Name.....SUGGESTED GUIDE.....Center/Index number...../.....

BOB-BONUS-2023

P525/3
CHEMISTRY
Paper 3
August, 2023
3¼ hours

JINJA JOINT EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

MOCK EXAMINATIONS –AUGUST, 2023

CHEMISTRY

PRACTICAL

Paper 3

3 hours 15 minutes

INSTRUCTIONS TO CANDIDATES

- *Answer* **all** *questions.*
- *Answers are to be written in the spaces provided.*
- *You are not allowed to use any reference books.*
- *Mathematical tables, slide rulers and non-programmable silent electronic calculators may be used.*
- *Candidates are not allowed to start working with the apparatus for the first 15 minutes. This time is to ensure that they have all the chemicals and apparatus they may need.*
- *Atomic masses: C=12, O=16, H=1, N=14, Cl=35.5*

For Examiner's Use Only

Q1	Q2	Q3	TOTAL
30	33	17	80

1. You are provided with the following;
FA1; which is a solution containing $45gl^{-1}$ of impure potassium dichromate (VI), $K_2Cr_2O_7$
FA2; Which is sodium thiosulphate solution of unknown concentration.
FA3; which is 10% Potassium iodide solution.
IM hydrochloric acid solution
Solid W which is Potassium iodate, KIO_3

You are required to
(a) Standardise solution FA2 using solid W
(b) Determine the percentage purity of potassium dichromate in FA1

Theory:
Iodide ions in solution are oxidized to Iodine by acidified solutions of Iodate(V) and dichromate(VI) according to the following equations

$IO^-_{3(aq)} + 6H^+_{(aq)} + 5I^-_{(aq)} \longrightarrow 3H_2O_{(l)} + 3I_{2(aq)}$

$Cr_2O_7^{2-}{}_{(aq)} + 14H^+_{(aq)} + 6I^-_{(aq)} \longrightarrow 2Cr^{3+}_{(aq)} + 7H_2O_{(l)} + 3I_{2(aq)}$

The iodine liberated quantitatively reacts with sodium thiosulphate solution.
Procedure

Part A:
(a) Weigh accurately about 2.7g of W and place it in a beaker containing about $20cm^3$ of distilled water. Stir to dissolve and transfer the contents of the beaker into a $250cm^3$ volumetric flask. Add more distilled water to make up to the mark and label the resultant solution FA4.
(b) Pipette $10cm^3$ of FA4 into a clean conical flask then add an equal volume of 1M hydrochloric acid followed by $10cm^3$ of solution FA3 to liberate iodine.
(c) Titrate the liberated iodine using solution FA2 from the burette until the solution turns pale yellow. Add 5 drops of starch indicator and continue the titration until the blue black complex is discharged.
(d) Repeat the procedure 2-3 times to obtain consistent readings and enter your results in table I below.

RESULTS:
Mass of container + W=.....22.70.....g (1 ½ marks)
Mass of Container alone=.....20.00.....g
Mass of W used =.....2.70.....g (02) (½ mark)
Volume of pipette used =.....10.0/10.....cm^3
Table I (4 ½ marks)

Final burette reading (cm^3)	10.00	19.60	29.20
Initial burette reading (cm^3)	0.00	10.00	19.60
Volume of FA2	10.00	9.60	9.60

Award only ±3 strictly 2dp
4½

Values of FA2 used to calculate average volume=.....9.60cm³, 9.60cm³.....(½ mark)

.....±0.1.....

.....

∴Calculate average volume of FA2= $\frac{9.60+9.60}{2}$ = 9.60cm³.....(3 marks)

Questions:

(a) Calculate the number of moles of

(i) Iodate(V) ions in 10cm³ of FA4 (2 marks)

(O =16, K = 39, I = 127)

1 mole of KIO_3 weigh (39+127+3×16)

= 214g

214g of KIO_3 Contain 1 mole

2.7g of KIO_3 Contain $\frac{1}{214} \times 2.7$ moles

$= 1.262 \times 10^{-2}$ moles

250cm³ of FA_4 solution Contain 1.262×10^{-2} moles of IO_3^-

∴10cm³ of FA_4 Contains $\frac{1.262 \times 10^{-2}}{250} \times 10$

$= 5.048 \times 10^{-4}$ moles

(ii) Thiosulphate ions, $s_2O_3^{2-}$ in 1dm³ of FA2 (3½ marks)

1 mole of IO_3^- react with 6moles of $S_2O_3^{2-}$

Moles of SO_3^{2-} reacted $= 6 \times 5.048 \times 10^{-4} = 3.0288 \times 10^{-3}$ moles.

9.60cm³ of FA_2 Contain 3.0288×10^{-3} moles of $S_2O_3^{2-}$

1000cm³ of FA_2 Contain $\frac{3.0288 \times 10^{-3}}{9.60} \times 1000$

$= 0.316$ moles of SO_3^{2-}

∴ Molarity of $S_2O_3^{2-} = 0.316M$

PART B

(a) Pipette 10cm³ of FA1 into a clean conical flask, then add an equal volume of 1M hydrochloric acid followed by 10cm³ of solution FA3 to liberate iodine.

(b) Titrate the liberated iodine using solution FA2 from the burette until the solution turns pale yellow. Add 5 drops of starch indicator and continue the titration until you obtain a green solution.

(c) Repeat the procedure 2-3 times to obtain consistent readings and enter your results in table II below.

RESULTS:

Volume of pipette used =.....10.0 / 10.....(½ mark)

Table II

Volume of pipette used = 10 / 10.0 (½ mark)

(4½ marks)

Final burette reading (cm^3)	23.00	24.80	47.60
Initial burette reading (cm^3)	0.00	2.00	24.80
Volume of FA2 used (cm^3)	23.00	22.80	22.80

4½

Values of FA2 used to calculate average volume: 22.80 cm^3 and 22.80 cm^3 ±0.1 Accept (½ mark)

∴ Calculate average volume of FA2 = $\frac{22.80 + 22.80}{2}$ = 22.80 cm^3 (3 marks)

±0.1 ✓
±0.2 ✓
±0.3 ✓
±0.4 ✓
±0.5 ✓

Questions:

(b) Calculate the number of moles of

(i) Thiosulphate ions, $S_2O_3^{2-}$ in FA2 that reacted. (2 marks)

1000 cm^3 of FA_2 solution contains 0.316 moles of $S_2O_3^{2-}$

22.80 cm^3 of FA_2 solution contain $\frac{0.316 \times 22.80}{1000}$

Moles of $S_2O_3^{2-}$ in FA_2 = 7.205×10^{-3} moles.

02

(ii) Dichromate(VI) ions, $Cr_2O_7^{2-}$ in 1dm^3 of FA1 (2 marks)

1 mole of $Cr_2O_7^{2-}$ react with 6 mole $S_2O_3^{2-}$

Moles of $Cr_2O_7^{2-}$ reacted = $\frac{1}{6} \times 7.205 \times 10^{-3}$

= 1.201×10^{-3}

⇒ 10 cm^3 of FA_1 solution contain 1.201×10^{-3} moles of $Cr_2O_7^{2-}$

1000 cm^3 of FA_1 solution contain $\frac{1.201 \times 10^{-3} \times 1000}{10}$

= 0.12 mol dm^{-3}

02

(c) Determine the mass and hence the percentage purity of $K_2Cr_2O_7$ in FA1.

(K=39, Cr=52, O=16)

1 mole of $K_2Cr_2O_7$ weigh (39×2) + (52×2) + (16×7)

= 294 g

294 g of $K_2Cr_2O_7$ contain 1 mole

1 mole of $K_2Cr_2O_7$ weigh 294 g

0.12 mole of $K_2Cr_2O_7$ weigh $\frac{294}{1} \times 0.12$

= 35.28 g

02

% $K_2Cr_2O_7$ in FA_1 = $\frac{35.28}{45} \times 100$

= 78.4%

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2. You are provided with substance Y which contains two cations and two anions. You are required to identify the cations and anions in Y. Carry out the following tests on Y and record your observations and deductions in the table below. Where a gas (es) is (are)evolved, it must be identified. (34 marks)

TESTS	OBSERVATIONS	DEDUCTIONS
(a) Heat two spatula endfuls of Y in a dry test tube first gently and then strongly until there is no further change.	White solid Colourless gas turns wet blue litmus red and lime water milky Reddish-brown residue when hot, yellow when cold Colourless condensate turns white anhydrous $CuSO_4$ blue	Non-transition metal cation CO_3^{2-} / HCO_3^- / $C_2O_4^{2-}$ or CH_3COO^- PbO, Pb^{2+} Hydrated salt. (Max 5)
(b) To two spatula endfuls of Y in a boiling tube, add dilute nitric acid dropwise until there is no further change. Decant off the solution	Effervescence/bubbles of a colourless gas turns blue litmus red and limewater milky Colourless solution	CO_2; CO_3^{2-} Non-transition metal ion present.
(c) To the decanted solution in (b), add dilute sodium hydroxide dropwise until in excess. Shake and filter, keep both the filtrate and residue.	White precipitate insoluble in excess Colourless filtrate White residue	Ba^{2+} or Ca^{2+} or Mg^{2+} (01) Al^{3+} or Zn^{2+} or Pb^{2+} or Sn^{2+} or Sn^{4+} Ba^{2+} or Ca^{2+} or Mg^{2+}
(d) To the filtrate from (c), add dilute nitric acid dropwise until the solution is just acidic. Divide the acidified filtrate into four parts	White precipitate soluble in excess to form a colourless solution	Al^{3+} or Pb^{2+} or Zn^{2+} or Sn^{2+} or Sn^{4+} (01)
(i) To the first part of the acidified filtrate, add dilute sodium hydroxide dropwise until in excess.	white precipitate soluble in excess to form a colourless solution	Pb^{2+} or Al^{3+} or Zn^{2+} or Sn^{2+} or Sn^{4+} (01)

Any additional strong ion added, cancels out correct one

(ii) To the second part of the acidified filtrate, add dilute ammonia solution dropwise until in excess	White precipitate insoluble in excess ammonia	Pb^{2+} or Al^{3+} or Sn^{2+} or Sn^{4+} 01
(iii) To the third part of the acidified filtrate, add 4-5 drops of sodium sulphate solution	white precipitate	Pb^{2+} 01
(iv) Use the fourth part of the acidified filtrate to carry out a test of your own choice to confirm one of the cations in Y. Record test and observations Test: Add K_2CrO_4 solution followed by excess NaOH/ethanoic acid Reject if test is not stated	A yellow precipitate soluble in excess sodium hydroxide	Pb^{2+} 02
(e) Dissolve the residue from (c) in dilute nitric acid. Then divide the acidic solution into four parts.	Colourless solution	Mg^{2+} or Ca^{2+} or Ba^{2+} 01
(i) To the first part of the acidic solution add dilute sodium hydroxide solution dropwise until in excess.	White precipitate Insoluble in excess	Mg^{2+} or Ca^{2+} or Ba^{2+} 01/2 reject :- Al wrong cations Wrong Cation / Anion cancels out Correct ones
(ii) To the second part of the acidic solution, add dilute ammonia solution dropwise until in excess and leave to stand for 1 minute.	White precipitate Insoluble in excess	Ba^{2+} or Mg^{2+} 01 rej: Pb^{2+} and Al^{3+}
(iii) To the third part of the acidic solution, add 3-4	white precipitate	Ba^{2+} 01

drops of dilute sodium sulphate solution		
(iv) Use the fourth part of the acidic solution to carry out a test of your own choice to confirm one of the cations in Y. Record test and observations Test: Add $K_2C_2O_4$ solution followed by excess sodium hydroxide solution Deny if test is not written	Yellow precipitate insoluble in NaOH	Ba^{2+} (02)
(f) To two spatula endfuls of Y in a boiling tube, add about 4 cm^3 of water, shake vigorously and filter. Keep both the filtrate and residue. Divide the filtrate into three portions	partly soluble Colourless filtrate white residue	Ba^{2+} or Pb^{2+} (01)
(i) To the first portion of the filtrate, add 3-4 drops of Barium nitrate solution	white precipitate	SO_4^{2-} or SO_3^{2-} or CO_3^{2-} or $C_2O_4^{2-}$ (1½)
(ii) To the second portion of the filtrate, add an equal volume of silver nitrate solution. Divide the resultant mixture into two parts.	white precipitate	$C_2O_4^{2-}$ or Cl^- (01)
To the first part of the mixture in f(ii), add dilute ammonia solution dropwise until in excess.	White precipitate soluble in excess forming a colourless solution	Cl^- or $C_2O_4^{2-}$ (1½)

To the second part of the mixture in f(ii), add dilute nitric acid dropwise until in excess.	White precipitate soluble in acid without bubbles of a gas	Cl^- absent $C_2O_4^{2-}$
(iii)To the third portion of the filtrate, add 3-4 drops of acidified potassium manganite(vii) solution and heat gently	Purple acidified $KMnO_4$ turns from purple to colourless. Bubbles of a colourless gas turns blue litmus red and lime water milky	$C_2O_4^{2-}$ CO_2, $C_2O_4^{2-}$

(g) Identify the

(i) cations in Y: Pb^{2+} d(iv) ..... and Ba^{2+} e(iv) .....

(ii) anions in Y: CO_3^{2-} (b) ..... and $C_2O_4^{2-}$ f(ii) .....

- Emphasise - correct symbol of ion
- wrong ion cancels out correct one
- Emphasis on spelling of technical terms
- deny if technical term wrongly spelt

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3. You are provided with substance H which is an organic compound. You are required to determine the nature of H. Carryout the following tests on H and record four observations and deductions in the table below. (16 marks)

TESTS	OBSERVATIONS	DEDUCTIONS
(a) Burn a small amount of H on spatula end or in a porcelain dish.	Colorless liquid burns with a yellow non-sooty flame	Aliphatic saturated compound of low Carbon content.
(b) Shake 1 cm^3 of H with about 4cm^3 of water. Test the solution with litmus paper and divide into three parts.	Soluble/miscible giving colorless solution Has no effect on both red and blue litmus.	polar compound of low molecular mass. Neutral, probably alcohol, carbonyl// ester present.
(i) To the first part of the solution, add 2-3 drops of iron(iii) chloride solution.	No purple coloration or Accept No observable change	Phenol absent.
(ii) To the second part of the solution, add 5 drops of acidified potassium dichromate (VI) solution and heat gently	No observable change or Accept Orange colour of acidified $K_2Cr_2O_7$ solution persists	Non-reducing compound probably Ketone, or tertiary alcohol
(c) To the third part of the solution, add 2,4 dinitrophenyl hydrazine solution dropwise until in excess.	Yellow precipitate	Ketone present Accept: Carbonyl present
(d) Dissolve 0.5cm^3 of H in about 1cm^3 of methanol. To the solution and 4cm^3 of iodine solution followed by sodium hydroxide dropwise until the solution becomes pale yellow.	Pale yellow precipitate	Ketone of the form $CH_3-\overset{\overset{O}{\|}}{C}-$

Heat the mixture and allow it to stand.		
(e) To 1 cm^3 of H, add an equal volume of Fehlings solution and heat the mixture.	No reddish-brown precipitate Accept or No observable change	Aldehyde absent Ketone present
(f) To 3 cm^3 of silver nitrate solution, add 2 drops of dilute sodium hydroxide. Then add ammonia solution dropwise until the precipitate just dissolves. Add 1cm^3 of H and warm	No silver mirror OR Accept No observable change	Aldehyde absent Ketone present

Comment on the nature of H.

(c) or (e) or (f)

H is an aliphatic ketone of the form

$CH_3-\overset{\overset{O}{\|}}{C}-$ ...

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