

## Chemistry Competition

The numbers in parentheses given after the numbers of the problems indicate grades of Russian school. The 8th grade pupils are supposed to solve 1 to 3 problems and 9th to 11th grade pupils solve 3 to 4 problems. The 8th grade is the first year of chemistry in Russian school and 11th grade is the last year before graduation. Solution of the problems meant for senior grades is welcome. The problems for junior grades do not affect the final score.

1. (8) A molecule of a medical drug consists of eight carbon atoms, nine hydrogen atoms, one nitrogen atom, and two oxygen atoms. Write down the molecular formula of the drug and calculate its relative molecular mass.

A dosage form of this drug is a suspension containing 24 mg of the compound in 1 mL. What volume of the suspension is required as a single dose for a child weighing 12 kg if the dose of the drug should be 10 mg per kg of the body weight?

2. (8–9) Magnesium and aluminium metal samples of equal mass were completely oxidized with oxygen. The oxidation of magnesium sample gave 8.0 g of the oxide. What is the mass of each of the metal samples taken and what is the mass of the aluminium oxide formed? Write down the oxidation reaction equations.

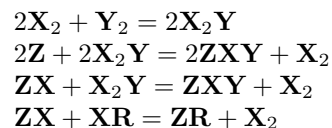
3. (8–11) How many grams of potassium iodide will precipitate from 73.0 g of a solution saturated at 80 °C on cooling down to 20 °C? The solubility of potassium iodide is 192 g per 100 g of water at 80 °C and 144 g per 100 g of water at 20 °C.

4. (9–10) Out of the list given below choose substances that can react with a 10% aqueous solution of sodium hydroxide. Write down the reaction equations for the possible reactions.

- |                                  |                      |
|----------------------------------|----------------------|
| 1) P <sub>2</sub> O <sub>5</sub> | 5) Al                |
| 2) CuO                           | 6) MgCO <sub>3</sub> |
| 3) ZnO                           | 7) Cl <sub>2</sub>   |
| 4) CuSO <sub>4</sub>             | 8) H <sub>2</sub> S  |

5. (9–10) A 27.4 g sample of barium metal was dissolved in 200 g of an aqueous solution of HCl with mass percentage concentration of 3.65%. What compounds will be present in solution after completion of the reaction? What are the mass percentage concentrations of these compounds?

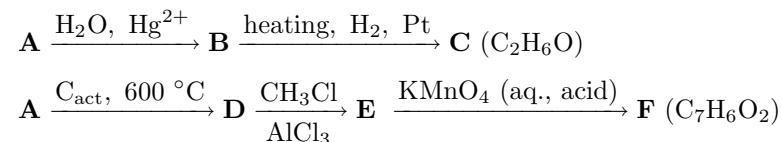
6. (9–10) The substances formed by elements **X**, **Y**, **Z** and **R** react in the following way:



Determine the elements **X**, **Y**, **Z** and **R** and the mentioned compounds. It is known that **X**<sub>2</sub>, **Y**<sub>2</sub> and **R**<sub>2</sub> are gases; compounds containing the element **Z** produce yellow colour of the flame; 0.1 mol of compound **XR** or **ZR** reacts with excess of a silver nitrate solution to give 14.35 g of a precipitate.

7. (10–11) Oxygen was passed through a hot tube containing a mixture of pyrite (FeS<sub>2</sub>) and iron metal powder until both substances completely reacted. After completion of the reaction, the product was taken out of the tube and weighed. The mass of the solid product was equal to the mass of the initial mixture. Determine the composition of the initial mixture in mass percentage. Write down the reaction equations.

8. (10–11)



The formulas in parentheses are the molecular formulas of compounds **C** and **F**.

What are compounds **A**, **B**, **C**, **D**, **E**, **F**? Write down the reaction equation between **C** and **F**.

9. (11) Monobasic monochlorocarboxylic acid **A** has no double bonds in the molecule. A 2.69 g portion of the acid is neutralized by 20 ml of a 1 mol/L solution of sodium hydroxide. The gaseous products formed upon combustion of an equal weight portion of this acid (2.69 g) can be absorbed by an aqueous solution of sodium hydroxide, complete neutralization of the gases requiring 220 mL of a 1 mol/L solution of sodium hydroxide. What is the molecular formula of acid **A**? What are the possible structural formulas of the acid? (without considering optical isomers). Write down the reaction equation of combustion.