

233/1

CHEMISTRY Paper 1

(THEORY)

Mar. 2021 – 2 hours



Name ... D. PAPA D. VINCENT ... Index Number ... 0724267950 ...

Candidates Signature Date ... 23/1

Instructions to Candidates

- (a) Write your name and index number in the spaces provided above.
- (b) Sign and write the date of examination in the spaces provided above.
- (c) Answer all the questions in the spaces provided in the question paper.
- (d) **Non-programmable** silent electronic calculators and KNEC mathematical tables may be used.
- (e) All working must be clearly shown where necessary.
- (f) This paper consists of 16 printed pages.
- (g) Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.
- (h) Candidates should answer the questions in English.

For Examiner's Use Only

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
17	18	19	20	21	22	23	24	25	26	27	28	Grand Total				

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1. Element A has mass number 40 and 21 neutrons.

(a) Write the electron arrangement of element A. (1 mark)

No. of electrons $40 - 21 = 19$ ✓^{1/2}

Electron arrangement 2.8.8.1 ✓^{1/2}

(b) Give the formula of the compound formed when element A reacts with sulphur. (S = 16.0) (1 mark)

A_2S OR SA_2 OR K_2S OR SK_2

2. Study the setup in Figure 1 and then answer the questions that follow.

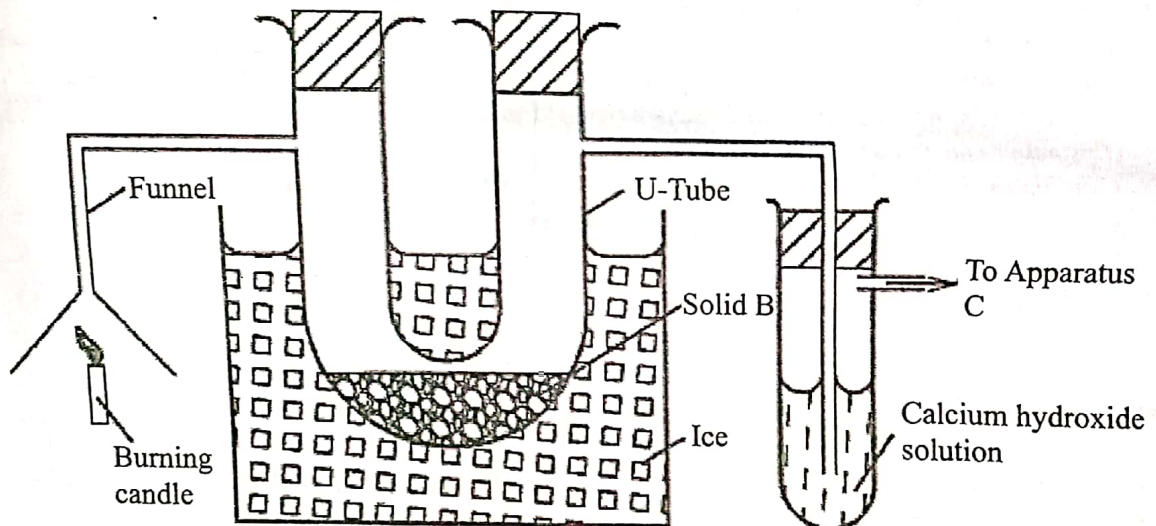


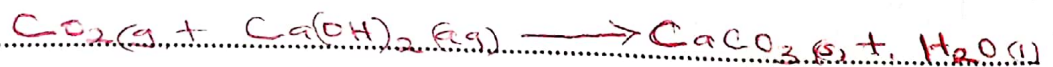
Figure 1

(a) At the end of the experiment, solid B changed from white to blue. Explain. (1 mark)

Solid B becomes hydrated hence turns from white to blue ✓
OR OR

Burning candle produces water ✓^{1/2} which combines with solid B to make it hydrated ✓^{1/2}.

(b) The other product of the burning candle formed a white precipitate with the calcium hydroxide solution. Write an equation for the reaction. (1 mark)



(Wrong state - penalise)
Symbol 1/2

(c) State the role of apparatus C. (1 mark)

OR
Accept To suck the gaseous product from the system
- pumping the products
- Remove the products
Rej: to push

(a) State and explain the factors that are considered when collecting a gas by displacement of:

(i) air; Density of the gas $\checkmark \frac{1}{2}$ (1 mark)

Accept If the gas is lighter than air - upward delivery
or downward displacement of air $\checkmark \frac{1}{2}$

either of the explain. If the gas is denser than air - downward delivery. (1 mark)

(ii) water. (1 mark)

Solubility in water

If the gas is insoluble or slightly soluble in water

(b) Other than collecting a gas by displacement of air or water, state another method that can be used to collect a gas. (1 mark)

- gas syringe
- solidification - SO_2
- Condensation
- freezing
- Collection over mercury
- liquidification

Correct Answer
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4. (a) Carbon(II) oxide was passed over 4.1 g of heated oxide of copper in a combustion tube until there was no further change. The mass of the final substance was found to be 3.29 g. Complete Table 1 and determine the empirical formula of the oxide.

(Cu = 64.0; O = 16.0)

Table 1

Element	Cu	O
Mass (g)	3.29	0.81 ✓ ^{1/2}
Number of Moles	$\frac{3.29}{64}$ 0.051 ✓ ^{1/2}	$\frac{0.81}{16}$ 0.051 ✓ ^{1/2}

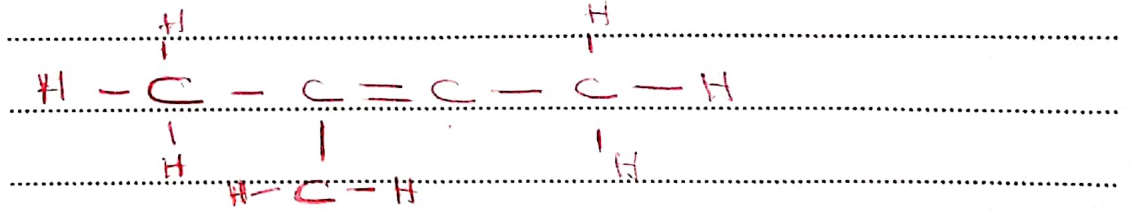
mole ratio

Empirical formula CuO ✓^{1/2} (2 marks)

- (b) State the property of carbon(II) oxide that was demonstrated in the experiment. (1 mark)

..... Reducing agent / reducing property ✓

5. (a) Draw the structural formula of 2-methylbut-2-ene. (1 mark)



- (b) Bromine water was added to 2-methylbut-2-ene. (1 mark)

- (i) State the observation made. (1 mark)

..... Bromine water is decolourised /
 Orange / brown / yellow bromine turns to colourless ✓

- (ii) Name the type of the reaction that took place. (1 mark)

..... Addition rxn ✓

..... Raj Halogenation } process
 Bromination } ✓

Rej All bonds must be shown.
 Condensed formula.
Rej Initial colour is not original colour of bromine.

6. Table 2 shows pH values of solutions of compounds D, E, F and G.

Table 2

Compound	D	E	F	G
pH value of solution	2	5	7	13

(a) State which one of the compounds is likely to be:

(i) sodium chloride;

(1 mark)
~~(1/2 mark)~~

F or pH 7

(ii) ammonium nitrate.

(1 mark)
~~(1/2 mark)~~

E or pH 5

(b) Select **two** compounds that can be used to illustrate the amphoteric nature of an oxide. (1 mark)

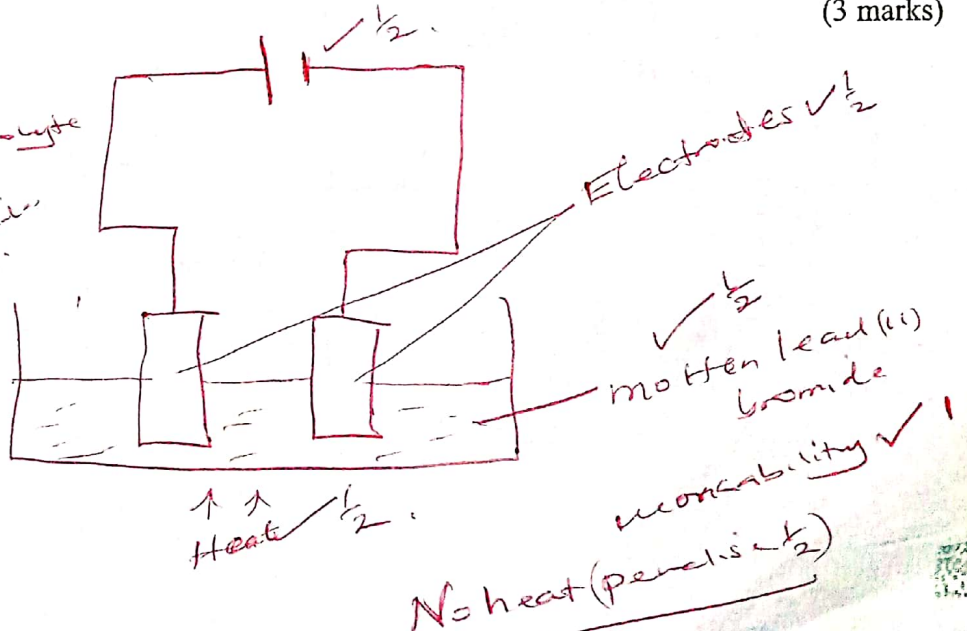
D and G or 2 and 13

(c) Give a reason for the answer in (b). (1 mark)

Amphoteric oxides react with both strong acids/acids and alkalis.

OR Amphoteric oxides behave as acids or bases.

7. Draw a labelled diagram of the setup of apparatus that can be used to electrolyse lead(II) bromide. (3 marks)

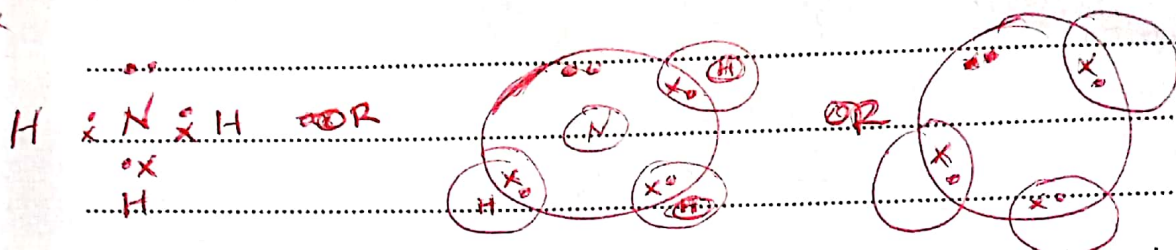


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8. (a) State the difference between a covalent bond and a dative covalent bond. (1 mark)

In covalent, shared electrons are contributed by both species/atoms while in dative, the shared electrons are from one of the atoms or species.

- (b) Using dots (•) and crosses (x) to represent electrons, draw a diagram to show the bonding in ammonia. (1 mark)



- (c) Using the diagram in (b), state one property that makes ammonia react with hydrogen ion. (1 mark)

- Nitrogen in ammonia contains a lone pair of electrons. ✓ OR
- presence of lone pair of electrons / unshared pair of e⁻

9. Figure 2 shows a reaction scheme starting with copper turnings. Study it and answer the questions that follow.

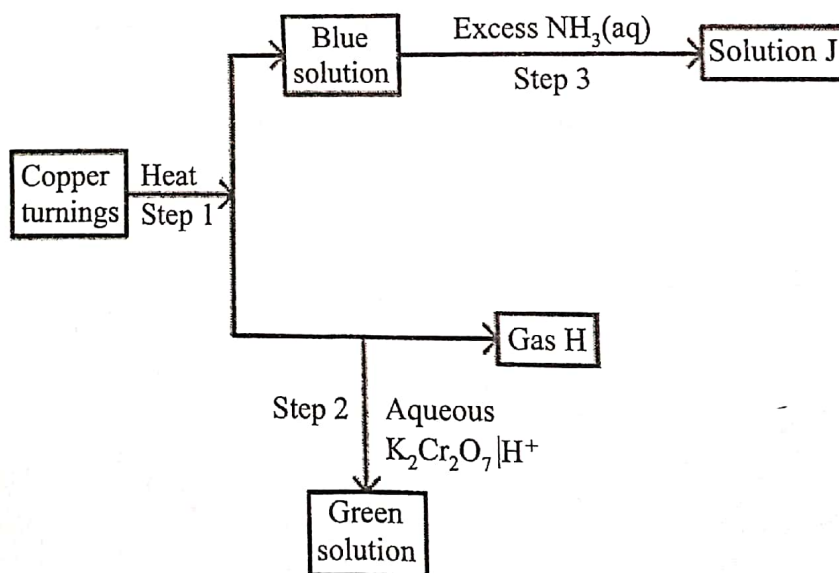


Figure 2

Reagent: dilute or H₂SO₄ (aq)

- (a) State the reagent that is added in step 1. (1 mark)
Conc. sulphuric(VI) acid Conc. H₂SO₄
or Sulphuric(VI) acid
- (b) Identify gas H. (1 mark)
SO₂ or Sulphur(VI) oxide
- (c) Write the formula of the complex ion in solution J. (1 mark)
[Cu(NH₃)₄]²⁺

10. When chlorine is bubbled through hot concentrated sodium hydroxide solution, sodium chlorate(V), sodium chloride and water are formed.

- (a) Write an equation for the reaction. (1 mark)
3 Cl₂(g) + 6 NaOH (aq) → NaClO₃ (aq) + 5 NaCl (aq) + 3 H₂O (l)
- (b) Sodium chlorate(V) and sodium chloride have different solubilities in water. Name a method that can be used to separate the salts. (1 mark)
Fractional crystallisation
- (c) Give *one* use of sodium chlorate(V). (1 mark)
- Herbicides *- Mnf of dyes*
- Bleaching agent *- In fireworks and explosives/matches*
- Treatment of sewage

11. Excess dilute hydrochloric acid was added to an alloy of copper and zinc in a beaker.

- (a) State the observations made. (2 marks)
fizzing / effervescence / production of gas bubbles ✓ 1
Colourless solution formed ✓ 1
Brown residue/solid ✓ 1
- (b) Excess aqueous sodium hydroxide was added to 2 cm³ of the solution obtained in the reaction. Write an ionic equation for the reaction that occurred. (1 mark)
Zn²⁺ (aq) + 4 OH⁻ (aq) → [Zn(OH)₄]²⁻ (aq)
OR
Zn(OH)₂ (s) + 2 OH⁻ (aq) → [Zn(OH)₄]²⁻ (aq)

12. Study the information in Table 3 and answer the questions that follow. The elements belong to the same chemical family. (The letters are not actual symbols of the elements).

Table 3

Element	Atomic radius (nm)	Ionic radius (nm)	Ionisation energy (kJ/mol)
L	0.157	0.095	494
K	0.203	0.133	418
M	0.123	0.060	519
N	0.235	0.169	376

- (a) Classify the elements as either metals or non-metals. Give a reason. (1 mark)

Metals ✓ because ionic radius is smaller than corresponding atomic radius / vice versa.

- (b) (i) Identify the element which is

I. least reactive M. ✓ (1/2 mark)

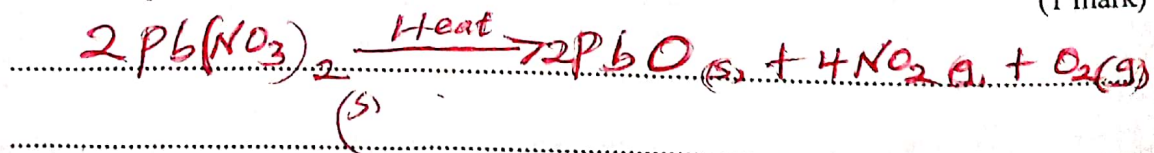
II. most reactive N ✓ (1/2 mark)

- (ii) Give a reason for the answer in b (i). (1 mark)

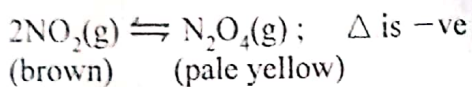
The more the ionization energy the less the reactivity or the more the ionization energy, the more the reactivity / OR use atomic radius to explain.

13. Nitrogen(IV) oxide is prepared by heating lead(II) nitrate. to explain

- (a) Write an equation for the reaction. (1 mark)



- (b) At room temperature, nitrogen(IV) oxide exists as an equilibrium mixture with dinitrogen tetraoxide.



State the observation made when the mixture is placed in an ice-bath. Give a reason. (2 marks)

Mixture turns yellow / yellow colour intensifies ✓
 - Decrease in temp, forward is favoured ✓
 more N₂O₄ is formed since the rxn is exothermic ✓

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14. Figure 3 shows an energy level diagram for the decomposition of hydrogen peroxide using a catalyst.

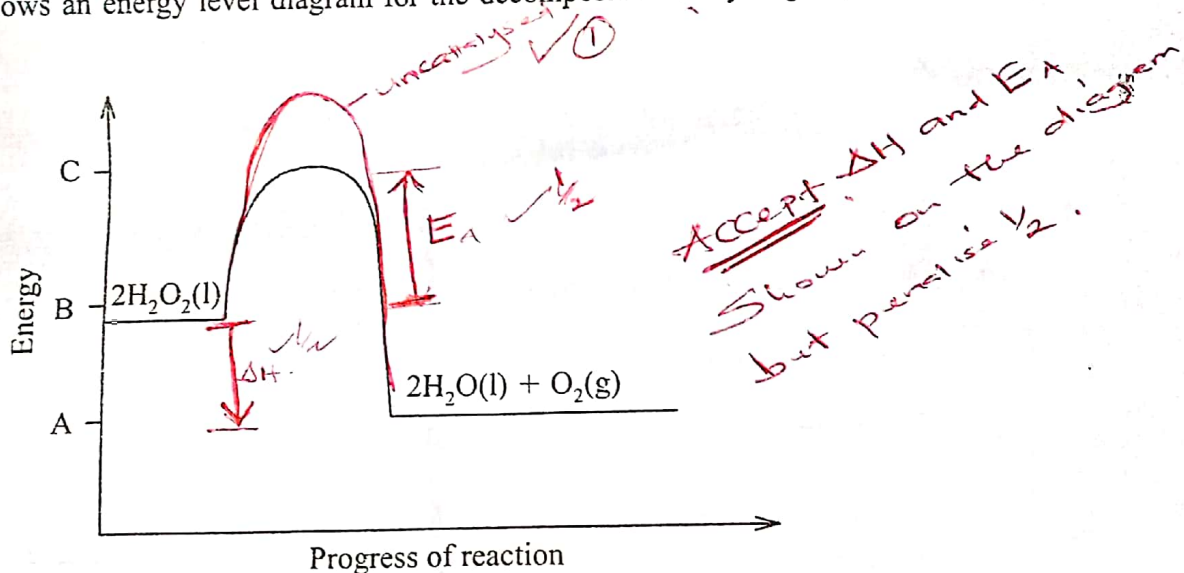


Figure 3

- (a) Using the energy values A, B and C, write an expression for:

- (i) ΔH of the reaction; (1 mark)

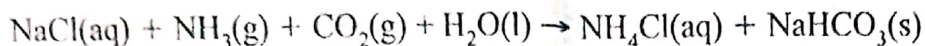
$\Delta H = A - B$ ✓

- (ii) activation energy. (1 mark)

$E_A = C - B$ ✓

- (b) On the same axis, sketch a curve that would be obtained if the reaction was carried out without a catalyst. (1 mark)

15. Sodium carbonate is prepared on large scale by the Solvay process. The equation for the main reaction that takes place in the carbonator is:



- (a) Describe how the sodium carbonate is obtained from the products of the carbonator. (1½ marks)

✓ 1/2
The products are filtered to obtain NaHCO_3 as a residue.

- The residue is heated to obtain Na_2CO_3

OR

The products are filtered then dried ✓ 1

- (b) One of the by-products of the Solvay process is calcium chloride. Explain how the calcium chloride is formed in this process. (1½ marks)

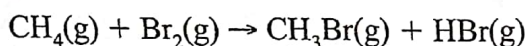
✓ 1/2
Calcium carbonate decomposes to form CaO and CO_2

- CaO reacts with water and then NH_4Cl to form CaCl_2 .

OR

use of equations correctly

16. Methane reacts with bromine as shown in the following equation.

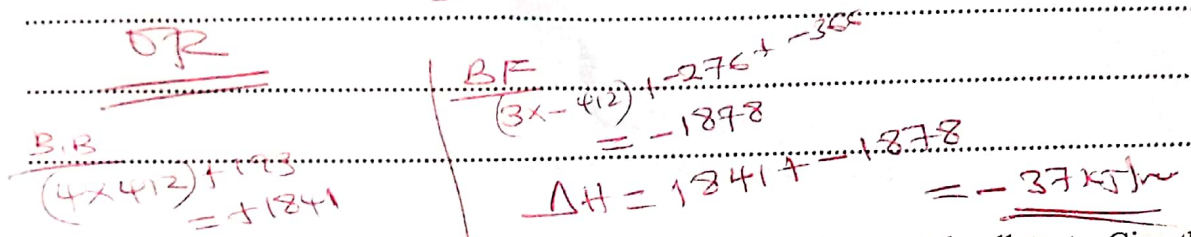
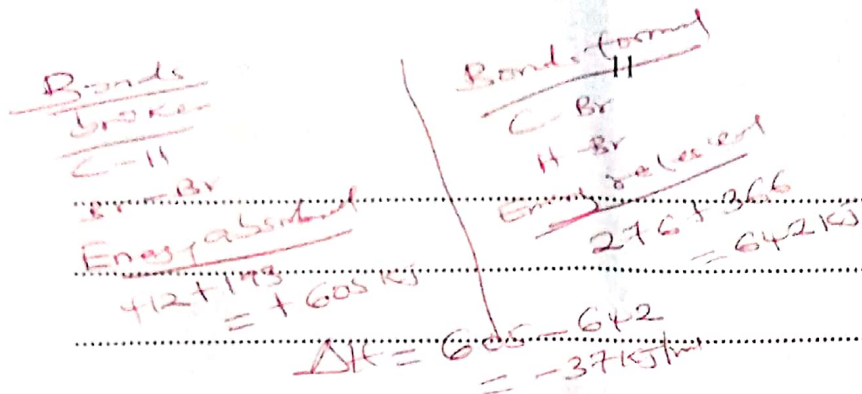


Using the bond energies in Table 4, calculate the enthalpy change, ΔH for the reaction.

Table 4

Bond	Bond energy (kJ mol^{-1})
C - H	412
C - Br	276
Br - Br	193
H - Br	366

(3 marks)



17. Some compounds such as CFCs and DDT are regarded as environmental pollutants. Give the complete names of:

(a) CFCs; (1 mark)

Chlorofluorocarbons

(b) DDT. (1 mark)

Dichlorodiphenyl trichloroethane

18. Use the information in Table 5 to answer the questions that follow.

Table 5

Liquid	Boiling point (°C)	Miscibility with water
Propanone	56	Miscible
Octane	126	Immiscible
Water	100	-

(a) State the method that can be used to separate propanone and water. (1 mark)

Fractional distillation / distillation

(b) Describe how a mixture of water and octane can be separated. (2 marks)

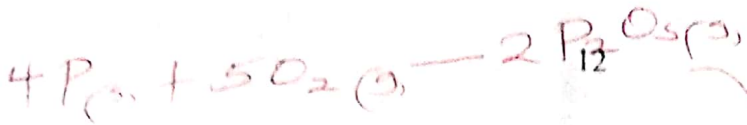
Place the mixture on a separating funnel / dropping funnel / barrette

Run down the bottom layer

Discard the interphase

OR
Use of a dropper
Suck the top layer
Suck the interphase
and discard it

NB
Remember
If interphase is
not discarded



19. 6.2 g of phosphorus was reacted with excess oxygen to form phosphorus(V) oxide. Determine the mass of the oxide formed. (O = 16.0 ; P = 31.0) (2 marks)

Moles of P = $\frac{6.2}{31} = 0.2 \checkmark$

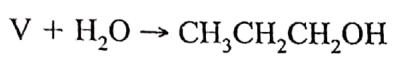
Moles of $P_2O_5 = \frac{1}{2} \times 0.2 = 0.1 \text{ mol}$

RFM of $P_2O_5 = (3 \times 31) + (5 \times 16) = 142$

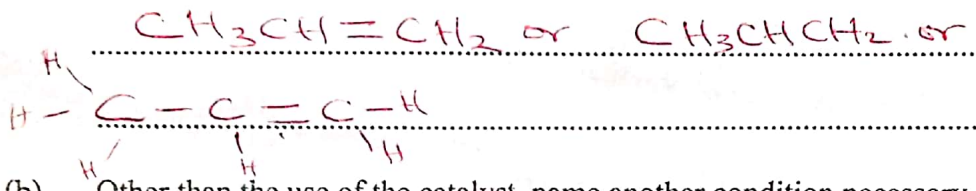
mass of $P_2O_5 = 142 \times 0.1 = 14.2 \text{ g}$

Final answer same

20. Compound V reacts with water as shown in the following equation.



(a) Give the structural formula of compound V. (1 mark)



(b) Other than the use of the catalyst, name another condition necessary for this reaction. (1 mark)

Heat or pressure of 60-70 atmospheres
Temp of 250-300°C.

Pres. increasing

(c) This type of reaction is called hydrolysis or hydration. State another name that can be used to describe the reaction. (1 mark)

Addition or oxidation

21. Salts may be classified as soluble or insoluble.

(a) Select from the following list a pair of compounds that can be used to prepare a soluble and an insoluble salt.

- $HNO_3, Pb(NO_3)_2, KNO_3, BaO, NaCl$

(i) Soluble salt (1 mark)

HNO_3 and BaO ✓

(ii) Insoluble salt (1 mark)

$Pb(NO_3)_2$ and $NaCl$ ✓

Heat/Boil
13

(b) Describe how a soluble salt is obtained from its solution. (1 mark)

- Evaporate the mixture to saturation ✓₂
- Allow to cool ✓_{1/2}
- Filter the residue

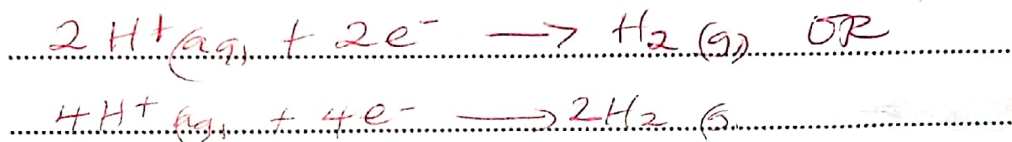
22.

(a) State **one** factor that affects the preferential discharge of ions at the cathode. (1 mark)

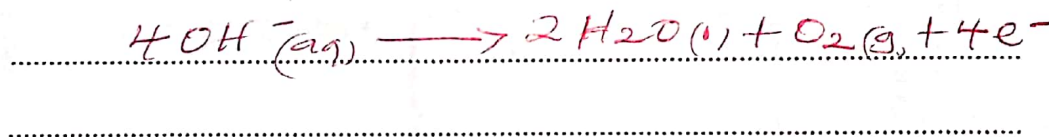
- Nature of the electrode
- Concentration
- Position of the element in the reactivity series
- Position on the electrochemical series

(b) Sodium sulphate was electrolysed using inert electrodes. Write the equation for the reaction that takes place at the:

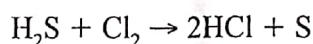
(i) cathode; (1 mark)



(ii) anode. (1 mark)



23. Consider the following reaction.



Determine the oxidation numbers of chlorine and sulphur in the reactants and products. (2 marks)

	Reactants	Products
Sulphur	-2 ✓ _{1/2}	0 ✓ _{1/2}
Chlorine	0 ✓ _{1/2}	-1 ✓ _{1/2}

24. (a) A volume of sulphur(IV) oxide gas diffused from an apparatus in 96 seconds.

Calculate the time taken by an equal volume of carbon(IV) oxide to diffuse under the same conditions. (C = 12.0 ; O = 16.0 ; S = 32.0) (1 mark)

$$\begin{array}{l|l} \text{RMM of SO}_2 = 64 \checkmark \frac{1}{2} & t_{\text{CO}_2} = 79.60 \text{ s} \\ \text{RMM of CO}_2 = 44 & \\ \hline \frac{t_{\text{SO}_2}}{t_{\text{CO}_2}} = \sqrt{\frac{64}{44}} \checkmark \frac{1}{2} & \end{array}$$

- (b) The rate of diffusion of neon was found to be 1.45 times faster than that of an equal volume of gas X at room temperature. Determine the relative formula mass of gas X (Ne = 20.0). (2 marks)

$$\begin{array}{l|l} \frac{R_{\text{Ne}}}{R_X} = 1.45 \checkmark \frac{1}{2} & \sqrt{\frac{m_X}{20}} = 1.45 \checkmark \frac{1}{2} \\ & \\ \hline & m_X = 2.1025 \times 20 \checkmark \frac{1}{2} \\ & = 42.05 = 42 \checkmark \frac{1}{2} \\ \hline \sqrt{\frac{m_X}{m_{\text{Ne}}}} = 1.45 & \end{array}$$

25. Complete combustion of one mole of an alkanol, $\text{C}_x\text{H}_y\text{OH}$ gave four moles of water. (C = 12.0, H = 1.0, O = 16.0)

Determine the: $3 \text{C}_x\text{H}_y\text{OH} + \text{O}_2 \rightarrow \text{CO}_2 + 4\text{H}_2\text{O}$.

- (a) values of x and y

(i) x

$$2 \frac{27}{2} \times 23 \checkmark 1$$

(1 mark)

(ii) y

$$= 7 \frac{7}{2} \times 7 \checkmark 1$$

(1 mark)

- (b) number of moles of oxygen required for the complete combustion. (1 mark)

$$3 \text{ moles}$$

(1 mark)

26. Radioactive decay of $^{228}_{90}\text{Th}$ gives X $^{224}_{88}\text{Ra}$ and gamma radiation.

(a) Identify X (1 mark)

(b) Write a nuclear equation for the decay. (1 mark)

(c) The half-life of $^{228}_{90}\text{Th}$ is 1.9 years. If after 5.7 years the mass of $^{228}_{90}\text{Th}$ was found to be 1.25 g. Determine the initial mass of the radioactive isotope. (1 mark)

No. of half life = $\frac{5.7}{1.9} = 3$

1.25 $\xrightarrow{1st}$ 2.5 $\xrightarrow{2nd}$ 5.0 $\xrightarrow{3rd}$ 10.0 ✓

10.0g ✓

(2 marks)

27. Figure 4 shows part of the structure of a polymer.

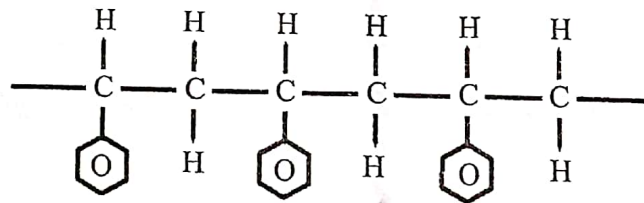
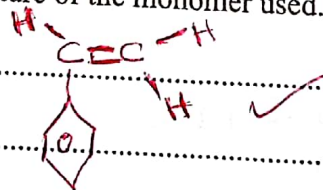


Figure 4

(a) Give the name of the polymer. (1 mark)

polyphenylenes or polystyrene

(b) Draw the structure of the monomer used. (1 mark)



(c) Give *one* use of the polymer. (1 mark)

- Packaging materials
- Insulators
- Cutting boards

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28. Figure 5 shows variation of number of outermost electrons (a) with atomic number of elements in the periodic table.

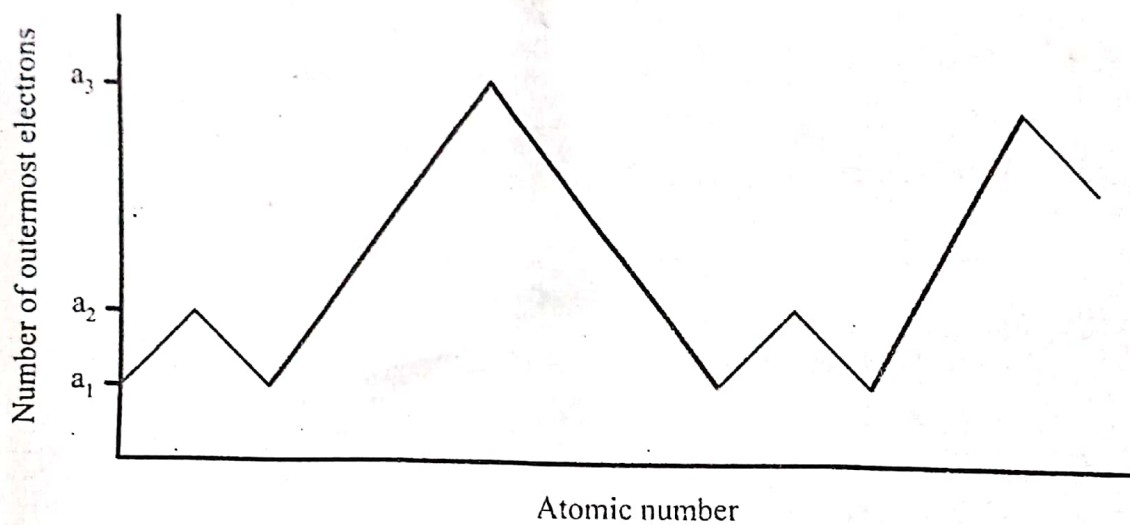


Figure 5

- (a) Give the values of

(i) a_1 (1 mark)

..... 1

(ii) a_3 (1 mark)

..... 8

- (b) State why elements with a_1 and a_2 outermost electrons do *not* react with each other. (1 mark)

..... Have a tendency to loose electrons

..... Both form positive ions

..... Both of them are metals

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