

# MIRROR JOINT EVALUATION TEST (JET 2)

## MOCK

**233/2      Chemistry (Theory)      Paper 2**

**JUNE, 2024**

**Time: 2 Hours**

Name: ..... M/G ..... Adm No: .....

Stream: ..... Signature: ..... School.....

**Instructions to candidates**

- (a) Write your Name, Stream, Admission Number and sign in the spaces provided above.
- (b) Answer all the questions in the spaces provided in the question paper.
- (c) KNEC mathematical tables and electronic calculators may be used for calculations.
- (d) All workings MUST be clearly shown where necessary.
- (e) This paper consists of 13 Printed pages. Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.
- (g) Candidates should answer the questions in English.

**FOR EXAMINERS USE ONLY**

Questions	Maximum Score	Candidate's Score
1	12	
2	11	
3	13	
4	13	
5	11	
6	11	
7	09	
<b>TOTAL</b>	<b>80</b>	

- 1.a) The grid given below represents part of the periodic table. Study it and answer the questions that follow. (The letters do not represent the actual symbols of the elements).

D						J		
E	F				X	I		
G		H				K		

(1 mark)

- i) What name is given to the group in which J and K belong?

Halogens ✓

rej. Halogen.

(1 mark)

- ii) Explain why element D can be placed in two positions in the periodic table?

Gains one electron like group VII elements or lose one electron like group I elements ✓ (true) I

(1 mark)

- iii) The ionic radius of K is larger than that of G. Explain.

K forms an ion by gaining electrons while G forms an ion by losing electrons.

(2 marks)

- iv) Compare reactivity of element F and G. Explain

G is more reactive than F since G has a larger atomic radius (hence easily readily loses electrons).

(2 marks)

- v) The electron configuration of ion X<sup>2-</sup> is 2.8.8. On the grid, indicate the position of X.

(1 mark)

I

- b) Study the information in the table below and answer the questions that follow.

(The letters do not represent the actual symbols of the substances.)

Substance	Melting point (°C)	Boiling point (°C)	Solubility in water	Density at room Temperature g/cm <sup>3</sup>
A	-117	78.5	Very soluble	0.8
B	-78	-33	Very soluble	$0.77 \times 10^{-3}$
C	-23	77	Insoluble	1.6
D	-219	-183	Slightly soluble	$1.33 \times 10^{-3}$

i) Which substance would dissolve in water and could be separated from the solution by fractional distillation? Explain.

A. ✓ B.P. close to that of water.

(2 marks)

2

ii) Which substance is a liquid at room temperature and when mixed with water two layers could be formed. Explain.

C. ✓ B.p above 25°C and insoluble in water

(1 mark)

1

iii) Which letter represents a substance that is a gas at room temperature and which can be collected:

I. Over water.

D. ✓ I

(1 mark)

1

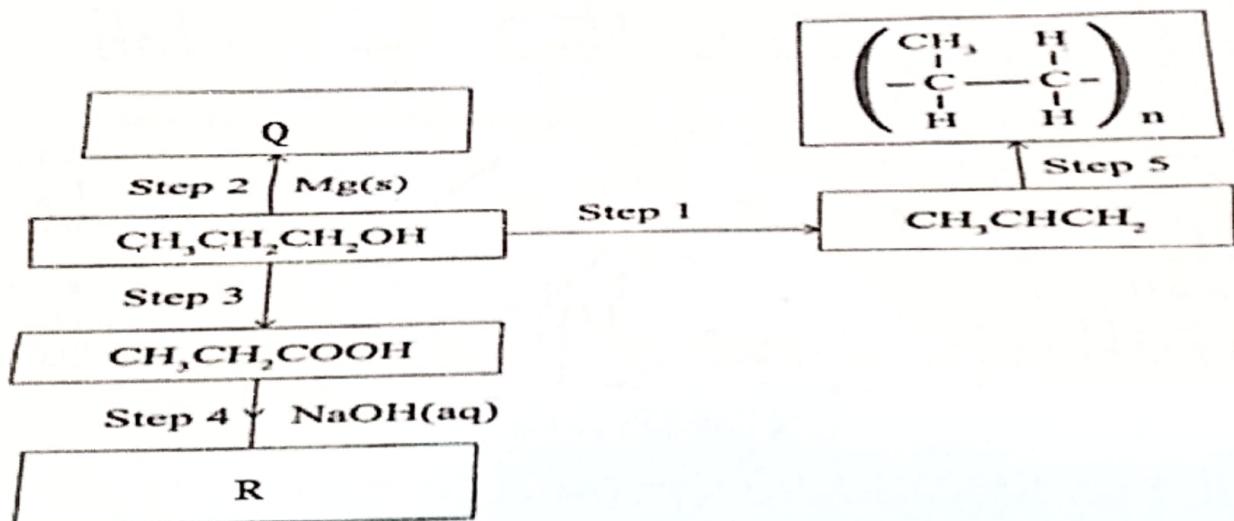
II. By downward displacement of air (Density of air  $1.29 \times 10^{-3}$  g/cm<sup>3</sup> at room temperature)

(1 mark)

B. ✓ I

1

2. The flow chart below shows reactions of some organic compound



(a) Write the formula and give the names of compounds

(i) Q

(2 marks)

Name ..... Magnesium propoxide ✓ rej. Magnesiumpropoxide

Formula.....  $(\text{CH}_3\text{CH}_2\text{CH}_2\text{O})_2\text{Mg}$  /  $(\text{C}_3\text{H}_7\text{O})_2\text{Mg}$  2

(ii) R

(2 marks)

Name..... Sodium propanoate ✓  
 Formula.....  $\text{CH}_3\text{CH}_2\text{COONa}$  ✓  $\text{C}_3\text{H}_5\text{O}_2\text{Na}$  ✓  
 rej. sodium propanoate. 2

(b) Give reagents and conditions necessary for carrying out

(i) Step 3

Accept  $\text{KMnO}_4$  2

Reagent:  $\text{H}^+/\text{KMnO}_4$  ✓  $\text{H}^+/\text{K}_2\text{Cr}_2\text{O}_7$   
 Condition: Heat ✓ 1

(ii) Step 5

(1 mark)

Reagent: Propene ✓ Prop-1-ene. ✓ Accept. Formula  
 Condition: High temp and High Pressure (broad) 1

(c) Step 1 can be carried out using concentrated Sulphuric (VI) acid and heat. Name another reagent and conditions that can be used to carry out step 1 (1 mark)

Aluminium oxide - Reagent:  
 Heat ✓ - Condition 1

(d) Give the name of the type of reaction taking place in

(i) Step 1

(1 mark)

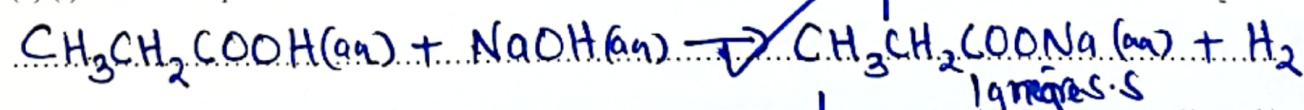
Dehydration ✓ rej. dehydrating agent 2

(ii) Step 5

(1 mark)

Addition polymerization ✓ Polymerization rej. addition reaction 2

(e) (i) Write an equation for the reaction in step 4 (1 mark)



(ii) State the observation made in step 2

(1 mark)

Bubbles of a colourless gas ✓ Bubbles  
 Accept effervescence... 2

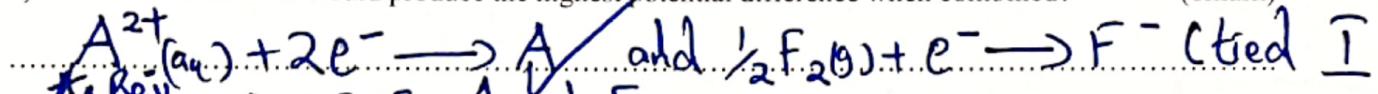
3. I) Use standard electrode potentials for elements A, B, C, D and F given below to answer the questions that follow.

	$E^\theta$ (Volts)
$A^{2+}_{(aq)} + 2e^- \rightarrow A_{(s)}$	-2.90
$B^{2+}_{(aq)} + 2e^- \rightarrow B_{(s)}$	-2.38
$C^+_{(aq)} + e^- \rightarrow \frac{1}{2}C_2_{(g)}$	0.0
$D^{2+}_{(aq)} + 2e^- \rightarrow D_{(s)}$	+0.34
$\frac{1}{2}F_2_{(g)} + e^- \rightarrow F^-_{(aq)}$	+2.87

a) Identify the strongest oxidizing agent. (1 mark)

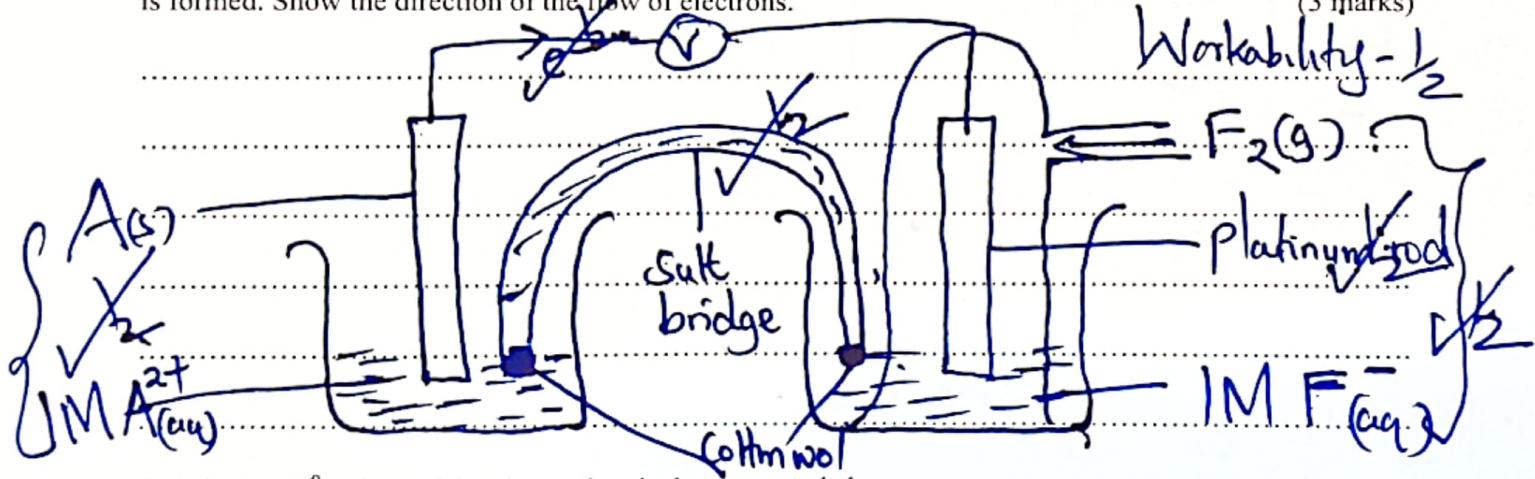


b) Which two half-cells would produce the highest potential difference when combined? (1 mark)



c) Draw a labelled diagram of the electrochemical cell that would be obtained when half-cells above (b)

is formed. Show the direction of the flow of electrons. (3 marks)



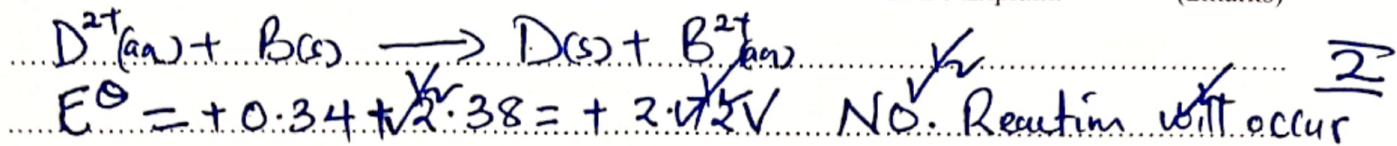
d) Calculate  $E^\theta$  value of the electrochemical cell constructed above. (2 marks)

$$E^\theta = +2.87 - (-2.90)$$

$$= +2.87 + 2.90 = +5.77 \text{ V}$$

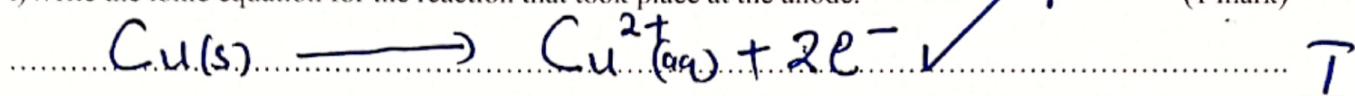
2

e) Is it advisable to store a solution of a nitrate of D in a container of metal B? Explain. (2marks)



II) During the electrolysis of aqueous copper (II) sulphate using copper electrodes, a current of 0.2 amperes was passed through the cell for 5 hours.

i) Write the ionic equation for the reaction that took place at the anode. 1 (1 mark)



ii) Determine the change in mass of the anode which occurred as a result of the electrolysis process.

(Cu = 63.5, 1 Faraday = 96500 Coulombs) (3 marks)

$$\text{Mass change} = \frac{63.5 \times (0.2 \times 5 \times 60 \times 60)}{2 \times 96,500} = 1.184g$$

Accept 1.18g. 3  
rej 1.2g.

4. The table below shows the volumes of nitrogen (IV) oxide gas produced when different volumes of 1 M nitric (V) acid were each reacted with 2.07g of lead at room temperature.

Volume of 1M nitric (V) acid ( $\text{cm}^3$ )	5	15	25	35	45	55
Volume of nitrogen (IV) oxide gas ( $\text{cm}^3$ )	60	180	300	420	480	480

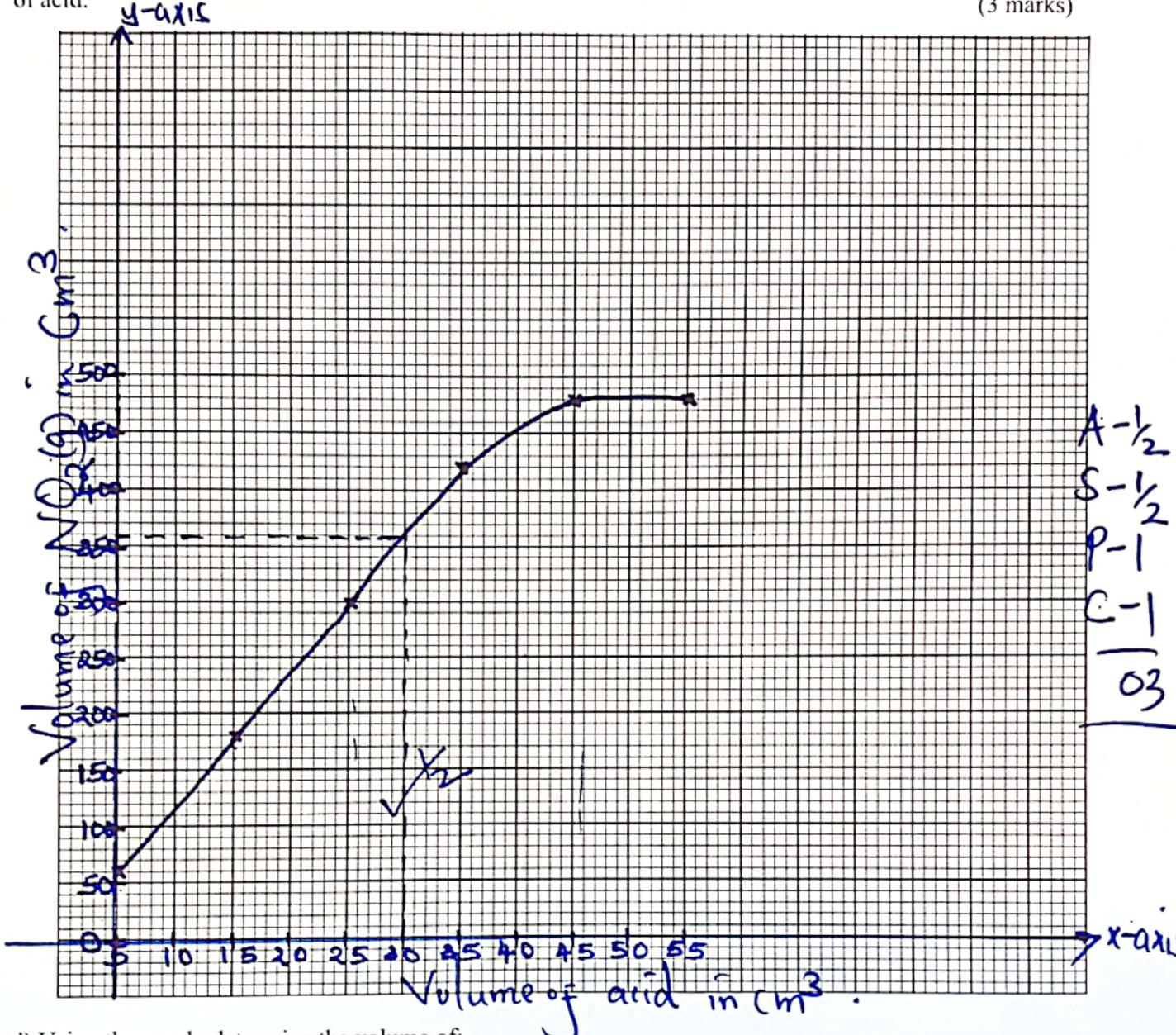
a) Give a reason why nitric (V) acid is not used to prepare hydrogen gas 1 mark

Nitric (V) acid is a strong oxidizing agent;  
(oxidizes  $H_2$  to  $H_2O$ ) I

b) Explain how rate of the reaction between lead and nitric (V) acid would be affected if the temperature of the reaction was raised.

Increase in temperature increases kinetic energy which then leads to increase in the number of significant successful collisions thereby increasing the rate of reaction 2

c) On the grid provided plot a graph of the volume of the gas produced (vertical axis) against the volume of acid. (3 marks)



d) Using the graph, determine the volume of:

i) Nitrogen (IV) oxide produced when 30cm<sup>3</sup> of 1M nitric (V) acid were reacted with 2.07g of lead.

(1 mark)

$\frac{360 \text{ cm}^3}{2}$

I

ii) 1M nitric (V) acid which would react completely with 2.07g of lead.

(1 mark)

$$45 \text{ cm}^3 \checkmark$$

e) Using the answer in (ii) above determine:

i) The volume of 1M nitric (V) acid which would react completely with one mole of lead ( $\text{Pb} = 207$ )

(2 marks)

$$\text{Moles of Pb} = \frac{2.07}{207} \checkmark = 0.01 \checkmark$$

$$\text{If } 0.01 \text{ moles} = 45 \text{ cm}^3 \text{ (Ans in d(10))} \\ 1 \text{ mol} = 1 \times 45 \checkmark = 4500 \text{ cm}^3 \checkmark$$

ii) The volume of nitrogen (IV) oxide gas produced when one mole of lead reacts with excess 1M nitric (V) acid at room temperature.

$$\text{If } 45 \text{ cm}^3 \text{ of HNO}_3 \longrightarrow 480 \text{ cm}^3 \text{ of NO}_2 \checkmark \text{ (1 mark)} \\ 4500 \text{ cm}^3 \longrightarrow \frac{4500 \times 480}{45} \checkmark \\ = 48,000 \text{ cm}^3 \checkmark$$

f) Calculate the number of moles of:

i) 1 M nitric (V) acid that reacted with one mole of lead.

(1 mark)

$$\text{Moles} = \frac{4500 \times 1}{1000} \checkmark \\ = 4.5 \text{ moles.} \checkmark \text{ I}$$

ii) Nitrogen (IV) oxide produced when one mole of lead was reacted with excess nitric (V) acid.

(Molar gas volume at r.t.p = 24000cm<sup>3</sup>)

(1 mark)

$$\text{If } 24,000 \text{ cm}^3 \text{ of NO}_2 = 1 \text{ mole.} \\ 48,000 \text{ cm}^3 \longrightarrow \frac{48,000 \times 1}{24,000} \checkmark \\ = 2 \text{ moles.} \checkmark \text{ I}$$

5.a) State the Hess's law.

(1 mark)

.....Enthalpy change in converting reactants to products is the same regardless of the route taken. I

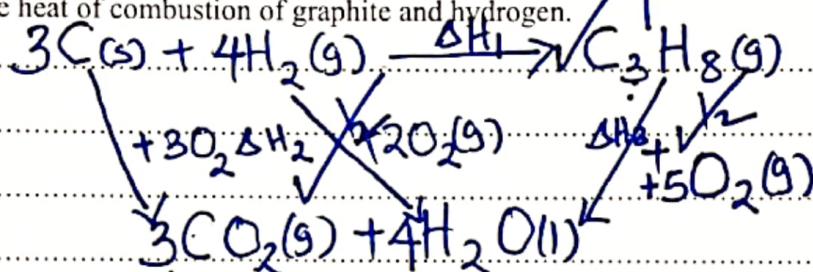
b) Use the following standard enthalpies of combustion of graphite, hydrogen and enthalpy of formation of propane.

$$\Delta H_C^\theta \text{ (Graphite)} = -393 \text{ kJ mol}^{-1}$$

$$\Delta H_H^\theta \text{ (H}_2\text{ (g)}) = -286 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\theta \text{ (C}_3\text{H}_8\text{ (g)}) = -104 \text{ kJ mol}^{-1}$$

i) Draw an energy cycle diagram that links the heat of formation of propane with its heat of combustion and the heat of combustion of graphite and hydrogen. (2 marks)



ii) Calculate the standard heat of combustion of propane. (2 marks)

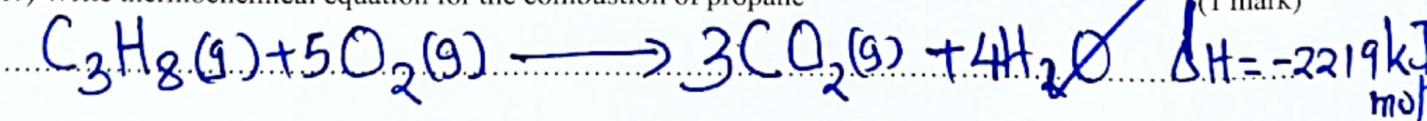
$$\begin{aligned}\Delta H_1 &= \Delta H_2 - \Delta H_3 \\ -104 &= ((3 \times -393) + (4 \times -286)) - \Delta H_3 \\ \Delta H_3 &= -2219 \text{ kJ mol}^{-1}\end{aligned}$$

2

iii) Calculate the heating value of propane ( $C=12.0$ ,  $H=1.0$ ) (1 mark)

$$\begin{aligned}-2219 &\quad \cancel{X} \\ 44 &= 50.43 \text{ kJ g}^{-1} \cancel{X} \\ &\quad \text{(Penalise for } \cancel{X} \text{ - negative sign)}\end{aligned}$$

iv) Write thermochemical equation for the combustion of propane (1 mark)



Penalise for  $\cancel{X}$  for missing  $\Delta H$ .

DF

d) Other than the enthalpy of combustion, state **two** other factors which should be considered when choosing a fuel.

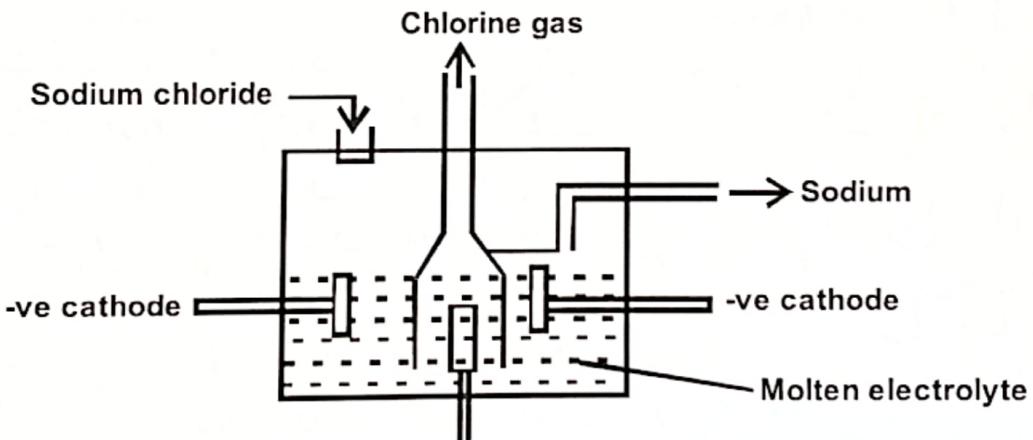
- Ease of transportation - Availability of fuel (2 marks)
- Environmental effect
- Cost of fuel Any 2 @ 1 mk. 2

e) The molar enthalpies of neutralization for dilute hydrochloric acid with sodium hydroxide solution is  $-57.2 \text{ kJ mol}^{-1}$  while that of ethanoic acid with sodium hydroxide solution is  $-55.2 \text{ kJ mol}^{-1}$ . Explain this observation.

Ethanoic acid is a weak acid; some heat energy is used to complete its ionization 2

6. Below is a simplified diagram of the Down's cell used for the manufacture of sodium.

Study it and answer the questions that follow.



i) Name the material of which the cathode and anode is made of.

Cathode - Steel Anode - Carbon graphite I (1 mark)

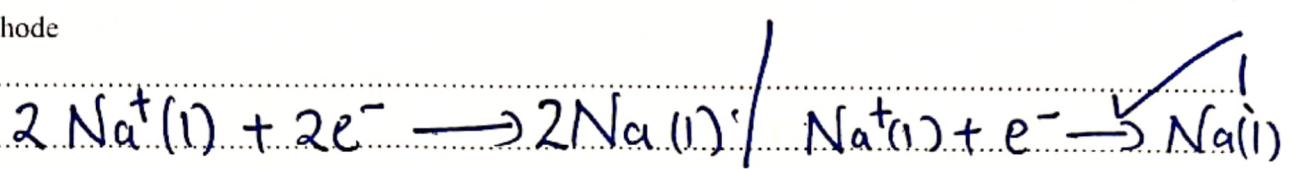
ii) What precaution is taken to prevent chlorine and sodium from recombining?

Steel diaphragm suspended between the electrodes I (1 mark)

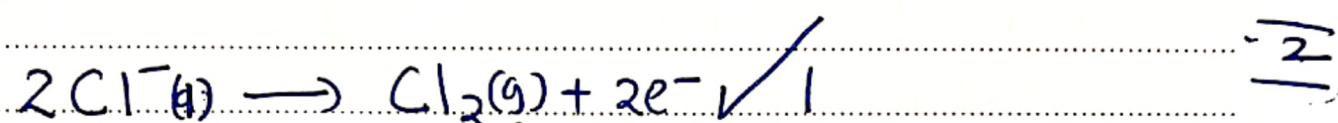
iii) Write an equation for the reaction that takes place at the cathode and anode.

(2 marks)

Cathode



Anode



iv) Name the salt that is added in this process and give the reason.

(2 marks)

Calcium chloride lowers the m.p./df sodium chloride from  $800^\circ\text{C}$  to  $600^\circ\text{C}$ .  $\frac{2}{2}$

v) Why is sodium chloride solution not suitable as an electrolyte for the manufacture of sodium metal?

Has  $\text{H}^+$  and  $\text{Na}^+$  migrating to the cathode;  $\text{H}^+$  preferentially discharged due to lower position in the electrochemical series.  $\frac{2}{2}$

vi) Sodium metal reacts with air to form two products. Name the products formed.

(2 marks)

Sodium oxide

Sodium peroxide  $\checkmark$

ref formula.  $\underline{\underline{2}}$

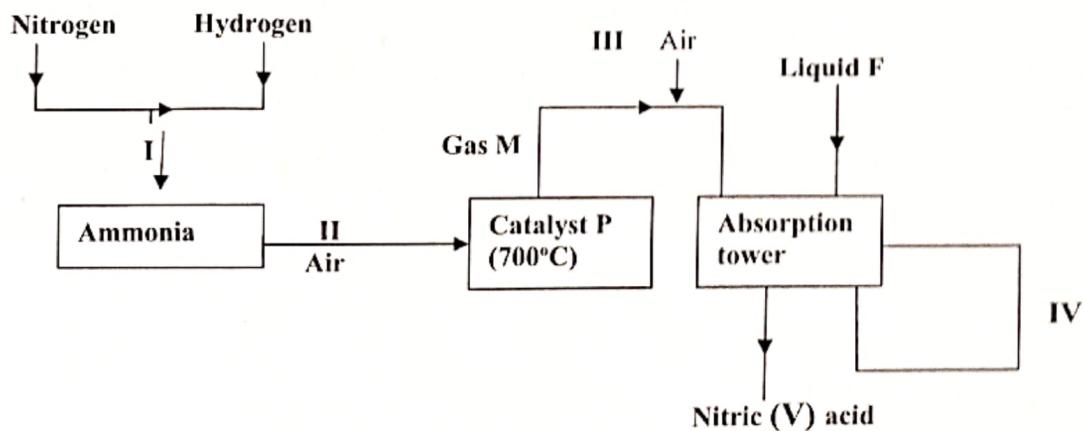
vii) State one use of sodium metal.

(1 mark)

- Sodium vapour is used in lamps for street lighting.
- Molten sodium is used as a reducing agent in the manufacture of titanium.
- liquid sodium is used as a coolant in nuclear reactors.
- Manufacture of tetraethyl lead used as an anti-knock in petrol.

(Any 1<sup>st</sup> correct use.)

7. Study the flow chart below and answer the questions which follow:



(i) Give one source of the following raw materials (2marks)

(a) Nitrogen gas

Fractional distillation of liquid air ✓

(b) Hydrogen gas - Cracking of long chain alkanes / Electrolysis of  $\text{H}_2\text{O}$

(ii) State two conditions required in process I (1mark)

Pressure of 200 atm

Temperature of 400-500°C

Finely divided iron catalyst

(iii) Name:

I) catalyst P

Platinum-Rhodium / Platinum / Nichrome wire / Copper wire

II) Gas M

Nitrogen (II) oxide

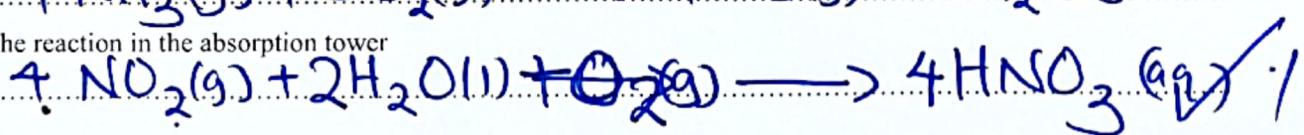
rej. NO.

(iv) Write chemical equations for; (2marks)

(a) Formation of gas M



(b) The reaction in the absorption tower



(Accept the 2 equations)  
for 1mk

(v) Give **two** reasons why step IV is necessary

(2marks)

- To reduce cost of production ✓ /
- To minimise pollution effects ✓ / 2

(vi) Give **one** use of nitric (VI) acid

(1mark)

- Manufacture of nitrogenous fertilizers.....
- Manufacture of explosives..... I
- Manufacture of dyes.....
- Purification of metals.....

(First correct 1,  
only - mark the  
1st one.)

03

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