

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 cm³ of 0.50 M K₂Cr₂O₇ to exactly 0.25 dm³ 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 cm³ of solution S into a conical flask

(ii) Add 10 cm³ of solution C, 10 cm³ of solution A, and 1 cm³ 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: $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$

Oxidation: $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^-$

Equation 2:

Oxidation: $\text{S}_2\text{O}_3^{2-} \rightarrow \text{S}_4\text{O}_6^{2-} + 2\text{e}^-$

Reduction: $\text{I}_2 + 2\text{e}^- \rightarrow 2\text{I}^-$

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

In equation 1:

Oxidant: $\text{Cr}_2\text{O}_7^{2-}$ (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: $\text{S}_2\text{O}_3^{2-}$ (loses electrons and is oxidized to $\text{S}_4\text{O}_6^{2-}$)

(c) (i) Molarity of Q:

Given 20 g of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ in 0.5 dm^3

Molar mass = $158 + (5 \times 18) = 248 \text{ g/mol}$

Moles = $20 \div 248 = 0.08065 \text{ mol}$

Molarity = $0.08065 \div 0.5 = 0.1613 \text{ mol/dm}^3$

(ii) Concentration in g/dm^3 :

$20 \text{ g} \div 0.5 \text{ dm}^3 = 40 \text{ g/dm}^3$

(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 $\text{Cr}_2\text{O}_7^{2-}$ ions.

The pale green colour at the end indicates the formation of Cr^{3+} ions, confirming that reduction of $\text{Cr}_2\text{O}_7^{2-}$ has occurred.

2. You are provided with the following:

P1: A solution containing 20 g of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ in 0.5 dm^3 of solution

P2: A solution of dilute hydrochloric acid

P₃: Distilled water

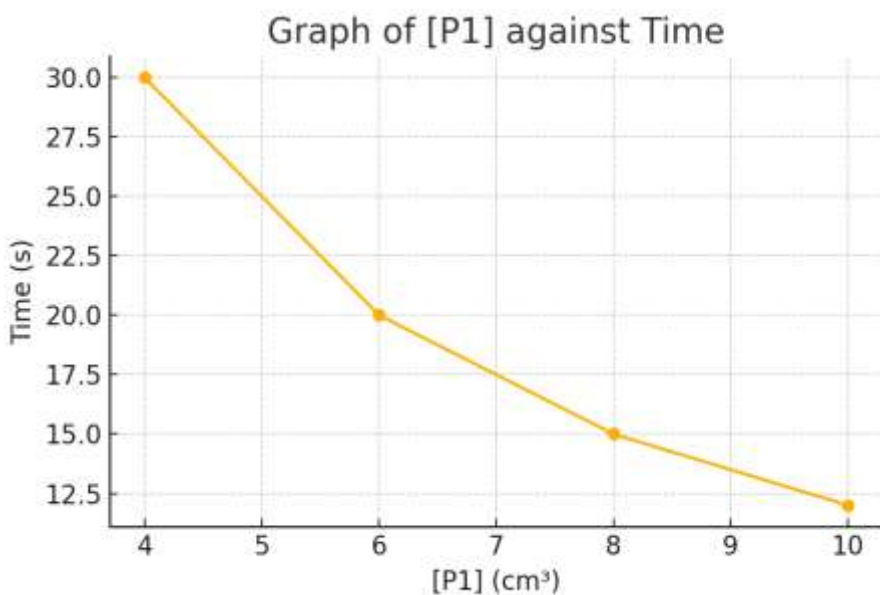
Stop watch

Procedure:

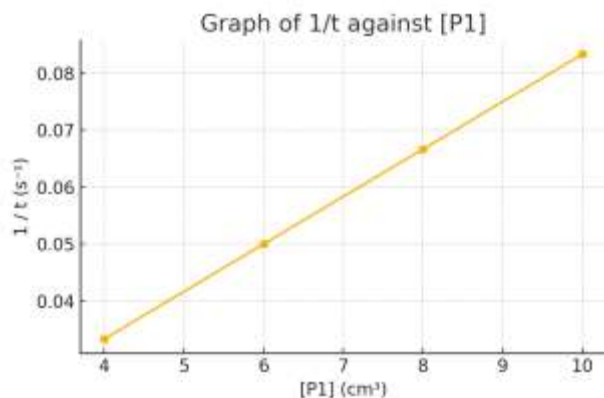
- (i) Pour 10 cm³ of solution P₂ into a conical flask
- (ii) Place the flask on a white paper marked “W”
- (iii) Add 10 cm³ of solution P₁ into the flask and start the stopwatch immediately
- (iv) Observe and record the time taken for the letter “W” to disappear
- (v) Repeat the experiment using 8, 6, 4 cm³ of solution P₁ and add distilled water (P₃) to maintain a total volume of 10 cm³ each time

Questions:

- (a) Plot a graph of [P₁] against time



- (b) Plot a graph of 1/t against [P₁]



(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

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^+

(ii) The molecular formula of sample T is $\text{NH}_4\text{Fe}(\text{SO}_4)_2$ or NH_4FeCl_4 (depending on confirmed common anion)

(iii) Reaction equation in experiment (d):

