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Chemistry Paper 3A WASSCE (SC), 2022

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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 *cm*3 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:

$$2Na_2S_2O_{3(aq)} + I_{2(aq)} \rightarrow Na_2S_2O_{6(aq)} + 2NaI_{(aq)}$$

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

Say V_B cm^3

(b) (i) Conc. of A in mol dm^{-3}

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

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

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

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

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

(ii) Mass in grammes of iodine in 1.00 dm^3 of A

Molar mass of iodine (I_2) = 2 x 127

= 254 g mol^{-1}

Mass of iodine = Molar mass of iodine x amount of iodine in A

= 254 x **a** g

= **b** 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 gentl 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 NH3**(1)** gas from NH4+
(ii)	**C**(aq) + BaCl2(aq) + excess dil HCl	White precipitate formed Precipitate insoluble	$SO3^{2-}$, $CO3^{2-}$, $SO4^{2-}$, S^{2-}present $SO4^{2-}$ present ($SO4^{2-}$ should be mentioned above to score)

(b) Cations present are Fe^{2+} and $NH4^{+}$
Anion present is $SO4^{2-}$

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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 NaHCO3, but a solution of AlCl3 does.

The expected answers include:

(a) Pass the gas through acidified KMnO4 solution if the pink colour does not change then the gas is CO2 if the pink colour changes to colourless then the gas is SO2

OR

SO2 turns acidified K2Cr2O7 solution green while CO2 does not

(b) (i) I. -: H2 - downward displacement of air / upward delivery

II. -: NH3 - 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 NaHCO3(aq) while AlCl3(aq) is acidic hence reacts with NaHCO3(aq) to liberate CO2.

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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:

$$2HNO_{3(aq)} + Na_2CO_{3(aq)}.x\,H_2O_{(aq)} \rightarrow 2NaNO_{3(aq)} + CO_2 + (x+1)H_2O_{(l)}.$$

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-;*
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 $HNO_3 = 1 + 14 + (16x3)$

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

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

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

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

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

$C_E = \frac{C_D V_D}{2V_E}$ (subject of formular)

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

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

(iii) Value of x

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

Molar mass of $Na_2CO_3 \cdot x\ H_2O = \frac{14.6}{\mathbf{e}}$

$= \mathbf{f}$ Say

$\therefore 106 + 18x = f$

$18x = f - 106$

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

$= \mathbf{g}$ Say

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Chemistry Paper 3B WASSCE (SC), 2022

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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:

F = ZnCO3(s) + Na2SO4(s)

	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 + BaCl2(aq) + dil HCl	White precipitate Insoluble in HCl(aq)	CO32- , SO32- , SO42-, S2- present SO42- Confirmed
(c)	Residue + dil HCl	Effervescence occurred Colourless, odourless gas evolved turned lime water milky	CO2 evolved from CO32-
(i)	Solution from (c) + NaOH(aq) in drops then in excess	White gelatinous precipitate precipitate soluble	Zn2+ /Al3+ Zn2+ / Al3+
(ii)	Second portion of solution from (c) + NH3(aq) in drops then in excess	White gelatinous precipitate Soluble in excess NH3(aq)	Zn2+ ,Al3+ (both mentioned to score) Zn2+ 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 *cm3* 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 *cm3* of 0.35 *mol dm-3* solution.

The expected answers include:

(a) Pale blue (gelatinous) precipitate is observed which dissolves in excess $NH_{3(aq)}$ to form a deep blue solution

(b) $C = \frac{m}{M \times V\ (dm^3)}$

$Mr\ (Na_2CO_3) = (2x23) + (1x12) + (3x16)$

$= 106\ g\ mol^{-1}$

$\therefore m(Na_2CO_3) = C \times M_{(Na_2CO_3)} \times V(dm^3)$

$= 0.35 \times 106 \times 0.6$

$= 22.3\ g$

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