THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/3B   **CHEMISTRY 3B**

(For Both School and Private Candidates)

Time: 3 Hours   **ANSWERS**   **Year: 2018**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. You are provided with the following solutions:
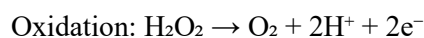
KK: 0.02 M potassium permanganate

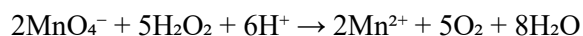LL: Impure 1.7 g hydrogen peroxide in 1 dm³ aqueous solution

SS: 1 M sulphuric acid

Questions

(a) Write half and overall ionic equations of the reaction between potassium permanganate and hydrogen peroxide

Half equations:

Oxidation: $H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$

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

Overall ionic equation:

$2MnO_4^- + 5H_2O_2 + 6H^+ \rightarrow 2Mn^{2+} + 5O_2 + 8H_2O$

(b) Calculate the percentage purity of hydrogen peroxide

Given:

Mass of impure H_2O_2 = 1.7 g

25 cm³ of LL required 21.0 cm³ of KK

Molarity of KK = 0.02 mol/dm³

Moles of $KMnO_4$ = 0.02 × 21.0 ÷ 1000 = 0.00042 mol

From equation, 2 mol $KMnO_4$ react with 5 mol H_2O_2

Moles of H_2O_2 = 5/2 × 0.00042 = 0.00105 mol

2

Mass of $H_2O_2 = 0.00105 \times 34.0 = 0.0357$ g

Purity = 0.0357 g in 25 cm³ of LL → in 1000 cm³ = $0.0357 \times 40 = 1.428$ g

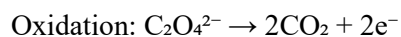% purity = $1.428 \div 1.7 \times 100 = 83.99\%$

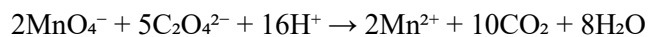Percentage purity = 84.0%

2. You are provided with:

U: 0.02 M $KMnO_4$
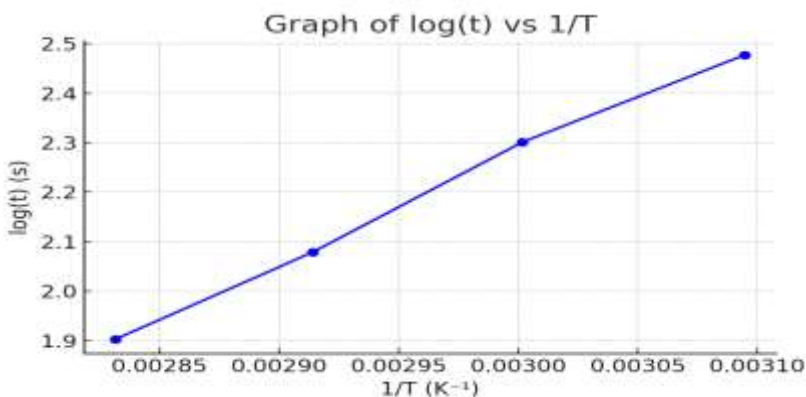
V: 0.05 M oxalic acid in 0.5 M H_2SO_4

Questions

(a) Write half ionic equations for the reaction:

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

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

Overall:

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

(b) Plot a graph of log t (s) against 1/T (K^{-1})

Graph of log(t) vs 1/T

Find this and other free resources at: http://maktaba.tetea.org

Prepared by: Maria Marco for TETEA

(c) Use the graph to determine the activation energy of the reaction

To solve for the activation energy (Ea) from the graph of log(t) vs 1/T, we follow these steps:

Identify the equation of the line

  The Arrhenius equation in linear form is:

  $\log(t) = -(Ea / 2.303R) \times (1/T) + \text{constant}$

  Here, the slope of the line is:

  $\text{slope} = -(Ea / 2.303R)$

Extract the slope from the graph

  From the graph, we determine the slope (m) as -13.2.

Use the slope to calculate Ea

  Rearranging the equation:

  $Ea = -\text{slope} \times 2.303 \times R$

  Where:

  - slope = -13.2

  - $R = 8.314$ J/mol·K (the universal gas constant)

Substitute the values into the equation

  $Ea = -(-13.2) \times 2.303 \times 8.314$

  $Ea = 13.2 \times 2.303 \times 8.314$

  $Ea = 254.05$ kJ/mol

So, the activation energy (Ea) is 254.05 kJ/mol.

3. You are provided with sample T containing two cations and two anions. Carry out the experiments described in Table 1. Record carefully your observations, make appropriate inferences and finally identify the cations and anions present in sample T.

Table 1: Table of results.

S/n	Experiment	Observations	Inference
1.1	To the first portion add NaOH	White precipitate forms, soluble in excess	Presence of amphoteric ion (Zn^{2+})
1.2	To the second portion add dilute HNO_3, then $AgNO_3$, then NH_3	White precipitate dissolves in excess ammonia	Presence of Cl^- ion
1.3	To the third portion add ammonia solution	Deep blue solution formed	Presence of Cu^{2+}
2(a)	Dissolve residue in HCl and observe any gas	Effervescence observed with colourless, odourless gas	Presence of CO_3^{2-} ion
2(b)(i)	Add NH_4OH to first portion until no further change	White precipitate formed remains insoluble	Confirms Zn^{2+}
2(b)(ii)	Add ammonium oxalate to second portion	White precipitate forms	Confirms Ca^{2+} or presence of oxalate

Conclusion:

(i) The cations in sample T are Cu^{2+} and Zn^{2+}

(ii) The anions in sample T are Cl^- and CO_3^{2-}

(iii) The compounds in the mixture are $CuCl_2$ and $ZnCO_3$