

The numbers in parentheses given after the numbers of the tasks indicate the grades of Russian school to which the task is recommended. The 8th grade is the first year of chemistry in Russian school and the 11th grade is the last year before graduation.

**Task 1. (8)** Which contains more atoms, 1 g of sulfur(VI) oxide or 1 g of copper(II) oxide? Give an explanation to your answer.

**Task 2. (8-9)** 12.5 mL of acetone was added into a flask containing 87.5 mL of water and the contents was thoroughly mixed. Then 1 mL of the liquid was taken from the flask into a vial.

Calculate how many acetone molecules are contained in the vial provided that the mixture in the flask was completely homogeneous.

The formula of acetone is  $(\text{CH}_3)_2\text{CO}$ . Consider the density of acetone to be  $0.8 \text{ g/cm}^3$ . The change in the volume upon mixing can be neglected.

**Task 3. (8-9)** In an aqueous solution of nitric acid, the total number of hydrogen atoms is half the total number of oxygen atoms. Calculate: (1) the ratio of the numbers of moles of the acid and water in this solution and (2) the weights of the acid and water contained in 100 g of the solution (round to the first decimal place).

**Task 4. (9-10)** Below are listed solid substances insoluble in water: 1) Fe, 2) Cu, 3)  $\text{CaCO}_3$ , 4) S, 5) ZnO, 6) CuS. Convert them to water-soluble substances by means of chemical reactions with any reagents (a soluble substance should be formed in one step). Write and balance equations of appropriate reactions and indicate conditions required for the reactions to proceed (not more than two methods for each substance).

**Task 5. (9-10)** A plate made of some unknown metal weighing 9.36 g was immersed into a copper sulfate solution prepared from 7.50 g of the hydrate  $(\text{CuSO}_4 \cdot 5\text{H}_2\text{O})$  and 92.50 g of water. After the reaction was completed (no copper left in the solution), the plate was taken out, washed with water, dried, and weighed. The weight was 7.92 g. Determine (1) the unknown metal (that formed the plate); (2) the mass fraction of copper sulfate in the initial solution; (3) the mass fraction of a salt in the final solution. Write down your reasoning and calculations.

**Task 6. (10-11)** Compound **A**, a yellowish powder weighing 10.25 g, was dissolved in an excess of a solution of sodium hydroxide with heating. As a result, 5.6 liters (STP) of gas **B** with a weight of 4.25 g was released. Gas **B** can be completely absorbed by an acid solution. Careful addition of an acid to the solution formed after dissolution of compound **A** resulted in precipitation of a solid. The precipitated solid was collected and annealed at a high temperature. This gave compound **C**, a white powder weighing 12.75 g. Identify the mentioned compounds, write down and balance the mentioned reaction equations, and write down your reasoning and

calculations.

**Task 7. (10-11)** Carbon atoms in organic molecules are called primary, secondary, tertiary, or quaternary depending on the number of carbon atoms they are bonded to (one, two, three, or four). The Table presents the numbers of atoms of different sorts in the molecules of several hydrocarbons that contain no multiple bonds.

Draw the structural formulae of hydrocarbons **A–F** and name them according to IUPAC rules

	primary	secondary	tertiary	quaternary
A	4	1	2	–
B	1	3	1	–
C	4	–	–	1
D	2	4	–	–
E	6	–	6	–
F	4	2	–	1

**Task 8. (10-11)** Catalytic dehydrogenation of a mixture of ethane and propane resulted in a mixture of ethylene and propylene with a molecular mass lower by 6.09% than the molecular mass of the initial mixture. The obtained gas mixture was allowed to react with water in the presence of an acid catalyst. Determine the composition of the initial hydrocarbon mixture (ethane and propane contents in vol.%). What compounds were formed in the reaction with water? Determine their quantitative composition (in wt %). Consider both reactions to proceed to the completion, that is, the starting reactants were completely converted to the indicated products. Write down your calculations.

**Task 9. (11)** A mixture of equal amounts (in moles) of iodoalkanes X and Y was treated with sodium metal in diethyl ether. Among other products, the reaction gave hydrocarbon Z containing 82.76% carbon (by weight) and having vapor density of 2.589 g/L (calculated for STP). Treatment of iodoalkane X with a solution of sodium hydroxide in water gives product W, which can be oxidized to give acetone. It is also known that iodoalkane Y contains 90.13% iodine (by weight).

(1) Identify hydrocarbon Z, iodides X, Y, and compound W. (2) What other products are formed in the reaction with sodium? Draw their structural formulae. Write down your reasoning and calculations.

---

Don't forget to **sign** your work (please, write the card number, your last name, school and grade) before **submitting** the work. You do not have to submit the sheet with the tasks. The tasks, their solutions and the results of the competition will be published at <http://turlom.olimpiada.ru> after November 20.