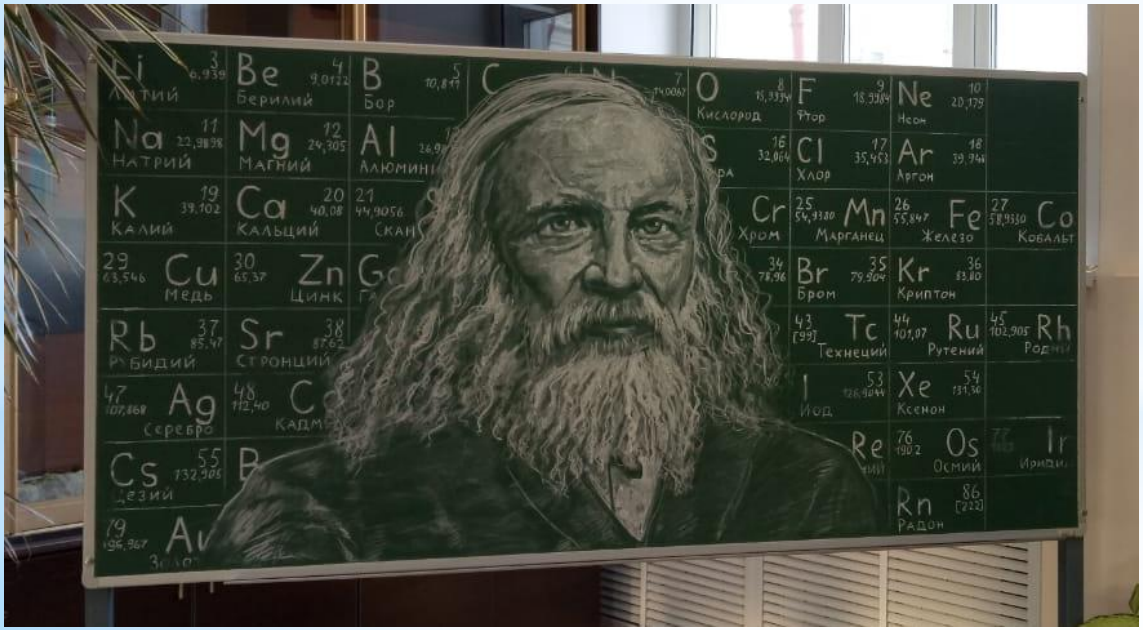
“Truth, of course, is one and eternal, but ... it is known and accessible only in parts, little by little, and not all at once in its general whole, and ... the ways to find parts of truth are diverse.”

D.I. Mendeleev



Subject is **«Chemistry 1.2»**

for foreign students

Lector is an Associate Professor

Machekhina Ksenia Igorevna

(Мачехина К.И.)

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RANKING PLAN FOR THE SEMESTER

Sum of points is 100 points
Work of semester is 80 points
Exam is 20 points

Subject "**Chemistry 1.2**"
The autumn semester 022/2023
The course I

The number of weeks is 16
Lectures – 16 hours
Practices - 8 hours.
Laboratory works– 24 hours.

Lectures	**Practices**	**Point**	**Laboratory works**	**Point**	**Test**	**Home -task**
1. Basic concepts and laws of chemistry			1. Oxides: nomenclature, classification, preparation, chemical properties	2		
			2. Determination of the equivalent and atomic mass of an unknown metal	2		2
2. The structure of the atom. Periodic Law			3. Determination of the molecular formula of crystalline hydrate	2		1
			4. Redox reactions	2		2
3. The chemical bond			5. Redox reactions	2		
			6. Six ways to express the concentration of a solution	2		3
4. Chemical thermodynamics			7. Solution preparation and determination of its concentration	2		
			8. Determination of the heat of solution	2		2
The conference week 1	Test 1				15	
5.Chemical balance. Chemical kinetics.	1. Thermochemical calculations	4	9. The rate of chemical reactions	2		2
6. Properties of non-electrolyte and electrolyte solutions	2. Chemical balance. Kinetics	4	10. Ion exchange reactions.	2		2
7. Electrochemical systems. Galvanic cells	3. Solutions of non-electrolytes and electrolytes	4	11. Salt hydrolysis	2		2
8. Electrolysis. Corrosion of metals	4. Electrochemical processes	4	12. Electrolysis of salt solutions	2		2
The conference week 2	Test 2				15	
Total		16		24	30	10

Literature

1. Общая химия. Базовый уровень. General chemistry. Basic level: учеб. пособие / Г. В. Соловьёва, О. А. Неволина, Т. С. Берсенёва, И. А. Мустаева ; англ. Перевод Т. С. Берсенёвой. – Екатеринбург: Изд-во Урал. ун-та, 2017. – 182 с. (https://elar.urfu.ru/bitstream/10995/46981/1/978-5-7996-1991-6_2017.pdf) (in Ru/Eng)

2. Стась Н.Ф., и др. Лабораторный практикум по общей и неорганической химии. – Томск: Изд-во ТПУ, 2013. (in Russian)

3. Стась Н. Ф. Справочник по общей и неорганической химии. – Томск: Изд-во ТПУ, 2014 – 85 с. (in Russian)

4. Стась Н.Ф., Коршунов А.В. Руководство к решению задач по общей химии. – Томск: ТПУ, 2013. – 212 с. (in Russian)

5. Голушкова Е.Б., и др. Сборник задач и упражнений по общей химии. – Томск: ТПУ, 2019. – 184 с. (in Russian)

«Basic concepts and laws of chemistry»

Lecture plan

1.Basic Chemical Terms and Difinitions.

2.Basic Laws of Chemistry.

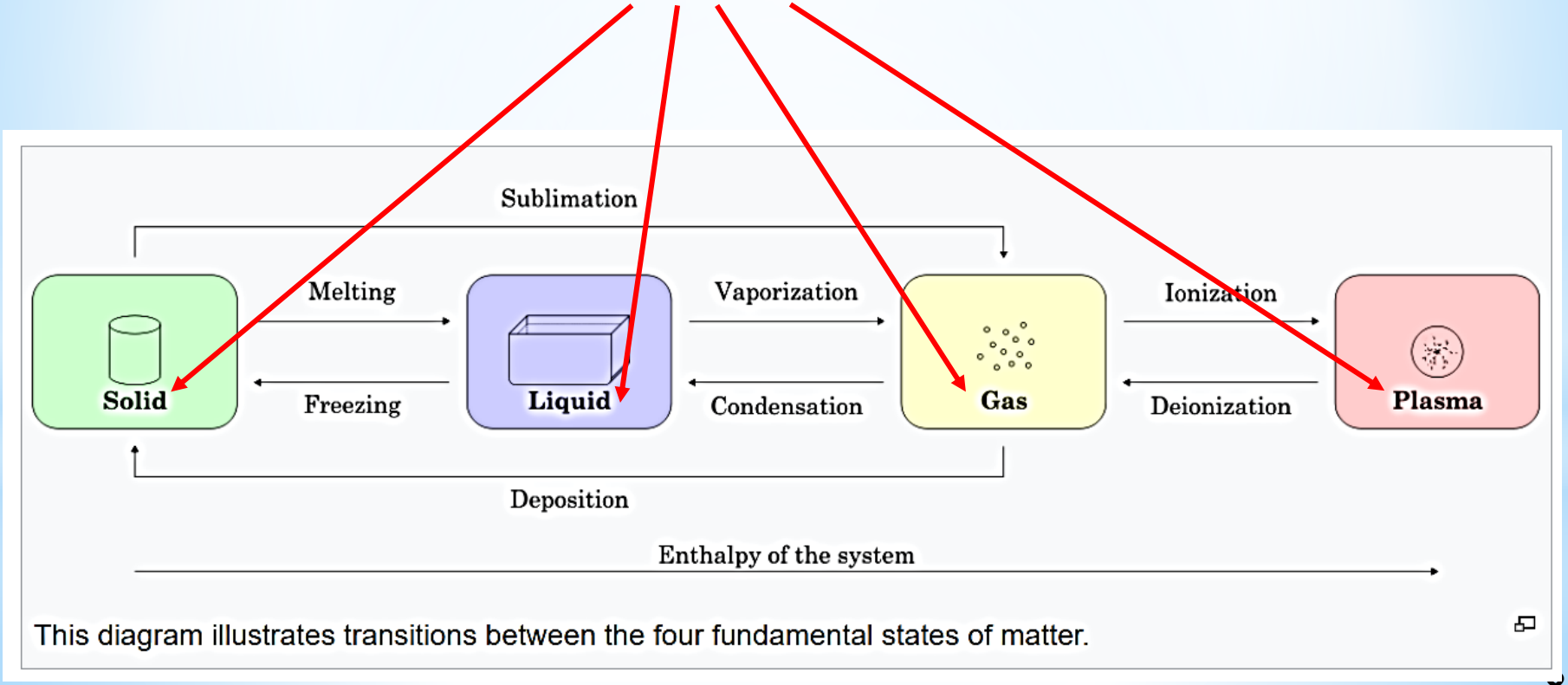
1. Basic Chemical Terms and Definitions

Chemistry is the branch of science concerned with the substances of which matter is composed, the research of their properties and reactions, and the use of such reactions to form new substance

1. Basic Chemical Terms and Definitions

* **What STUFF is made off?**

States of matter:



1. Basic Chemical Terms and Definitions

An **ELEMENT** is a pure chemical substance that cannot be broken down into other substances

An **ATOM** is the smallest unit of an element which retains all of the properties of the element

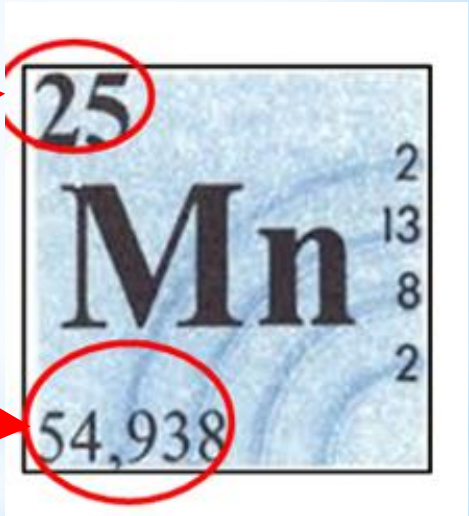
1. Basic Chemical Terms and Definitions

Atom consists of nuclear and electrons (ē).

The **nuclear** consists of protons (p) and neutrons (n).

Atomic number = # of protons

Mass number = (# protons) + (# neutrons)



p = **25**

ē = **25**

n = 55-25 = **30**

1. Basic Chemical Terms and Definitions

ISOTOPES are atoms that have the same nuclear charge (the number of protons), but a **different number of neutrons** in the nucleus.

ISOTOPES OF CARBON

	Carbon-12		Carbon-13		Carbon-14	
Protons	6	Mass number 12	6	Mass number 13	6	Mass number 14
Neutrons	6		7		8	
Electrons	6		6		6	

1. Basic Chemical Terms and Definitions

A MOLECULE is a group of atoms which contains one or more pairs of electrons distributed between two atoms and a forms a chemical bond. Molecules are electrically neutral.

$$CO_2 \quad H_2SO_4$$

1. Basic Chemical Terms and Definitions

An **ION** is an atom or a group of atoms that have a positive or negative electrical charge.

A **CATION** is ion with a positive charge which forms when neutral atoms lost one or more electrons

Na^+

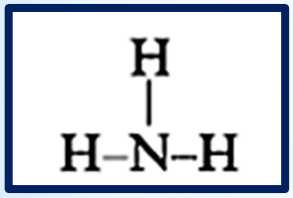
An **ANION** is an ion, which has a negative charge because of the increase of the electron number.

Cl^-

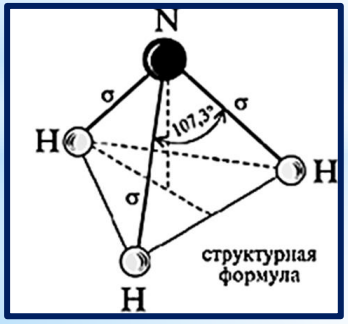
1. Basic Chemical Terms and Definitions

NH_3

The **molecular formula** gives the types and numbers of atoms which present in molecule.



The **graphic formula** indicates the sequence of arrangement of atoms in a molecule.



The **structural formula** reflects the relative position of atoms, the angle and length of the bond.

1. Basic Chemical Terms and Definitions

Substance is the matter which has a specific composition and specific properties

https://infourok.ru/prezentaciya-po-anglijskomu-yazyku-osnovy-himii-4640832.html

1. Basic Chemical Terms and Definitions

A **simple substance** is a substance that consists of atoms of the same chemical element.

O_2, Cu, N_2

An **allotropy** is the phenomenon when one element forms several simple substances.

Oxygen : O_2 – dioxygen, O_3 – ozone.

Carbon: Diamond, Graphite, Fullerenrs, Carbyne and Etc.

A **compound** is a substance that is made up of atoms of several elements.

CaO, HCl, Na_2SO_4

1. Basic Chemical Terms and Definitions

Valency (valentia - strength) is the capacity of an atom of an element to form chemical bonds with other atoms.

I I	I II	III I	IV I
HBr,	H_2O,	NH_3,	CH_4

1. Basic Chemical Terms and Definitions

Amount of substance (n), [mol]

A **mole** is the amount of a substance containing as many structural units as there are in 12 g of the ^{12}C isotope.

It was established that 12 g of the 12C isotope contains $6.02 \cdot 10^{23}$ atoms. This important constant is the **Avogadro constant** (N_A); its units is mol^{-1}.

$$N_A = 6{,}02 \cdot 10^{23}$$

1. Basic Chemical Terms and Definitions

Molar mass (M) is a mass of 1 mol of substance [g/mol]

$$M = \frac{m}{n}$$

m *is a mass of substance, g*

M *is a molar mass, g/mol*

1. Basic Chemical Terms and Definitions

An **Equivalent** - a real or conditional particle of a substance that in a given acid-base reaction combines or is replaced with one atom or hydrogen ion or in a given redox reaction is equivalent to one electron.

$$E = 1/V,$$

where V is a valency of element in compound.

1. Basic Chemical Terms and Definitions

The **Equivalence factor** (f) is fraction of a particle constituting the equivalent; f can be equal to 1, 1/2, 1/3, etc.

Molar equivalent mass (M_{ek}) is the mass of 1 mol equivalents, expressed in grams, (g/mol)

1. Basic Chemical Terms and Definitions

Molar equivalent mass of an element :

$$M_{эк} = \frac{A}{B} = \frac{A}{Z}$$

where A is atomic mass of element, B (V) is valency, Z is the charge or oxidation state of an element in a compound.

For example, $M_{эк}$ (Mn) **in compound** $KMnO_4$

$$M_{эк}(Mn) = \frac{55}{7} = 18{,}3\ g/mol$$

1. Basic Chemical Terms and Definitions

Molar equivalent mass of substances :

$$M_{эк} = \frac{M}{К \cdot Z}$$

M is molar mass of substances,
К is the number of ions that are replaced during the reaction,
Z is the charge of the ion.

1. Basic Chemical Terms and Definitions

1. $NaOH + HCl = NaCl + H_2O$

$$M_э(NaOH) = \frac{M(NaOH)}{1 \cdot 1} = 40 g/mol$$

2. $\boldsymbol{H_3}PO_4 + 2KOH = K_2\boldsymbol{H}PO_4 + 2H_2O$

$$M_э(H_3PO_4) = \frac{M(H_3PO_4)}{\mathbf{2} \cdot 1} = 49 g/mol$$

1. Basic Chemical Terms and Definitions

Molar equivalent mass in Redox reaction:

$$M_{эк} = \frac{M}{n(\bar{e})}$$

M is molar mass oxidizing or reducing agent,

n(ē) is the number of electrons received or given away by one molecule

2. Basic Laws of Chemistry

1. The fundamental laws,
2. The stoichiometric laws.

Fundamental laws

- ✓ Law of conservation of mass
- ✓ law of energy conservation
- ✓ Charge conservation law
- ✓ Periodic law of D.I. Mendeleev

2. Basic Laws of Chemistry

The Law of Equivalents (J.B. Richter, 1792)

Masses (volumes) of reacting without residue substances are proportional to their equivalent masses (volumes)

$$\frac{m_1}{m_2} = \frac{M_{Э1}}{M_{Э2}} \quad \textit{или} \quad \frac{V_1}{V_2} = \frac{V_{Э1}}{V_{Э2}}$$

1, 2 – any two substances from the chemical reactions

2. Basic Laws of Chemistry

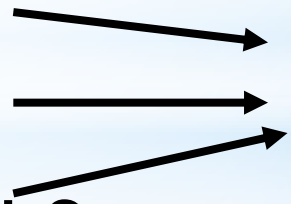
Law of constancy of composition

Ж. Л. Пруст

1754 - 1826

Any chemically pure compound has the same constant composition regardless of the method of its preparation.

- $N_2 + 3H_2 = 2NH_3$
- $NH_4Cl = NH_3 + HCl$
- $NH_4Cl + NaOH = NH_3 + NaCl + H_2O$



NH_3

2. Basic Laws of Chemistry

The law of specific heat capacities

Multiplying the specific heat capacity (C.) of a simple substance in the solid state by its atomic mass (A) is an approximately constant value equal to 26 J/K·mol.

$$C_{уд.} \cdot A \approx 26 \text{ J/K·mol.}$$

2. Basic Laws of Chemistry

Avogadro's Law

Equal volumes of different gases under the same conditions contain the same number of molecules

Амедео Авогадро (1776-1856)

Only for gases!

2. Basic Laws of Chemistry

Consequence 1 of the law: one mol of any gas at n.c. occupies a volume equal to 22.4 L

Normal conditions (n.c.):

$T_o = 273K$ и $P = 101,3$ kPa

Molar volume: ***Vm = 22,4 L/mol***

2. Basic Laws of Chemistry

Consequence 2 of the law: the ratio of the masses of equal volumes of gases is equal to the ratio of their molar masses

$$\frac{m_1}{m_2} = \frac{M_1}{M_2} = D$$

D – relative density

Relative density in air:

$$D_{air} = \frac{M_г}{M_{air}} = \frac{M_г}{29}$$

2. Basic Laws of Chemistry

When there is a normal conditions

$$\frac{P_0 \cdot V_0}{T_0} = \mathbf{R=const}$$

R – universal gas constant

R = 8,314 J/mol·K or 8,314 Pa·м^3/ mol·K.

2. Basic Laws of Chemistry

Mendeleev–Clapeyron equation

$$P \cdot V = \frac{m}{M} R \cdot T$$

P –is a gas pressure, Pa
V is the volume of gas, м^3
m –ismass of gas, g
M is molar mass of gas, g/mol
R = 8,314 Pa·м^3/mol·K
T is temperature, K

«Basic concepts and laws of chemistry»

Lector: PhD, Machekhina Ksenia Igorevna

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Home task № 1.

1. Calculate the molar equivalent mass of sulfuric acid if the reactions proceed:

$$H_2SO_4 + 2KOH = K_2SO_4 + 2H_2O$$

$$H_2SO_4 + KOH = KHSO_4 + H_2O$$

Home task № 2.