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P525/1
CHEMISTRY
PAPER 1
JUNE 2024
2 HRS 45 MINS

A-Level

S.6
PCB/SM
BCM/ICT
PCM/ICT
BCA/SM
BCG/SM & FCM

FINAL MARKS
%

Tick your subject combination

UGANDA ADVANCED CERTIFICATE OF EDUCATION
INTERNAL EXAMINATION PROGRESS –, 2024
CHEMISTRY PAPER 1

(Principal Subject) **DURATION:** 2 Hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

- ✓ This paper consists of two **sections A and B, Section A** is compulsory and attempt **only six** questions from **Section B.** *Any additional question(s) answered will **not** be marked.*
- ✓ Incorrect symbols, formulae and spellings of especially technical terms will lead to loss of marks. And **good hand writing** is **paramount** please Boys.
- ✓ The **periodic table**, with **relative atomic masses**, is attached at the end of the paper.
- ✓ Illustrate your answers with **equations where applicable**, ***Non-programmable scientific calculators may be used.***
- ✓ **Assume where necessary, use the following values.**
  - — Molar gas constant, R = 8.314 JK^{-1} mol^{-1}.
  - — Molar volume of gas at s.t.p = 22.4 litres.
  - — Standard temperature, T = 273.15 K.
  - — Standard pressure, P = 101325 Nm^{-2}.
  - — Molar volume of gas at r.t.p = 24.0 litres.

This paper consists of 06 pages. You should check the question paper to ensure that all pages are printed as indicated and no questions are missing.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	TOTAL

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SECTION A–46 MARKS
ATTEMPT ALL QUESTIONS IN THIS SECTION.

1.(a) A solution containing 1.5% of a polymer was found to have an osmotic pressure of 3.6×10^{-4} atmospheres at room temperature. Calculate the molecular mass of the polymer.

(02½ marks)

1 atm = 101,325Pa

3.6×10^{-4} atm = ?

$\therefore \frac{3.6 \times 10^{-4}\ atm \times 101,325\ Pa}{1\ atm}$

$M_r = \frac{mRT}{\Pi V} \Leftrightarrow M_r = \frac{1.5 \times 0.0821 \times 298}{\frac{760}{760} \times 3.6 \times 10^{-4} \times 100 \times 10^{-3}}$ [Since 1.5% = 1.5g in Volume of 100cm³]

$M_r = 1,019,408.3g.$ ✓

Correct conversions award ½ mk

OR

760mmHg (1atm)

$M_r = \frac{mRT}{\Pi V} \Leftrightarrow M_r = \frac{1.5 \times 8.314 \times 298}{3.6 \times 10^{-4} \times 101,325 \times 100 \times 10^{-6}}$ 02½

$M_r = 1,018,822.3g.$ ✓

Deduct ½ mk minus SI unit in the final answer.

b) Explain why in the determination of molecular mass of polymers, osmotic pressure is used instead of ebullioscopic and cryoscopic methods. (02 marks)

Polymers have high molecular masses. This therefore causes very small temperature change which is difficult to measure on Thermometer since colligative property (ies) is inversely proportional to the molar mass hence molar mass obtained will be higher than the true value. 02

S.3 Chemistry.

Time: 1:30mins

Lucas reagent [Anhydrous zinc chloride and conc. Hydrochloric acid].

A cloudy solution [White precipitate] within 5 mins with $CH_3(CH_2)_2CH(OH)CH_3$ at 25°

No cloudiness
Solution appear at room temp with $CH_3CH_2CH(OH)CH_2CH_3$

2. Name one reagent that can be used to distinguish between each of the following pairs of compounds. In each case, state what is observed if the reagent is separately treated with each member of the pair.

a) $CH_3CH_2CH_2CH(OH)CH_3$ & $CH_3CH_2CH(OH)CH_2CH_3$ (03 marks)

Reagent:

Iodine solution in sodium hydroxide solution. ✓

Reject: Accept: Iodoform test. 03

- $H^+_{(aq)}/Cr_2O_7^{2-}{}_{(aq)}$
- PCl_3 or PCl_5
- CH_3COCl.
- $H^+_{(aq)}/CrO_3{}_{(s)}$
- Na metal.

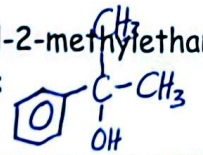
Observation (s):

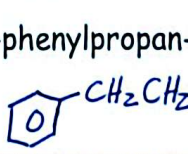
Yellow precipitate with $CH_3(CH_2)_2CH(OH)CH_3$.

No observable change with $CH_3CH_2CH(OH)CH_2CH_3$.

b) 2-phenyl-2-methylethan-2-ol & 3-phenylpropan-1-ol (03 marks)

Reagent:



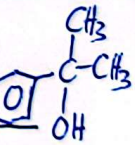


Lucas reagent [Anhydrous zinc chloride + conc. HCl acid]

Observation (s):

Accept: [White PPt] at 25°

Cloudy solution is formed within 0-5 mins with



No cloudy solution is formed at room temperature unless when heated.

3.(a) Thorium, $^{232}_{90}Th$ undergoes radioactive decay to give element, X according to the following equation below:

$$^{232}_{90}Th \longrightarrow {}^{a}_{b}X + {}^{4}_{2}\alpha$$

Calculate:

i. The atomic number of element, $^{a}_{b}X$. (01 mark)

$90 = b + 2$ ✓ $\Leftrightarrow b = 90 - 2 \Leftrightarrow b = 88$ ✓ ; 88 X.

ii. The mass number of element, $^{a}_{b}X$. (01 mark)

$232 = a + 4 \Leftrightarrow a = 232 - 4 \Leftrightarrow a = 228$, ^{228}X.

b) Element, X decays further to form element, Y as shown below in the equation:

$$X \longrightarrow {}^{a}_{b}Y + {}^{0}_{-1}\beta$$

Calculate:

i. The atomic number of element, Y. (01 mark)

$88 = b - 1 \Leftrightarrow b = 88 + 1 \Leftrightarrow b = 89$, ^{89}Y.

ii. The mass number of element, Y. (01 mark)

$228 = a + 0 \Leftrightarrow a = 228 - 0 \Leftrightarrow a = 228$, ^{228}Y

c) A radioactive isotope of element, X had an initial activity of **250 counts per second** on a Geiger counter. After **40 minutes**, the activity had declined to **240 counts per second**. Calculate the **half-life** of element, X. (03 marks)

Data:

Initial activity, $A_0 = 250$ counts/s.

Final activity, $A_t = 240$ counts/s.

Time taken to declined = 40 mins.

$$\ln\left[\frac{A_0}{A_t}\right] = \lambda t \Leftrightarrow \ln\left[\frac{250}{240}\right] = \lambda \times 40 \Leftrightarrow \lambda = 1.021 \times 10^{-3}$$

$$t_{\frac{1}{2}} = \frac{\ln 2}{\lambda} \Rightarrow t_{\frac{1}{2}} = \frac{\ln 2}{1.020549863 \times 10^{-3}} \Leftrightarrow t_{\frac{1}{2}} = 679.2 \text{ mins}.$$

[Deduct ½ mk minus S.I Unit in it's final answer]

4.(a) Define the term hydration energy. (01 mark)

Hydration energy is the heat evolved when one mole of gaseous ions dissolves in water to form an infinitely dilute solution.

OR [insist on 1 mole or given out]

Solvation energy is the enthalpy change when one mole of a gaseous ions is surrounded by water molecules to form an infinite dilute solution.

b) State two factors which affect the magnitude of hydration energy. (03 marks)

Ionic radius ✓

Ionic charge ✓ or Charge on the ion

01

c) The table below shows enthalpies of hydration of Ca^{2+} & Cl^- ions.

Ions	Enthalpy of hydration [kJ/mol
Ca^{2+}	1,577
Cl^-	381

i. State whether the values of enthalpies of hydration of Ca^{2+} & Cl^- given in the table above are positive or negative. Give a reason for your answer. (01½ marks)

The values of hydration given are negatives ✓; Bise heat is released ✓ or given out ✓ when gaseous ions are surrounded by water molecules. 01½

ii. Calculate the enthalpy of hydration of calcium chloride. (01½ marks)

Hydration energy of $CaCl_2$, $\Delta H_h = \Delta H_{h\,Ca^{2+}} + 2\Delta H_{h\,Cl^-}$ ✓

$= -1,577 + 2(-381)$ ✓

$= -1,577 - 762$

$= -2,339\ kJ/mol$ ✓

[Reject: ⁻ or -, kJ/mol]

5. The table below shows the first ionization energies and melting points of some group (II) elements of the periodic table. Use the information in it to answer the followings questions.

Elements	Mg	Ca	Sr	Ba
1st Ionization energy [kJ/mol]	738	590	549	505
Melting points [°C]	649	839	769	729

Briefly explain the variation in trends of:

a) First ionization energy. (02½ marks)

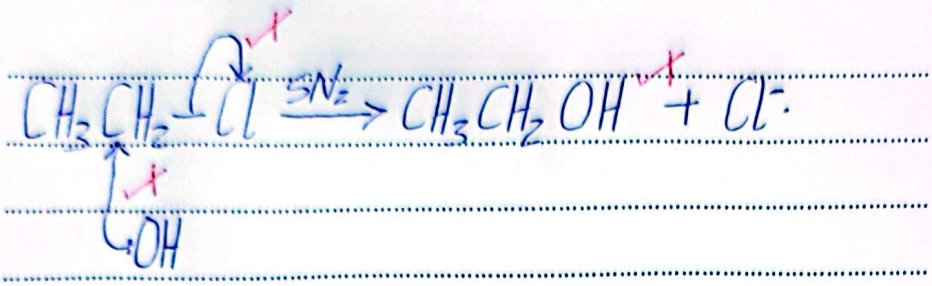
Ionization energy decreases from magnesium to barium due to increases in nuclear charge and shielding effect because an extra shells are completely filled with electrons added as increase in screening effect outweighs that of nuclear charge. Effective nuclear charge decreases as atomic radius increases hence outermost electrons are far away and weakly attracted by the nucleus/is atom requiring low amount of energy to detached/removed the most loosely held electron

b) Melting points. (02½ marks)

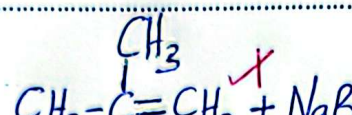
Melting points increases from magnesium to calcium then reduces to barium. From magnesium to barium, their atomic radius and bond length increases as bond strength reduces hence decreasing the amount of energy needed to break the metallic bonds. Magnesium bear lower melting point than calcium because magnesium has hexagonal close-packed structure as calcium centered-cubic or open packed structure.

6. Complete the following equations and write a mechanism for the reaction in each case.

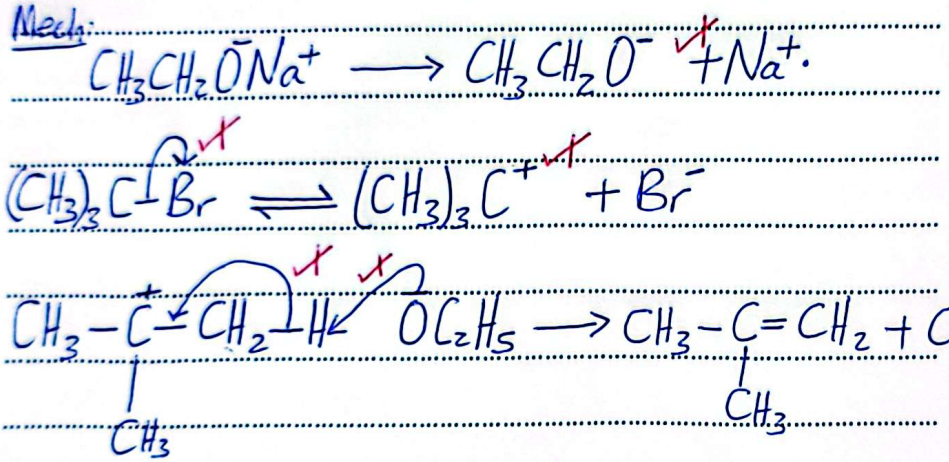
a) $CH_3CH_2Cl + OH^- \xrightarrow{Heat}$ $CH_3CH_2OH + Cl^-$ (02 marks)



02

b) $(CH_3)_3C\text{-}Br \xrightarrow[\text{Ethanol/Heat}]{CH_3CH_2ONa^+}$  (03 marks)

Mech:



03

7.(a) State what would be observed and write equation for the reaction that would take place when:

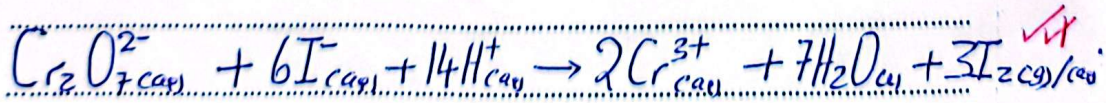
i. Potassium iodide was added to acidified potassium dichromate solution. (02½ marks)

Observation (s):

Orange solution turns to green solution and a brown solution is evolved.

02½

Equation:



ii. Sodium thiosulphate was added to the mixture in a (i) above.

(02½ marks)

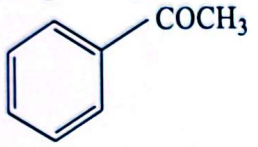
Observation (s):

Brown solution turns to colourless solution. 02½

Equation:

$2S_2O_{3(aq)}^{2-} + I_{2(aq)} \longrightarrow S_4O_{6(aq)}^{2-} + 2I_{(aq)}^{-}$

8. Name the reagent(s) and condition(s) that can be used to effect the following changes.



from

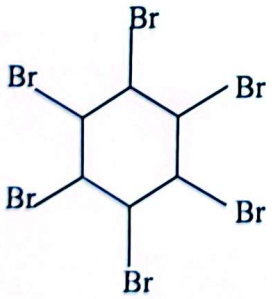
a) (01 mark)

Reagent (s): Ethanoyl bromide or chloride. 01

Accept: Acid anhydride i.e. $CH_3COO-\overset{O}{\overset{\|}{C}}-CH_3$

Condition (s): Anhydrous aluminium (III) bromide / Iron (III) bromide catalyst refluxed on a water bath at a temperature of 50°C.

Anhydrous Iron (III) Chloride catalyst at a temperature of 50°C.



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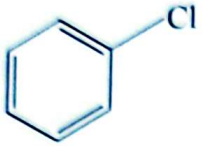
b) (01 mark)

Reagent (s): Bromine gas.

Condition(s): Presence of ultra-light ✓ OR
Direct sunlight ✓

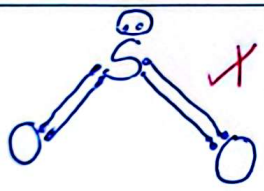
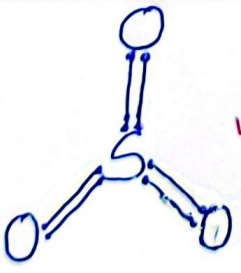
c)  from  (01 mark)

Reagent (s): Chlorine gas ✓ 01

Condition (s): Anhydrous iron (III) chloride ✓ catalyst at room temperature. Accept: Iron in present of heat

9.(a) Draw the structures and name the shape of the following oxides. In each case state the oxidation state of sulphur atom.

(03 marks)

Oxide (s)	Structure	Shape	Oxidation state of sulphur
SO_2	 ✓	V-shape OR ✓ Bent shape Reject: shaped	+4 ✓ Reject: 4 +4 or + 4
SO_3	 ✓	Trigonal Planar ✓ shape	+6 ✓ Reject: 6 +6 or +6.

03

b)(i) Name the reagent that can be used to distinguish the oxides in (a). (01 mark)

Accept: Acidified potassium dichromate (VI) solution ✓ 01
Acidified potassium permanganate solution ✓

ii. State what would be observed if each oxide is separately treated with the reagent you have named in b (i) above. (01 mark)

Purple solution turns colourless with SO_2. ✗
No observable change occurs with SO_2. ✗ 01
Accept: Orange solution turns green solution with SO_2. ✗
No observable change occurs with SO_3. ✗

iii. Write equation(s) for the reaction(s) that would take place when each oxide is separately treated with reagent you have named b (i). (01½ marks)

$2MnO_{4(aq)}^{-} + 6H_2O_{(l)} + 5SO_{2(g)} \longrightarrow 2Mn_{(aq)}^{2+} + 5SO_{4(aq)}^{2-} + 4H_{(aq)}^{+}$ ✓✗ 01½

OR

$Cr_2O_{7(aq)}^{2-} + 2H_{(aq)}^{+} + 3SO_{2(g)} \longrightarrow 2Cr_{(aq)}^{3+} + 3SO_{4(aq)}^{2-} + H_2O_{(l)}$ ✓✗

SECTION B-54 MARKS

ATTEMPT ANY SIX QUESTIONS IN THIS SECTION.

10.(a) Write an equation of reaction between water and the oxides of: (@01½ marks)

i. Sodium.

$Na_2O_{(s)} + H_2O_{(l)} \longrightarrow 2NaOH_{(aq)}$ ✓✗

Award ANY correct. $Na_2O_{2(s)} + 2H_2O_{(l)} \longrightarrow 4NaOH_{(aq)} + O_{2(g)}$ ✓✗ 03

ii. Magnesium.

$MgO_{(s)} + H_2O_{(l)} \rightleftharpoons Mg(OH)_{2(aq)}$ ✓✗

$P_4O_{10(s)} + 6H_2O_{(l)} \rightarrow 4H_3PO_{4(aq)}$ ✓✓

OR

$P_2O_{5(s)} + 3H_2O_{(l)} \rightarrow 2H_3PO_{4(aq)}$ ✓✓

iii. Phosphorous. $P_4O_{6(s)} + 6H_2O_{(l)} \xrightarrow{\text{cold}} 4H_3PO_{3(aq)}$ ✓✓

$P_4O_{6(s)} + 6H_2O_{(l)} \xrightarrow{\Delta} 3H_3PO_{4(aq)} + PH_{3(g)}$ ✓✓

b) Write equation for the reaction between concentrated sulphuric acid and: (@01½ marks)

i. Magnesium.

$Mg_{(s)} + 2H_2SO_{4(l)} \longrightarrow MgSO_{4(aq)} + 2H_2O_{(l)} + SO_{2(g)}$ ✓✓

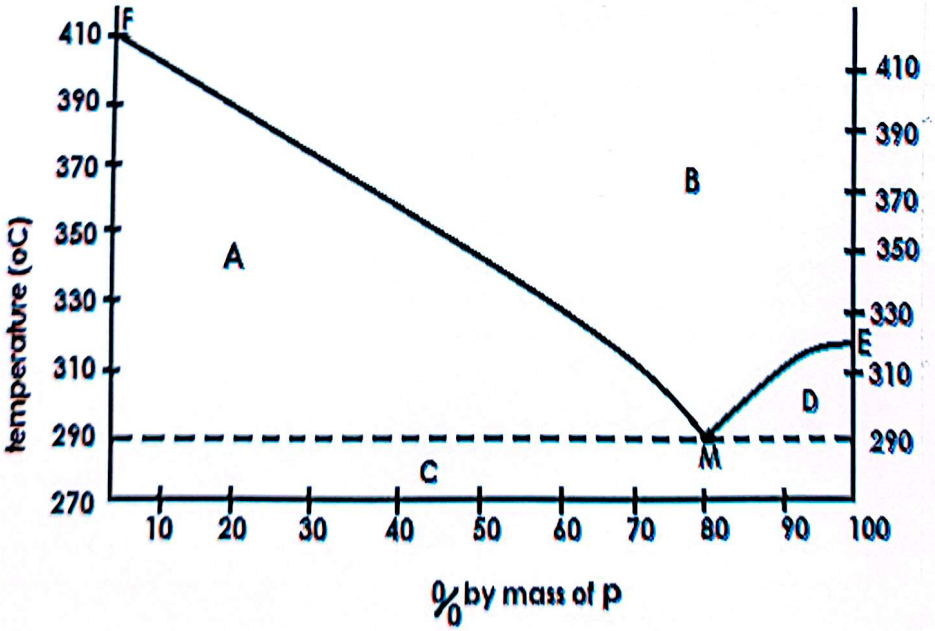
ii. Hydrogen bromide.

$2HBr_{(g)} + H_2SO_{4(l)} \rightarrow 2H_2O_{(l)} + Br_{2(g)} + SO_{2(g)}$ ✓✓

iii. Phosphorous.

$P_{4(s)} + 10H_2SO_{4(l)} \rightarrow P_4O_{10(s)} + 10H_2O_{(l)} + 10SO_{2(g)}$ ✓✓

11. The phase diagram for a mixture of metals P & Q is shown below.



a) Identify the regions A, B, C & D. (02 marks)

A: Solid P and liquid. ✓

B: Liquid mixture or Solution. ✓

C: Solid P and solid Q. or Solid mixture. ✓

D: Solid Q and liquid. ✓

02

b) State what point M represent. (01 mark)

Eutectic mixture.

c) Using the diagram, estimate the melting point of: (01 mark)

P: 410°C ± 2°C. ✓

Q: 325°C ± 2°C. ✓

01

d) Describe what would happen if a mixture containing **50%** by mass of P and Q is cooled from **410°C** to **270°C**. (03 marks)

The mixture cools to 270°C without change in phase. At 270°C, Metal P begins to solidify [crystallise] as the composition of pure metal Q increases in the Liquid mixture. The freezing-point decreases up to eutectic point temperature as further cooling is done.

At the eutectic point; the temperature and composition remains constant until the whole system crystalises or solidify hence the mixture cools with no change in phase up to 270°C.

03

e) State one each difference and similarity between the substance at point M and a pure compound. (@01 mark)

i. Difference:

Eutectic mixtures are heterogenous while compounds are homogenous mixtures. ✓ 01

Eutectic mixtures composition varies with pressure while compounds composition doesn't varies with pressure ✓

Eutectic mixtures separated by physical means. ✓

ii. Similarity:

Have constant compositions at constant pressure. ✓

Have cooling curves like pure metals. ✓ 01

Have sharp melting point at constant pressure. ✓

12.(a) Define the term enthalpy of solution. (01 mark)

Enthalpy of solution is the enthalpy change that takes place when one mole of a solute dissolves in a specific amount of water until there is no further heat change. ✓ 01

b) In an experiment to determine the enthalpy of solution of anhydrous and hydrated copper (II) sulphate salts, **4.0g** of anhydrous salt was added to **50g** of water and temperature of water rose by **8.0°C**. When **4.0g** of the hydrated salt [$CuSO_4.5H_2O$] was added to **50g** of water, the temperature of water dropped by **1.3°C**. Calculate the enthalpy of solution in **kJ/mol** of: [Specific heat capacity of solution = **4.2J/g/°C**]

i. Anhydrous copper (II) sulphate. (02½ marks)

Heat evolved = mass of solution x S.H.C x ΔT.
= 54 x 4.2 x 8 ✓ ≈ 1,814.4J. ✓

R.F.M of $CuSO_4$ = 64(1) + 32(1) + 16(4) ≈ 160. ✓
No of $CuSO_4$ = 4/160 ≈ 0.025. ✓ 02½

0.025 mole of $CuSO_4$ produce 1,814.4J.
1 mole " " " 1,814.4J/0.025 moles
= -72,576J/mol. ✓

Molar enthalpy of solution = -72.576KJ/mol. ✓

ii. Hydrate copper (II) sulphate. (02 marks)

Heat evolved = mass of solution x S.H.C x ΔT
= 54 x 4.2 x 1.3 ✓ ≈ 294.84J. ✓

R.F.M of $CuSO_4.5H_2O$ ≈ 64 + 32 + 16(4) + 5(18) ≈ 250. ✓
No of mole of $CuSO_4.5H_2O$ = 4/250 ≈ 0.016. ✓ 02

0.016 mole of $CuSO_4.5H_2O$ liberate 294.84J.
1 " " " " 294.845/0.016 mole
Molar enthalpy of solution = +18.4275KJ/mol. ✓ = +18427.5J/ ✓

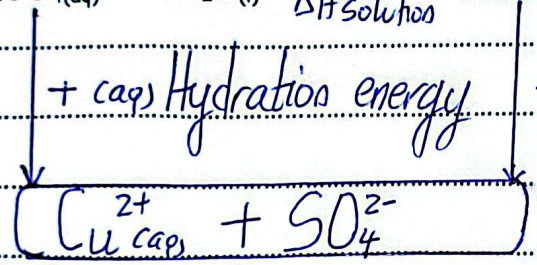
iii. Comment on the difference in values of enthalpy of solution calculated in (b) above. (02 marks)

Anhydrous copper (II) sulphate is more ✓ soluble in water than hydrated copper (II) sulphate.

This is because enthalpy of solution of anhydrous copper (II) sulphate is exothermic [-ve] implying that hydration energy outweighs Lattice energy hence the reaction releases enough amount of energy to separate the ions in the salt. 02

c) Calculate the enthalpy change for the reaction:

$CuSO_{4(aq)} + 5H_2O_{(l)} \xrightarrow{\Delta H_{solution}} CuSO_4.5H_2O_{(l)}$



02

Mathematically:

ΔH solution of $CuSO_4$ = Hydration energy of $CuSO_4$ + ΔH solution of $CuSO_4.5H_2O$.

-72.576 = Enthalpy of hydration $+18.4275$

Enthalpy of hydration of $CuSO_4$ = -91.0035 kJ/mol.

13. Nitrogen and hydrogen react to form ammonia according to equation below: $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ $\Delta H = -92$kJ/mol

a) State the industrial conditions used to obtain a maximum yield of ammonia gas. (01½ marks)

Temperature of about 450–550°c.

Pressure range of 200–500 atms.

Finely divided iron catalyst.

01½

b) During the manufacture of nitric acid, ammonia is catalytically oxidized to P which is further oxidized to Q. Q is then reacted with water to produce nitric acid.

i. Name P and Q. (@0½ mark)

P = Nitrogen monoxide. ✓½

Q = Nitrogen dioxide. ✓½ 01

ii. Write equations for the formation of: (@01½ marks)

P:

$4NH_{3(g)} + 5O_{2(g)} \underset{850°C}{\overset{Pt\text{-}Cat}{\rightleftharpoons}} 4NO_{(g)} + 6H_2O_{(g)}$ ✓½

Q:

$2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$ ✓½ 04½

Nitric acid: OR: $3NO_{2(g)} + H_2O_{(l)} \rightarrow 2HNO_{3(aq)} + NO_{(g)}$ ✓½

$4NO_{2(g)} + 2H_2O_{(l)} + O_{2(g)} \longrightarrow 4HNO_{3(aq)}$ ✓½

c) Write equations for the reaction of concentrated nitric acid and: (@01½ marks)

i. Carbon.

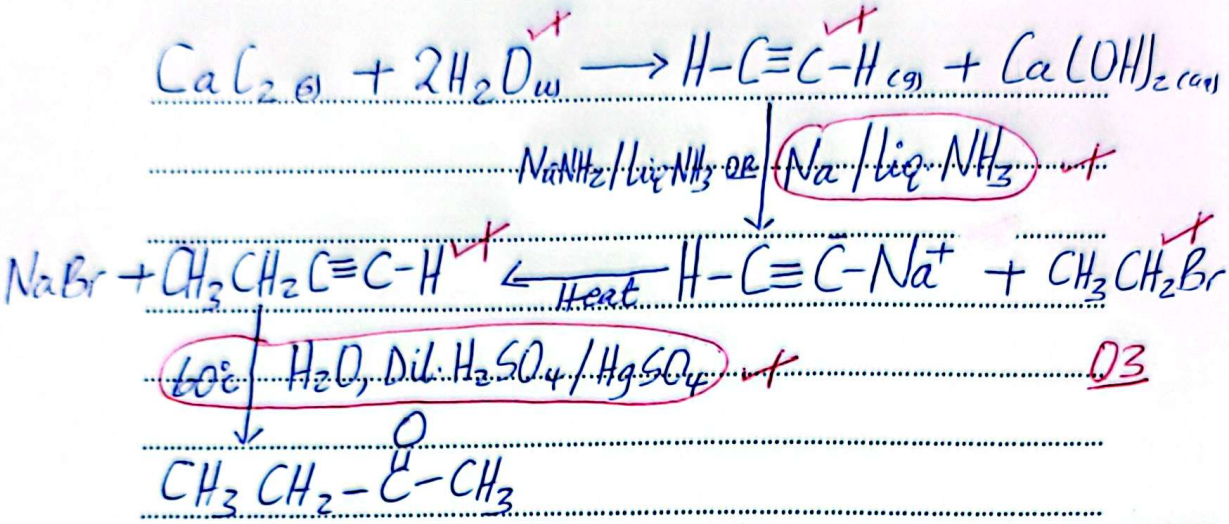
$C_{(s)} + 4HNO_{3(aq)} \longrightarrow 2H_2O_{(l)} + 4NO_{2(g)} + CO_{2(g)}$ ✓½

ii. Copper. 03

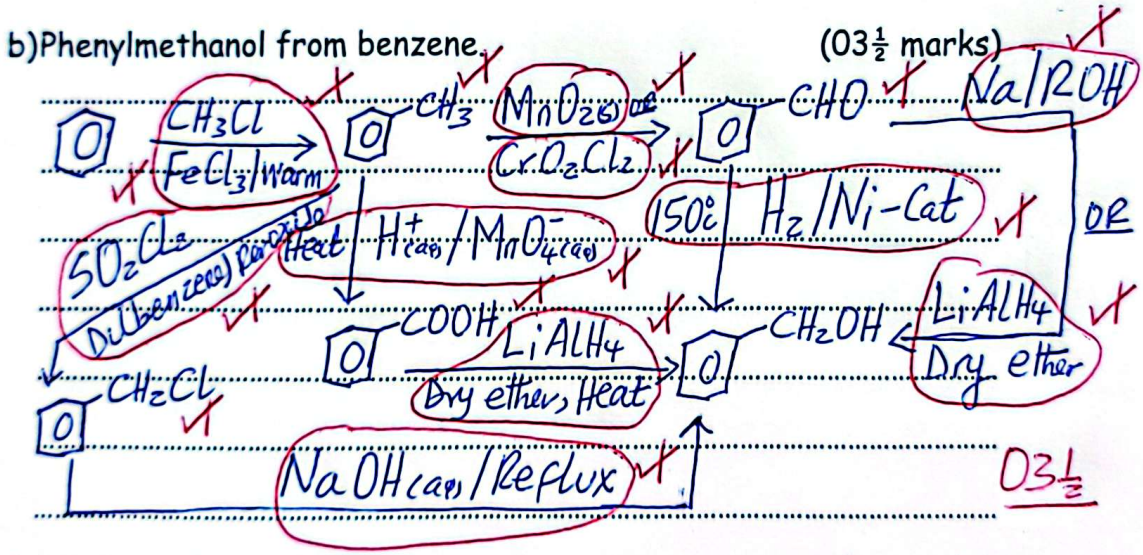
$Cu_{(s)} + 4HNO_{3(aq)} \longrightarrow Cu(NO_3)_{2(aq)} + 2H_2O_{(l)} + 2NO_{2(g)}$ ✓½

14. Write equations to show how the following compounds can be synthesized.

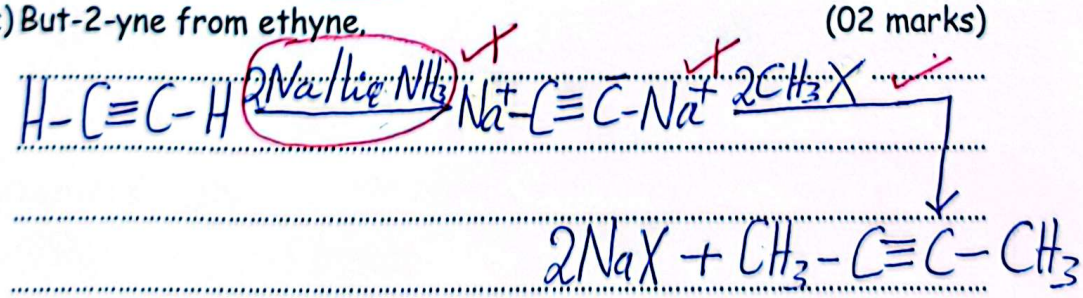
a) Butanone from calcium carbide. (03½ marks)



b) Phenylmethanol from benzene. (03½ marks)



c) But-2-yne from ethyne. (02 marks)



15.(a) The saturated vapour pressures of liquids A & B which form an ideal solution at 20°C are 15kN/m² and 35kN/m² respectively. If the total pressure above the solution is 29kN/m², Calculate the:

i. Mole fraction of A in the liquid mixture. (02 marks)

$P_T = P_A + P_B$; But $P_A = X_A P_A^o$, $P_B = X_B P_B^o$

$\therefore$

$P_T = X_A P_A^o + X_B P_B^o$ ✓ ; Also: $X_A + X_B = 1$

Hence: $X_B = 1 - X_A$ ✓

$P_T = X_A P_A^o + (1 - X_A) P_B^o \Leftrightarrow 29 = X_A(15) + (1 - X_A)35$ ✓

$29 = 15X_A - 35X_A + 35 \Leftrightarrow 29 - 35 = [15 - 35]X_A$ 02

Mole fraction of A, $X_A = 0.3$ ✓

ii. Composition of the vapour above the liquid mixture of A and B. (02 marks)

$P_A = X_A P_A^o \Leftrightarrow P_A = 0.3(15) \Leftrightarrow P_A = 4.5 kN/m^2$ ✓

$P_B = (1 - X_A)P_B^o \Leftrightarrow P_B = (1 - 0.3)35 \Leftrightarrow P_B = 24.5 kN/m^2$ ✓

02

Vapour composition of A $= 4.5/29 \simeq 0.155$ ✓

Vapour composition of B $= 24.5/29 \simeq 0.845$ ✓

b) The boiling point-composition diagram for a mixture of hydrochloric acid and water is shown below:
(Diagram needed)

i. State how the mixture deviates from Raoult's law. Give a reason for your answer. (02 marks)

Negatively. Because at maximum point, it shows that liquid boils off giving a vapour of the same composition as a pure liquid known as Azeotrope. 02

ii. Explain the causes of the deviation you have stated in b (i) above. (03 marks)

The Hydrochloric acid ionises in water producing hydrogen, H^+ and chloride, Cl^- ions. The forces of attraction between ions and water molecules are stronger than individual water and HCl acid molecules since ions are hydrated with strong ion-dipole attraction hence reduces the escaping tendency of molecules into vapour state. 03

16.(a) An organic compound, P has a molecular formula C_4H_9Br.

i. Name the functional group in organic compound, P. (01 mark)

Carbon-bromine bond. 01

ii. Write the structural formulae and names of all possible isomers of organic compound, P. (04 marks)

$CH_3CH_2CH_2CH_2Br$; 1-bromobutane.

$CH_3CH_2CH(Br)CH_3$; 2-bromobutane.

$CH_3-\underset{\underset{Br}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3$; 2-bromo-2-methylpropane. 04

$CH_3\,\underset{\underset{CH_3}{|}}{CH}\,CH_2Br$; 1-bromo-2-methylpropane

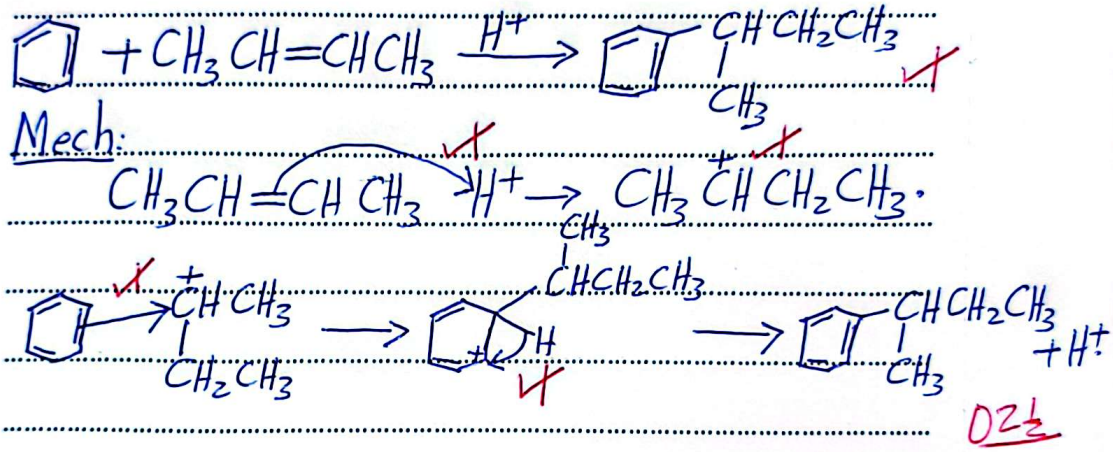
iii. Identify two isomers in a (ii) that when reacted with hot ethanolic potassium hydroxide solution give the same product. (01 mark)

$CH_3CH_2CH_2CH_2Br$, $CH_3CH(CH_3)CH_2Br$, $CH_3CH_2CH(Br)CH_3$. 01

iv. Write the structural formula and name of the product in a (iii). (01 mark)

$CH_3CH=CHCH_3$; But-2-ene. 01

b) Outline the mechanism for the reaction between the product in a (iii) and benzene in presence of an acid. (02 marks)



02½

17. The table below shows values for the atomic and ionic radii of the alkali metals.

Element	Atomic radius [x 10^{-10}m]	Ionic radius [x 10^{-10}m]
Lithium	1.23	0.68
Sodium	1.57	0.97
Potassium	2.03	1.33
Rubidium	2.16	1.47
Caesium	2.35	1.67

a) In every case, the radius of an ion is smaller than that of the corresponding atom. Explain. (02 marks)

The ions are formed by loosing electrons; when electrons are lost; Protons numbers becomes greater than the remaining few electrons as screening effect reduces resulting to an increase in effective nuclear charge hence the remaining few electrons become more strongly attracted by the nucleus than repelled. 02½

b) Explain the increase in atomic radius along the series lithium to Caesium. (02 marks)

Atomic radius increases from Lithium to Caesium due to increase in both nuclear charge and shielding effect; however, the increase in screening effect outweighs that of nuclear charge since an extra-orbital completely filled with electrons are added as effective nuclear charge decreases and outermost electrons are far and weakly attracted by the nucleus ato 02½

c) The ions Na^+, Mg^{2+} & Al^{3+} have the same electronic configuration, yet they have different ionic radii. Suggest a reason for this. (02 marks)

The ions are formed by loosing electrons; reducing the screening effect as protons numbers remains uneffected; hence effective nuclear charge increases in the order of charge Na^+; Mg^{2+} and Al^{3+} since protons numbers increases in the order as ionic radius decreases of $Na^+ > Mg^{2+} > Al^{3+}$. 02

d) Which of the alkali metal ions in the gaseous state is likely to have the highest hydration energy? Give a reason. (03 marks)

Aluminium Al^{3+} ion because it has smaller ionic radius with high charge hence high charge density and polarising power. Therefore it attract water molecules strongly to become more hydrated with more amount of energy. 03

THE PERIODIC TABLE

1	2											3	4	5	6	7	8
1.0 H 1																1.0 H 1	4.0 He 2
6.9 Li 3	9.0 Be 4											10.8 B 5	12.0 C 6	14.0 N 7	16.0 O 8	19.0 F 9	20.2 Ne 10
23.0 Na 11	24.3 Mg 12											27.0 Al 13	28.1 Si 14	31.0 P 15	32.1 S 16	35.4 Cl 17	40.0 Ar 18
39.1 K 19	40.1 Ca 20	45.0 Sc 21	47.9 Ti 22	50.9 V 23	52.0 Cr 24	54.9 Mn 25	55.8 Fe 26	58.9 Co 27	58.7 Ni 28	63.5 Cu 29	65.7 Zn 30	69.7 Ga 31	72.6 Ge 32	74.9 As 33	79.0 Se 34	79.9 Br 35	83.8 Kr 36
85.5 Rb 37	87.6 Sr 38	88.9 Y 39	91.2 Zr 40	92.9 Nb 41	95.9 Mo 42	98.9 Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56	139 La 57	178 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	204 Tl 81	207 Pb 82	209 Bi 83	209 Po 84	210 At 85	222 Rn 86
223 Fr 87	226 Ra 88	227 Ac 89															

		139 La 57	140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
		227 Ac 89	232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	254 Es 99	257 Fm 100	256 Md 101	254 No 102	260 Lw 103

♥ ===END===

WELCOME TO SENIOR SIX, YEAR 2023

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