**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: 2015**

**Instructions**

1. This paper consists of THREE questions.

2. Answer all questions.

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1. You are provided with the following:

S: A solution made by diluting 10.00 $cm^3$ of 0.50 M $K_2Cr_2O_7$ to exactly 0.25 $dm^3$ with distilled water

Q: Sodium thiosulphate solution

A: Dilute sulphuric acid solution

B: Starch solution

C: A 10% potassium iodide solution

Procedure:

(i) Measure 25.0 $cm^3$ of solution S into a conical flask

(ii) Add 10 $cm^3$ of solution C, 10 $cm^3$ of solution A, and 1 $cm^3$ of solution B to the flask

(iii) Titrate the mixture against solution Q until the blue colour disappears

(iv) Repeat to obtain three concordant titre values

Questions:

(a) Write the half reaction equations to show the oxidation and reduction processes for equations 1 and 2

Equation 1:

Reduction: $Cr_2O_7^{2-} + 14H^+ + 6e^- \text{-----> } 2Cr^{3+} + 7H_2O$

Oxidation: $2I^- \text{-----> } I_2 + 2e^-$

Equation 2:

Oxidation: $S_2O_3^{2-} \text{-----> } S_4O_6^{2-} + 2e^-$

Reduction: $I_2 + 2e^- \text{-----> } 2I^-$

(b) For each reaction, identify the oxidant and the reductant. Give a reason for your answer.



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In equation 1:

Oxidant: $Cr_2O_7^{2-}$ (accepts electrons and is reduced to $Cr^{3+}$)

Reductant: $I^-$ (loses electrons and is oxidized to $I_2$)

In equation 2:

Oxidant: $I_2$ (accepts electrons and is reduced to $I^-$)

Reductant: $S_2O_3^{2-}$ (loses electrons and is oxidized to $S_4O_6^{2-}$)

(c) (i) Molarity of Q:

Given 20 g of $Na_2S_2O_3 \cdot 5H_2O$ in 0.5 $dm^3$

Molar mass = 158 + (5 × 18) = 248 g/mol

Moles = 20 ÷ 248 = 0.08065 mol

Molarity = 0.08065 ÷ 0.5 = 0.1613 mol/$dm^3$

(ii) Concentration in g/$dm^3$:

20 g ÷ 0.5 $dm^3$ = 40 g/$dm^3$

(d) What is the significance of the orange and pale green colourations in this experiment?

The orange colour at the start indicates the presence of $Cr_2O_7^{2-}$ ions.

The pale green colour at the end indicates the formation of $Cr^{3+}$ ions, confirming that reduction of $Cr_2O_7^{2-}$ has occurred.

2. You are provided with the following:

$P_1$: A solution containing 20 g of $Na_2S_2O_3 \cdot 5H_2O$ in 0.5 $dm^3$ of solution

$P_2$: A solution of dilute hydrochloric acid



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$P_3$: Distilled water

Stop watch

Procedure:

(i) Pour 10 $cm^3$ of solution $P_2$ into a conical flask

(ii) Place the flask on a white paper marked "W"

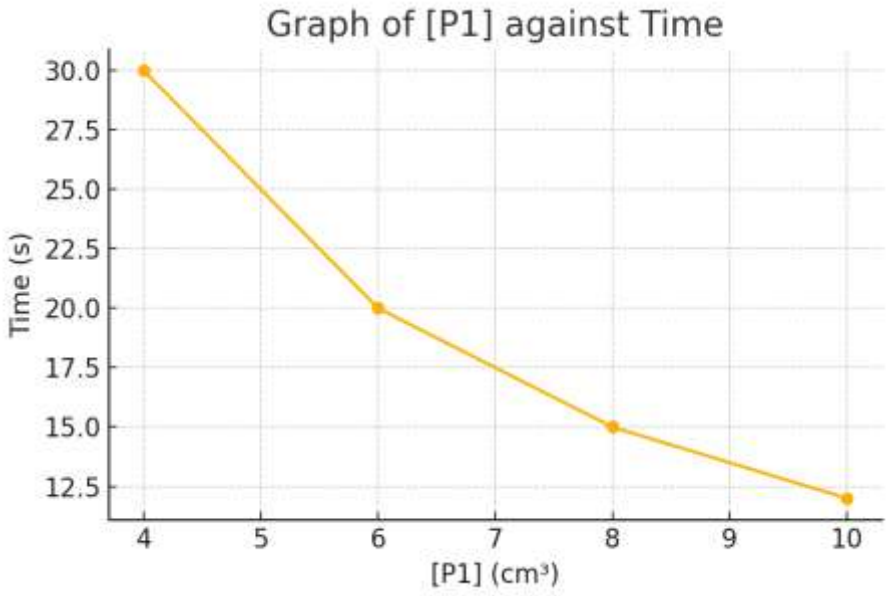
(iii) Add 10 $cm^3$ of solution $P_1$ into the flask and start the stopwatch immediately

(iv) Observe and record the time taken for the letter "W" to disappear

(v) Repeat the experiment using 8, 6, 4 $cm^3$ of solution $P_1$ and add distilled water ($P_3$) to maintain a total volume of 10 $cm^3$ each time

Questions:

(a) Plot a graph of [$P_1$] against time




(b) Plot a graph of 1/t against [$P_1$]



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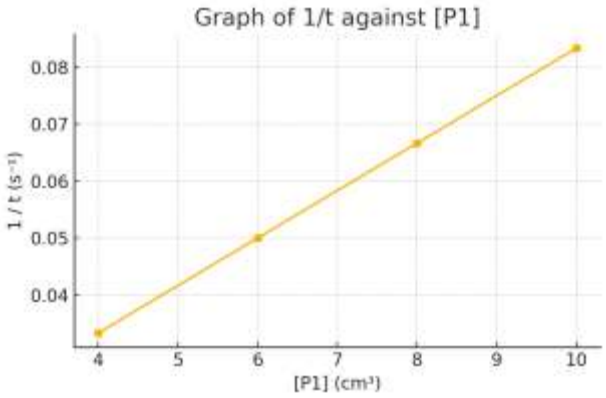


(c) What is the effect of concentration of $P_1$ on the rate of the reaction?

As the concentration of $P_1$ increases, the time taken for the cross (W) to disappear decreases. This means the rate of reaction increases with concentration of $P_1$. Therefore, the reaction is faster at higher concentrations of sodium thiosulphate.

(d) What is the order of reaction with respect to $P_1$? Give a reason for your answer.

The order of reaction with respect to $P_1$ is first order. This is because the graph of 1/t versus $[P_1]$ gives a straight line through the origin, indicating that the rate is directly proportional to the concentration of sodium thiosulphate.

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

Table 3:

(a) Appearance.

Observation: White crystalline solid

Inference: Presence of a typical salt

(b) Heat a little of sample T in a dry test tube.

Observation: Brown gas evolved with possible charring



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Inference: Presence of nitrate ion ($NO_3^-$)

(c) Dissolve a little of sample T in water and divide the resulting solution into four portions:

(i) To one portion add NaOH solution and warm gently.

Observation: Reddish-brown precipitate formed

Inference: Presence of $Fe^{3+}$ ion

(ii) To the second portion add $AgNO_3$ solution till excess.

Observation: White precipitate formed

Inference: Presence of $Cl^-$ ion

(iii) To the third portion add few drops of potassium hexacyanoferrate (III).

Observation: Deep blue precipitate formed

Inference: Presence of $Fe^{3+}$ ion

(iv) To the fourth portion add ethanoic acid followed by lead ethanoate solution.

Observation: White precipitate formed

Inference: Presence of $Cl^-$ or $SO_4^{2-}$ ion

(d) To a little sample T in a dry test tube, add dilute sodium hydroxide solution.

Observation: Gas with ammoniacal smell evolved

Inference: Presence of $NH_4^+$ ion

Conclusion:

(i) The cations in sample T are $Fe^{3+}$ and $NH_4^+$



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(ii) The molecular formula of sample T is $NH_4Fe(SO_4)_2$ or $NH_4FeCl_4$ (depending on confirmed common anion)

(iii) Reaction equation in experiment (d):

$NH_4^+(aq) + OH^-(aq) \text{ -----> } NH_3(g) + H_2O(l)$



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