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Question 1A

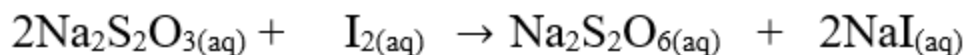
A is an aqueous solution of Iodine. **B** is 0.100 mol dm⁻³ sodium trioxothiosulphate (II).

- a. Put **B** into the burette. Pipette 20.0 cm³ or 25.0 cm³ of **A** into a conical flask. Add **B** from the burette until the reddish-brown colour fades to pale yellow, then add a few drops of starch indicator to obtain a dark blue solution. Continue adding **B** slowly from the burette until one drop of **B** causes the blue colour to disappear, leaving a colourless solution.

Repeat the titration to obtain concordant titre values.

Tabulate your results and calculate the average volume of **B** used.

The equation for the reaction is:



- b. From your results and the information provided, calculate the:

- i. Concentration in mol dm⁻³ of iodine in **A**;
- ii. mass in grammes of iodine in 1.00 dm³ of **A**.

[I=127.0]

[17 marks]

Observation

Majority of the candidates responded to this question and their performance was above average.

In part (a), majority of the candidates carried out the titration experiment correctly;

In part (b), majority of the candidates calculated the concentration in mol dm⁻³ of iodine in **A** and mass of iodine in 1.00 dm³ of **A**.

The expected answers include:

(a) Two concordant titres

Averaging

(b) (i) Say V_B cm³
Conc. of A in mol dm⁻³

$$\frac{C_A V_A}{C_B V_B} = \frac{1}{2}$$

$$C_A = \frac{C_B V_B}{2 V_A}$$

$$C_A = \frac{0.1 \times V_B \times 1}{2 V_A}$$

$$= \mathbf{a} \text{ mol dm}^{-3} \text{ Say}$$

(correct to 3 sig. fig. to score, wrong unit, no score)

(ii) Mass in grammes of iodine in 1.00 dm³ of A
 Molar mass of iodine (I₂) = 2 x 127
 = 254 g mol⁻¹

$$\text{Mass of iodine} = \text{Molar mass of iodine} \times \text{amount of iodine in A}$$

$$= 254 \times \mathbf{a} \text{ g}$$

$$= \mathbf{b} \text{ g say}$$

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Question 2A

C contains **two** cations and one anion.

- a. Dissolve **all** of **C** in about 10 cm³ of distilled water. Carry out the following exercise on portions of the resulting solution:
- i. To about 2 cm³ of the solution, add NaOH(aq) in drops then in excess. Warm gently the resulting mixture.
 - ii. To about 2 cm³ of the solution, add BaCl₂(aq) followed by excess dilute HCl.
- b. From your results, identify the cations and anions in the sample.
[18 marks]

Observation

This question was based on qualitative analysis of a mixture of two salts. This question was attempted by majority of the candidates and their performance was above average.

In part (a), majority of the candidates were able to state the observations and inferences.

In part (b), majority of the candidates were able to identify the cations and anions in the sample.

The expected answers include:

Fe(NH₄)₂ (SO₄)₂

	TEST	OBSERVATION	INFERENCE

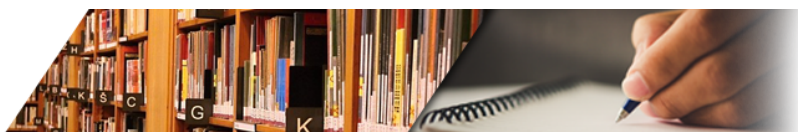
(a)	C + distilled water	Dissolved to give a pale green solution	Fe^{2+} , Cu^{2+} may be present (Both ions mentioned to score)
(i)	C (aq)+ NaOH(aq) in drops then in excess mixture warmed	Green (gelatinous) precipitate formed Precipitate insoluble Colourless gas with choking smell evolved which turned moist red litmus paper blue or forms white fumes with HCl gas	Fe^{2+} present $\text{NH}_3(1)$ gas from NH_4^+
(ii)	C (aq) + BaCl_2 (aq) + excess dil HCl	White precipitate formed Precipitate insoluble	SO_3^{2-} , CO_3^{2-} , SO_4^{2-} , S^{2-} present SO_4^{2-} present (SO_4^{2-} should be mentioned above to score)

- (b) Cations present are Fe^{2+} and NH_4^+
Anion present is SO_4^{2-}

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Question 3A

(a) Describe **one** chemical test to distinguish between carbon (IV) oxide and sulphur (IV) oxide.

[3 marks]

(b) (i) State the laboratory method of collection of each of the following gases:

- (I) H₂;
- (II) NH₃;
- (III) HCl.

(ii) Give a reason for **each** of the answers stated in 3(b)(i). [6 marks]

(c) State the method used in separating each of the following mixtures:

- i. two miscible liquids;
- ii. soluble salt and insoluble salt.

[3 marks]

(d) Explain **briefly** why a solution of KCl does not give off a gas when mixed with NaHCO₃ solution, but a solution of AlCl₃ does.

[3 marks]

Observation

This question was based on the knowledge of Test of Practical. It was attempted by majority of the candidates and their performance was above average.

In part (a), majority of the candidates described one chemical test to distinguish between carbon (IV) oxide and sulphur (IV) oxide.

In part (b), majority of the candidates stated the laboratory method of collection of the gases.

In part (c), majority of the candidates stated the method used in separating the mixtures.

In par (d), majority of the candidates could not explain why a solution of KCl does not give off a gas when mixed with NaHCO_3 , but a solution of AlCl_3 does.

The expected answers include:

(a) Pass the gas through acidified KMnO_4 solution if the pink colour does not change then the gas is CO_2 if the pink colour changes to colourless then the gas is SO_2

OR

SO_2 turns acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution green while CO_2 does not

(b) (i) I. -: H_2 - downward displacement of air / upward delivery

II. -: NH_3 - upward delivery / downward displacement of air

III. -: HCl - downward delivery / upward displacement of air

(ii) I - lighter / less dense than air

II - lighter / less dense than air

III. - denser / heavier than air

(c) (i) Use of simple / fractional distillation

(ii) Dissolution in water followed by filtration to obtain insoluble salt. Then crystallization / evaporation to dryness of filtrate to obtain soluble salt.

(d) KCl(aq) is neutral hence does not react with $\text{NaHCO}_3(\text{aq})$ while $\text{AlCl}_3(\text{aq})$ is acidic hence reacts with $\text{NaHCO}_3(\text{aq})$ to liberate CO_2 .

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Question 1B

D is a solution containing 3.15 g of HNO₃ in 500 cm³ of solution.

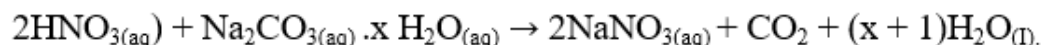
E is a solution containing 14.6 g of Na₂CO₃.x H₂O per dm³.

- a. Put **D** into the burette and titrate it against 20.0 cm³ or 25.0 cm³ portions of **E** using methyl orange as indicator.

Repeat the titration to obtain **concordant** titre values.

Tabulate your results and calculate the average volume of **D** used.

The equation for the reaction is:



- b. From your results and the information provided, calculate the:
- i. concentration of **D** in mol dm⁻³;
 - ii. concentration of anhydrous Na₂CO₃ in **E** in mol dm⁻³;
 - iii. volume of x in Na₂CO₃.xH₂O.

[H=1.0; C=12.0; N = 14.0; O = 16.0, Na = 23.0]

[22 marks]

Observation

This question was on titration experiment. Majority of the candidates that responded to this question performed above average.

In part (a), majority of the candidates obtained concordant values from the titration experiment;

In part (b), majority of the candidates calculated the concentration of **D** in mol dm⁻³ and concentration of anhydrous Na₂CO₃ in **E** in mol dm⁻³.

The expected answers include:

(a) Two concordant titres

Averaging

Say V_D : Av. volume used

(b) (i) Conc. of D in mol dm⁻³

Molar mass of HNO₃ = 1 + 14 + (16x3)

$$= 63 \text{ g mol}^{-1} \quad (\text{wrong unit, no score})$$

Conc. of D g dm⁻³ = $\frac{1000}{500} \times 3.15$

$$= 6.30 \text{ g dm}^{-3}$$

$$\text{Conc. of D mol dm}^{-3} = \frac{6.3}{63} = 0.100 \text{ mol dm}^{-3} \quad (\text{Accept } 0.1 / 0.10)$$

(ii) $\frac{C_D V_D}{C_E V_E} = \frac{2}{1}$ (mole ratio)

$$C_E = \frac{C_D V_D}{2 V_E} \quad (\text{subject of formula})$$

$$C_E = \frac{0.100 \times V_D}{2 \times V_E} \quad (\text{correct substitution})$$

$$= e \text{ mol dm}^{-3} \text{ Say} \quad (\text{Correct to 3 sig. fig. wrong unit, no score})$$

(iii) Value of x

$$\text{Molar mass} = \frac{\text{Conc. (g dm}^{-3})}{\text{Conc. (mol dm}^{-3})}$$

$$\text{Molar mass of Na}_2\text{CO}_3 \cdot x \text{ H}_2\text{O} = \frac{14.6}{e}$$

$$= f \text{ Say}$$

$$\therefore 106 + 18x = f$$

$$18x = f - 106$$

$$x = \frac{f - 106}{18}$$

$$= g \text{ Say}$$

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Question 2B

1. **F** is a mixture of **two** inorganic salts. Carry out the following exercises on **F**.

Record your observations and identify any gas(es) evolved.

State the conclusions you draw from the results of **each** test.

- a. Put all of **F** into a boiling tube and add about 10 cm³ of distilled water. Stir well and filter. Keep both the filtrate and residue. Test the filtrate with litmus paper.
- b. To about 2 cm³ of the filtrate add few drops of BaCl₂(aq) followed by dilute HCl.
- c. Put all the residue into a test tube and add 1 cm³ of dil HCl. Divide the resulting mixture into two.
 - i. To the first portion of the mixture, add NaOH(aq) in drops and then in excess.
 - ii. To the second portion of the mixture, add NH₃(aq) in drops and then in excess.

Observation

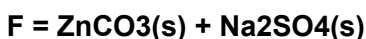
This question was popular among the candidates as majority of them responded to it.

In part (a), majority of the candidates were able to write the observations and inferences correctly.

In part (b), only few candidates were able to deduce the inferences.

In part (c), majority of the candidates wrote correct observations and inferences.

The expected answers include:



	TEST	OBSERVATION	INFERENCE
(a)	F + water and filter	Partly soluble, colourless filtrate	

	Filtrate + litmus paper	white residue No effect on either blue or red litmus paper	filtrate is neutral
(b)	Filtrate + BaCl ₂ (aq) + dil HCl	White precipitate Insoluble in HCl(aq)	CO ₃ ²⁻ , SO ₃ ²⁻ , SO ₄ ²⁻ , S ²⁻ - present SO ₄ ²⁻ - Confirmed
(c)	Residue + dil HCl	Effervescence occurred Colourless, odourless gas evolved turned lime water milky	CO ₂ evolved from CO ₃ ²⁻
(i)	Solution from (c) + NaOH(aq) in drops then in excess	White gelatinous precipitate precipitate soluble	Zn ²⁺ / Al ³⁺ Zn ²⁺ / Al ³⁺
(ii)	Second portion of solution from (c) + NH ₃ (aq) in drops then in excess	White gelatinous precipitate Soluble in excess NH ₃ (aq)	Zn ²⁺ , Al ³⁺ (both mentioned to score) Zn ²⁺ confirmed

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Question 3B

(a) State what would be observed if aqueous ammonia is added in drops till it is in excess to a sample of copper (II)chloride in a test tube.
[3 marks]

(b) Calculate the mass of sodium trioxocarbonate (IV) required to prepare 600 cm^3 of 0.35 $mol\ dm^{-3}$ solution. [C=12.0, O=16.0, Na = 23.0]
[3 marks]

Observation

Majority of the candidates responded to this question and their performance was above average.

In part (a), majority of the candidates stated what would be observed if aqueous ammonia is added in drops till it is in excess to a sample of copper(II) chloride solution in a test tube.

In part (b), majority of the candidates could not calculate the mass of sodium trioxocarbonate (IV) required to prepare 600 cm^3 of 0.35 $mol\ dm^{-3}$ solution.

The expected answers include:

- (a) Pale blue (gelatinous) precipitate is observed which dissolves in excess $\text{NH}_3(\text{aq})$ to form a deep blue solution
- (b) $C = \frac{m}{M \times V (\text{dm}^3)}$
 $M_r (\text{Na}_2\text{CO}_3) = (2 \times 23) + (1 \times 12) + (3 \times 16)$
 $= 106 \text{ g mol}^{-1}$
 $\therefore m(\text{Na}_2\text{CO}_3) = C \times M_{(\text{Na}_2\text{CO}_3)} \times V(\text{dm}^3)$
 $= 0.35 \times 106 \times 0.6$
 $= 22.3 \text{ g}$

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