

THE KENYA NATIONAL EXAMINATIONS COUNCIL
Kenya Certificate of Secondary Education

233/1

CHEMISTRY

Paper 1

(THEORY)

Mar. 2021 – 2 hours



Ex No.
1363

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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.

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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}

Accept
2.8.8.1
2.8.2.1
2.8.1

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

A₂S OR SA₂ OR K₂S OR SK₂

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

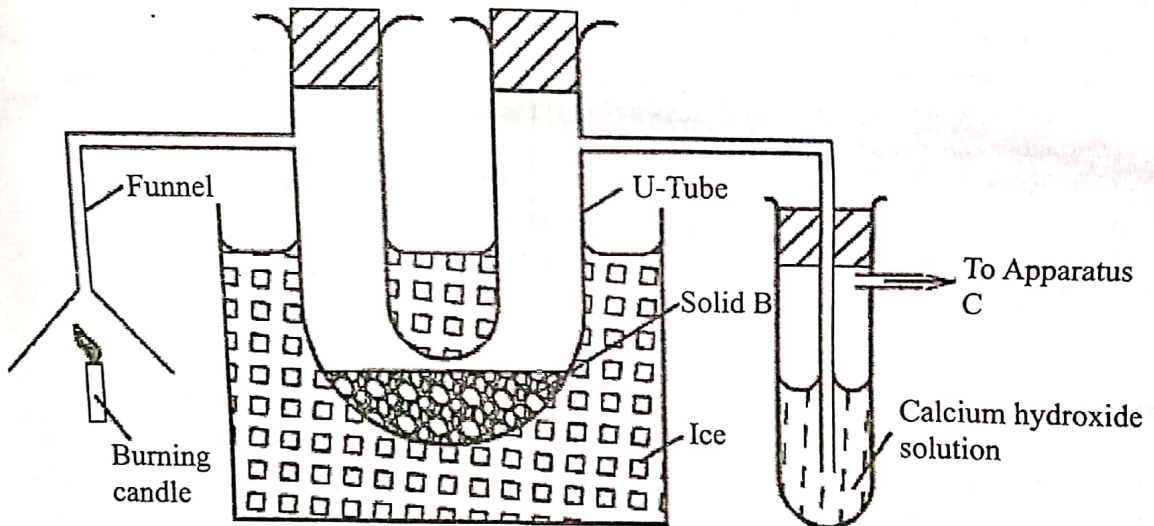


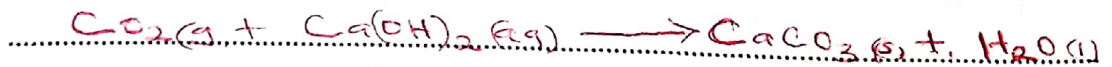
Figure 1

(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

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

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

3. (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)

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

(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 - SO₂
- Condensation
- freezing
- Collection over mercury
- liquidification

Correct Explanation without stating

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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)

Marked independently

D and G or 2 and 13

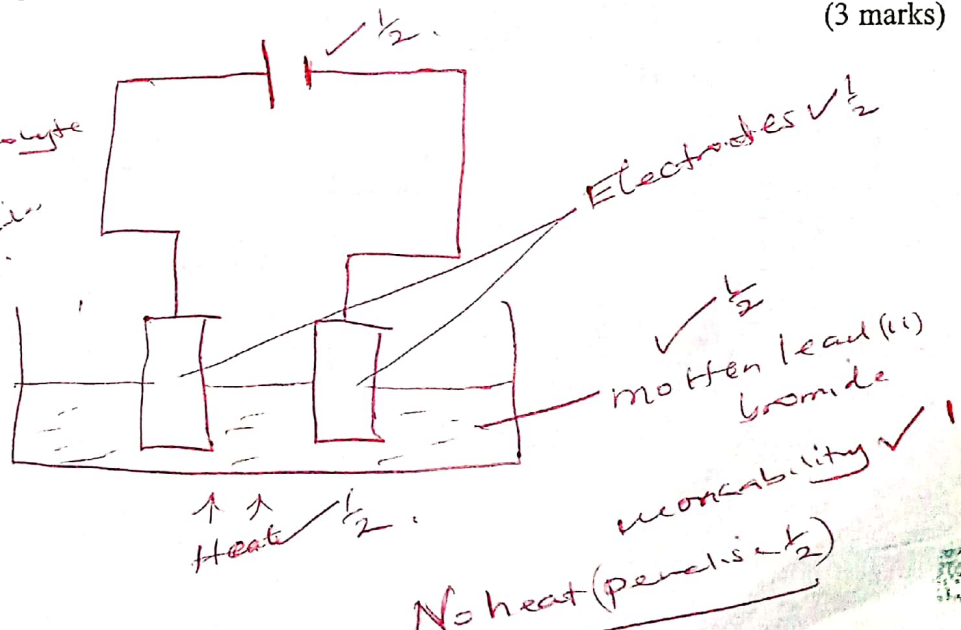
(c) Give a reason for the answer in (b). (1 mark)

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)

Wearability
- Electrodes are above the electrolyte
- Cells
- Heat
- Anodes and cathodes not correctly labelled



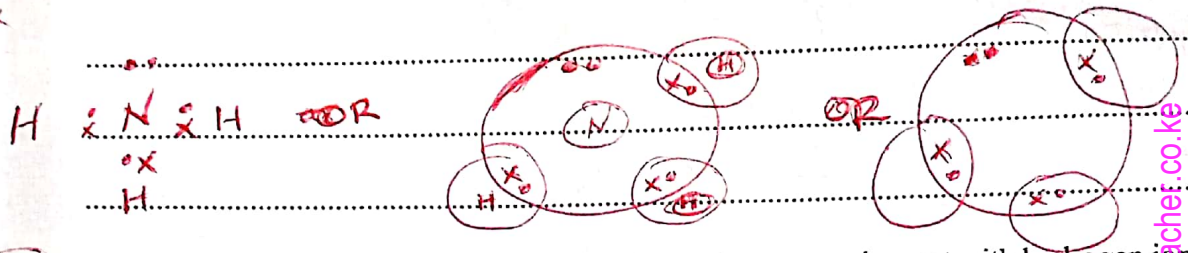
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8. (a) State the difference between a covalent bond and a dative covalent bond. (1 mark)

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)

Answer 1/2 mark
4 only - ok
used



(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 electron / unshared pair of e-

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

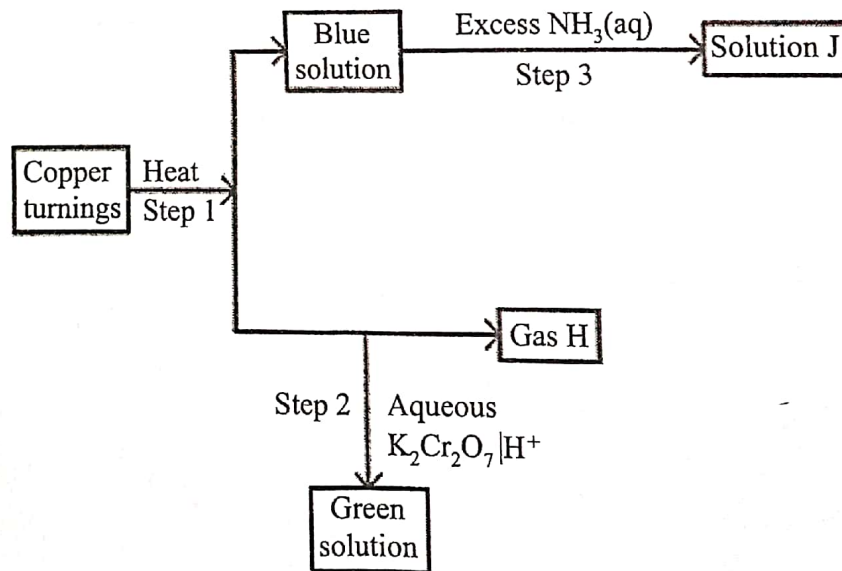


Figure 2

Reagent dilute or
H₂SO₄ (aq)

- (a) State the reagent that is added in step 1. (1 mark)

 Conc. sulphuric(VI) acid or 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⁺ (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)

 $3 Cl_2(g) + 6 NaOH(aq) \rightarrow NaClO_3(aq) + 5 NaCl(aq) + 3 H_2O(l)$

- (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
 - 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)

 $Zn^{2+}(aq) + 4 OH^{-}(aq) \rightarrow [Zn(OH)_4]^{2-}(aq)$

 OR

 $Zn(OH)_2(s) + 2 OH^{-}(aq) \rightarrow [Zn(OH)_4]^{2-}(aq)$

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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 ✓ $\frac{1}{2}$ Ionic radius ✓ $\frac{1}{2}$
 smaller than ^{corresponding} atomic radius / vice versa.

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

I. least reactive M. ✓ $\frac{1}{2}$ (½ mark)

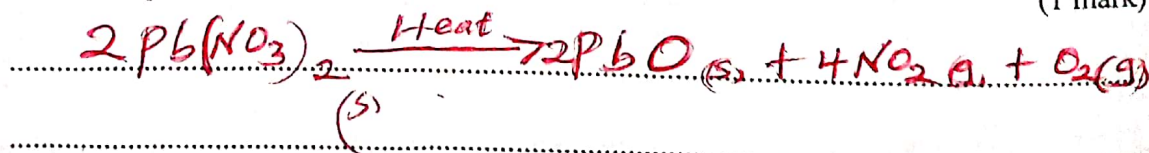
II. most reactive N ✓ $\frac{1}{2}$ (½ mark)

- (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

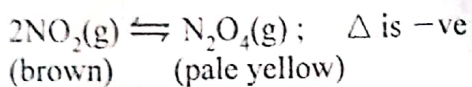
- (a) Write an equation for the reaction. (1 mark)



Accept
 A lot of heat is required
 Less heat is required

Tried

- (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 N_2O_4 is formed since the rxn is exothermic

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

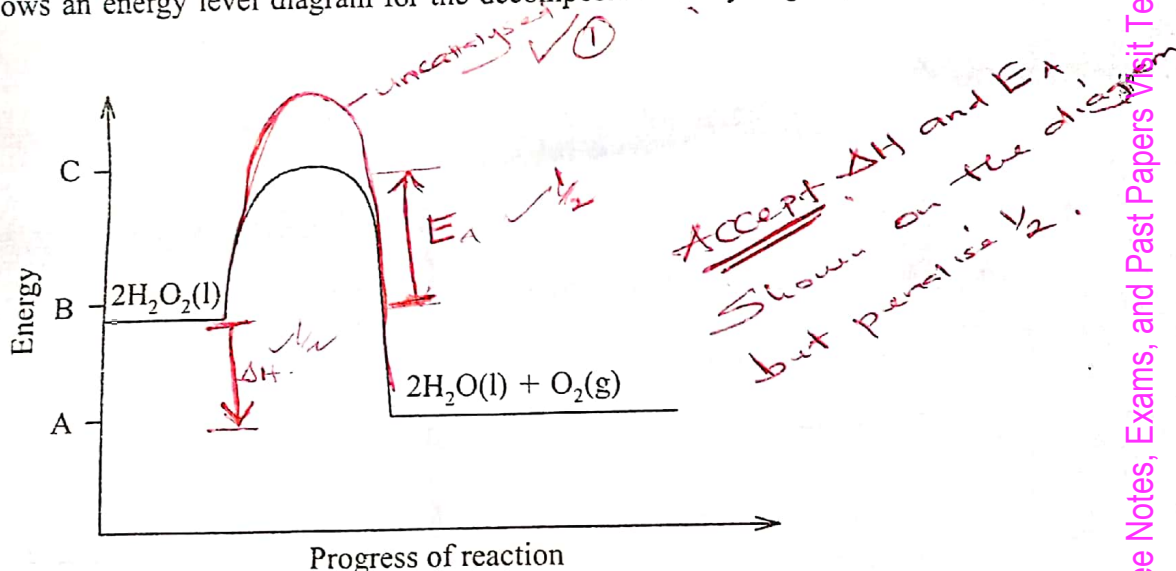


Figure 3

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

- (i) ΔH of the reaction; (1 mark)

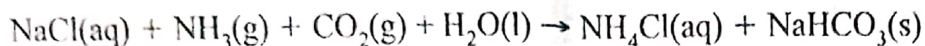
$\Delta H = A - B$ ✓ 1

- (ii) activation energy. (1 mark)

$E_A = C - B$ ✓ 1

- (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)

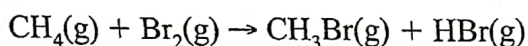
Calcium carbonate decomposes to form CaO and CO_2

- 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.

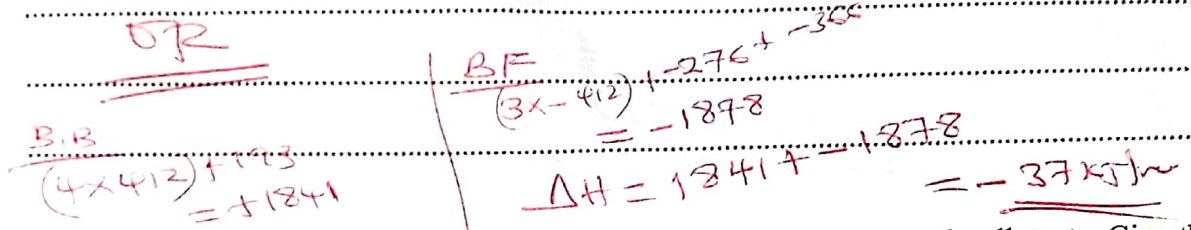
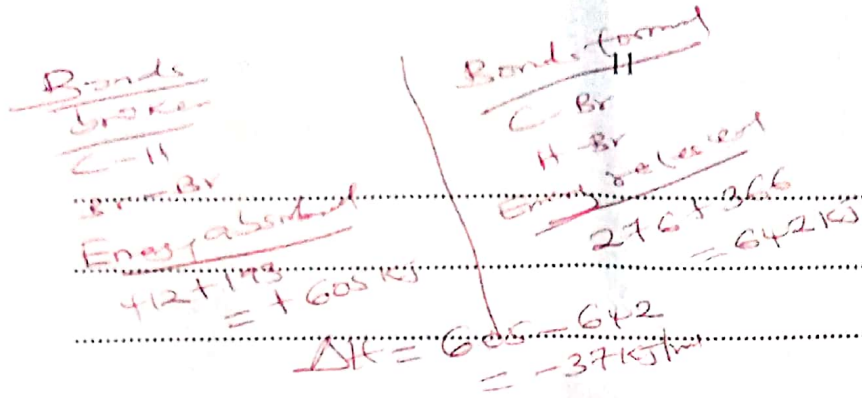
Table 4

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

(3 marks)

✓ 1/2
 Ca(OH)_2 reacts with NH_4Cl to form CaCl_2 .

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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)

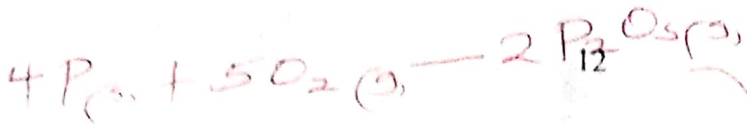
Fractional distillation / distillation

(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 = $\frac{6.2}{31} = 0.2 \checkmark$

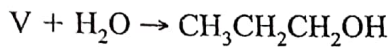
Moles of $P_2O_5 = \frac{1}{2} \times 0.2 = 0.1 \text{ mol}$

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

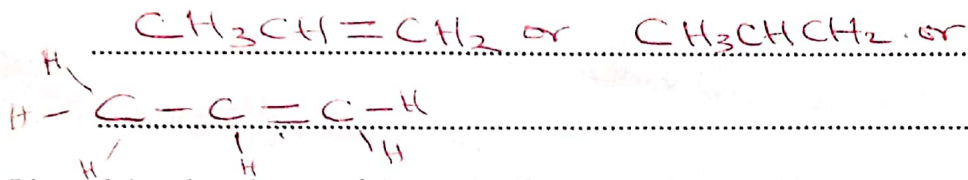
mass of $P_2O_5 = 142 \times 0.1 = 14.2 \text{ g}$

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)

Pres. warming

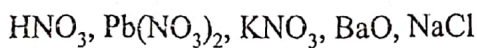
Heat or pressure of 60-70 atm or Temp of 250-300°C.

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

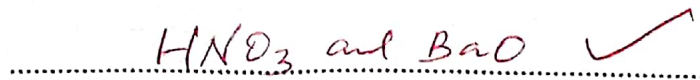
Addition or oxidation

21. Salts may be classified as soluble or insoluble.

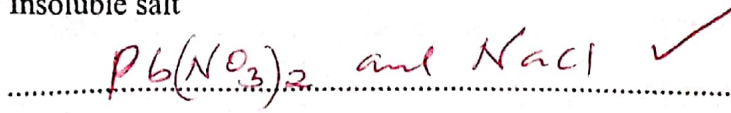
(a) Select from the following list a pair of compounds that can be used to prepare a soluble and an insoluble salt.



(i) Soluble salt (1 mark)



(ii) Insoluble salt (1 mark)



Heat/Boil
13

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

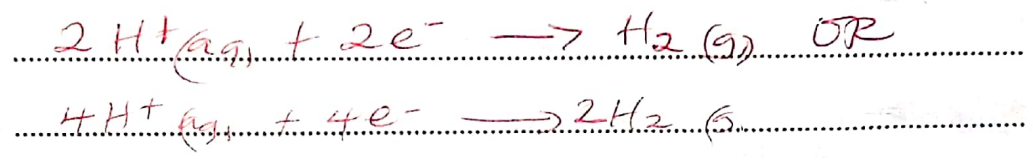
- Evaporate the mixture to saturation
- Allow to cool
- Filter the residue

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

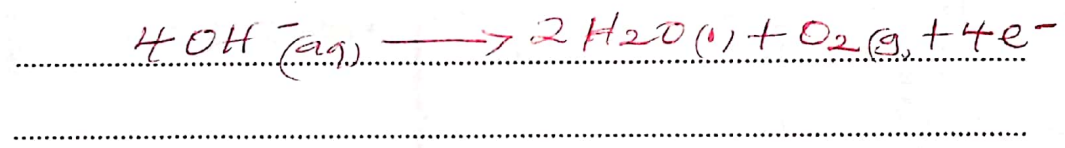
- Nature of the electrode
- Concentration
- Position of the element in the reactivity series
- Position on the electrochemical series

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

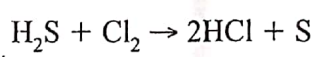
(i) cathode; (1 mark)



(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}

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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)

$$\begin{array}{l} \text{RMM of SO}_2 = 64 \quad \checkmark \frac{1}{2} \\ \text{RMM of CO}_2 = 44 \end{array} \quad \left| \quad \begin{array}{l} t_{\text{CO}_2} = 79.60 \text{ s} \\ \underline{\hspace{2cm}} \end{array}$$

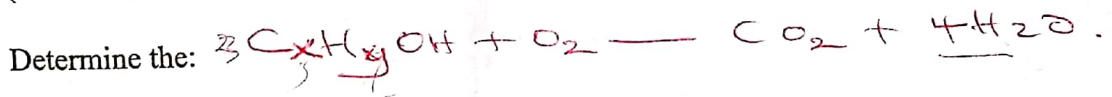
$$\frac{t_{\text{SO}_2}}{t_{\text{CO}_2}} = \sqrt{\frac{64}{44}} \quad \checkmark \frac{1}{2}$$

(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)

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

$$\sqrt{\frac{m_X}{20}} = 1.45$$

25. Complete combustion of one mole of an alkanol, C_xH_yOH gave four moles of water. (C = 12.0, H = 1.0, O = 16.0)



(a) values of x and y

(i) x = 23 (1 mark)

(ii) y = 7 (1 mark)

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

3 moles

C₂₃H₇OH

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 = 5.7 / 1.9 = 3
1.25 → 2.5 → 5.0 → 10.0 ✓
10.0g ✓

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

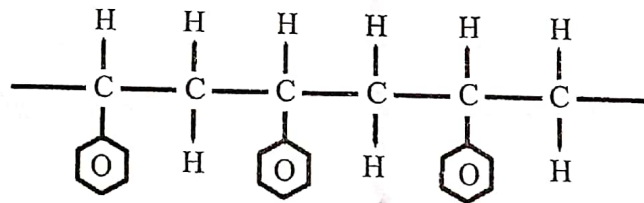
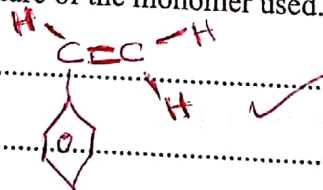


Figure 4

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

polyphenylethene 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

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

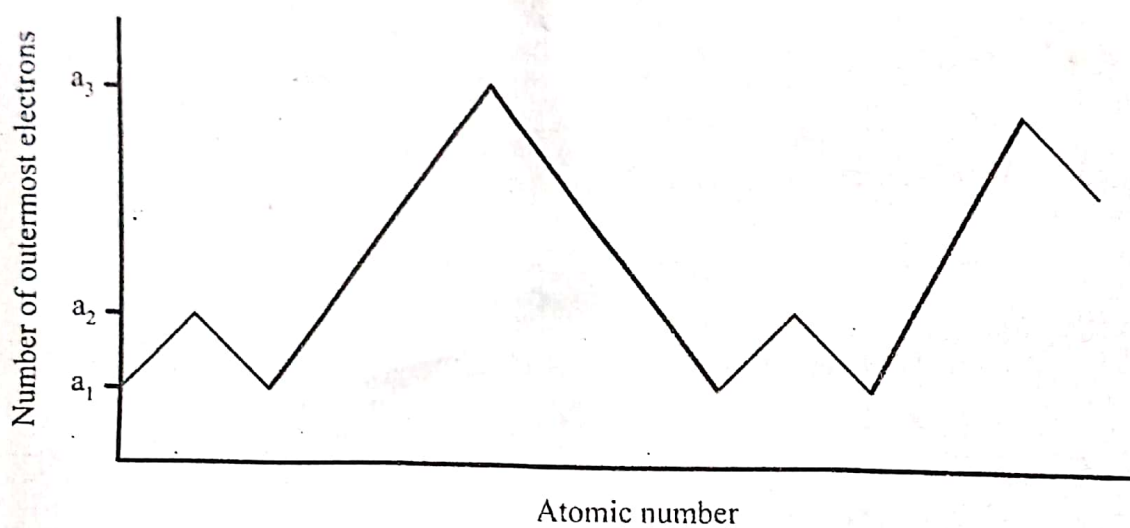


Figure 5

- (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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