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The volumetric analysis - titration

Task 1

The aim of the task is the determination of the concentration of hydrochloric acid solution on the basis of acid-base reactions with the use of standard sodium hydroxide solution.

The principle of reaction

The determination is based on the neutralization of the hydrochloric acid by standard solution of sodium hydroxide against phenolphthalein. After the neutralization of the entire titrated acid, excess sodium hydroxide modifies the solution to alkalinity, where the color of phenolphthalein becomes pink.

$$HCl + NaOH \rightarrow NaCl + H_2O$$

Protocol

Take accurately 10 cm^3 of the solution of unknown concentration of HCl into Erlenmeyer flask and add three drops of phenolphthalein as an indicator. Titrate with 0.1 mol / dm^3 NaOH with vigorous stirring pending the pink color.

Calculate the molar concentration of an unknown HCl solution using the formula:

$$C_{NaOH} \cdot V_{NaOH} = C_{HCl} \cdot V_{HCl}$$

Task 2

The aim of the task is to determine the percentage and molar concentration of salicylic acid in commercial salicylic spirit.

The principle of reaction

The determination is based on the neutralization of the salicylic acid with standard NaOH solution against the phenolphthalein.
Excess sodium hydroxide, which was not used to the neutralization of the entire titrated acid solution, modifies the solution to alkalinity, where the color of phenolphthalein becomes pink.

$$HO\text{-}C_6H_4COOH + NaOH \rightarrow HO\text{-}C_6H_4COONa + H_2O$$

Proctocol

Take accurately 10 cm^3 of salicylic acid solution of unknown concentration into Erlenmeyer flask and add 3 drops of phenolphthalein as an indicator. Titrate with 0.1 mol/ dm^3 NaOH solution with vigorous stirring until the colouration of the solution.
Calculate the percentage and molar concentration of the analysed solution of salicylic acid.

Task 3

The aim is to determine the properties of potassium permanganate depending on the pH of the solution.

The principle of reaction

Depending on the pH of the solution the change of the level of oxidation of $KMnO_4$ can be observed:

- in an acidic pH of solution a **colorless** ion Mn^{2+} is obtained

$$\mathbf{2\ KMnO_4 + 5\ Na_2SO_3 + 3\ H_2SO_4 \rightarrow 2\ MnSO_4 + 5\ Na_2SO_4 + K_2SO_4 + 3H_2O}$$
$$\mathbf{Mn\ (VII) \rightarrow Mn\ (II)}$$

- in a neutral pH of solution **brown** MnO_2 is obtained

$$\mathbf{2\ KMnO_4 + 3\ Na_2SO_3 + H_2O \rightarrow 2\ \downarrow MnO_2 + 3\ Na_2SO_4 + 2\ KOH}$$
$$\mathbf{Mn\ (VII) \rightarrow Mn\ (IV)}$$

- in an alkaline pH of solution **green** ion MnO_4^{2-} is obtained

$$\mathbf{2\ KMnO_4 + Na_2SO_3 + 2KOH \rightarrow 2\ K_2MnO_4 + Na_2SO_4 + H_2O}$$
$$\mathbf{Mn\ (VII) \rightarrow Mn\ (VI)}$$

Protocol

Pipette the reagents in amounts shown in the table into 4 tubes (A, B, C, D). Before adding the solution of Na_2SO_3 mix the contents of the tubes thoroughly. Observe the reactions.

Test-tube	$KMnO_4$ 0.1 mol/dm^3	H_2SO_4 2 mol/dm^3	H_2O dest.	NaOH 1 mol/dm^3	Na_2SO_3 0.1 mol/dm^3
A	1 cm^3	-	3 cm^3	-	-
B	1 cm^3	1 cm^3	1 cm^3	-	1 cm^3
C	1 cm^3	-	2 cm^3	-	1 cm^3
D	1 cm^3	-	1 cm^3	1 cm^3	1 cm^3

Task 4

The aim is manganometric estimation of the concentration of hydrogen peroxide.

The principle of reaction

Determination of hydrogen peroxide is based on its properties of reduction reaction with permanganate (VII). Permanganate (VII) added from the burette into the peroxide solution is reduced and discolored. After a total oxidation of peroxide, excess $KMnO_4$ stains titrated solution to pink, which confirms the achievement of the end point.

$$2\ MnO_4^- + 5\ H_2O_2 + 6\ H_3O^+ \rightarrow 5\ O_2 + 2\ Mn^{+2} + 14\ H_2O$$

Protocol

Take the Erlenmeyer flask and measure exactly 2 cm^3 of the peroxide with an unknown concentration, 10cm^3 of distilled water and 5 cm^3 of 2 mol/ dm^3 H_2SO_4. Mix gently.
Titrate the solution with 0.1 mol / dm^3 $KMnO_4$ with vigorous stirring until the colouration of the solution. For the endpoint of the titration we take a moment when you add a drop of $KMnO_4$ and solution turns pink and the color of it will persist for one minute.

Note, how many ml of titrant (standard solution) has been used. Calculate the percentage concentration of analysed peroxide solution taking into account that 1 ml of standard 0.1 mol / dm^3 $KMnO_4$ solution reacts with 1,7008 mg of H_2O_2.
Query: why H_2SO_4 solution has been added to this analysis? (to answer, look to Task 3)

Lublin, 28.07.2017