PRACTICAL PROBLEMS

PROBLEM 1 (practical)

You will follow the concentration change of one of the reactants by the method of comparative visual colorimetry. From data obtained experimentally plot graphically the change of the reactant concentration in dependence on time.

Procedure:

1. Making of the comparative colorimetric scale of bromine solution

Measure with a syringe into 10 identical test-tubes the following quantities of bromine water (0.01-molar): into the first one – 10.0 cm^3; 2nd – 9.0 cm^3; 3rd – 8.0 cm^3, ... 9th – 2.0 cm^3; into the tenth one – 1.0 cm^3. Then add to all the test-tubes (except the first one) distilled water to reach a total volume of 10.0 cm^3 in each. Seal the test-tubes with stoppers and mix the solutions. Put the test-tubes in a stand with a white background. Finally calculate the concentration (in mol dm^{-3}) of bromine in the solutions in all test-tubes.

2. Reaction of bromine solution with formic acid

Carry out the reaction by mixing 100.0 cm^3 of bromine solution with 1.0 cm^3 of 1.00-molar solution of formic acid. Immediately after mixing transfer 10.0 cm^3 of the resulting solution to the test-tube identical with that used for colorimetric scale. By comparing the colour shade of the reaction mixture (in one-minute intervals) with that of the solutions in the scale, investigate changes of bromine concentration in dependence on time.

Put the data in a table containing time (*t*) and concentration of Br_2.

Task:

Plot the bromine concentration in dependence on time a read the half-time of the reaction from the diagram.

Questions:

1.1 Write the equation for the reaction of bromine with formic acid assuming that the reactants are in stoichiometric amounts.

1.2 In analytical chemistry a volumetric solution of bromine can be prepared by dissolving a mixture of bromate and bromide in acid medium. Explain this mode of preparation by means of a chemical equation in ionic form.

SOLUTION

Questions:

1.1 $HCOOH\ (aq) + Br_2\ (aq) \rightarrow CO_2\ (g) + 2\ H^+\ (aq) + 2\ Br^-\ (aq)$

1.2 $BrO_3^- + 5\ Br^- + 6\ H^+ \rightarrow 3\ Br_2 + 3\ H_2O$

PROBLEM 2 (practical)

By thermometric titration of a hypochlorite solution with a solution of propanone you will find the equivalent amounts of the reactants and consequently, the reaction products.

Procedure:

For the reaction of a hypochlorite solution with a propanone use solutions tempered at laboratory temperature (check). Put 100,0 cm^3 of a hypochlorite solution into a thermobeaker, insert a thermometer and keep adding a 4-molar solution of propanone in 1,0 cm^3 portions from burette, stirring the reaction mixture continuously by means of the thermometer (carefully, do not break!). Stir the reaction mixture thoroughly after each addition and read the highest temperature reached. Keep on adding the propanone solution as long as the temperature rises. Then add three more portions and finish the experiment. Keep the reaction mixture for possible later use.

Problems:

2.1 Draw a titration curve from the data of the temperature changes and consumption of propanone solution. Read the end point of the titration from the curve. Express the equivalent amounts of the reactants in moles.

2.2 Write equation for the chemical reaction and name the product that is formed.

2.3 Suggest a calculation for the approximate value of the reaction heat from the data obtained.

2.4 Consider the procedure of isolation of the product from the reaction mixture and give the method of its identification.

2.5 The exact concentration of a hypochlorite solution can also by determined by measuring the volume of oxygen released after catalytic decomposition of hypochlorite. Illustrate the principle of this method by means of a chemical equation and show schematically the procedure for the calculation.

SOLUTION

2.2 $CH_3COCH_3 + 3\ ClO^- \rightarrow CHCl_3 + 2\ OH^- + CH_3COO^-$

chloroform

2.3 Calculation of heat evolved in the course of the reaction:

$Q = m\, c\, \Delta t$

Q – reaction heat,

m – mass of the solution,

c – specific heat capacity of the solutions taking part in the reaction,

Δt – temperature difference (elevation of temperature)

On the basis of the data obtained in the task, it is possible to calculate Q value per one mole of reactant.

2.4 The mixture contains:

reactants – (excess of about 3 cm^3 of the 4-molar propanone solution),

products – $CHCl_3$, OH^-, CH_3COO^-.

Acetone and chloroform are separated from other substances in the aqueous solution by means of a separatory funnel and a subsequent distillation.

Identification of chloroform: smell, density.

2.5 $2\ ClO^- \rightarrow O_2$

$2\ mol \rightarrow 1\ mol = 22.4\ dm^3$

PROBLEM 3 (practical)

If a known excess of hydroxide solution with a known concentration is added to a weighed sample of ammonium salt and the liberated ammonia is removed by boiling, it is possible to determine the unreacted quantity of hydroxide by titration with a volumetric solution of an acid.

Procedure:

Three samples of an ammonium salt, weighed with accuracy of 0.001 g, are at your disposal. Introduce each of them into a 250 cm^3 Erlenmeyer flask. Add 50.0 cm^3 of a 0.2-normal sodium hydroxide solution to each sample. Put several boiling stones into each mixture and heat the flasks slowly on a small flame till there is no more ammonia in the liberating vapours. After expelling ammonia, cool the solution to the laboratory temperature, add 2 or 3 drops of indicator solution (Bromothymol blue) and titrate with a 0,2-normal volumetric solution of oxalic acid to the first lasting yellow colour of the solution.

Problems:

3.1 Calculate the molar mass of ammonium salt from the experimental data.

3.2 The sample is a salt of a monobasic inorganic acid. Consider which one.

3.3 Calculate the absolute and relative error of your determination.

3.4 Give reactions by means of which ions of the salt can be proved in the solution.