

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.

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1. You are provided with the following:

RR: A solution made by dissolving 0.7 g of potassium permanganate in 0.25 dm³ of distilled water

SS: A solution made by dissolving 3.15 g of oxalic acid crystals (H₂C₂O₄·xH₂O) in 0.5 dm³ of distilled water

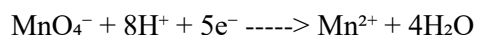
TT: A solution of 1 M sulphuric acid

Thermometer

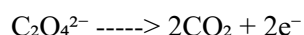
Questions

(a)

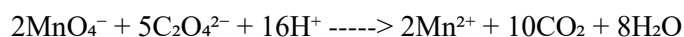
(i) Write the half ionic equation for the reduction of MnO₄⁻ in the presence of the acid TT.



(ii) Write the half ionic equation for the oxidation of C₂O₄²⁻ ions.



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



(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 MnO₄⁻ ions.

(c) Calculate the:

(i) Molarity of RR

Molar mass of KMnO₄ = 158 g/mol

Mass used = 0.7 g

$$\text{Volume} = 0.25 \text{ dm}^3$$

$$\text{Moles} = 0.7 / 158 = 0.00443 \text{ mol}$$

$$\text{Molarity} = 0.00443 \text{ mol} / 0.25 \text{ dm}^3 = 0.01772 \text{ mol/dm}^3$$

(ii) Molarity of SS

$$\text{Molar mass of } \text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O} = 90 + x(18), \text{ assume } x = 2, \text{ total} = 126 \text{ g/mol}$$

$$\text{Mass} = 3.15 \text{ g}, \text{ Volume} = 0.5 \text{ dm}^3$$

$$\text{Moles} = 3.15 / 126 = 0.025 \text{ mol}$$

$$\text{Molarity} = 0.025 / 0.5 = 0.05 \text{ mol/dm}^3$$

(iii) Concentration of oxalic acid in g/dm³

$$= 3.15 \text{ g} / 0.5 \text{ dm}^3 = 6.3 \text{ g/dm}^3$$

(iv) Value of x in the compound $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$

$$\text{Let total molar mass} = 90 + 18x$$

$$\text{Given that } 3.15 \text{ g gives } 0.025 \text{ mol}$$

$$\text{So molar mass} = 3.15 / 0.025 = 126$$

$$\text{Then } 90 + 18x = 126$$

$$18x = 36$$

$$x = 2$$

(v) Molar mass of SS = $90 + 18x = 126 \text{ g/mol}$

2. You are provided with the following:

CM₁: 0.2 M Na₂S₂O₃ solution

CM₂: 0.1 M HCl solution

CM₃: Distilled water

CM₄: Piece of white paper marked “X”

Stop watch

Questions

(a) Calculate the value of m.

From the data:

Experiment A: 2 cm³ Na₂S₂O₃, 8 cm³ water → 10 cm³ total

t = 60 sec, 1/t = 0.0167

Experiment B: 4 cm³ Na₂S₂O₃, 6 cm³ water → t = 34 sec, 1/t = 0.0294

Experiment C: 8 cm³ Na₂S₂O₃, 2 cm³ water → t = 18 sec, 1/t = 0.0556

Compare experiments A and B:

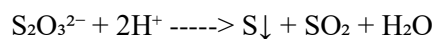
[Na₂S₂O₃] doubles → 1/t increases from 0.0167 to 0.0294

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.



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

Rate law: rate = K[S₂O₃²⁻]^m[H⁺]ⁿ

Using values from experiment C:

$$[\text{S}_2\text{O}_3^{2-}] = 0.2 \text{ mol/dm}^3 \times 8/20 = 0.08 \text{ mol/dm}^3$$

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

$$\text{rate} = 1/t = 0.0556$$

$$K = \text{rate} / ([\text{S}_2\text{O}_3^{2-}]^1 \times [\text{H}^+]^2)$$

$$K = 0.0556 / (0.08 \times 0.01) = 0.0556 / 0.0008 = 69.5$$

(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)



(b)

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

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