

Introduction to **Titrimetric analysis**

Practicum. Topic № 1

Lecturer: prof. of the Department of Biochemistry of “Professor
V.F. Voino-Yasenetsky Krasnoyarsk State Medical University”

Darya Rudenko

Why is it important to study chemistry?

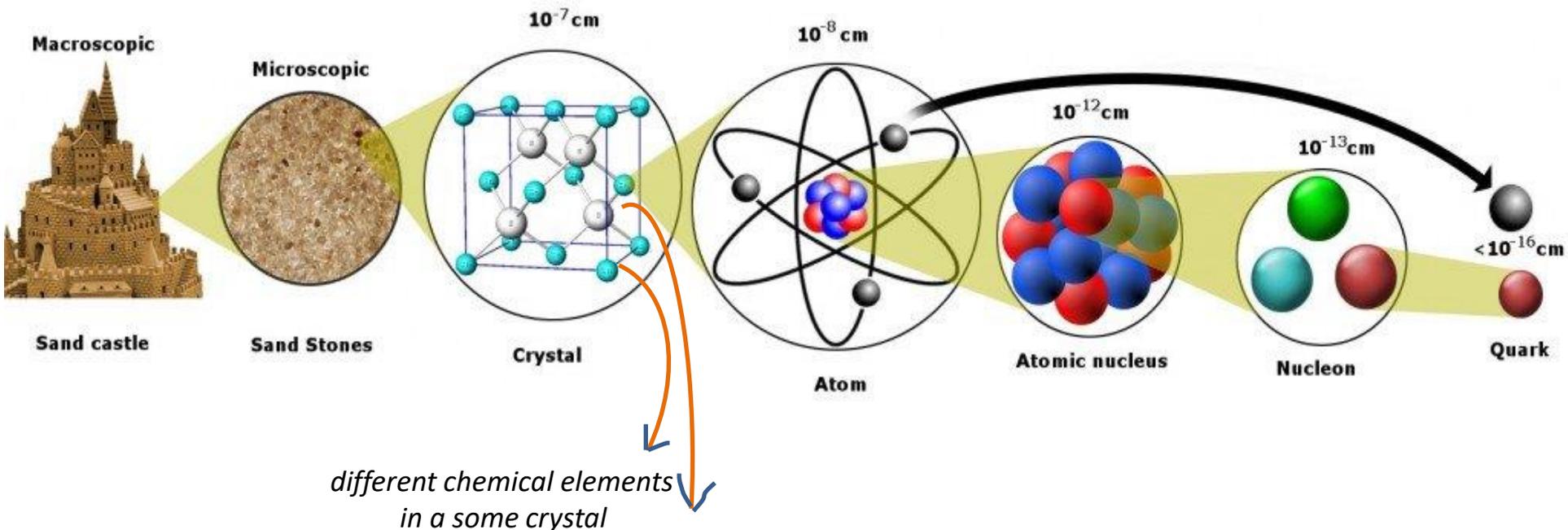


KEEP
CALM
AND
STUDY
ON

- **Chemistry** is the science about substances (matter), their properties and transformations.
- All objects around you are substances. Nature, food, furnitures, technics, clothers, drugs are all substances. **The human body is a mix** of many different substances and their interactions.
- Therefore, the knowledges about substances (matter), their properties and transformations, chemical's laws are most important for comprehension living systems.

What are substances made of?

- The substances can be pure or mixtures, it also can be gas, liquid or solid
- But the all substances (matter) are made of different little particles – chemical elements



Matter

Variable composition?

No

Yes

Pure Substances

Mixture

Separable into simpler substances?

No

Yes

Element

Compound

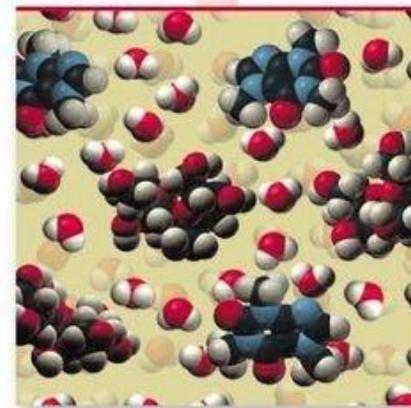
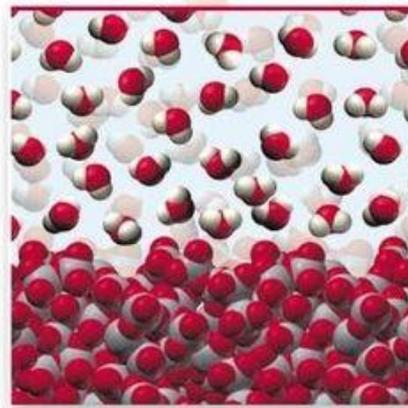
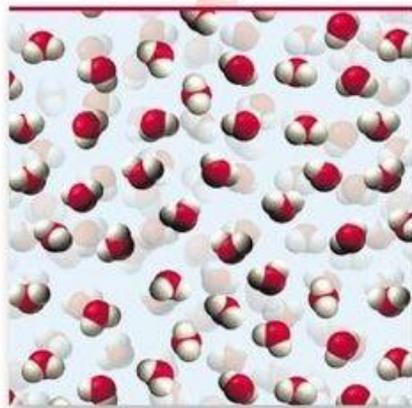
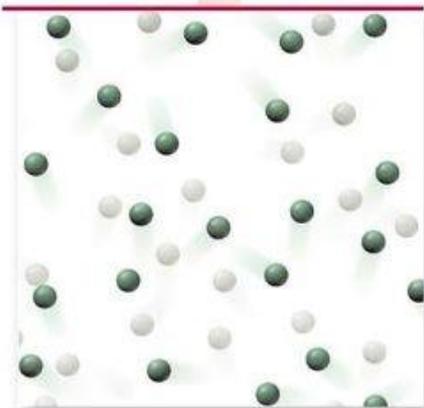
Uniform throughout?

No

Yes

Heterogeneous

Homogeneous



Helium

Pure water

Wet sand

Tea with sugar

**All chemical elements of
our Earth are in the
Periodic table**

English-Chinese Periodic Table of Elements 英漢元素周期表

1 / Ia

18 / VIIIA

1 H 氫 hydrogen 1.0079 1s ¹												2 He 氦 helium 4.0026 1s ²								
3 Li 鋰 lithium 6.941 [He]2s ¹		4 Be 鈹 beryllium 9.0122 [He]2s ²		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> atomic num 元素 symbol oxidation states element name atomic weight electron configuration </div>										10 Ne 氖 neon 20.180 [He]2s ² 2p ⁶						
11 Na 鈉 sodium 22.990 [Ne]3s ¹		12 Mg 鎂 magnesium 24.305 [Ne]3s ²		<div style="display: flex; justify-content: space-around;"> alkalai metals alkaline earths lanthanoid actinoid transition metals </div>										13 B 硼 boron 10.811 [He]2s ² 2p ¹		14 C 碳 carbon 12.011 [He]2s ² 2p ²	15 N 氮 nitrogen 14.007 [He]2s ² 2p ³	16 O 氧 oxygen 15.999 [He]2s ² 2p ⁴	17 F 氟 fluorine 18.998 [He]2s ² 2p ⁵	18 Ar 氬 argon 39.948 [Ne]3s ² 3p ⁶
				<div style="display: flex; justify-content: space-around;"> Solid Liquid Gas Synthetic Unknown </div>																
		19 K 鉀 potassium 39.098 [Ar]4s ¹	20 Ca 鈣 calcium 40.078 [Ar]4s ²	21 Sc 釷 scandium 44.956 [Ar]4s ² 3d ¹	22 Ti 鈦 titanium 47.867 [Ar]4s ² 3d ²	23 V 釩 vanadium 50.942 [Ar]4s ² 3d ³	24 Cr 鉻 chromium 51.996 [Ar]4s ¹ 3d ⁵	25 Mn 錳 manganese 54.938 [Ar]4s ² 3d ⁵	26 Fe 鐵 iron 55.845 [Ar]4s ² 3d ⁶	27 Co 鈷 cobalt 58.933 [Ar]4s ² 3d ⁷	28 Ni 鎳 nickel 58.693 [Ar]4s ² 3d ⁸	29 Cu 銅 copper 63.546 [Ar]4s ¹ 3d ¹⁰	30 Zn 鋅 zinc 65.409 [Ar]4s ² 3d ¹⁰	31 Ga 鎵 gallium 69.723 [Ar]4s ² 3d ¹⁰ 4p ¹	32 Ge 鍺 germanium 72.64 [Ar]4s ² 3d ¹⁰ 4p ²	33 As 砷 arsenic 74.922 [Ar]4s ² 3d ¹⁰ 4p ³	34 Se 硒 selenium 78.96 [Ar]4s ² 3d ¹⁰ 4p ⁴	35 Br 溴 bromine 79.904 [Ar]4s ² 3d ¹⁰ 4p ⁵	36 Kr 氪 krypton 83.798 [Ar]4s ² 3d ¹⁰ 4p ⁶	
37 Rb 銣 rubidium 85.468 [Kr]5s ¹		38 Sr 銦 strontium 87.62 [Kr]5s ²		39 Y 鈷 yttrium 88.906 [Kr]5s ² 4d ¹	40 Zr 鋯 zirconium 91.224 [Kr]5s ² 4d ²	41 Nb 鈮 niobium 92.906 [Kr]5s ¹ 4d ⁴	42 Mo 鉬 molybdenum 95.94 [Kr]5s ¹ 4d ⁵	43 Tc 錳 technetium [98]	44 Ru 鈷 ruthenium 101.07 [Kr]5s ¹ 4d ⁷	45 Rh 銲 rhodium 102.91 [Kr]5s ¹ 4d ⁸	46 Pd 鈀 palladium 106.42 [Kr]4d ¹⁰	47 Ag 銀 silver 107.87 [Kr]5s ¹ 4d ¹⁰	48 Cd 鎘 cadmium 112.41 [Kr]5s ² 4d ¹⁰	49 In 銦 indium 114.82 [Kr]5s ² 4d ¹⁰ 5p ¹	50 Sn 錫 tin 118.71 [Kr]5s ² 4d ¹⁰ 5p ²	51 Sb 銻 antimony 121.76 [Kr]5s ² 4d ¹⁰ 5p ³	52 Te 碲 tellurium 127.60 [Kr]5s ² 4d ¹⁰ 5p ⁴	53 I 碘 iodine 126.90 [Kr]5s ² 4d ¹⁰ 5p ⁵	54 Xe 氙 xenon 131.29 [Kr]5s ² 4d ¹⁰ 5p ⁶	
55 Cs 銫 cesium 132.905 [Xe]6s ¹		56 Ba 鋇 barium 137.327 [Xe]6s ²		71 Lu 鑷 lutetium 174.97 [Xe]6s ² 4f ¹⁴ 5d ¹	72 Hf 鈷 hafnium 178.49 [Xe]6s ² 4f ¹⁴ 5d ²	73 Ta 鉭 tantalum 180.95 [Xe]6s ² 4f ¹⁴ 5d ³	74 W 鎢 tungsten 183.84 [Xe]6s ² 4f ¹⁴ 5d ⁴	75 Re 錳 rhenium 186.21 [Xe]6s ² 4f ¹⁴ 5d ⁵	76 Os 銱 osmium 190.23 [Xe]6s ² 4f ¹⁴ 5d ⁶	77 Ir 銲 iridium 192.22 [Xe]6s ² 4f ¹⁴ 5d ⁷	78 Pt 鉑 platinum 195.08 [Xe]6s ¹ 4f ¹⁴ 5d ⁹	79 Au 金 gold 196.97 [Xe]6s ¹ 4f ¹⁴ 5d ¹⁰	80 Hg 汞 mercury 200.59 [Xe]6s ² 4f ¹⁴ 5d ¹⁰	81 Tl 鉍 thallium 204.38 [Xe]6s ² 4f ¹⁴ 5d ¹⁰ 6p ¹	82 Pb 鉛 lead 207.2 [Xe]6s ² 4f ¹⁴ 5d ¹⁰ 6p ²	83 Bi 鉍 bismuth 208.98 [Xe]6s ² 4f ¹⁴ 5d ¹⁰ 6p ³	84 Po 釷 polonium [209] [Xe]6s ² 4f ¹⁴ 5d ¹⁰ 6p ⁴	85 At 砒 astatine [210] [Xe]6s ² 4f ¹⁴ 5d ¹⁰ 6p ⁵	86 Rn 氡 radon [222] [Xe]6s ² 4f ¹⁴ 5d ¹⁰ 6p ⁶	
87 Fr 釷 francium [223] [Rn]7s ¹		88 Ra 釷 radium [226] [Rn]7s ²		103 Lr 鑷 lawrencium [262] [Rn]7s ² 5f ¹⁴ 6d ¹	104 Rf 鈷 rutherfordium [267] [Rn]7s ² 5f ¹⁴ 6d ²	105 Db 鈮 dubnium [268] [Rn]7s ² 5f ¹⁴ 6d ³	106 Sg 鉬 seaborgium [271] [Rn]7s ² 5f ¹⁴ 6d ⁴	107 Bh 錳 bohrium [270] [Rn]7s ² 5f ¹⁴ 6d ⁵	108 Hs 銱 hassium [277] [Rn]7s ² 5f ¹⁴ 6d ⁶	109 Mt 銲 meitnerium [277] [Rn]7s ² 5f ¹⁴ 6d ⁷	110 Ds 銲 darmstadtium [281] [Rn]7s ¹ 5f ¹⁴ 6d ⁹	111 Rg 銲 roentgenium [285] [Rn]7s ² 5f ¹⁴ 6d ¹⁰	112 Cn 鉍 copernicium [285] [Rn]7s ² 5f ¹⁴ 6d ¹⁰	113 Nh 鉍 nihonium [285] [Rn]7s ² 5f ¹⁴ 6d ¹⁰ 7p ¹	114 Fl 鉍 flerovium [289] [Rn]7s ² 5f ¹⁴ 6d ¹⁰ 7p ²	115 Mc 鉍 moscovium [289] [Rn]7s ² 5f ¹⁴ 6d ¹⁰ 7p ³	116 Lv 鉍 livermorium [294] [Rn]7s ² 5f ¹⁴ 6d ¹⁰ 7p ⁴	117 Ts 鉍 tennessine [294] [Rn]7s ² 5f ¹⁴ 6d ¹⁰ 7p ⁵	118 Og 鉍 oganeson [294] [Rn]7s ² 5f ¹⁴ 6d ¹⁰ 7p ⁶	

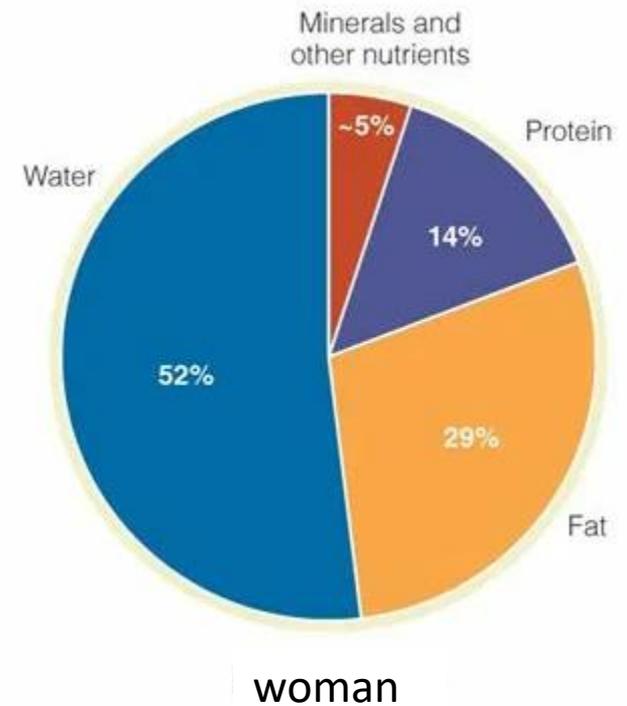
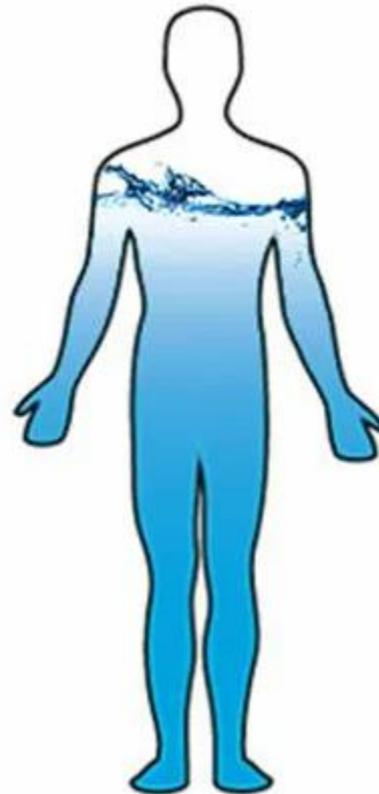
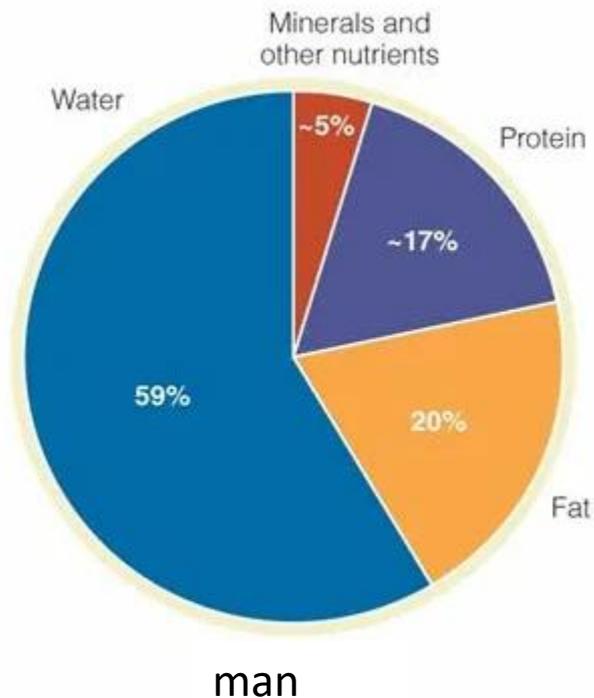
57-70
lanthanoids
鑷系元素

actinoids
釷系元素

57 La 鑷 lanthanum 138.91 [Xe]6s ² 5d ¹	58 Ce 鈷 cerium 140.12 [Xe]6s ² 4f ¹ 5d ¹	59 Pr 鐳 praseodymium 140.91 [Xe]6s ² 4f ²	60 Nd 鈹 neodymium 144.24 [Xe]6s ² 4f ⁴	61 Pm 鈷 promethium [145] [Xe]6s ² 4f ⁶	62 Sm 鈇 samarium 150.36 [Xe]6s ² 4f ⁶	63 Eu 鎳 europium 151.96 [Xe]6s ² 4f ⁷	64 Gd 釷 gadolinium 157.25 [Xe]6s ² 4f ⁷ 5d ¹	65 Tb 鈷 terbium 158.93 [Xe]6s ² 4f ⁹	66 Dy 鑷 dysprosium 162.50 [Xe]6s ² 4f ¹⁰	67 Ho 鈹 holmium 164.93 [Xe]6s ² 4f ¹¹	68 Er 鈷 erbium 167.26 [Xe]6s ² 4f ¹²	69 Tm 鈇 thulium 168.93 [Xe]6s ² 4f ¹³	70 Yb 鑷 ytterbium 173.04 [Xe]6s ² 4f ¹⁴
89 Ac 釷 actinium [227] [Rn]7s ² 6d ¹	90 Th 釷 thorium 232.04 [Rn]7s ² 6d ²	91 Pa 鐳 protactinium 231.04 [Rn]7s ² 5f ² 6d ¹	92 U 鈹 uranium 238.03 [Rn]7s ² 5f ³ 6d ¹	93 Np 鈇 neptunium [237] [Rn]7s ² 5f ⁶ 6d ¹	94 Pu 鈇 plutonium [244] [Rn]7s ² 5f ⁶	95 Am 鈇 americium [243] [Rn]7s ² 5f ⁷	96 Cm 釷 curium [247] [Rn]7s ² 5f ⁶ 6d ¹	97 Bk 鈇 berkelium [247] [Rn]7s ² 5f ⁹	98 Cf 鑷 californium [251] [Rn]7s ² 5f ¹⁰	99 Es 鈇 einsteinium [252] [Rn]7s ² 5f ¹¹	100 Fm 鈇 fermium [257] [Rn]7s ² 5f ¹²	101 Md 鈇 mendelevium [268] [Rn]7s ² 5f ¹³	102 No 鈇 nobelium [269] [Rn]7s ² 5f ¹⁴

Solutions

- The human body is a mainly variety of solutions



Solutions

- **A solution** is a system of variable composition, consisting of two or more components (solvent + solutes) and the products of their interaction



SOLUTE
Substance
dissolving



SOLVENT
Liquid the solute
dissolves in



SOLUTION
Solute dissolved in
solvent

Solutions

- **A solvent** is a component that does not change its state of aggregation upon dissolution (or the predominant component of a solution).
- **A solute (dissolved substance)** is a component whose molecules or ions are evenly distributed in the volume of the solvent.



SOLUTE
Substance
dissolving

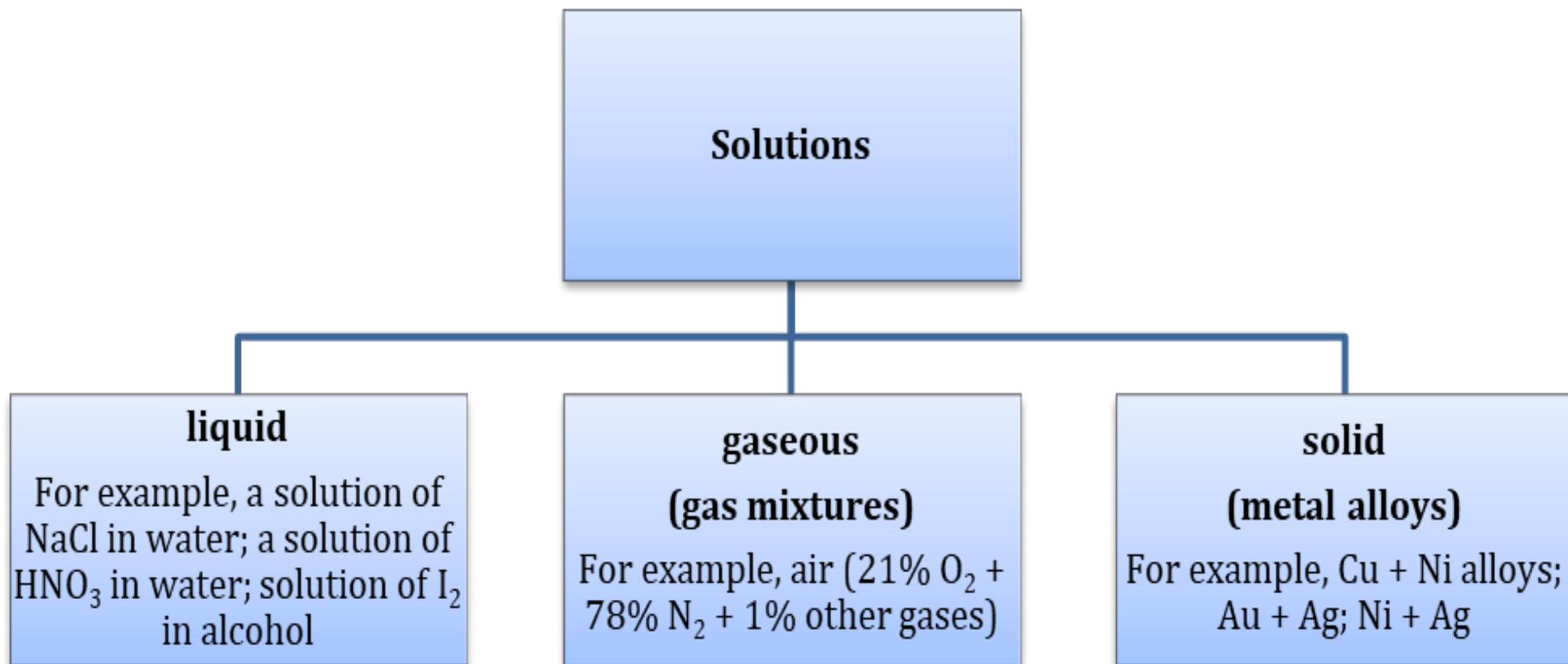


SOLVENT
Liquid the solute
dissolves in



SOLUTION
Solute dissolved in
solvent

Classification of solutions by aggregate state



The liquid solutions are:

- water of the seas and oceans, and even tap water;
- biological fluids with low-molecular and high-molecular substances dissolved in them

blood, lymph;

sweat;

gastric and intestinal juices;

saliva;

bile;

cytosol;

mitochondrial matrix;

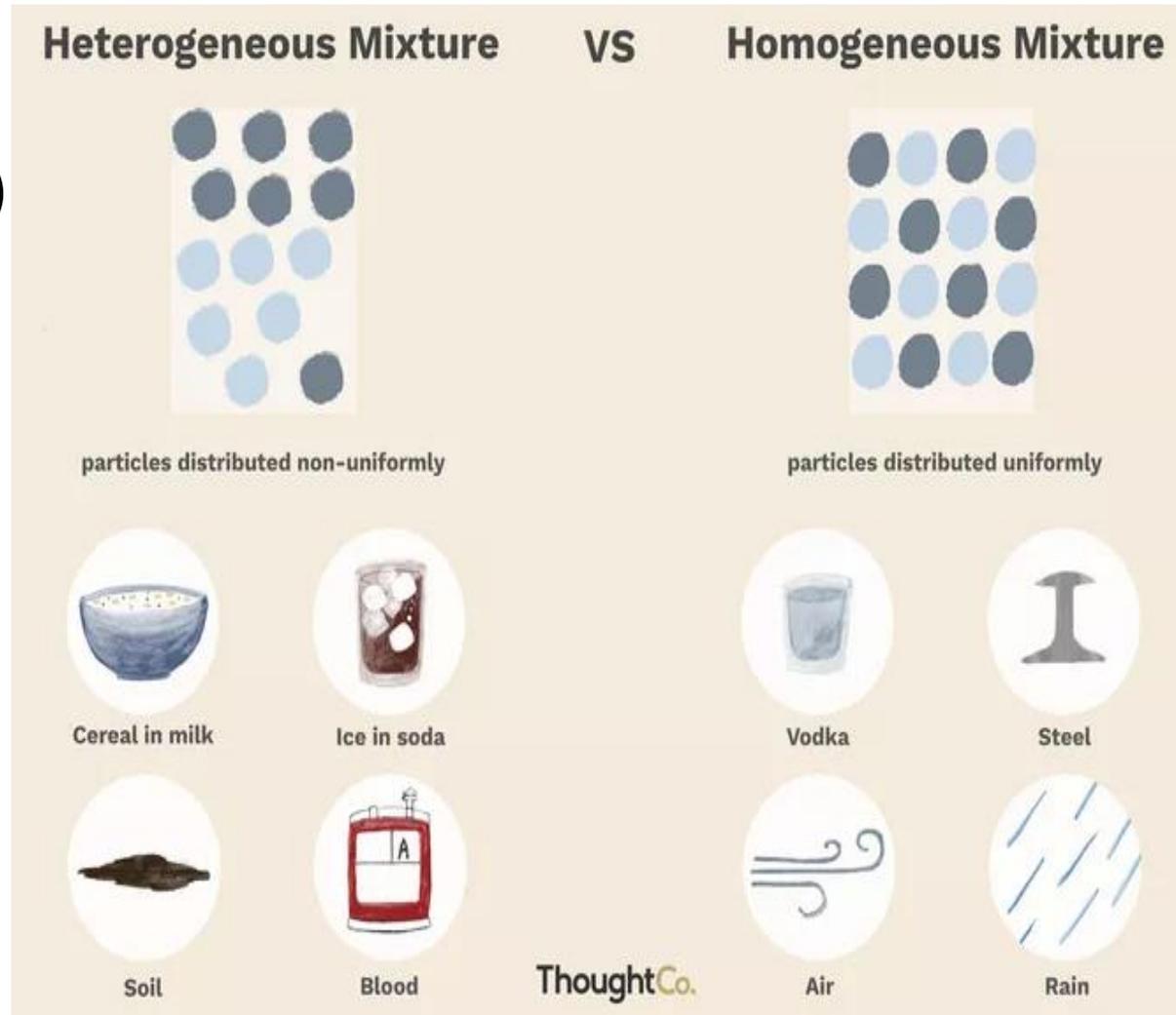
urine;

cerebrospinal fluid...

and many other

Classification of solutions by solute particle structure

- True solutions
(particle size 10^{-10} - 10^{-9} m)
- Colloidal solutions
(particle size 10^{-9} - 10^{-6} m)
- Solutions of high-molecular weight compounds



True solution

- **True solution** is solution in which particles of a solute are in water or other solvent in the form of molecules, atoms or ions. For example solutions of low-molecular weight compounds (salts, acids, alkalis).



This solutions are homogeneous mixture

Colloidal solutions

- **Colloidal solutions** are solutions related to dispersed systems, where the particles of the dispersed phase are in the dispersion medium in the form of micelles.



Colloidal solutions are heterogeneous mixture

What does mean “**concentration**”?

- In chemistry, **concentration** is the abundance of a constituent divided by the total volume of a mixture. A concentration can be any kind of chemical mixture, but most frequently solutes and solvents in solutions
- Several types of mathematical description can be distinguished

Ways of expressing concentration

Concentration	Formula	Definition
Mass fraction of solute (percentage) C (%)	$\omega = \frac{m_{s-sol}}{m_{p-pa}} \cdot 100\%$	C (%) is the ratio of the mass of the solute to the total mass of the solution. The mass fraction of a solute shows what mass of a substance is dissolved in 100 g of a solution
Molar concentration C (mol/l)	$C = \frac{n_{s-sol}}{V_{p-pa}} = \frac{m_{s-sol}}{V_{p-pa} \cdot M_{s-sol}}$	C (mol/L) is the ratio of the amount of solute to the volume of the solution. Molar concentration indicates the number of moles of a solute contained in 1 liter of solution
Molar equivalent concentration (normal concentration) C (1/z) (mol/l)	$C(1/z) = \frac{n(1/z)}{V} = \frac{m}{M(1/z)V}$	C (1/z) (mol/l) is the ratio of the amount of substance equivalents to the volume of the solution. The molar equivalent concentration indicates the number of mole equivalents of a solute contained in 1 liter of solution
Molal concentration Cm (mol/kg)	$C_m = \frac{n_{s-sol}}{m_{p-sol}}$	Cm (mol/kg) is the ratio of the amount of solute to the mass of the solvent. Molal concentration indicates the number of moles of a solute in 1000 g of solvent
Titer T (g/ml)	$T = \frac{m}{V_{(ml)}}$	T (g/ml) is the ratio of the mass of the solute to the volume of the solution, expressed in milliliters. The titer shows what mass of the substance is contained in 1 ml of solution

Tasks

1. Answer at the following questions:

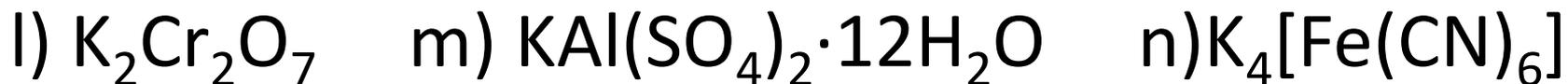
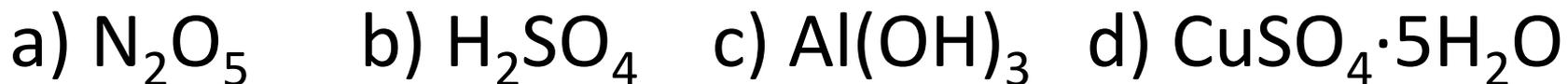
- a) What is the “Periodic Table”? Why is it needed?
- b) What is the “solution”, “solvent”, “solute”?
- c) What do you know about ways of expressing solution concentration?

Tasks



How to Calculate Molar Mass (Molecular Weight).mp4

2. Watch the video “How to calculate molar mass” (I sent it you) and calculate the molar mass of the following compounds:



Contact

- You can send me the answer to my e-mail (darya.taldykina@yandex.ru)
- **Please, indicate your name and the number of your group**
- *Best wishes for you, your course instructor is **Darya Rudenko** (prof. of the Department of Biochemistry of “Professor V.F. Voino-Yasenetsky Krasnoyarsk State Medical University”)*