MUMIAS WEST SUBCOUNTY MOCK EXAMINATIONS-2022

233/2: Chemistry Paper 2-Theory

Marking Scheme

Name: …… Index No: …… Sign: ……

For Examiners use only

Question	Max Score	Student's Score
1	12	
2	13	
3	13	
4	11	
5	10	
6	10	
7	11	
Total	80	

1. The table below gives information on four elements represented by letters K, L, M and N. Study it and answer the questions that follow. The letters do not represent the actual symbols of the elements.

Element	Atomic number	Electron arrangement	Atomic radius (nm)	Ionic radius (nm)
K	***12 √(1/2 mark)***	2,8,2	0.136	0.065
L	17	***2,8,7 √(1/2 mark)***	0.099	0.181
M	***19 √(1/2 mark)***	2,8,8,1	0.203	0.133
N	20	***2,8,8,2 √(1/2 mark)***	0.174	0.099

a) Complete the table by filling in the missing atomic numbers and electron arrangements (2mrks)
(1/2 mark for each correct)

b)) Which two elements have similar properties? Explain (2mks)

K and N √ (1 mk)
They belong to the same chemical family √ (1mk)

c)) What is the formula of the oxide of M? (1mk)

M_2O √ (1mrk)

d) Which element is a non-metal? Explain (2mks)

L√ (1mrk)
Forms ions by gaining one electron√ (1mrk)

e) Which one of elements is the strongest reducing agent? Explain (2mks)

M √ (1mrk)
Loses electrons most readily/most electropositive √ (1mrk)

f) Explain why ionic radius of N is less than that of M (1mk)

the ion of N has more protons √ (1/2 mrk) than that of M and hence experiences stronger nuclear attractive force√ (1/2 mrk)

g) Explain why the ionic radius of L is bigger than its atomic radius (2mks)

L forms ions by gaining electrons √ (1mrk)
This increases the repulsion √ (1/2 mrk) between the electrons in the outermost energy level and reduces the effective nuclear attractive force √ (1/2mrk).

Total 12

2. a) Define the term Molar enthalpy of neutralization. (1mrk)

The heat change that occurs when one mole of water is formed through acid-base neutralization reaction √ (1mrk)

b) In an experiment to determine the molar enthalpy of neutralization, 25.0cm^3 of 2M sulphuric (vi) acid was added to 50cm^3 of 2M sodium hydroxide in a lagged plastic beaker. The mixture was stirred with a thermometer and the final temperature attained recorded. The full results obtained in the experiment were as follows;

volume of 2M sulphuric vi acid used	25.0xm^3
initial temperature of the acid, T_1	19.0^{0}C
volume of 2M sodium hydroxide used	50.0cm^3
initial temperature of the hydroxide, T_2	21.0^{0}C
final temperature attained T_4 =	27.5^{0}C

Given that the specific heat capacity of the mixture, C=4.2kJ/kg/K and that the density of the mixture is 1g/cm^3, use the results above to answer the following questions.

i) Find T_3, the common initial temperature. 1mrk

√*(1/2 mrk)*

$$T_3 = \frac{T1+T2}{2} = \frac{19.0+21.0}{2} = 20.0$$ *√(1/2 mrk)*

ii) Calculate the heat change during the experiment. 3mks

Heat=MCΔT
But M=DxV= 1g/cm^{3}x (25+50)cm^3 √(1/2mrk)
=75g = 0.075kg √(1/2mrk)

√(1/2mrk) *√(1/2mrk)*
Hence Heat= 0.075kgx4.2kJ/kg/Kx(27.5-20.0)K
=0.075X4.2kJx7.5
= 2.3625kJ√(1mrk)

iii) Work out the molar heat of neutralization 3mrks

Equation: H_2SO_4+ 2NaOH ⟶ Na_2SO_4 + 2H_2O √(1mrk)

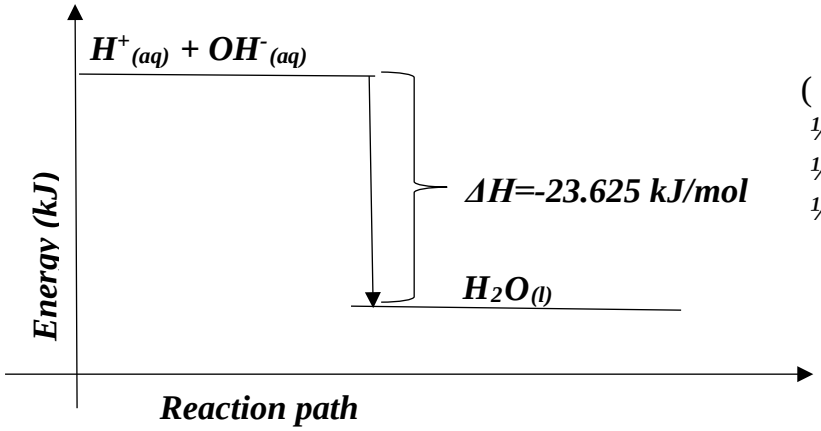
Moles of water formed= moles of NaOH that reacted
= $\frac{2.0x50}{1000}$ = 0.1 moles *√(1/2 mrk)*

Hence molar heat change
0.1 moles of water ⟶ 2.3625kJ of heat
∴ 1 mole of water ⟶ $\frac{1.0x2.3625}{0.1}$ = 23.625kJ/mol *√(1/2 mrk)*
Hence ΔH_n = -23.625kJ/mole √1mrk

iv) Write the thermochemical ionic equation for this process 1mrk

$2H^+_{(aq)} + 2OH^-_{(aq)}$ ⟶ $2H_2O_{(l)}$ ΔH=-23.625 kJ/mol √(1mrk)
Accept *$H^+_{(aq)} + OH^-_{(aq)}$ ⟶ $H_2O_{(l)}$ ΔH=-23.625 kJ/mol*

v) Draw the energy level diagram for the process. 2mrks



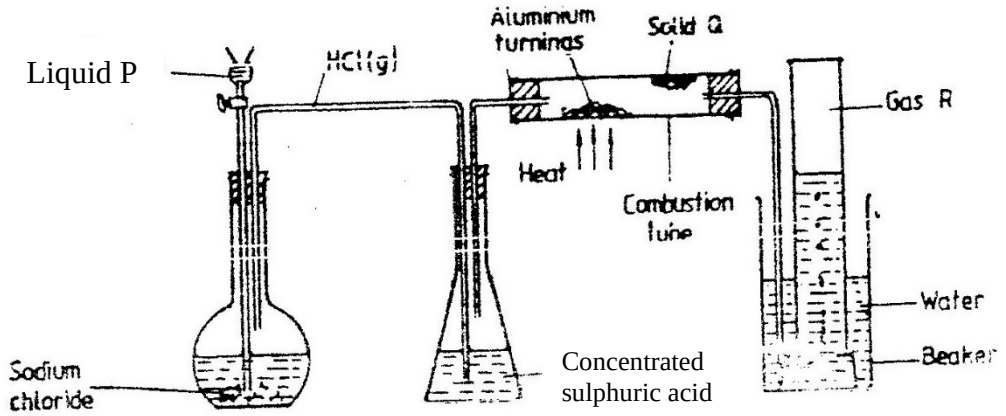
(½ mark for both axes labelled
½ mark for arrow in right direction
½ mark for reactants and products
½ mark for the ΔH)

vi) State any two sources of error in this experiment. 2mrks

1. Loss of heat to the environment
2. Heat absorbed by the apparatus is not accounted for.
3. Errors in volume and temperature measurements. ***(1mrk for any correct Max 2mrks)***

Total: 13

3. In an experiment hydrogen chloride gas was prepared and reacted with aluminium turnings to form a solid Q and gas R as shown in the diagram below.



(i) Name: Liquid P (1mrk)

Concentrated sulphuric vi acid/ Sulphuric vi acid/$H_2SO_{4(l)}$ / H_2SO_4 √(1mrk)

Solid Q (1mk)

Alumunium chloride / $AlCl_3$ √(1mrk)

Gas R (1mk)

Hydrogen /H_2 √(1mrk)

(ii) Write the chemical equation for the reaction that takes place;

a) in the flat-bottomed flask (1mrk)

$H_2SO_{4(l)} + NaCl_{(s)} \longrightarrow NaHSO_{4(s)} + HCl_{(g)}$ √(1mrk)

b) in the combustion tube (1mrk)

$2\,Al_{(s)} + 6HCl_{(g)} \longrightarrow 2AlCl_{3(s)} + 3H_{2(g)}$ √(1mrk)

Penalize ½ once for wrong/missing state symbols

(ii) Name another substance that could serve the same purpose as the concentrated sulphuric acid in this experiment. (1mk)

Anhydrous Calcium Chloride √(1mrk)

(iii) Explain the following observation. When blue litmus paper was dipped into the water in the beaker at the end of the experiment it turned red. (1mrk)

Excess/unreacted hydrogen chloride gas dissolves in the water forming an acidic solution since it is an acidic gas. √(1mrk)

(iv) Explain why solid Q collects farther away from the heated aluminium (2mks)

At this high temperature, it forms as a gas √(1mrk). Further from the heat, on the cooler parts of the combustion tube, it sublimes √(1mrk) to solid.

(v) Given that 1.35g of aluminium reacted completely with the hydrogen chloride gas, calculate

a) the mass of the product Q formed (Al=27, Cl= 35.5, H= 1) (2mrks)

From the equation,

2moles of Al → 2moles of $AlCl_3$
Thus 2(27)g of Al → 2(27+3(35.5))
54g of Al → 160.5g $AlCl_3$ √(1/2mrk)
∴ 1.35g of Al → $\frac{1.35 \times 160.5}{54}$ √(1/2mrk)
= 4.0125g √(1mrk)

Some students may find moles first before converting to mass.

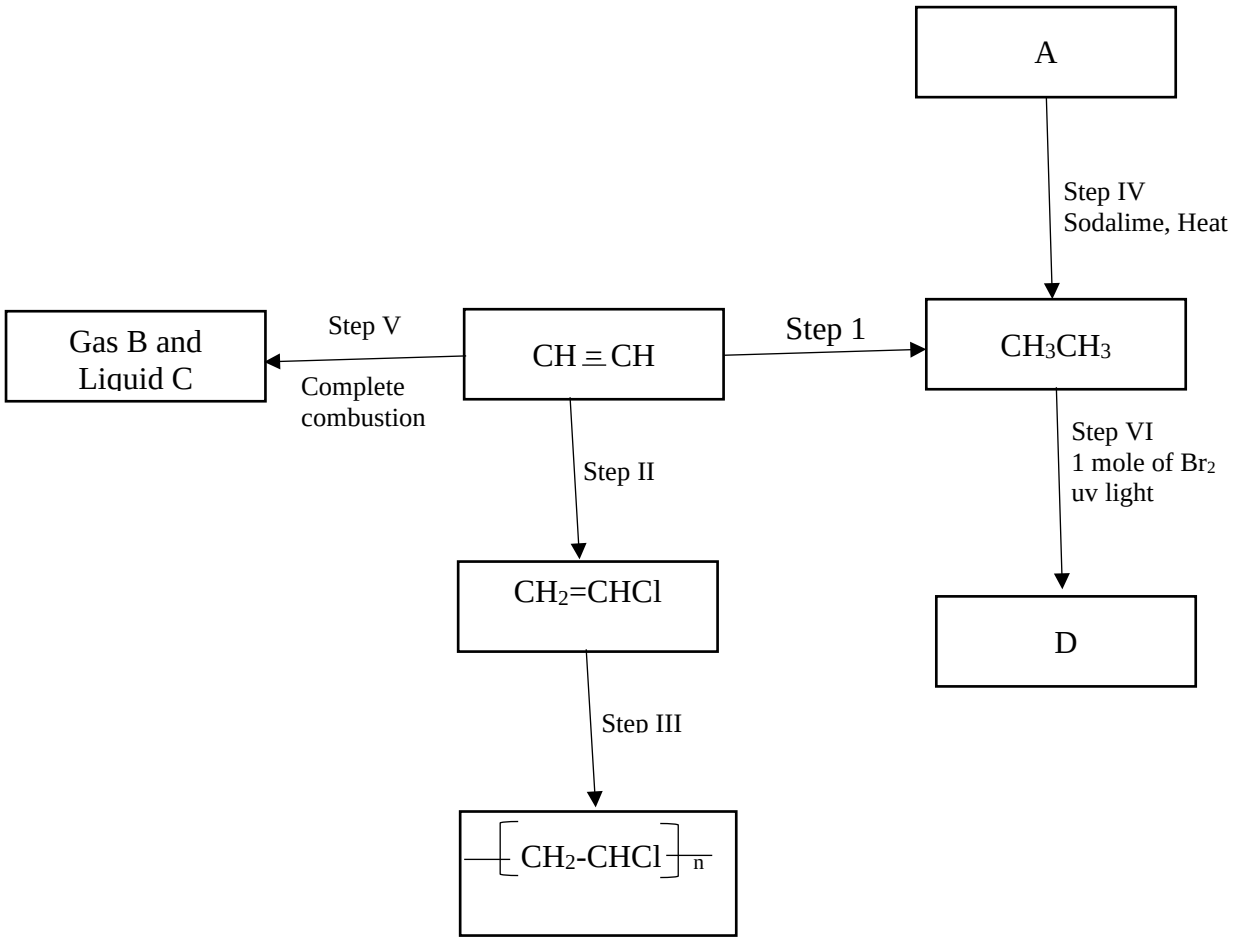
b) The volume of gas R formed measured at stp. (one mole of gas occupied 22.4 litres at standard temperature and pressure.) (2mks)

from the equation;

2moles of Al → 3moles of H_2
Thus: 2(27)g of Al → 3(22.4) litres of H_2
54g of Al → 67.2 litres of H_2 √(1/2mrk)
∴ 1.35g of Al → $\frac{1.35 \times 67.2}{54}$ √(1/2mrk)
= 1.6427 litres √(1mrk)

Total: 13

4. Study the scheme given above and answer the questions that follow



(i) Name the reagents used in:

Step I ***Hydrogen / H_2 √(1/2mrk)***

Step II ***Hydrogen chloride / HCl √(1/2mrk)*** (1mrks)

(ii) Name substances; (2mrks)

A

Sodium Propanoate √(1/2mrk)

B

Carbon iv Oxide √(1/2mrk)

C

Water √(1/2mrk)

D

Bromoethane / 1-Bromoethane √(1/2mrk)

(iii) Write an equation for the reaction that takes place in Step iv (3mrks

$CH_3CH_2COONa + NaOH \longrightarrow C_2H_6 + Na_2CO_3$ √(1mrk) (ignore state symbols)

Accept correct structural formulae

Step v

$2C_2H_{2(g)} + 5O_{2(g)} \longrightarrow 4CO_{2(g)} + 2H_2O_{(l)}$ ***√(1mrk) (ignore state symbols)***

Accept correct structural formulae

Step vi

$C_2H_6 + Br_2 \longrightarrow C_2H_5Br + HBr$ ***√(1mrk) (ignore state symbols)***

Accept correct structural formulae

(iv) Explain one disadvantage of the continued use of items made from the compound formed in step III (1mrk)

It is nonbiodegradable and hence a pollutant of the environment/Produces poisonous gases when burnt. √(1mrk)

v) Name the type of reaction that takes place in (2mrks)

Step i

Addition / Hydrogenation √(1/2mrk)

Step iii

Polymerization √(1/2mrk)

Step v

Combustion/ Burning √(1/2mrk)

Step vi

Substitution √(1/2mrk)

(vi) State the conditions necessary for step ii and iii to take place (2mrks)

Step ii

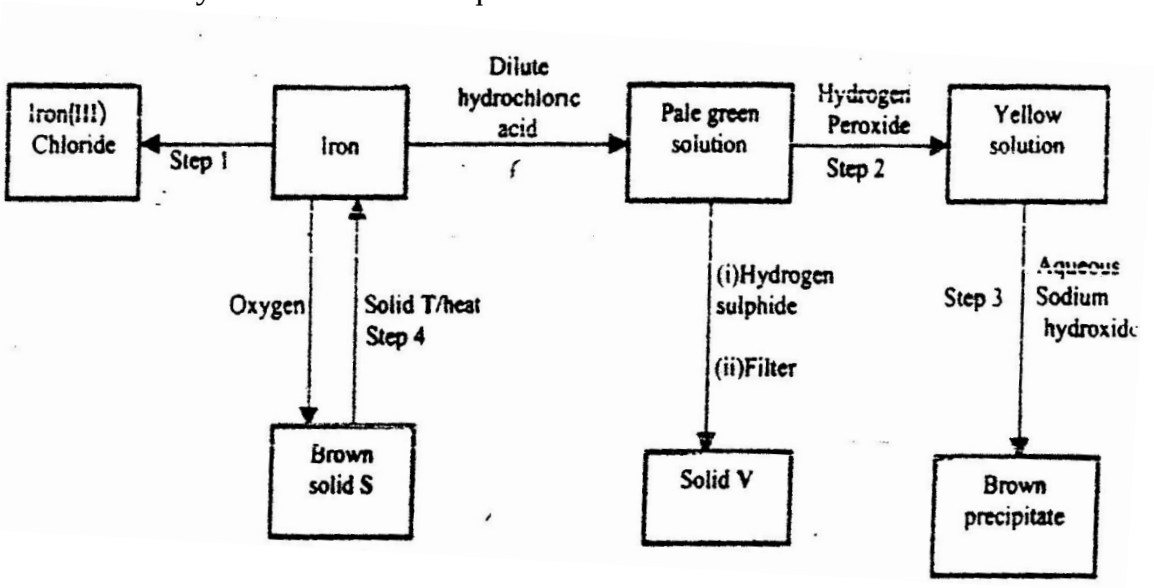
Presence of nickel catalyst √ (1/2 mark) and Heat √ (1/2 mark)

Step iii

High temperature √(1/2 mark) and high Pressure √ (1/2 mark)

Total: 11

5. a) The flow chart below shows a sequence of reactions starting with iron metal. Study it and answer the questions that follow.



i) Name the reagent and state the condition necessary for the reaction in step 1. 2mrks

Reagent

Chlorine gas √ (1mark)

Condition

Heat √(1mark)

ii) Give the names of the following 3mrks

i) Solid S

Iron iii oxide √(1mark)

ii) Solid V

Iron ii sulphide √(1mark)

iii) Solid T

Mg/Zn/Ca √(1mark)

iii) Give reasons for the colour change in step 2. 1mrk

Hydrogen peroxide is an oxidizing agent √(1/2mark) and oxidizes iron (ii) ions to iron (iii) ions √(1/2mark)

iv) Write an ionic equation for the reaction which takes place in step 3. 1mrk

$$Fe^{3+}_{(aq)} + 3OH^-_{(aq)} \longrightarrow Fe(OH)_{3(s)}$$ ***√(1mark)***

v) Name one other substance that could be used instead of sodium hydroxide in step III. 1mrk

Potassium Hydroxide solution √(1mark)

b) In an experiment 3.36g of iron fillings were added to excess aqueous copper(II) sulphate solution. Calculate the mass of copper that was deposited. (Cu = 63.5, Fe = 56.0) 2mrks

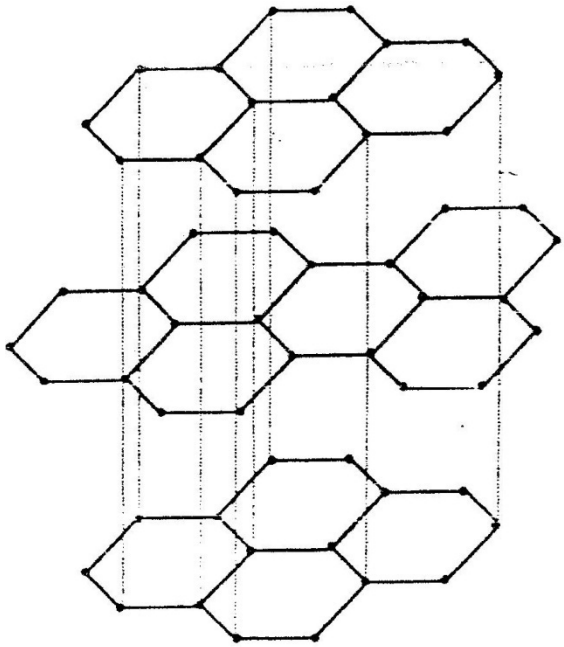
$Fe(s) + Cu^{2+}_{(aq)} \longrightarrow Fe^{2+}_{(aq)} + Cu(s)$ √***(1mark)***

1mole(56g) Fe ⟶ 1 mole(63.5g) Cu

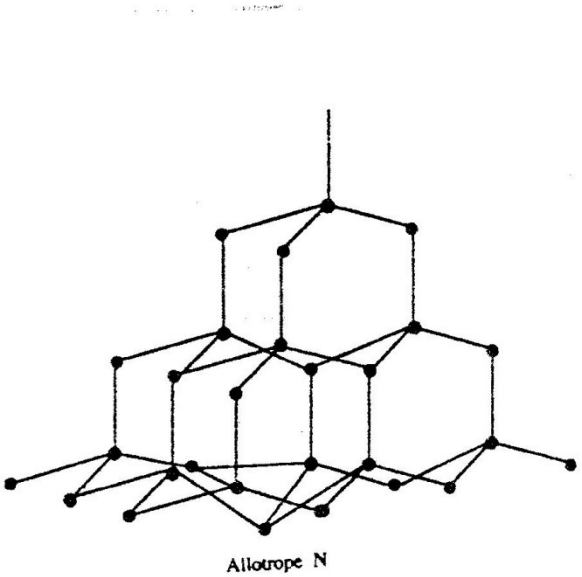
∴ ***3.65g Fe*** ⟶ $\frac{3.65 \times 63.5}{56}$ = 4,1388g Cu √***(1mark)***

Total: 10

6. (a) The following diagrams show the structures of two allotropes of carbon. Study them and answer the questions that follow



Allotrope M



Allotrope N

(i) Name allotrope 1mrk

M

Graphite √(1mark)

N

Diamond √(1mark)

(ii) Give one use of N

. 1mrk

-In jewelry

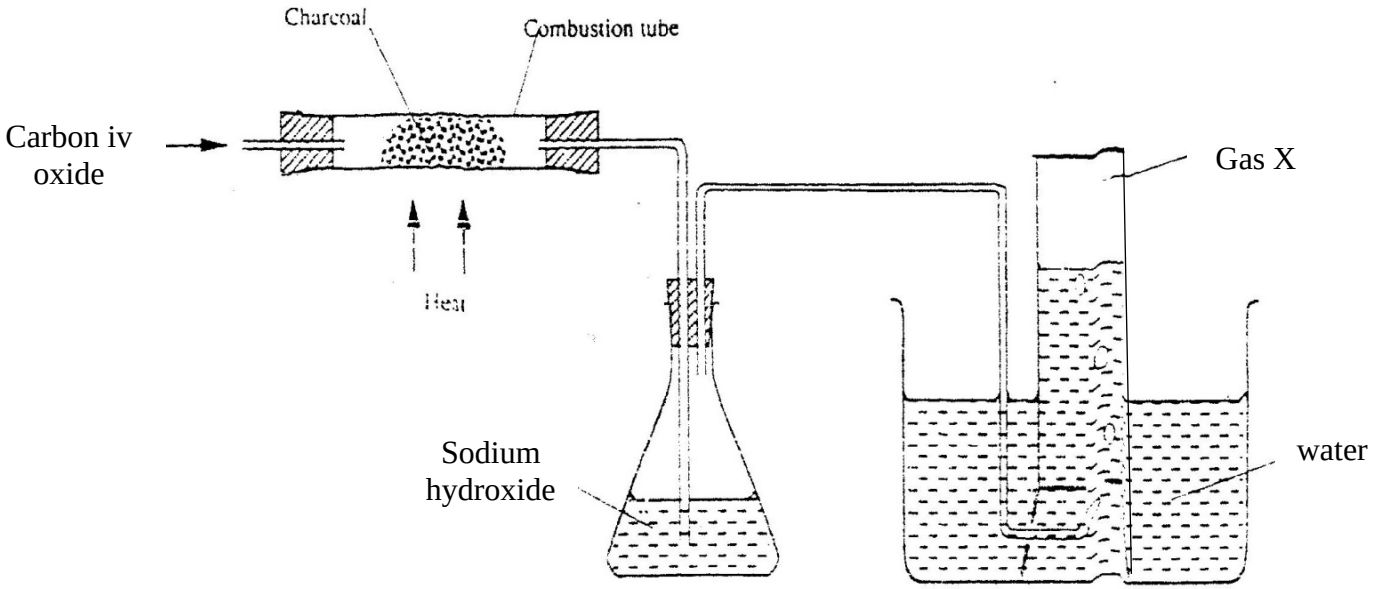
- Making glass cutters and drilling bits

(1 mark for any one, max 1 mark)

(iii) Which allotrope conducts electricity? Explain in terms of structure and bonding 2mrks

M/Graphite √(1/2mark). In graphite, every carbon atom is bonded to three other carbon atoms √(1/2marks) in a layer of hexagonal rings using three √(1/2mark)of the four valence electrons. The fourth valence electron remains delocalized √(1/2mark) making graphite a good electrical conductor.

(b) In an experiment, carbon iv oxide gas was passed over heated charcoal and the gas produced collected as shown in the diagram that follows;



(i) Write an equation for the reaction that takes place in the combustion tube. 1mrk

$CO_{2(g)} + C_{(s)} \longrightarrow 2CO_{(g)}$ ***√(1mark) (penalize ½ for wrong/no state symbols)***

(ii) State the purpose of sodium hydroxide in the set up and explain how it works using a chemical equation. 2mrks

To absorb the unreacted/excess carbon jv oxide. √(1mark)

$NaOH_{(aq)} + CO_{2(g)} \longrightarrow NaHCO_{3(aq)}$ ***√(1mark)***

(iii) Describe a simple chemical test that can be used to distinguish between carbon iv oxide and carbon ii oxide. 2mrks

1. Pass the gases separately through fresh lime water √(1mark). Carbon iv oxide forms a white ppt √(1/2mark) but carbon (ii) oxide does not √(1/2mark).
2. Try to separately ignite √(1mark) them. Carbon (ii) oxide burns √(1/2mark) with a blue flame while CO_2 does not burn √(1/2mark)

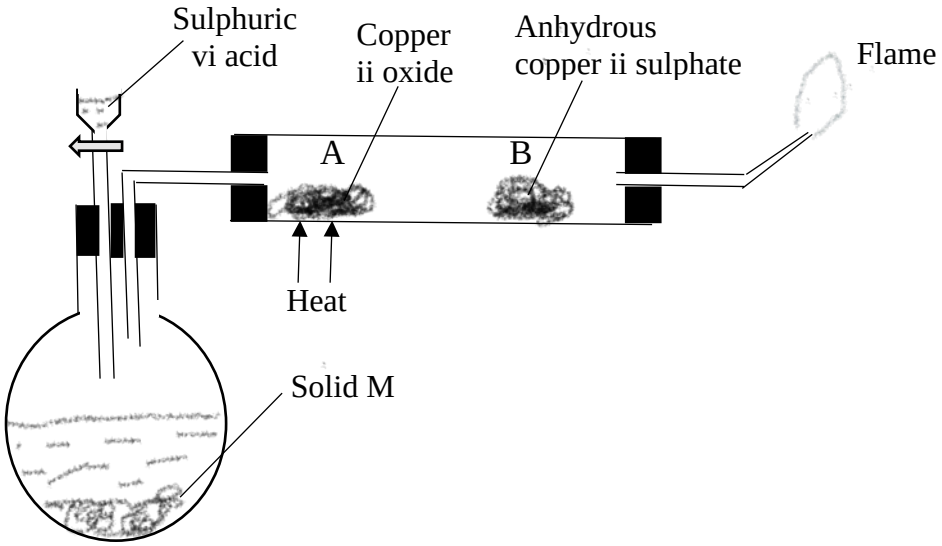
(any one or any other that is workable, max 2 marks)

(iv) Give one use of carbon ii oxide 1mrk

1. As a fuel
2. As a reducing agent in extraction of metals
(1mark for any correct, max 1 mark)

Total: 10

7. The diagram below is set – up used by a student in an attempt to prepare hydrogen gas and react it with hot copper ii oxide in a combustion tube.



(a) Name one suitable substance that can be used as solid M. 1mrk

Zinc/Zn, Iron/Fe, Magnesium/Mg (any one for I mark)

(b) Write an equation for the reaction that would take place
i) in the round-bottomed flask 1mrk

1mark for correct equation based the correct answer in (a) above

ii) at A 1mrk

$$CuO_{(s)} + H_{2(g)} \longrightarrow Cu_{(s)} + H_2O_{(g)}$$ ***√(1mark)***

iii) at the flame 1mrk

$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(g)}$ ***√(1mark)***

c) State and explain the observations made 4mrks

i) at point A

Black copper ii oxide turns brown √(1mark). Hydrogen gas reduces black copper ii oxide to brown copper metal √(1mark).

ii) at point B

The anhydrous copper ii sulphate changes from white powder to blue crystals √(1mark). White anhydrous copper ii sulphate combines with the steam formed and changes to hydrated copper ii sulphate √(1mark).

c) Explain why it is necessary to burn excess hydrogen. 1mrk

Because a mixture of hydrogen with air is explosive. √(1mark)

(d) Give two commercial uses of hydrogen. 2mrk

- ***As a rocket fuel***
- ***In hardening of oils to form fats during the manufacture of margarine.***
- ***In the manufacture of ammonia.***
- ***In welding***
- ***In weather balloons***
- ***Manufacture of hydrochloric acid***
- ***As a fuel in fuel cells***

(1 mark for any correct max 2 marks)

Total: 10