THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/3A **CHEMISTRY 3A**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2017**

Instructions

1. This paper consists of THREE questions.
2. Answer all questions.

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1. You are provided with the following:

D_1: 250 cm^3 solution containing 1.8 g of MnO_2 and 2.2 g of oxalic acid

D_2: 0.02 M potassium permanganate

D_3: 1 M sulphuric acid

Questions

(a) With the aid of oxidation-reduction half reaction equations, write specifically the oxidizing and reducing agents in equations (1) and (2)

Equation (1):

Reduction: $MnO_2 + 4H^+ + 2e^- \rightarrow Mn^{2+} + 2H_2O$

Oxidation: $H_2C_2O_4 \rightarrow 2CO_2 + 2H^+ + 2e^-$

Reducing agent: oxalic acid

Oxidizing agent: MnO_2

Equation (2):

Reduction: $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

Oxidation: $C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$

Reducing agent: oxalate

Oxidizing agent: MnO_4^-

(b) Calculate the concentration of oxalic acid in:

(i) mol/dm^3

Number of moles = mass / molar mass = 2.2 / 126 = 0.01746 mol

Volume = 250 cm^3 = 0.25 dm^3

Concentration = 0.01746 / 0.25 = 0.0698 mol/dm^3

(ii) g/dm^3

Mass = 2.2 g in 250 cm^3 → in 1 dm^3 = 2.2 × 4 = 8.8 g/dm^3

(c) Calculate the percentage purity by mass of manganese dioxide in the sample

Mass of MnO_2 = 1.8 g

Molar mass = 86.94 g/mol

Moles = 1.8 / 86.94 = 0.0207 mol

From equation (1), 1 mol MnO_2 reacts with 1 mol $H_2C_2O_4$

So required mol of oxalic acid = 0.0207 mol

Available mol = 2.2 / 126 = 0.01746 mol

Reaction only used 0.01746 mol of oxalic acid

Therefore actual MnO_2 = 0.01746 mol × 86.94 = 1.518 g

Percentage purity = 1.518 / 1.8 × 100 = 84.33%

2. You are provided with the following:

AE: hydrogen peroxide

AF: sodium thiosulphate

AG: potassium iodide

AH: starch solution

AJ: 0.5 M sulphuric acid

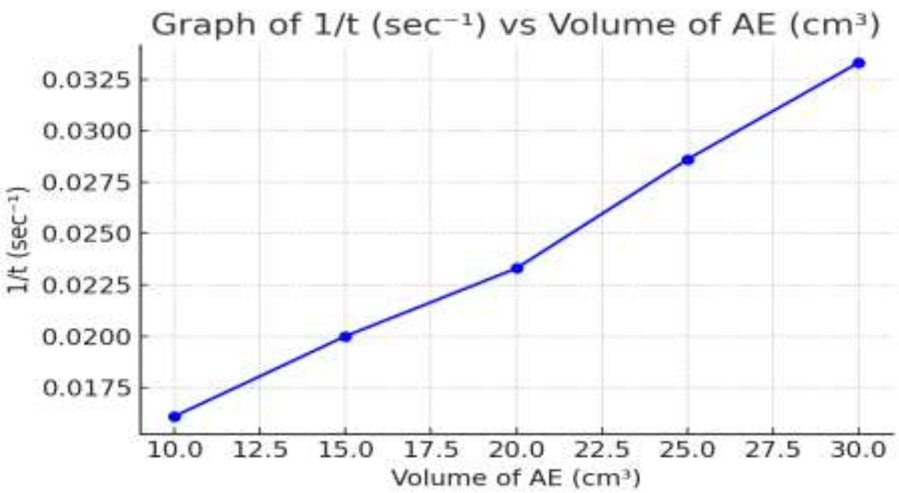
Table 1:

Experiment	Volume of AE (cm^3)	Volume of water (cm^3)	Time t (sec)	1/t (sec^{-1})

1	30	5	30	0.0333
2	25	10	35	0.0286
3	20	15	43	0.0233
4	15	20	50	0.0200
5	10	25	62	0.0161

(a) From the experimental results, as volume of AE decreases (i.e. concentration of H_2O_2 decreases), the time taken for the blue colour to appear increases. Therefore, the rate of reaction decreases. This shows that the concentration of hydrogen peroxide directly affects the rate of reaction.

(b) Plot a graph of 1/t vs volume of AE



(c) The graph shows a linear increase of rate with AE. Hence, the order of reaction with respect to H_2O_2 is 1.

(d) To calculate the rate constant, use the rate law:

rate = $k[H_2O_2]^1$

rate = 1/t

concentration ∝ volume (since total volume is constant)

So k = (1/t) / volume

Use experiment 1:

1/t = 0.0333, volume = 30 cm^3

k = 0.0333 / 30 = 0.00111 (in arbitrary units)

(e) Sodium thiosulphate is used to delay the appearance of iodine colour by reacting with any iodine formed until all thiosulphate is used. It helps in accurately measuring the time it takes for iodine to accumulate and form the starch–iodine complex (blue).

3. Sample C contains two cations and a common anion. Use the information given in the experiment column in Table 2 to complete the observations and inferences and hence identify the two cations and the common anion.

Table 2:

S/n	Experiment	Observations	Inferences
(a)	Observe the appearance of sample C	White crystalline solid	Presence of a salt
(b)	Add dilute hydrochloric acid to a dry sample C	Effervescence observed	Presence of carbonate or bicarbonate
(c)	Add 1 ml conc. sulphuric acid to solid C in test tube	Brown fumes evolved	Presence of nitrate ion
(d)	Perform flame test	Green flame	Presence of barium ion (Ba^{2+})
(e)	Heat a small sample in a dry test tube	Residue turns yellow when hot, white when cold	Presence of zinc ion (Zn^{2+})
(f)	Make solution of C in water and divide into four portions	-	-
(g)	To 1st portion, add ammonium solution	White gelatinous precipitate	Confirms Zn^{2+}
(h)	To 2nd portion, add potassium hexacyanoferrate(II)	Apple green precipitate	Confirms Ba^{2+}
(i)	To solid sample, add MnO_2 then conc. H_2SO_4	Brown gas evolved	Confirms NO_3^-

Conclusion:

(i) The cations in sample C were barium (Ba^{2+}) and zinc (Zn^{2+})

(ii) The anion in sample C was nitrate (NO_3^-)

(iii) The ionic equation which took place at stage (c):

$NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O$

(iv) Sample C contained barium nitrate and zinc nitrate salts