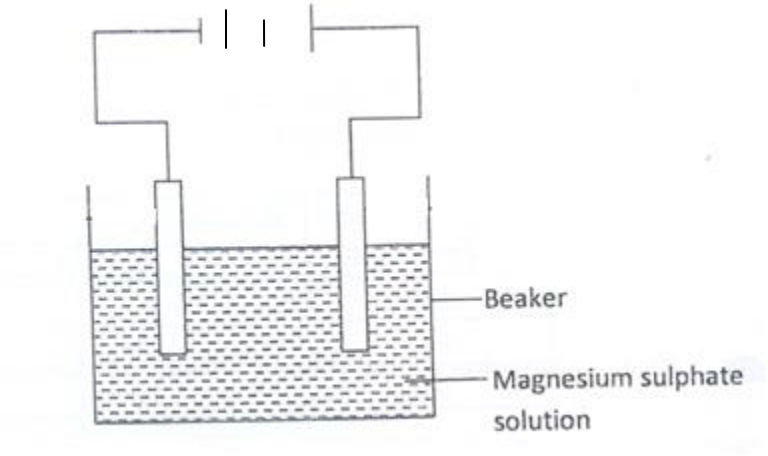
FORM 4 CLUSTER CHEMISTRY PP2 MARKING SCHEME

1. (a) Define an electrolyte. **(1mark)**

An electrolyte is a substance which when molten or dissolved in water conducts an electric current and gets decomposed by the current.✓1

(b)The set-up below was used to carry out electrolysis of an aqueous solution of magnesiumsulphate using carbon electrodes.



i) State and explain the observation made at the cathode. **(2 marks)**

Bubbles of a colourless gas✓*1 due to formation of hydrogen gas* ✓ ½ when H^+ (aq) *ions are discharged.* ✓½

(ii) Write down an equation for the reaction that occurs at the anode. **(1mark)**

$4OH^-(aq) \longrightarrow 2H_2O(l) + O_{2(g)} + 4e^-$ ✓1

(iii)What change occurred to the concentration of magnesium sulphate solution during the experiment? Explain. **(3 marks)**

Concentration of magnesium sulphate increased✓*1because amount of water decreased* ✓*1 as water is decomposed to hydrogen and oxygen gases.* ✓*1which escape.//OH -and* H^+ *are discharged.*

(c)During the electrolysis of dilute copper (II) chloride, the mass of the platinum cathode increased by 3.2g. If a current of 2.5 amperes was passed through the solution for some time, calculate the time taken. (Cu= 64.0; 1 faraday = 96,500 Coulombs) **(3 marks)**

$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$ ✓½

64g of Cu ⟶ *2×96500 Coulombs*

3.2g of Cu ⟶ = (3.2×96500)/64 ✓½ =9650 Coulombs ✓½

Q=It; 9650=2.5×t ✓½; t=9650/2.5 ✓½*: t=3860 seconds* ✓½*; accept 64.33 min*

d) Use the information below to answer the question that follows.

$Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s)$ E^θ =- 1.66v

$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$ E^θ = - 0.44v

Why is it not advisable to keep a solution of iron (II) nitrate in a container made of aluminium? **(2 marks)**

$E^\theta_{cell} = E^\theta_{reduced} - E^\theta_{oxidized}$

= -0.44-(-1.66) ✓½

=+1.22 V ✓½*; hence a reaction occurs between aluminium and the solution* ✓***1***

(e)Other than electroplating, give one application of electrolysis. **(1 mark)**

-Extraction of more reactive metals e.g sodium, aluminium from their molten ores.

- Purification of copper.

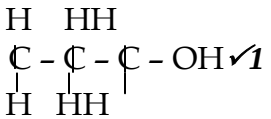
- Manufacture of sodium hydroxide from brine.

*- Manufacture of chlorine from brine. (**Any one = ✓1)***

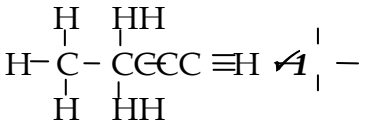
TOTAL = 13 MARKS

2. a) Draw the structural formula of :**(3 marks)**

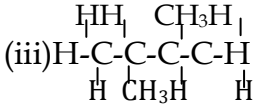
(i) Propan-1-ol



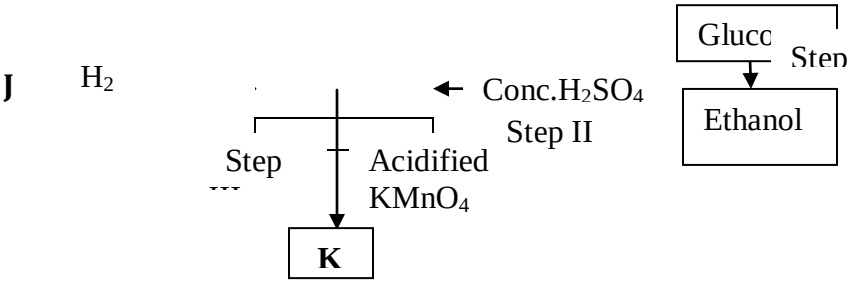
(i) Pent-2-yne



(ii) 2,3-dimethylbutane



(b)Study the reaction scheme below and answer the questions that follow.



(i) Name the process in step I **(1 mark)**

Fermentation ✓1

(ii) Give the two conditions necessary in step II **(2 marks)**

Excess concentrated sulphuric (VI) acid ✓1

Temperature: 160^{o}C-180^{o}C ✓1 (any value in range)

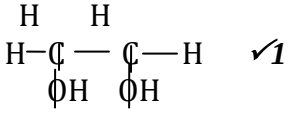
(iii) State the observation made in step III. **(1 mark)**

Colour of acidified potassium manganate (VII) changes from <u>purple</u> to <u>colourless</u> ✓1

(iii) Name compound J. **(1 mark)**

Ethane ✓1

(iv) Draw the structural formula of compound K. **(1 mark)**


✓1

(c) Water is added dropwise to calcium carbide in a conical flask.

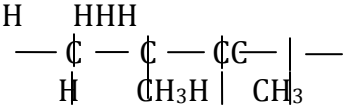
(i)Identify the gas produced. **(1 mark)**

Ethyne ✓1

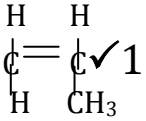
(ii)Write a chemical equation for the reaction that occurs. **(1 mark)**

$$CaC_2(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + C_2H_2(g)$$ ✓1

(d)Part of a polymer is required below.



(i) Draw the structural formula of the monomer of this polymer. **(1 mark)**


✓1

(ii) State one use of this polymer. **(1 mark)**

To make;

Plastic crates and boxes, carpets and plastic bottles. (Any one = ✓1)

TOTAL= 13 MARKS

3. The grid below represents part of the periodic table. Study it and answer the questions that follow. The letters are not the actual symbols of the elements.

Y	R					Q	X		
	V		W			J ✓1		U	

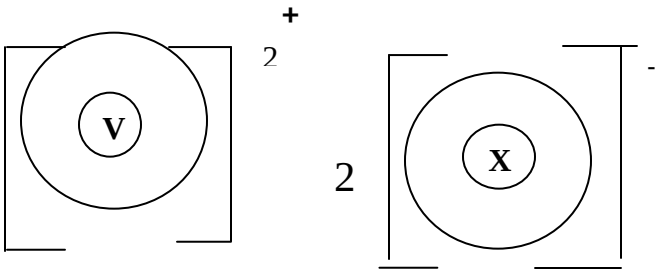
(a)Select an element whose oxide is amphoteric.**(1 mark)**

W ✓1

(b)On the grid indicate with letter J the position of element J which is in period 3 and forms a stable ion J^{2-}. **(1 mark)**

(See diagram)

(c)Draw a dot-cross diagram to show bonding in the compound consisting of elements V and X only. **(2 marks)**



✓2

(d)Write an equation to show the formation of an ion by R. **(1 mark)**

$R \longrightarrow R^{2+} + 2e^-$ ✓1

(e)Which is the least reactive element? Give a reason for your answer. **(2 marks)**

U✓1;

It has a completely filled outermost energy level✓***1 therefore neither gains nor loseselectrons//OR has stable electron arrangement.***

(f)Write an equation for the reaction that occurs when element Y is placed in water. **(1 mark)**

$2Y_{(s)} + 2H_2O\ (l) \longrightarrow 2YOH\ (aq) + H_2\ (g)$ ✓***1***

(g)How does the atomic radius of W compare with that of V? Explain. **(2 marks)**

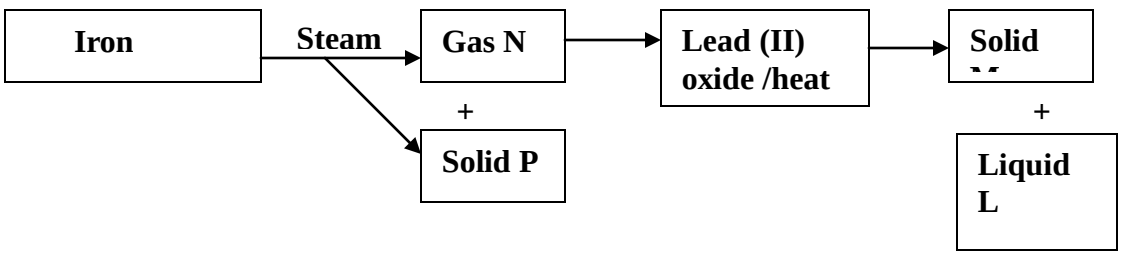
Atomic radius of W is smaller than that of V. ✓***1This is because nuclear charge attraction in W is stronger than in V*** ✓***½while both have same number of occupied energy levels***✓***½***

(h)Name the chemical family to which elements R and V belong. **(1 mark)**

Alkaline earth metals✓***1***

TOTAL= 11MARKS

4. a) Use the chart below to answer the questions that follow.



Identify:

Gas **N** ***Hydrogen //H_2***(g) ✓½ **(½ mark)**

Solid **P*Tri-iron tetraoxide //*** ***Fe_3O_4***(s) ✓½ **(½ mark)**

Solid **M*Lead*** // ***Pb***(s) ✓½ **(½ mark)**

Liquid **L*Water //H_2O*** ✓½ **(½ mark)**

b) Name the method that can be used to extract oil from castor oil seeds. **(1 mark)**

Solvent extraction ✓1

c) i) In the method named above, state the property of oil that enables the extraction to take place. **(1 mark**)

Oil dissolves in an organic solvent ✓1

ii) Describe an experimental procedure that can be used to obtain oil from the seeds.**(3 marks)**

Crush ✓½***the seeds in a mortar using a pestle*** ✓½***.Continue crushing and addpropanone a little at a time*** ✓½***.Decant*** ✓½**the mixture into an evaporating dish. Leave the mixture of oil and propanone in the sunlight for propanone to evaporate leaving the oil behind** ✓1

d) How is phosphorus stored in the laboratory? Explain your answer. **(1 mark)**

Under water ✓½ ***it smoulders when left in the air.*** ✓½

e) i) In the fractional distillation of liquid air some substances must be removed, name two substances removed.

(1 mark)

Dust particles, Carbon (IV) oxide,water vapour (**any two=** ✓**1)**

ii) Why must the substances named in (i) above be removed? **(1 mark)**

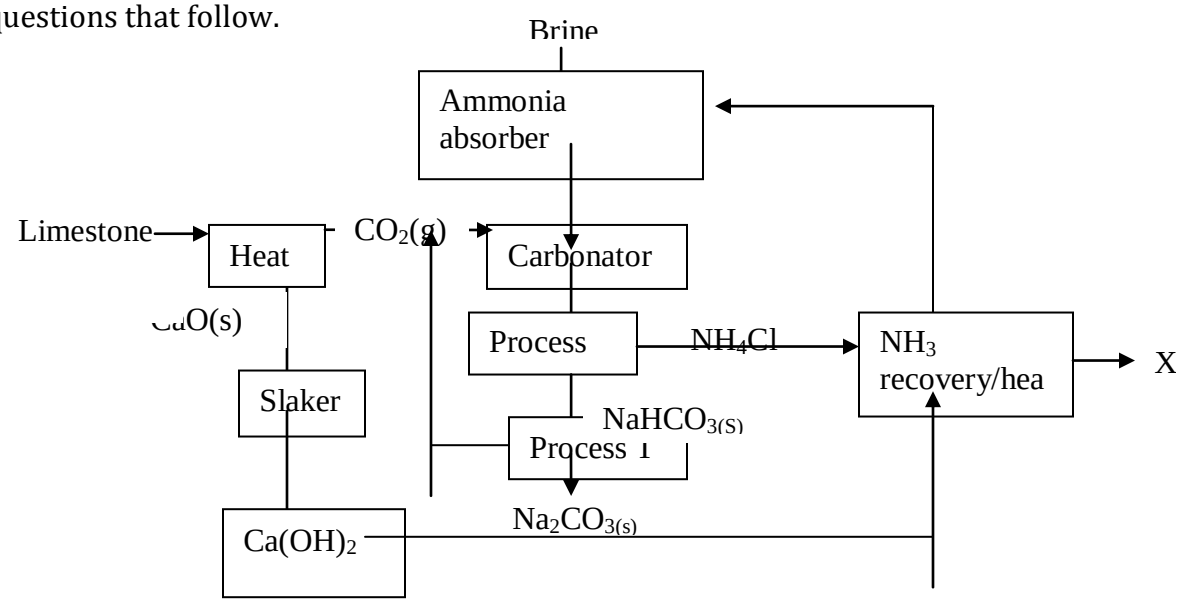
To prevent blocking the pipes in the rest of the system ✓1

iii) State the processes involved in fractional distillation of liquid air. **(2 marks)**

Removal of dust particles by passing through filters or by electrostatic pptn ✓½,***removal of carbon (IV)oxide by passing the remaining gases through conc.sodium hydroxide*** ✓½,***cooling the remaining part of air to -25^{o}C to remove water vapour,repeated compression and expansion to cool the air to liquid at -200^{o}C*** ✓½,***boiling the liquid mixture in a fractionating column to obtain the fractions.*** ✓½

TOTAL =12 MARKS

5. Study the flow chart below showing the Solvay process and use it to answer the questions that follow.



a) Write the equation for the reaction producing substance X. **(1 mark)**

$NH_4Cl(aq) + Ca(OH)_2\ (aq)$ – heat ***$\rightarrow CaCl_{2(s)} + 2NH_3(g) + 2H_2O(g)/(l)$*** ✓**1**

b) Name processes Y and T. **(1 mark)**

Y ***Filtration*** ✓½

T ***Heating/Thermal decomposition*** ✓½

c) In the carbonator, two reactions take place. Write the two equations for the reactions. **(2 marks)**

$NH_3(g) + CO_2(g) + H_2O(l) \longrightarrow NH_4HCO_{3\ (s)}$ ✓***1***

$NH_4HCO_3(s) + NaCl(aq) \longrightarrow NH4Cl(aq) + NaHCO_3(s)$ ✓1

d) Explain why the Solvay process is said to be one of the most efficient industrial process.
(1 mark)

Ammonia and carbon (IV) oxide are <u>recycled</u> ✓½ ***thus <u>minimizing cost</u>*** ✓½

e) 16.8g of sodium hydrogen carbonate are completely decomposed by heating. Calculate;

$2NaHCO_3(s) \xrightarrow{\text{heat}} Na_2CO_{3(s)} + CO_2(g) + H_2O(l)$ ✓1

168g of $NaHCO_3$ yield106 g of Na_2CO_3

16.8 g would yield (16.8/168) ×106 ✓½=10.6 g of Na_2CO_3 ✓½

ii) the volume in litres of the gas produced at s.t.p **(2 marks)** (Molar Gas Volume at s.t.p =22400 cm^3, Na=23.0, C=12.0, H= 1.0, O=16.0)

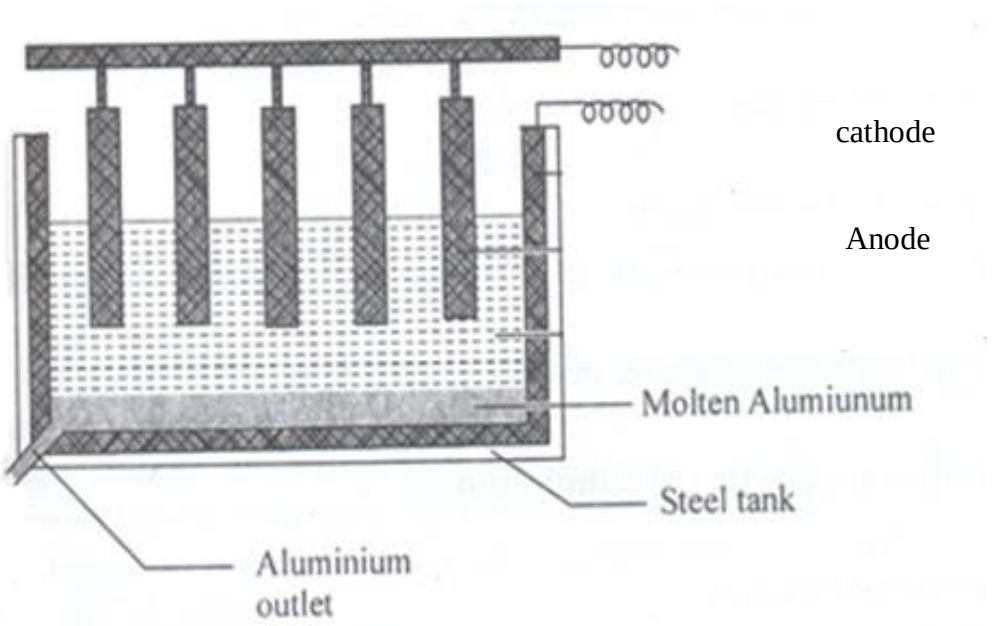
1mole of CO_2 at s.t.poccupies 22.4 litres

168g of $NaHCO_3$ evolve 22.4 litres of the gas ✓½
16.8 g of $NaHCO_3$ would evolve (16.8/168) ×22.4 ✓½=2.24 litres ✓½

f) Give two industrial uses of sodium carbonate. **(2 marks)**
Softening of hard water ✓1
Manufacture of glass ✓1

TOTAL = 11 MARKS

6 . The diagram below shows the electrolysis process in the extraction of aluminium. Study it and answer the questions that follow.



a) i) Name the main ore from which aluminium is extracted from.**(1 mark)**

Bauxite ✓*1*

ii) Explain how the impurities present in the ore are removed. **(3 marks)**

the roasted ore is heated with concentrared sodium hydroxide ✓*1,aluminium oxide being amphoteric dissolves in sodium hydroxide, SiO_2 also dissolve while iron (III) oxide is insoluble in the base is filtered out as red mud.* ✓**1** *the remaining mixture is precipitated to remove $SiO_2(s)$in form of sodium silicate* ✓*1 or $CO_2(g)$ is bubbled into the solution to pptaluminium hydroxide leaving behind sodium silicate.*

b) Label on the diagram the anode and the cathode. **(1 mark)**

See diagram

c) The melting point of aluminium oxide is 2015^{o}C but the electrolysis is carried out at temperature of around 800^{o}C.

i) Why is the electrolysis not carried out at 2015^{o}C? **(1 mark)**

It is expensive to maintain such high temperature ✓*1*

ii) How is the temperature lowered to about 800^{o}C? **(1 mark)**

$Al_2O_3$is dissolved in cryolite ✓*1*

d) Duralumin (an alloy of aluminium) is preferred to pure aluminium in the construction of aeroplane bodies. Give **two** properties that make it suitable for making the aeroplane bodies. **(2 marks)**

Light

Hard

Strong(any 2x 1=2)

TOTAL =9 MARKS

7.a) - it is bulky ✓½
- it has low heating value ✓½
- it produces CO under limited supply of air which is poisonous
- CO_2 produced cause global warming on prolong use (***any two 1mk)***

b) i) Heat evolved = MCΔT
= 450g x $\frac{4.2}{gk}$J x 21.5K ✓1
= 40,635J or 40.635KJ ✓1

ii) Mass of ethanol burnt
= 1.5g (113.5 - 112.0)
1.5g → 40.635KJ
∴ 46g → ?
$\frac{46 \times 40.635}{1.5}$ ✓1 = -1246.14KJmol^{-1}
or
1 mole = 46g
? = 1.5g
= $\frac{1.5}{46}$ = 0.0326 moles of ethanol ✓½
0.0326 moles → 40.635KJ
∴ 1 mole → ?

$\frac{40.635}{0.0326}$ ✓½ = -1246.47 ✓½
(penalise ½mk for missing negative sign of ΔH)

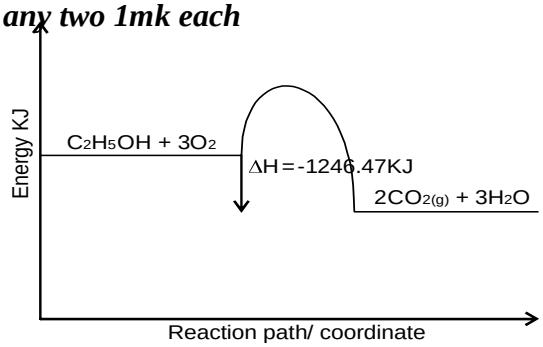
II. $C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$
ΔH = -1246.47KJ/mol
(penalise ½mk for missing ΔH value)

III. - loss of heat to the surrounding environment✓1
- heat absorbed by the apparatus ✓1

- incomplete combustion of ethanol

any two 1mk each

IV.



c) i) Point of complete neutralisation ✓1

ii) Heat was produced during neutralisation hence increase in temperature ✓1

iii) When methanoic acid is used, there would be a lower ✓1 temperature rise since some heat is <u>absorbed</u>✓½ to <u>completely ionise methanoic acid</u>✓½ before neutralisation occurs