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: 2016**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. You are provided with the following:

RR: A solution made by dissolving 0.7 g of potassium permanganate in 0.25 dm^3 of distilled water

SS: A solution made by dissolving 3.15 g of oxalic acid crystals ($H_2C_2O_4 \cdot xH_2O$) in 0.5 dm^3 of distilled water

TT: A solution of 1 M sulphuric acid

Thermometer

Questions

(a)

(i) Write the half ionic equation for the reduction of MnO_4^- in the presence of the acid TT.

$MnO_4^- + 8H^+ + 5e^- \text{-----> } Mn^{2+} + 4H_2O$

(ii) Write the half ionic equation for the oxidation of $C_2O_4^{2-}$ ions.

$C_2O_4^{2-} \text{-----> } 2CO_2 + 2e^-$

(iii) Write the overall balanced redox ionic reaction equation in this particular experiment.

$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \text{-----> } 2Mn^{2+} + 10CO_2 + 8H_2O$

(b) Explain why the end point was pink in colour.

At the end point, all oxalate ions have reacted. Excess permanganate remains in the solution, imparting a pink colour due to unreacted MnO_4^- ions.

(c) Calculate the:

(i) Molarity of RR

Molar mass of $KMnO_4$ = 158 g/mol

Mass used = 0.7 g

Volume = 0.25 dm^3

Moles = 0.7 / 158 = 0.00443 mol

Molarity = 0.00443 mol / 0.25 dm^3 = 0.01772 mol/dm^3

(ii) Molarity of SS

Molar mass of $H_2C_2O_4 \cdot xH_2O$ = 90 + x(18), assume x = 2, total = 126 g/mol

Mass = 3.15 g, Volume = 0.5 dm^3

Moles = 3.15 / 126 = 0.025 mol

Molarity = 0.025 / 0.5 = 0.05 mol/dm^3

(iii) Concentration of oxalic acid in g/dm^3

= 3.15 g / 0.5 dm^3 = 6.3 g/dm^3

(iv) Value of x in the compound $H_2C_2O_4 \cdot xH_2O$

Let total molar mass = 90 + 18x

Given that 3.15 g gives 0.025 mol

So molar mass = 3.15 / 0.025 = 126

Then 90 + 18x = 126

18x = 36

x = 2

(v) Molar mass of SS = 90 + 18x = 126 g/mol

2. You are provided with the following:

CM_1: 0.2 M $Na_2S_2O_3$ solution

CM_2: 0.1 M HCl solution

CM_3: Distilled water

CM_4: Piece of white paper marked “X”

Stop watch

Questions

(a) Calculate the value of m.

From the data:

Experiment A: 2 cm^3 $Na_2S_2O_3$, 8 cm^3 water → 10 cm^3 total

t = 60 sec, 1/t = 0.0167

Experiment B: 4 cm^3 $Na_2S_2O_3$, 6 cm^3 water → t = 34 sec, 1/t = 0.0294

Experiment C: 8 cm^3 $Na_2S_2O_3$, 2 cm^3 water → t = 18 sec, 1/t = 0.0556

Compare experiments A and B:

[$Na_2S_2O_3$] doubles → 1/t increases from 0.0167 to 0.0294

Rate increase factor = 0.0294 / 0.0167 ≈ 1.76

Concentration increase factor = 2

m = log(1.76) / log(2) = 0.246 / 0.301 = 0.82 ≈ 1

(b) Write the ionic equation in this experiment.

$S_2O_3^{2-} + 2H^+$ -----> $S\downarrow + SO_2 + H_2O$

(c) Given that the value of n = 2, find the value of K.

Rate law: rate = K[$S_2O_3^{2-}$]^m[H^+]^n

Using values from experiment C:

$[S_2O_3^{2-}] = 0.2\ mol/dm^3 \times 8/20 = 0.08\ mol/dm^3$

$[H^+] = 0.1\ mol/dm^3$

rate = 1/t = 0.0556

K = rate / ($[S_2O_3^{2-}]$^1 × $[H^+]$^2)

K = 0.0556 / (0.08 × 0.01) = 0.0556 / 0.0008 = 69.5

(d) From the experiment above, is it possible to find the value of n? Give reason for your answer.

No, because concentration of HCl is constant across all experiments, so the order with respect to H^+ cannot be determined.

(e) What causes the precipitations to take place in the reaction?

Formation of insoluble sulfur (S) due to decomposition of thiosulphate ion.

3. Sample X contains a common cation and two anions. Use the information given in the experiment column in Table 3 to complete the observations and inferences and hence identify the common cation and the two anions.

Table 3:

S/n	Experiment	Observations	Inferences	
1	Observe the appearance of the sample X	White crystalline solid	Sample X is likely to be an inorganic salt	
2	Heat small portion of sample X in a dry test tube	No water droplets	no gas evolved	Absence of water of crystallization and carbonate
3	Place a spatulaful of sample X in a test tube; add concentrated sulphuric acid	Colourless gas with pungent smell evolved that turns blue litmus red	Presence of chloride ion (Cl^-)	

4	Place a spatulaful of sample X in a test tube and add sodium hydroxide solution	White gelatinous precipitate formed	insoluble in excess	Presence of aluminium ion (Al^{3+})
5(i)	Prepare a solution of X. In the first portion add barium chloride	White precipitate formed	Presence of sulphate ion (SO_4^{2-})	
5(ii)	In the second portion add silver nitrate solution	White precipitate formed	Presence of chloride ion (Cl^-)	

Conclusion:

(a)

Stage 4: $Al^{3+}(aq) + 3OH^-(aq)$ -----> $Al(OH)_3(s)$

Stage 5(i): $SO_4^{2-}(aq) + Ba^{2+}(aq)$ -----> $BaSO_4(s)$

Stage 5(ii): $Cl^-(aq) + Ag^+(aq)$ -----> $AgCl(s)$

(b)

The cation in sample X is aluminium (Al^{3+})

The anions are chloride (Cl^-) and sulphate (SO_4^{2-})