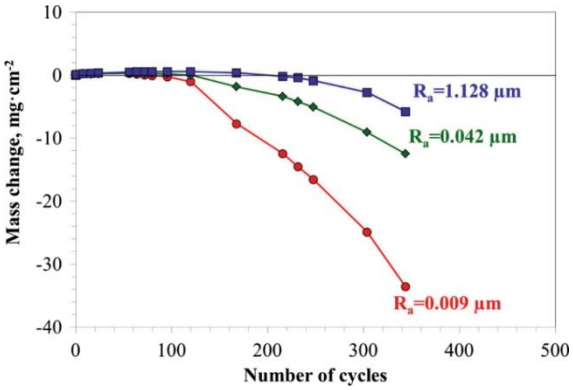
And how to solve the inverse problem - to stop burning, extinguish the flame? Obviously, it is necessary either to cool the substance below the ignition temperature, or to stop the access of oxygen to it.

Pour some alcohol into a porcelain cup, set it on fire, and then cover the cup tightly with a sheet of thick paper. The flame of alcohol will go out, since there is no access to air, and the paper will not ignite, since it will not heat up to the ignition temperature.



The fire is extinguished by covering the burning object with a tarp or blanket. You need to act quickly and decisively. Such action has prevented many fires and saved many lives. To extinguish burning wood or coal, they are flooded with water. Water lowers the temperature and prevents air from reaching the hot substance.

Although the oxidation of substances occurs with the release of heat, it may not be accompanied by combustion. This process is called slow oxidation.



In air, for example, manure is oxidized. Therefore, in hot frames and greenhouses, manure is used to warm the soil.

If it is difficult to remove the heat released during the slow oxidation of a substance, its temperature can rise to the ignition temperature. Then spontaneous combustion occurs. In factories and car depots, it is forbidden to accumulate oily rags in heaps after wiping machines so that spontaneous combustion does not occur.

TASK 1. Find out if the following suggestions are **TRUE** or **FALSE**.

1. Combustion is an oxidation reaction, which is accompanied by the release of heat.

2. The temperature during combustion in air is lower as the released heat is spent not only on heating the initial substances, but also on heating nitrogen.

3. A substance must be preheated to a certain temperature, which is called the ignition temperature of this substance to ignite in air.

4. It is necessary only to heat the substance to the ignition temperature to cause combustion.

5. It is forbidden to keep oily rags after wiping machines in factories not to cause spontaneous combustion.

TASK 2. Fill in the **gaps** with appropriate words.

combustion *scale* *rotating* *heat*
slow *ignition* *flooded* *oxidation*

1. The sparks bursting from under the knife, which is sharpened on a rapidly _____ stone, are red-hot particles of the same iron _____ that is obtained when iron burns in oxygen.

2. Although the oxidation of substances occurs with the release of _____, it may not be accompanied by _____. This process is called slow oxidation.

3. If it is difficult to remove the heat released during the _____ oxidation of a substance, its temperature can rise to the _____ temperature.

4. To extinguish burning wood or coal, they are _____ with water.

5. _____ reactions, accompanied by the release of heat and light, are called combustion.

TASK 3. **Match** the words in **the two columns**.

1. slow	**a)** stone
2. the burning	**b)** substance
3. an oxidation	**c)** temperature
4. inverse	**d)** reaction
5. initial	**e)** oxidation
6. the ignition	**f)** object
7. a rapidly rotating	**g)** problem

TASK 4. **Choose** the appropriate **verb**.

to extinguish *to cause* *to collide* *to provide*
to maintain *to dilute* *to preheat* *to continue*

1. If air has access to an ignited substance, then it _____ to burn, because due to the heat released during combustion, the temperature of the substance is _____ above the temperature of its ignition.

2. Combustion in air is slower than in oxygen, because oxygen in air is highly _____ with nitrogen and fewer oxygen molecules _____ with the surface of the burning substance.

3. To ignite a substance in air, it must be _____ to a certain temperature, which is called the ignition temperature of this substance.

4. The fire is _____ by covering the burning object with a tarp or blanket.

5. To _____ combustion, it is necessary to heat the substance to the ignition temperature and _____ access to oxygen.

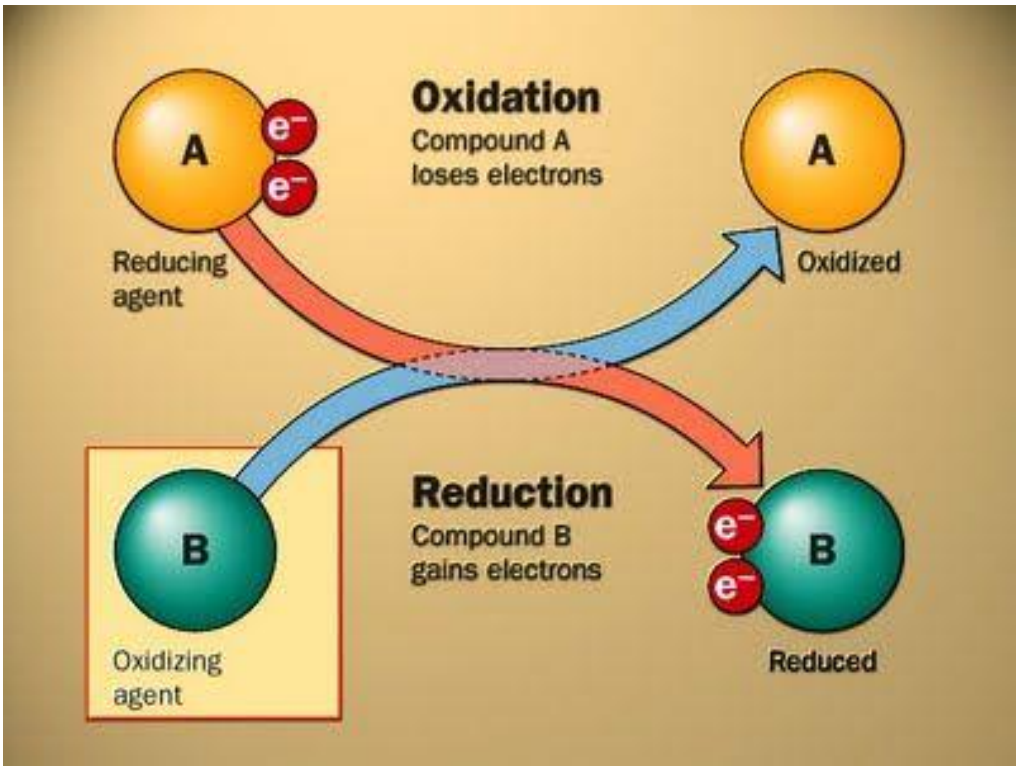
TASK 5. **Translate** the following text **into English**.

Горіння - це реакції окиснення, що супроводжуються виділенням тепла й світла. Окиснення речовин, що відбувається без світла, а лише з виділенням теплоти (теплової енергії), називають повільним окисненням. Реакція повільного окиснення не супроводжується появою світла і відбувається повільно.

На теплових електростанціях горіння палива (вугілля, продуктів переробки нафти) використовують з метою перетворення теплової енергії в електричну. У двигунах автомобілів бензин спалюють, щоб перетворити хімічну енергію на механічну. На металургійних заводах (таку назву мають підприємства з виробництва металів з руд) багато реакцій відбуваються

завдяки горінню. Зокрема, у виробництві заліза з руд присутнє спалювання коксу - високосортного вугілля.

Час від часу на виробництві трапляються вибухи горючих речовин, змішаних з киснем, які призводять до руйнувань і навіть людських втрат. Зокрема, у вугільних шахтах трапляються вибухи суміші повітря з метаном. Багато збитків завдають пожежі при недбалому ставленні чи внаслідок самозайманння (наприклад, горіння торф'яних ґрунтів у спеку) тощо.



EDUCATION VOCABULARY

GLOSSARY

A

absorption (n, uncount) un.**3** – **поглинання** - a process in which something takes in liquid, gas, or heat.

abundant (adj) un.**11** – **поширений**, **численний** - something that is abundant exists or is available in large quantities so that there is more than enough.

to **accompany** (v) un.**13** – **супроводжуватися** - to happen or exist at the same time as something else.

adjacent (*adj*) un.**13** – **суміжний, сусідній** - a room, building, piece of land etc that is adjacent to something is next to it.

aid (n, count) un.**8** – **допоміжна речовина**, **добавка** - something such as a machine or tool that helps someone do something.

aluminum (n, uncount) un.**1** – **алюміній** - a silver-white metal that is very light and is used to make cans, cooking pans, window frames etc. It is a chemical element: symbol Al.

amount (n, count/uncount) un.**2** – **кількість**, **об'єм** – a quantity of something such as time, money, or a substance.

application (n, count, uncount) un.**1** – **використання** – the practical purpose for which a machine, idea etc can be used, or a situation when this is used.

to **attach** (v) un.**7** – **скріплювати**, **пов'язувати** - to fasten or connect one object to another (=fix).

B

blinding(adj) un.**11** – **сліпучий** – so bright or strong that you cannot see properly.

boiling point (n, count, sing) un.**1** – **температура кипіння** – the temperature at which a liquid boils.

to **bond** with/to (v) un.2 – **поєднуватися** – to connect with something.

bottom (n, count) un.**11** – **дно** - the lowest inner surface of something such as a container.

brazier (n) un.**9** – **жаровня**, **конфорка** - a metal container that holds a fire and is used to keep people warm outside.

brittle(adj) un.**9** – **крихкий**, **ламкий** - hard but easily broken.

burner (n, count) un.**11** – **пальник** - the part of an oven or heater that produces heat or a flame.

C

calcination (n, uncount) un.**5** – **кальцинація**, **випал** - the process of heating a substance to a high temperature but below the melting or fusing point, causing loss of moisture, reduction or oxidation, and dissociation into simpler substances.

to **calcine** (v) un.**3** – **прожарювати**, **обпалювати**, **спопеляти** - to heat (something, such as inorganic materials) to a high temperature but without fusing in order to drive off volatile matter or to effect changes (such as oxidation or pulverization).

to **calculate** (v) un.**6** – **обчислити**, **підрахувати** - to find out how much something will cost, how long something will take etc, by using numbers.

carbon (n, uncount) un.**1** – **вуглець** - a chemical substance that exists in a pure form as diamonds, graphite etc, or in an impure form as coal, petrol etc. It is a chemical element: symbol C.

to **cease** (v) un.**10** – **зупинятися**, **припинятися** - to stop doing something or stop happening.

cell (n, count) un.**2** – **клітина** - the smallest part of a living thing that can exist independently.

to **char** (v) un.**13** – **обгорати**, **обпалювати**, **обвуглювати** – to burn something so that its outside becomes black.

charcoal (n, uncount) un.**5** – **деревне вугілля** - a black substance made of burnt wood that can be used as fuel.

cloudy (adj) un.**12** – **непрозорий** – cloudy liquids are not clear.

coating (n, count) un.**10** – **покриття** - a thin layer of something that covers a surface.

to **collide** (v) un.**14** – **стикатися** – to hit something or someone that is moving in a different direction from you.

combination reaction un.**10** – **реакція сполуки** – combination of two or more different things that exist together or are used or put together.

combustible (n, adj) un.**3** – **легкозаймистий** - able to burn easily.

to **compose** (v) un.**2** – **утворювати**, **складати** – to combine together to form something (=make up).

combustion (n, uncount) un.**13** – **горіння**, **окислення** - the process of burning, chemical activity which uses oxygen to produce light and heat.

complex (adj) un.**4 – складний**, **багатокомпонентний** - consisting of many different parts and often difficult to understand (=complicated).

composition (n, count/uncount) un.**6** – **складання**, **побудова**, **з'єднання** – the way in which something is made up of different parts, things, or members.

to **conduct** (v) un.**5** – **проводити**, **пропускати** - if something conducts electricity or heat, it allows electricity or heat to travel along or through it.

conductivity (n, uncount)un.**5** – **провідність**, **електропровідність** - ability to conduct electricity, heat etc.

to **consider** (v) un.**7** – **подумати**, **розкинути мозком** - to think about something carefully, especially before making a choice or decision.

to **consist** of (v) un.**2** – **складатися з** - to be formed from two or more things or people.

constant (adj) un.**7** – **постійна величина** - happening regularly or all the time (=continual).

constituent (n, count) un.**5** - one of the substances or things that combine to form something.

to **consume** (v) un.**9** – **споживати**, **витрачати**, **поглинати** - to use time, energy, goods etc.

to **contaminate with** (v) un.**2** – **забруднювати**, **отруювати** - to make a place or substance dirty or harmful by putting something such as chemicals or poison in it.

to **contradict** (v) un.**9** – **заперечувати**, **спростовувати** - to disagree with something, especially by saying that the opposite is true.

to **convert** to-into (v) un.**10** – **перетворити**, **трансформувати** - to change something into a different form, or to change something so that it can be used for a different purpose or in a different way.

copper (n, uncount) un.**1** – **мідь** - a soft reddish-brown metal that allows electricity and heat to pass through it easily, and is used to make electrical wires, water pipes etc. It is a chemical element: symbol Cu.

corrosive (adj) un.**1** – **їдкий, агресивний** - a corrosive liquid such as an acid can destroy metal, plastic etc.

to **crush** (v) un.**5** – **потовкти в порошок** - to press something in order to break it into very small pieces or into a powder.

crust (n, count/uncount) un.**11** – **кора, осад** - a thin hard dry layer on the surface of something, the hard outer layer of the Earth.

crystalline (adj) un.**1** – **кристалічний**, **прозорий** - made of crystals, very clear or transparent, like crystal.

D

decisively (adv) un.**14** – **рішуче**, **безбоязно** - definite and clear in a way that leaves no doubt.

decomposition reaction (n, count) un.**10** – **реакція розпаду** – to decompose means to divide into smaller parts, or to make something do this.

to **decrease** (v) un.**9** – **зменшувати**, **знижувати**, **скорочуватися** – to become less or go down to a lower level, or to make something do this (=reduce).

density (n, uncount) un.**1** – **щільність** – the degree to which an area is filled with people or things.

to **depend on** (v) un.**2** – **залежати від**, **покладатися на** - to need the support, help, or existence of someone or something in order to exist, be healthy, be successful etc (=rely on).

to **depict** (v) un.**7** – **малювати**, **описувати** - to describe something or someone in writing or speech, or to show them in a painting, picture etc.

to **derive** (v) un.**7** – **виводити**, **вилучати** - to develop or come from something else.

to **destroy** (v) un.**8** – **зруйнувати**, **знищити** - to damage something so badly that it no longer exists or cannot be used or repaired.

to **dilute** (v) un.**14** – **розбавлятися** - to make a liquid weaker by adding water or another liquid.

to **dissolve** (v) un.**2** – **розчинятися** - if a solid dissolves, or if you dissolve it, it mixes with a liquid and becomes part of it.

divalent (*adj*)un.**7** – **двовалентний**, **двохатомний** - bonded to two other atoms or groups.

E

elementary (adj) un.**4** – **простий**,**основний**, **елементарний** - simple or basic.

ember (n, count) un.**11** – **тліюче вугілля** - a piece of wood or coal that stays red and very hot after a fire has stopped burning.

equation (n, count) un.**10** – **рівняння** – a statement in mathematics that shows that two amounts or totals are equal.

essence (n, count/uncount) un.**8** – **есенція**, **екстракт** - the most basic and important quality of something, a liquid obtained from a plant, flower etc that has a very strong smell or taste and is used especially in cooking.

evaporation (n, uncount) un.**8** – **випаровування**, **пароутворення** - if a liquid evaporates, or if heat evaporates it, it changes into a gas.

to **exhaust** (v) un.**6** – **виснажувати**, **спустошувати** - to use all of something (=use up).

explosion (n, count) un.**3** – **вибух** - a loud sound and the energy produced by something such as a bomb bursting into small pieces.

to **extinguish** (v) un.**14** – **гасити** - to make a fire or light stop burning or shining(=put out).

to **extract** from (v) un.**2** – **витягувати** - to carefully remove a substance from something which contains it, using a machine, chemical process etc.

F

to **facilitate** (v) un.**3** – **сприяти, полегшувати** - to make it easier for a process or activity to happen.

to **familiarize** (*v*) un.**7** – **познайомити** - to make known or familiar.

flame (n, count/uncount) un.**11** – **полум'я** - hot bright burning gas that you see when something is on fire.

to **flatten out** (v) un.**5** – **робитися плоским** - to make something flat or flatter, or to become flat or flatter.

to **flood** (v) un.**14** – **наповнювати** (рідиною) – to cover a place with water, or to become covered with water.

fraction (n, count) un.**6** – **дробова частина** - a part of a whole number in mathematics, such as ½ or ¾/.

fractional (adj) un.**12** – **незначний**, **дробовий** - very small in amount (=tiny), relating to fractions, in mathematics.

fragile (adj) un.**1** – **крихкий** - easily broken or damaged.

fume (n, count) un.**13** – **дим або пара з сильним запахом** - to give off smoke or gases.

fusible (adj) un.**1** – **легкоплавкий**, **розчинний** - able to be fused or melted easily.

G

gaseous (adj) un.**2** – **газоподібний** – like gas or in the form of gas.

to **glow** (v) un.**4** – **горіти**, **тліти** - to produce or reflect a soft steady light (=shine).

greenhouse (n, count) un.**14** – **теплиця** – a glass building used for growing plants that need warmth, light, and protection.

(**finely**) **ground** (adj) un.**3 – розмелений, подрібнений** - broken up into powder or very small pieces, using a special machine.

H

handle (n, count) un.**11** – **ручка** - the part of an object that you use for holding it.

hardness (n, uncount) un.**1** – **твердість**, **щільність** - a material that would combine the flexibility of rubber with the hardness of glass.

heating (n, uncount) un.**3** – **розжарювання, підігрівання** - making something warm.

homogeneous (adj) un.**4** – **одноманітний**, **односкладний** - consisting of people or things that are all of the same type.

hydrogen (n, uncount) un.**4** – **водень** - a colourless gas that is the lightest of all gases, forms water when it combines with oxygen, and is used to produce ammonia and other chemicals. It is a chemical element: symbol H.

I

to **ignite** (v) un.**3 – запалювати, загорятися** - to start burning, or to make something start burning.

to **immerse** (v) un.**11** – **занурювати в рідину** - to put someone or something deep into a liquid so that they are completely covered.

(**foreign**) **impurity** (n, count/pl) un.**2** – **стороння домішка** – a substance of a low quality that is contained in or mixed with something else, making it less pure.

inanimate nature (n, uncount) un.**11** – **нежива природа** - not living.

to **increase** (v) un.**9** – **збільшити**, **вирости** - if you increase something, or if it increases, it becomes bigger in amount, number, or degree.

infinity (n) un.**8** – **нескінченність**, **безмежність** - a space or distance without limits or an end, a number that is too large to be calculated.

inverse (adj) un.**14** – **зворотний**, **протилежний** - if there is an inverse relationship between two amounts, one gets bigger at the same rate as the other gets smaller.

to **involve** (v) un.**8** – **передбачати виконання** - to include or affect someone or something.

iron (n, uncount) un.**1** – **залізо** – a common hard metal that is used to make steel, is magnetic, and is found in very small quantities in food and blood. It is a chemical element: symbol Fe.

J

jar (n, count) un.**11** – **скляна банка** – a glass container with a wide top and a lid, used for storing food such as jam or honey, or the amount it contains.

to **join** (v) un.**8** – **пов'язувати**, **з'єднувати** - to connect or fasten things together.

L

lack (n, uncount, v) un.**5** – **нестача**, **потреба**, **відсутність** - when there is not enough of something, or none of it.

lime (CaO) (n, uncount) un.**3** - **вапно**, **накип** - a white substance obtained by burning limestone, used for making cement, marking sports fields etc.

to **link** (v) un.**7** – **пов'язувати**, **з'єднувати**, **зчіплювати** - to make a connection between two or more things or people.

luminous (adj) un.**13** – **той, що світиться, блискучий** - shining in the dark, very brightly coloured, especially in green, pink, or yellow.

lump (n, count) un.**2** – **великий шматок** - a small piece of something solid, without a particular shape.

lustre (n, uncount) un.**5** – **блиск** - an attractive shiny appearance.

M

to make up something (v) un.**11** – **утворювати**, **складати** - to combine together to form something (=constitute).

manure (n, uncount) un.**14** – **органічне добриво** – waste matter from animals that is mixed with soil to improve the soil and help plants grow.

melting point (n, count) un.**1** – **температура плавлення** - the temperature at which a solid substance becomes a liquid.

to **mix** (v) un.**8** – **змішувати**, **з'єднувати** - if you mix two or more substances or if they mix, they combine to become a single substance, and they cannot be easily separated.

mixture (n, count) un.**4** – **суміш** - a combination of substances that are put together but do not mix with each other.

molten (adj) un.**13** – **розплавлений**, **рідкий** – molten metal or rock has been made into a liquid by being heated to a very high temperature.

monovalent (*adj*) un.**7** – **одновалентний** - having a valence of one.

to **move** (v) un.**8** – **переносити**, **рухати** - to change from one place or position to another, or to make something do this.

to **multiply** (v) un.**6** – **множити** - to do a calculation in which you add a number to itself a particular number of times.

N

nylon (n, uncount) un.**1** – **нейлон** - a strong artificial material that is used to make plastics, clothes, rope etc.

O

to **obtain** (v) un.**9** – **здобувати**, **досягати** - to get something that you want, especially through your own effort, skill, or work (=get).

to **occur** (v) un.**8** – **відбуватися** - to happen or exist in a particular place or situation.

occurrence (n, count) un.**3** – **виникнення**, **поява** - something that happens.

odour (n, count/uncount) un.**3** – **аромат**, **запах** - a smell, especially an unpleasant one.

opaque (adj) un.**5** – **непрозорий**, **непроникний** - opaque glass or liquid is difficult to see through and often thick.

to **originate** (v) un.**8** – **виникати**, **брати початок** - to come from a particular place or start in a particular situation.

oxidation (n, uncount) un.**12** – **окислення** - gain of oxygen.

oxide (n, count/uncount) un.**12** – **окис** - a substance which is produced when a substance is combined with oxygen.

to **oxidize** (v) un.**12** – **окисляти**, **окислюватися** - to combine with oxygen, or make something combine with oxygen, especially in a way that causes rust.

oxygen (n, uncount) un.**1** – **кисень** – a gas that has no colour or smell, is present in air, and is necessary for most animals and plants to live. It is a chemical element: symbol O.

P

phenomenon (n, count) un.**8** – **феномен**, **явище** - something that happens or exists in society, science, or nature, especially something that is studied because it is difficult to understand.

poisonous (adj) un.**1** – **отруйний** - containing poison or producing poison (a substance that can cause death or serious illness if you eat it, drink it etc).

powder (n, count/uncount) un.**2** – **порошок** - a dry substance in the form of very small grains.

precipitate (n, count) un.**3** – **осад** - a solid substance that has been chemically separated from a liquid.

to **preserve** (v) un.**8** – **зберігати** - to make something continue without changing.

property (n) un.**1** – **властивість** - a quality or power that a substance, plant etc has (=characteristic).

protein (n, count/uncount) un.**1** – **білок, протеїн** - one of several natural substances that exist in food such as meat, eggs, and beans, and which your body needs in order to grow and remain strong and healthy.

provision (n) un.**8** – **приготування**, **резерв**, **підготовка** - a condition in an agreement or law.

Q

qualitative (adj) un.**6** – **якісний** - relating to the quality or standard of something rather than the quantity.

quantitative (adj) un.**6** – **кількісний** - relating to amounts rather than to the quality or standard of something.

R

rapid (adj) un.**14** – **швидкий** - happening or done very quickly and in a very short time (=fast, quick).

ratio (n, count) un.**6** – **пропорція**, **коефіцієнт відносини** - a relationship between two amounts, represented by a pair of numbers showing how much bigger one amount is than the other.

reacting substance (n) un.**9** – **речовина, що реагує** - substance or material which enters into a chemical reaction with other stable or unstable material.

red-hot(adj) un.**4** – **нагрітий до червоного розжарювання** - metal or rock that is red-hot is so hot that it shines red.

relative (adj) un.**6** – **відносне число** - having a particular value or quality when compared with similar things.

release (n, uncount) un.**3** – **виділення** - when a chemical, gas etc is allowed to flow out of its usual container.

to **represent** (v) un.**7** – **зображати**, **представляти** - to be a sign or mark that means something.

residue (n, count/uncount) un.**5** – **осад**, **зола**, **нагар** - a substance that remains on a surface, in a container etc and cannot be removed easily, or that remains after a chemical process.

respiration (n, uncount) un.**11** – **дихання** - the process of breathing.

resulted substance (n) un.**9** – **отримана речовина** – the substance we get as a result of a chemical reaction.

to **retain** (v) un.**4** – **зберігати**, **утримувати** - to keep something or continue to have something.

retort (n, count) un.**9** – **колба** (**посудина**) - a bottle with a long narrow bent neck, used for heating chemicals.

to **rotate** (v) un.**14** – **обертати** - to turn with a circular movement around a central point, or to make something do this (=revolve, spin).

S

scale (n, count) un.**9** – **розмір**, **шкала**, **градація** - a whole range of different types of people or things, from the lowest level to the highest.

sealed (adj) un.**9** – **герметичний** - shut or protected with something that prevents air, water etc from getting in or out.

sediment (**formation**) (n, count/uncount) un.**3** – **осад** - solid substances that settle at the bottom of a liquid.

to **separate** (v) un.**8** – **відокремлювати**, **розкладати** - to divide or split into different parts, or to make something do this.

shell (n) un.**13** – **оболонка** - the outside structure of something, especially the part of a building that remains when the rest of it has been destroyed.

to **smoulder** (v) un.**11** – тліти - if something such as wood smoulders, it burns slowly without a flame.

solid (n, count) un.**2** – **тверде тіло** - a firm object or substance that has a fixed shape, not a gas or liquid.

soluble (adj) un.**1** – **розчинний** - a soluble substance can be dissolved in a liquid.

solution (n, count/uncount) un.**2** – **розчин** – a liquid in which a solid or gas has been mixed.

soot (n, uncount) un.**13** – **сажа**, **кіптява**, **нагар** – black powder that is produced when something is burned.

spark (n, count) un.**14** – **іскра** - a very small piece of burning material produced by a fire or by hitting or rubbing two hard objects together.

splinter (n, count) un.**11** – **скіпа**, **тріска** - a small sharp piece of wood, glass, or metal, that has broken off a larger piece.

starch (n, count/uncount) un.**1** – **крохмаль** - a substance which provides your body with energy and is found in foods such as grain, rice, and potatoes, or a food that contains this substance (=carbohydrate).

stopper (n, count) un.**10** – **пробка** - the thing that you put in the top part of a bottle to close it (=cork).

substance (n, count) un.**1** – **речовина** - a particular type of solid, liquid, or gas.

substitution reaction (n, count) un.**10** – **реакція заміщення** - substitution is when someone or something is replaced by someone or something else, or the person or thing being replaced.

to **subtract** (v) un.**9** – **віднімати** - to take a number or an amount from a larger number or amount.

sulpfur (n, uncount) un.**4** – **сірка** - a common light yellow chemical substance that burns with a very strong unpleasant smell, and is used in drugs, explosives, and industry. It is a chemical element: symbol S.

surface (n, count) un.**11** – **поверхня** - the outside or top layer of something.

to **suspend** (v) un.**2** – **призупиняти** - to officially stop something from continuing, especially for a short time (=stop).

T

tarp / **tarpaulin** (n, count/uncount) un.**14** – **брезент**, **парусина** – a large heavy cloth or piece of thick plastic that water will not pass through, used to keep rain off things.

test tube (n, count) un.**4** – **контрольна пробірка** - a small glass container that is shaped like a tube and is used in chemistry.

tissue (n, uncount) un.**2** – **тонкий папір** - light thin paper used for wrapping, packing etc.

transparent (adj) un.**11** – **прозорий** - if something is transparent, you can see through it (=clear).

V

valence (n, count) un.**7** – **валентність** - a measure of the power of atoms to combine together to form compounds.

vaporous (adj) un.**2** – **пароподібний** - unsubstantial; diaphanous; airy.

variable (adj) un.**7** – **непостійний**, **нестійкий** - likely to change often.

vessel (n) un.**9** – **посудина (для рідини**), **склянка** - a container for holding liquids.

volatile (adj) un.**13** – **речовина**, **що легко випаровується** – a volatile liquid or substance changes easily into a gas.

volume (n, count/sing) un.**2** – **обсяг**,**об'єм** – a measurement of the amount of space that a substance or object fills, or the amount of space in a container (=space filled).

W

wax (n, uncount) un.**12** – **віск** - a solid substance made of fat or oil and used to make candles, polish etc.

whitish (adj) un.**13** – **блідий**, **світлий** - almost white in colour.

wick (n) un.**13** – **гніт** - the piece of thread in a candle, that burns when you light it.

wire (n, count/uncount) un.**11** – **дріт** - thin metal in the form of a thread, or a piece of this.

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