

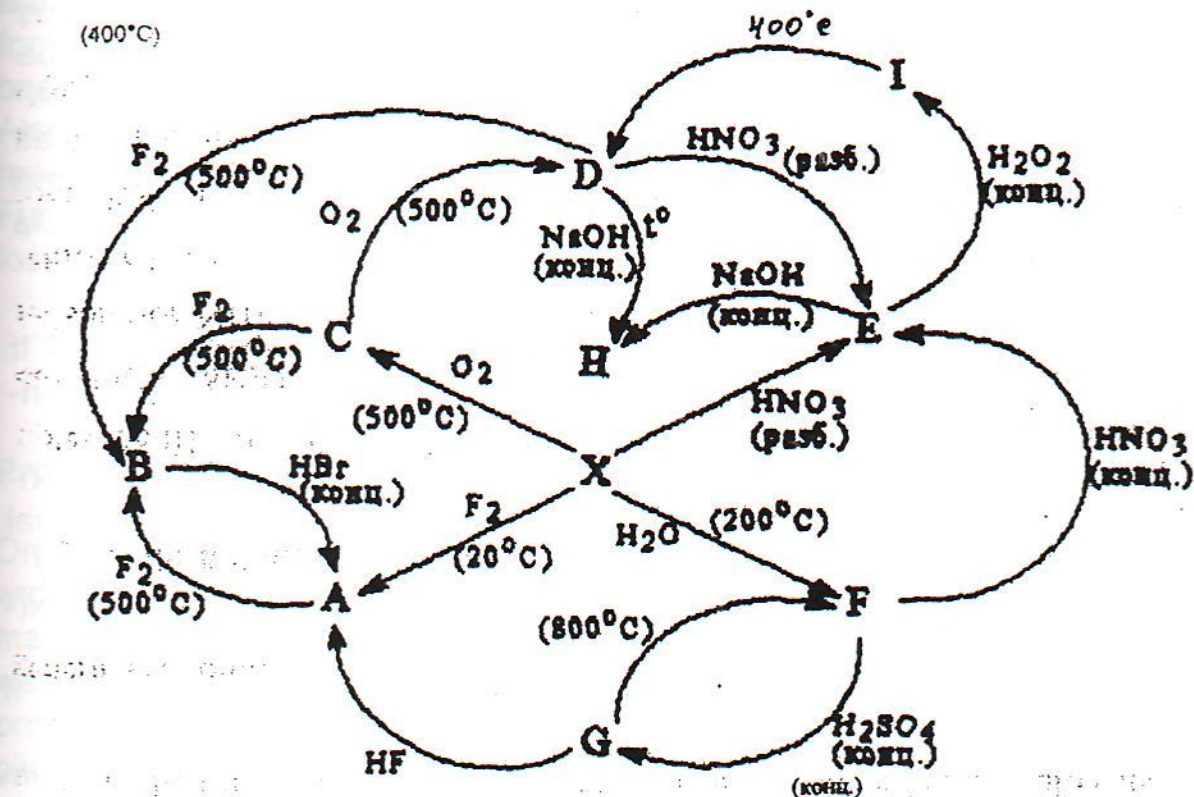


ХИМИЯ

С H I M E S T R Y

Problem 1.

A scheme of chemical transformation of the element X and its compounds A-I is given:



Colours and melting points of element X and its compounds A-I are represented in the table below:

Substance	colour	M.p.	substance	Colour	M.p.
X	silver-white	not more than 1100	E	Yellow	59.5
A	green	1036	F	brown	2850
B	white	64	G	White	Decomposed >750
C	dark green	Decomposed >900	H	yellow	?
D	yellow-orange	Decomposed >450	I	light-yellow	Decomposed >250

Determine the element X and its compounds A-I. Write the equations of all reaction. (14)

Problem 2.

In Konarev's book "For kin on chemistry" the history of discovery two compounds can be found. The gas-lighting hi the streets of London appeared In 1814. Lighting gas was stored in special Iron tanks under the pressure in the basement. In wintertime, especially In very cold weather, the gas did not provide bright light Owners of the gas plants applied Michael Faraday, a famous physicist and chemist. The scientist established a part of lighting gas to be concentrated on the bottom of the tank as transparent liquid (after condensation). By that way Faraday found out the new hydrocarbon and named it as «carburized hydrogen». At July 16th, 1875 Michael Faraday made a report on his discovery at the opening ceremony of Royal London Society. The formula of substance was...

Answer the following question:

1. What is the formula of "carburized hydrogen" and how do we call it now? It is known from Faraday data that it contains 92,5% of carbon and its density by hydrogen is equal to 39.
2. What is the formula of the other hydrocarbon discovered by Faraday, containing 85,7% of hydrogen and possessing the density by nitrogen, equal to 2?
3. Calculate, at what volume ratio the mixture of vapors of these hydrocarbons and air is explosive.
4. Estimate approximate linear size of molecule of "carburized hydrogen", if its modern density value is approximately equal to 0,9?
5. A famous physicist A. Stoletov told about Faraday: "Never since Galileum time the world has met so many astonishing and various discoveries made by one man only and is doubtful that we will see new Faraday soon..." What do you know about Faraday discoveries, particularly in chemistry? What new terms did Faraday introduce to science? Give some examples.

Problem 3.

The electrolysis of solution of butyric acid in a colorless solvent leads to a mixture of gas A and gas B as the products on anode. Gas A contains 27.27% of carbon, gas B - 19.15% of carbon. The product on the cathode has been found to be the light colorless gas C. Ratio of volumes A:B:C is equal to 1:1:8. The secondary electrochemical reactions may be neglected.

Determine gases A, B, C and the solvent X. What by-products could form in the described process?

Problem 4.

A mixture, M, of two salts A and B is heated at 1000 K. The resulting mixture, M1, contains two salts, A1 and B1. The cation in A1 absorbs in the violet region of visible spectrum and is very inert to usual reagents. The anion of A1, in acidic medium, reacts with aromatic primary amines to form important components in the dyes industry. B1 contains a cation which doesn't precipitate with HCl, H_2S (H^+), NH_4S (pH=9) or CO_3^{2-} . It can be isolated with HO^- , when forms an uncoloured pinkish jelly precipitate, which isn't soluble in excess of base.

Also B1 contains phosphorus and oxygen in the molar ratio P:O=1:3.5. Molar mass of B1 is 222 g mol^{-1} .

Further knowing that B contains nitrogen and hydrogen and by heating M loses 18.92% of its mass:

- Find A, B, A1, B1 and write the reactions involved.
- Calculate the composition of mixture M.

Problem 5.

Organic substance A, being inert towards metal sodium, is known to be widely used in synthetic organic chemistry. A sample of substance A with mass of 54.6 g was oxidized by 66.67 l of O_2 ; gas B (50.0 l) and H_2O (37.8 g) were obtained. All measurements were made at the temperature of 21°C and pressure of 770 Torr. Determine the substance A; indicate the fields of its application in organic chemistry.

Problem 6.

For a given substance, C_p has the following values: (given in cal/mol \cdot K):

$$\begin{aligned} (C_p)_s &= 5 \times 10^{-5} T^3 && (\text{for } 0 \leq T \leq 50) \\ (C_p)_s &= 6 && (\text{for } 50 \leq T \leq 200\text{K}) \\ (C_p)_L &= 7 && (\text{for } 200 \leq T \leq 500\text{K}) \end{aligned}$$

The melting point of this substance is $T_m = 200\text{K}$ and the melting enthalpy is $\Delta H_m = 400 \text{ cal/mol}$

a) Determine (on the basis of the third principle of thermodynamics) the absolute entropy of this substance at 400K.

b) Determine the melting enthalpy variation, the melting entropy variation and the melting free enthalpy variation at 150K. Is the melting process spontaneous or not at this temperature?

EXPERIMENTAL PART

There are BaCl_2 , AgNO_3 , $\text{Ca}(\text{CH}_3\text{COO})_2$, H_2SO_4 together with the investigated solution on the laboratory table. Using these solutions and also the additional reagents and equipment:

- make an anion in the investigated solution;
- determine the amount of the anion;
- prove the necessity for the titration to be carried out in weak alkaline medium;
- write the equation of the reactions.

Reagents: EDTA, hydrochloric acid, sample of barium chloride dihydrate (BaCl_2 , AgNO_3 , $\text{Ca}(\text{CH}_3\text{COO})_2$), ammonium buffer, eriochrome black T, distilled water.

Equipment: Slide, microscope, Mor dropper (20 ml), burette, funnel, measuring flask (100 ml), flask for titration, chemical glasses, measuring cylinder.