CHEMISTRY PAPER 1 MARKING SCHEME
FORM 3,END YEAR 2023

1. Given a mixture of sodium chloride, silver chloride, and ammonium chloride, describe how each component can be obtained. (3 Marks)

- Heat the mixture to sublime ammonium chloride and cool the vapour against a cool surface to deposit it.
- Add water to the remaining mixture and stir to dissolve sodium chloride. Filter the mixture to obtain sodium chloride solution as a filtrate and silver chloride as a residue.
- Dry the residue between fresh filter papers.
- Heat the filtrate to saturation and allow to cool to obtain crystals of sodium chloride.

[marking points at half mark each]

2. (a) ***To remove carbon (IV)oxide gas***

   (b) $3Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$

   (c) ***Argon***

3. (a) A-***Hot compressed air***

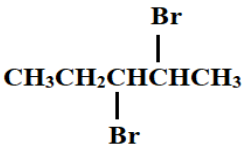
   B- ***Molten sulphur and water***

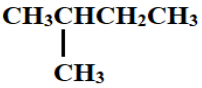
   C- ***Super heated water***

   (b) ***To melt sulphur deposit***

   (c) ***sulphur has low melting point***

4. Give the systematic name of the following compounds (2 Marks)





2,3-dibromopentane 2-methylbutane

5. (a) Define Gay-Lussac's law (1 Mark)

When gases react at constant temperature and pressure, they do so in volumes that bear a simple ratio to one another, and to the volumes of the product if all the products are gaseous.

(b) In an experiment a mixture of 126.0cm^3 of nitrogen gas and 120.0cm^3 of hydrogen gas was heated in the presence of iron catalyst. Determine the composition of the final gaseous mixture. (2 Marks)

$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

$H_2 : N_2$

$3 : 1$

$120 : \frac{120 \times 1}{3}$

$= 40$

$120cm^3$ H_2 only requires $40cm^3$ N_2

remaining nitrogen

$126cm^3 - 40cm^3 = 86cm^3$

ammonia formed

since all hydrogen reacted

$H_2 : NH_3$

$3 : 2$

$120 : \frac{120 \times 2}{3} = 80cm^3$

product is $80cm^3$ NH_3 and $86cm^3$ unreacted N_2

6. The table below shows certain properties of substances **M**, **N**, **K**, and **L**.

Substance	Melting point (°C)	Solubility in water	Electrical conductivity
M	-119	Soluble	Solution does not conduct
N	1020	Soluble	Solution conducts
K	1740	Insoluble	Does not conduct
L	1600	Insoluble	Conducts at room temperature

Which of the substances:

a) Is a metal (½ Mark)

L

b) Has a simple molecular structure (½ Mark)

M

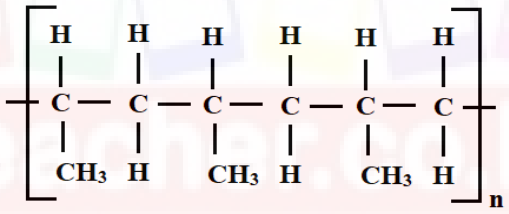
c) Has a giant covalent structure (½ Mark)

K

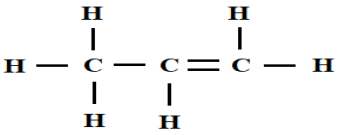
d) Has a giant ionic structure (½ Mark)

N

7. A polymer has the following structure

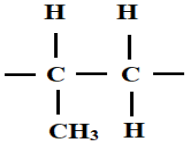


a) Draw and name the monomer (2 Marks)



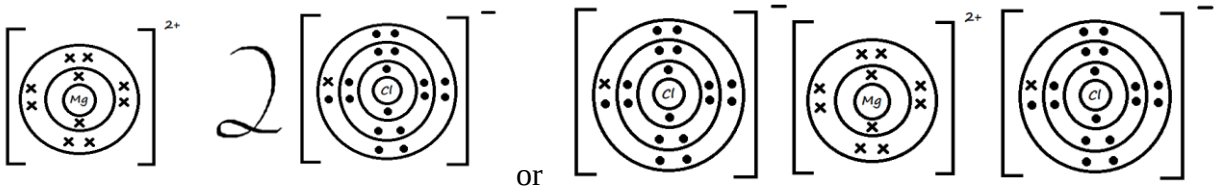
propene

b) Draw the repeating unit of the polymer (2 Marks)



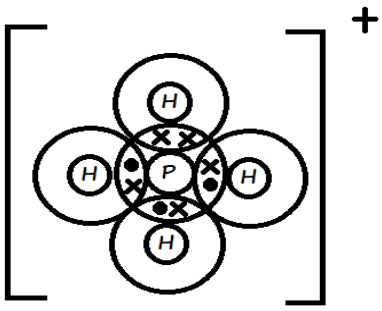
8. Draw dot (•) and cross (×) diagrams to show bonding in:

a) Magnesium chloride (2 Marks)



or

b) Phophonium ion (PH_4^+) (2 Marks)



9.

a) A piece of burning magnesium was introduced into a jar of nitrogen. State and explain the observation made (2 Marks)

The magnesium continues to burn in nitrogen. Magnesium reacts with nitrogen to form magnesium nitride.

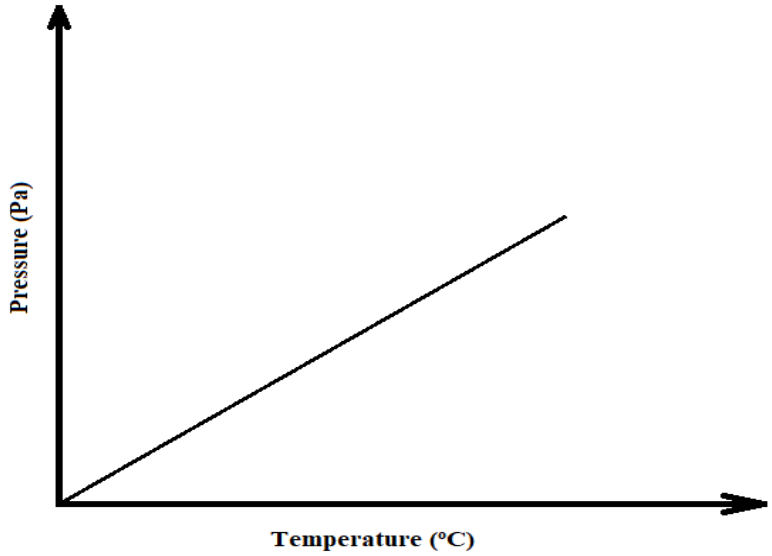
b) Water was added to the product of the reaction in **a)** and the resultant solution tested with red and blue litmus papers. State and explain the observation made (2 Marks)

Red litmus paper turns blue while blue litmus paper remains blue. Magnesium nitride reacts with water to form magnesium hydroxide and ammonia, which are alkaline.

10. Briefly describe how sodium carbonate powder can be obtained in the laboratory starting with concentrated sodium hydroxide solution
(2 Marks)

Bubble a limited amount of carbon (IV) oxide gas through the sodium hydroxide solution to obtain sodium carbonate solution. Heat the solution to evaporation to allow formation of sodium carbonate powder.

11. The sketch graph below shows the relationship between pressure and temperature of a gas in a fixed volume container.



a) State the relationship between pressure and temperature that can be deduced from the graph (1 Mark)

An increase in temperature results in an increase in pressure of a fixed mass of gas.

b) Using the kinetic theory of matter, explain the relationship shown by the sketch graph (2 Marks)

An increase in temperature results to an increase in kinetic energy of gas particles. The number of collisions between the particles and the walls of the container increases, hence, an increase in pressure.

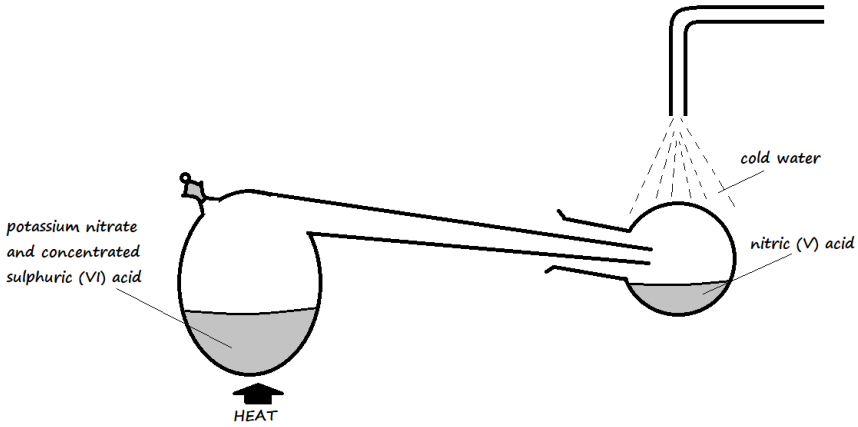
12. (a) Group VIII elements are said to be inert. Explain. (1 Mark)

They have fully occupied outermost energy levels hence do not lose or gain electrons

(b) In terms of structure and bonding, explain why group VIII elements exist as gases at room temperature (2 Marks)

Their atoms are held together by weak Van der Waal's forces that require little energy to break. At room temperature, the energy is sufficient to break these forces hence atoms are free to move.

13. Nitric (V) acid may be prepared in the laboratory by the action of concentrated sulphuric (VI) acid in a suitable nitrate and distilling off the nitric (V) acid



a) Why does the setup only consist of apparatus made of glass? (1 Mark)

Nitric acid attacks rubber and other materials but glass is inert.

b) Pure nitric (V) acid is colourless but the product in the collection vessel is yellow. Explain (1 Mark)

Some nitric (V) acid decomposes in the presence of heat to yield nitrogen (IV) oxide which is brown and later condenses to form yellow dinitrogen tetra-oxide. The dinitrogen tetra-oxide dissolves in the acid to yield the yellow colouration.

c) Why is it possible to separate nitric (V) acid from sulphuric (VI) acid in the setup? (1 Mark)

Nitric (V) acid is volatile and therefore easily vaporises while sulphuric (VI) acid is not volatile and does not easily vaporise.

14. Name the catalyst used in the following processes:

a) Large scale manufacture of ammonia gas in the Haber process (1 Mark)

Finely divided iron catalyst

b) Large scale manufacture of concentrated sulphuric (VI) acid in the Contact process (1 Mark)

Platinum or Vanadium (V) oxide.

c) Laboratory preparation of oxygen using hydrogen peroxide (1 Mark)

Manganese (IV) oxide

15. What mass of magnesium carbonate would remain if 15.0g of magnesium carbonate reacts with 25cm^3 of 4M hydrochloric acid solution? (3 Marks)

$MgCO_{3\,(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2\,(aq)} + CO_{2\,(g)} + H_2O_{(l)}$

Moles HCl

1000cm^3 contains 4 moles

25cm^3 contains $\frac{25 \times 4}{1000}$

= 0.1 moles HCl

Moles $MgCO_3$

RFM = 24 + 12 + 3(16)

= 84

If 84g = 1 mole

15g = $\frac{15 \times 1}{84}$ = 0.1786 moles

moles $MgCO_3$ reacting

HCl	:	$MgCO_3$
2	:	1
0.1	:	$\frac{0.1 \times 1}{2}$

= 0.05 moles

remaining $MgCO_3$

Actual - Reacting = Remaining

0.1786 - 0.05 = 0.1286 moles

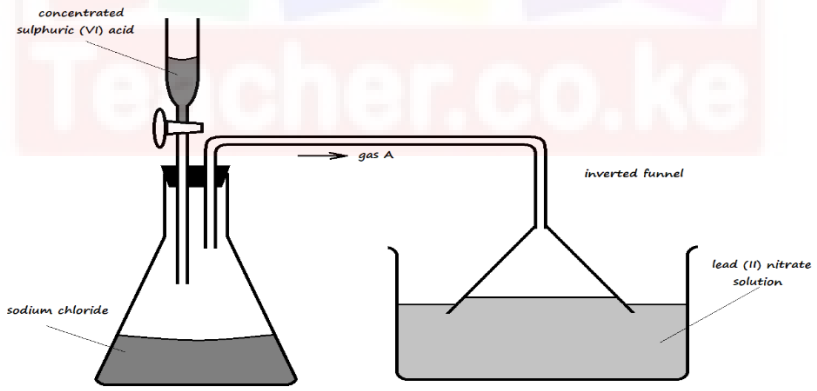
moles to mass

since 1 mole = 84g

0.1286 moles = $\frac{0.1286 \times 84}{1}$

= 10.8024g

16. The setup below was used to investigate the reaction of a certain gas with lead (II) nitrate solution



a) Identify gas **A** (1 Mark)

Hydrogen chloride gas

b) State the observation made in the trough containing lead (II) nitrate solution (1 Mark)

A white precipitate is formed in the solution

c) Write an ionic equation for the reaction occurring in the trough (1 Mark)

$Pb^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_{2\,(aq)}$

17. Element **Q** reacts with dilute acids, but not with cold water. Element **R** does not react with dilute acids. Element **S** displaces element **P** from its oxide. **P** reacts with cold water. Arrange the four elements in order of reactivity, starting with the most reactive element. (2 Marks)

$$S \rightarrow P \rightarrow Q \rightarrow R$$

18. A fixed mass of a gas occupies $200cm^3$ at 0^oC and 740mmHg pressure. Calculate its volume at -48^oC and 780mmHg. (3 Marks)

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$T_1 = 0 + 273 = 273$$

$$T_2 = -48 + 273 = 225$$

$$\frac{740 \times 200}{273} = \frac{780 \times V_2}{225}$$

$$V_2 = \frac{740 \times 200 \times 225}{273 \times 780}$$

$$= 15.29cm^3$$

19. In an experiment, a sample of an oxide of lead was heated over coke for some time. The following results were obtained:

Mass of the oxide before heating = 8.92g

Mass of residue after heating = 8.28g

a) Determine the empirical formula of the oxide of lead (Pb = 207, O = 16) (2 Marks)

mass of oxygen released

8.92g – 8.28 = 0.64g

mass of magnesium = 8.28g

	Pb	O
mass	8.28	0.64
R.A.M.	207	16
mole	$\frac{8.28}{207}$	$\frac{0.64}{16}$
	=0.04	=0.04
ratio	$\frac{0.04}{0.04}$	$\frac{0.04}{0.04}$
	1	1

E.F. = PbO

b) Write an equation for the reaction in the experiment above (1 Mark)

$$2PbO_{(s)} + C_{(s)} \rightarrow 2Pb_{(s)} + CO_{2(g)}$$

20. The information in the table below relates to the physical properties of the chlorides of certain elements.

Formula of compound	**NaCl**	**$MgCl_2$**	**$AlCl_3$**	**$SiCl_4$**	**PCl_3**	**SCl_2**
Boiling point (^oC)	1470	1420	Sublimes at 180^oC	60	75	60
Melting point (^oC)	800	710		-70	-90	-80

a) Select **two** chlorides that are liquid at room temperature (2 Marks)

$SiCl_4$, PCl_3, SCl_2

[the first two of the candidate's answer]

b) Explain why $AlCl_3$ has a much lower melting point than $MgCl_2$, although both aluminium and magnesium are metals. (2 Marks)

$AlCl_3$ has its atoms bonded covalently to each other to form a simple molecule, while $MgCl_2$ experiences ionic bonding. $AlCl_3$ therefore has weak Van der Waal's forces that require little energy to weaken while $MgCl_2$ has strong ionic bonds that require a lot of energy to weaken.

21. 400cm^3 of a gas **D** diffuses through a porous plug in 50 seconds, while 600cm^3 of oxygen gas diffuses from the same apparatus in 30 seconds. Calculate the relative molecular mass of gas **D**. (O = 16) (2 Marks)

$$\frac{R_D}{R_{O2}} = \sqrt{\frac{M_{O2}}{M_D}}$$

$$R_D = \frac{V_D}{T_D} = \frac{400}{50}$$

$$= 8cm^3/sec$$

$$R_{O2} = \frac{V_{O2}}{T_{O2}} = \frac{600}{30}$$

$$= 20cm^3/sec$$

$$M_{O2} = 2(16)$$

$$= 32$$

$$\frac{8}{20} = \sqrt{\frac{32}{M_D}}$$

$$\left(\frac{8}{20}\right)^2 = \frac{32}{M_D}$$

$$M_D = 32 \div \left(\frac{8}{20}\right)^2$$

$$= 200$$

22. Calculate the volume of oxygen produced when 10g of silver nitrate was completely decomposed by heating at standard temperature and pressure
(Ag = 108, N = 14, O = 16, Molar gas volume at s.t.p. = 22400cm^3) (3 Marks)

$2AgNO_{3\,(s)} \xrightarrow{heat} 2Ag_{(s)} + 2NO_{2\,(g)} + O_{2\,(g)}$

10g

moles $AgNO_3$

RFM = 108 + 14 + 3(16)
= 170

If 170g = 1 mole
10g = $\frac{10 \times 1}{170}$
= 0.05882 moles

moles O_2

$AgNO_3$: O_2
2 : 1
0.05882 : $\frac{0.05882 \times 1}{2}$
= 0.02941 moles

volume of O_2

since 1 mole = 22400cm^3
0.02941 moles = $\frac{0.02941 \times 22400}{1}$
= 658.82cm^3

23. The electron arrangement of ions W^{3+} and Z^{2-} are 2.8 and 2.8.8 respectively.

a) In which groups do elements **W** and **Z** belong? (1 Mark)

W – Group III Z – Group VI

b) Write the formula of the compound that would be formed between **W** and **Z** (1 Mark)

W_2Z_3

24. 20cm^3 of a solution containing 2.7g/dm^3 of an alkali **XOH** completely reacted with 25cm^3 of 0.045M sulphuric (VI) acid. Calculate the relative atomic mass of element **X** (O = 16, H = 1)

(3 Marks)

moles H_2SO_4

1000cm^3 → 0.045moles
25cm^3 → $\frac{25 \times 0.045}{25}$
= 0.001125 moles

moles XOH

H_2SO_4 : XOH
1 : 2
0.001125 : $\frac{0.001125 \times 2}{1}$
= 0.00225 moles

mass XOH reacting

1000cm^3 contains 2.7g
20cm^3 contains $\frac{20 \times 2.7}{1000}$
= 0.054g

this implies
0.00225 moles XOH = 0.054g XOH
thus 1 mole XOH = $\frac{1 \times 0.054}{0.00225}$
= 24

Since R.F.M. XOH = 24
X + 16 + 1 = 24
X = 24 – 16 – 1
X = 7

25. Calculate the number of sulphate ions in $150cm^3$ of 0.1M aluminium sulphate, $Al_2(SO_4)_3$ (3 Marks)

$$(L = 6.023 \times 10^{23})$$

$Al_2(SO_4)_{3\,(aq)} \rightleftharpoons 2Al^{3+}_{(aq)} + 3SO_4^{2-}{}_{(aq)}$

$150cm^3$

0.1M

moles $Al_2(SO_4)_3$

$1000cm^3$ contains 0.1 moles

$150cm^3$ contains $\frac{150 \times 0.1}{1000}$

$= 0.015$ moles

moles SO_4^{2-}

$Al_2(SO_4)_3 : SO_4^{2-}$

$1 : 3$

$0.015 : \frac{0.015 \times 3}{1}$

$= 0.045$ moles

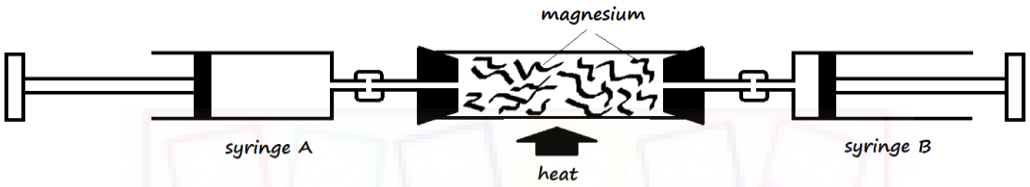
number of ions

since 1 mole $= 6.023 \times 10^{23}$

0.045 moles $= 0.045 \times 6.023 \times 10^{24}$

$= 2.71035 \times 10^{22}$ ions

26. The following apparatus was set up to investigate the percentage of oxygen in air by slowly passing $100cm^3$ of air from syringe **A** to syringe **B** and then back until the volume of air remained constant. Study it and use it to answer the questions that follow.



a) Identify the mistake in the setup (1 Mark)

Use of magnesium in the combustion tube

b) Why was the air moved slowly from syringe **A** to syringe **B** and vice versa? (1 Mark)

To ensure most of its active part reacted with the metal in the combustion tube

c) Write an equation for the reaction that took place in the combustion tube after the mistake was corrected (1 Mark)

$$2Cu_{(s)} + O_{2\,(g)} \rightarrow 2CuO_{(s)}$$

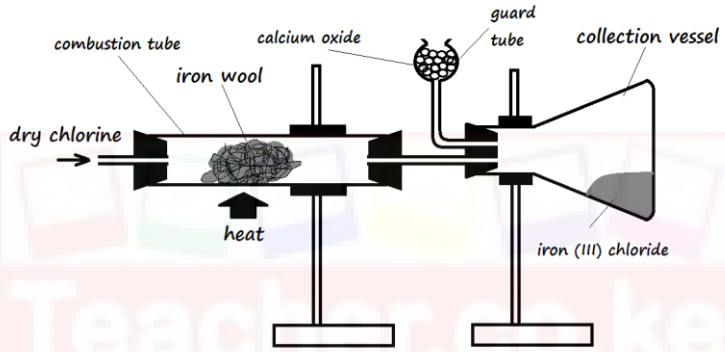
27. A luminous flame produces bright yellow light. Explain (1 Mark)

Due to insufficient supply of air, unburnt carbon particles heat up and glow to give yellow light

28. Magnesium reacts by losing its 2 valence electrons. How does its 1st and 2nd ionization energy compare? Explain (2 Marks)

The 2nd ionization energy is higher than the 1st ionization energy. After losing the first valence electron, there are fewer electrons for the number of protons left, resulting in an increase in the effective nuclear force of attraction that holds the remaining electrons more tightly.

29. The apparatus below was used for the preparation of iron (III) chloride in the laboratory. Study it and use it to answer the questions that follow.



a) Why is it preferred to use calcium oxide rather than calcium chloride in the guard tube? (2 Marks)

Apart from preventing moisture from entering the collection vessel, calcium oxide reacts with excess chlorine to minimise its emission to the environment.

b) What property of iron (III) chloride makes it possible to be collected as shown in the diagram?
(1 Mark)

It sublimes when heated and deposits when cooled