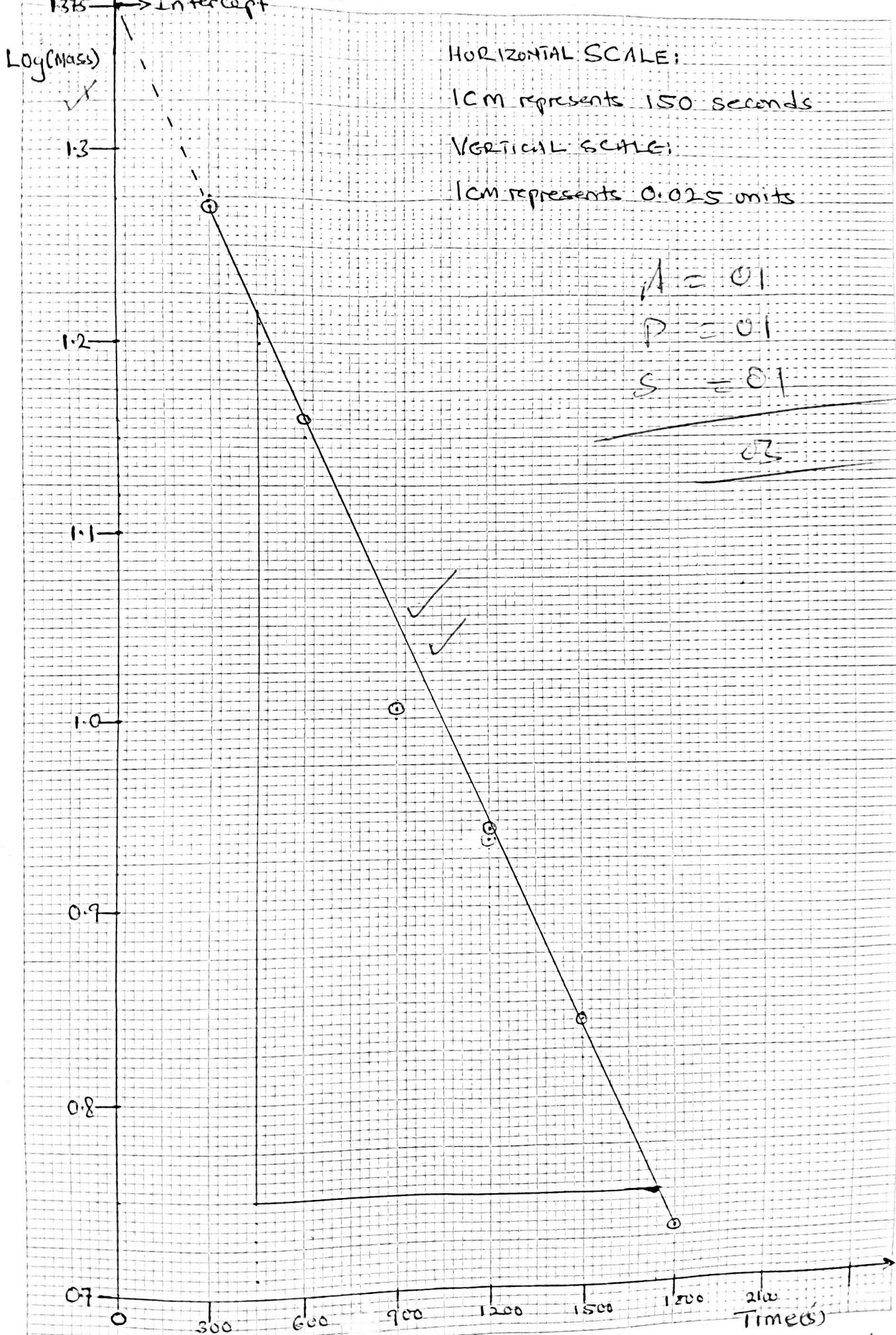


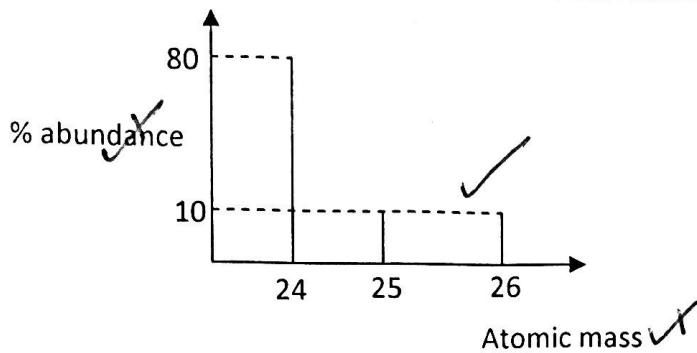
JJEB UACE MOCK 2020 CHEMISTRY P525/2 MARKING GUIDE

Number	Possible response	SCORE
1(a) (i)	Relative atomic mass is the ratio of the mass of an atom of an element to a twelfth ($\frac{1}{12}$ th) the mass of one atom carbon-12 isotope ✓	0.1
(ii)	Relative abundance refers to the proportion of a given isotope in nature as compared to other isotopes of the same element in a given sample ✓	0.1
(iii)	Relative intensity refers to the height of the peak formed by an isotope on the mass spectrum ✓	0.1
(b)	<ul style="list-style-type: none"> • The mass spectrometer is evacuated through the evacuation pump to prevent interference to movement of the positive ions by air molecules • A vaporized magnesium sample is then introduced into the ionization chamber where it's subjected to a beam of moving electrons from the electron gun that collide with the Magnesium gaseous atoms to cause ionization and form positive gaseous ions; $Mg_{(g)} \longrightarrow Mg_{(g)}^{2+} + 2 e^-$ • The positive ions formed are accelerated at the same velocity and kinetic energy by the electric field so that they enter the magnetic field. • In the magnetic field the positive ions are deflected according to their mass to charge ratio, such that ions of higher mass to charge ratio are deflected least while those of low mass to charge ratio are deflected most. • The strength of the magnetic field is therefore varied such that different ions hit or enter the collector. The positive ions with same mass to charge ratio enter the collector and produce an electric current which is amplified and detected as a line peak on the mass spectrum. • Each line peak on the mass spectrum corresponds to an isotope with a specific mass. The height of the line peak is directly proportional to the relative abundance of the isotope that produced it. 	0.6
	$\text{Relative atomic mass} = \sum \left(\frac{\text{Isotopic mass} \times \text{Relative abundance}}{\text{Total abundance}} \right) \checkmark$	
(c) (i)	<p>Let each of the percentage abundance of ^{26}Mg and ^{25}Mg be n The percentage abundance of ^{24}Mg will be $(100 - 2n)$</p> <p>Relative atomic mass $= \frac{(25n) + (26n) + (24 \times (100 - 2n))}{100}$</p> <p style="text-align: center;">$= \frac{(25n) + (26n) + (2400 - 48n)}{100}$</p> <p style="text-align: center;">$= \frac{51n - 24n + 2400}{100}$</p> <p style="text-align: center;">$= 51n - 48$</p> <p style="text-align: center;">$24.3 = 51n - 48$</p> <p style="text-align: center;">$2430 - 2400 = 51n - 48$</p> <p style="text-align: center;">$30 = 51n - 48$</p> <p style="text-align: center;">$30 = 51n$</p> <p style="text-align: center;">$n = \frac{30}{51}$</p> <p style="text-align: center;">$n = 0.588$</p> <p style="text-align: center;">\therefore Each line peak on the mass spectrum \checkmark corresponds to the isotope ^{25}Mg</p> <p>The percentage abundance of $^{25}Mg = 10$</p> <p>The percentage abundance of $^{26}Mg = 10$</p> <p>The percentage abundance of $^{24}Mg = 80 \checkmark$</p>	1½

A GRAPH OF Log(Mass) AGAINST TIME(s)



(ii)

Mass spectrum of Magnesium

(d)

Values plotted

$\log(\text{Mass})$	1.27	1.16	1.05	0.94	0.84	0.73 ✓
Time (s)	300	600	900	1200	1500	1800

04

See the graph attached ;

 $Axes = 01 \quad Plotting = 01 \quad shape = 01$ e (i) The decay is first order or one because a graph of $\log(\text{Mass})$ against time plotted is a straight line with a negative slope.

(ii)

From the equation for first order reactions ; $\log Nt = \frac{-\Lambda t}{2.303} + \log No$

$$\text{Slope} = \frac{-\Lambda}{2.303}$$

$$\begin{aligned} \text{From graph slope} &= \frac{\text{Change in } \log(\text{Mass})}{\text{time}} \\ &= \frac{1.215 - 0.75}{450 - 1740} = -3.6 \times 10^{-4} \end{aligned}$$

$$\frac{-\Lambda}{2.303} = -3.6 \times 10^{-4} \quad \checkmark$$

$$\Lambda = 3.6 \times 10^{-4} \times 2.303$$

$$\Lambda = 8.29 \times 10^{-4} \text{ per second}$$

1½

(iii)

Original mass No;

$$\log No = \text{intercept}$$

$$\text{From graph intercept} = 1.375 \quad \checkmark$$

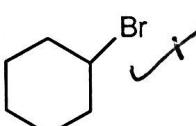
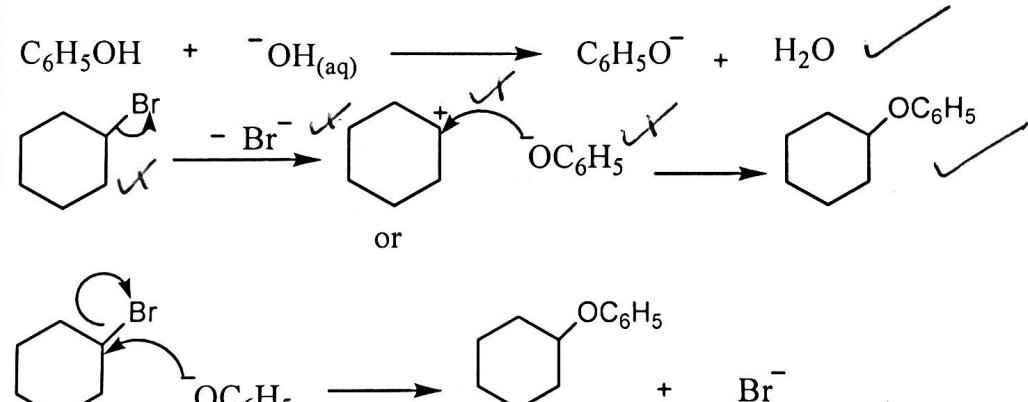
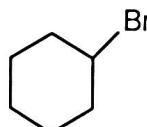
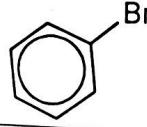
$$\log No = 1.375 \quad \checkmark$$

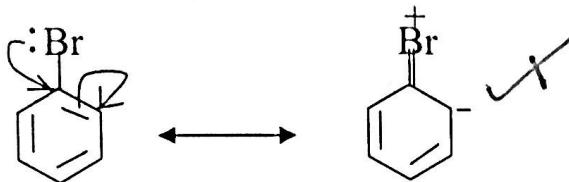
$$No = 10^{1.375}$$

$$No = 23.71g \quad \checkmark$$

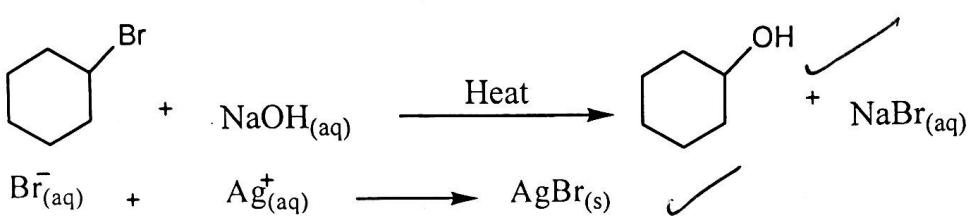
01

20

2(a) (i)	<p>RMM of $C_nH_{2n-1}Br$ = $12n + 2n - 1 + 80$ $= 14n + 79$</p> <p>Percentage of Bromine in RMM is 49.08</p> <p>Therefore $\frac{80}{14n+79} \times 100 = 49.08$</p> <p>$n = 5.999 \approx 6$</p> <p>Molecular mass = $C_6H_{11}Br$</p>	02
(ii)	<p>Structure :</p>  <p>Name : Bromocyclohexane</p>	01
(b) (i)	Aqueous sodium hydroxide solution and Heat	01
(ii)	$C_6H_5OH + ^-\text{OH}_{(\text{aq})} \longrightarrow C_6H_5\text{O}^- + H_2O$ 	04
(c) (i)	<p>Reagent : Hot sodium hydroxide solution, dilute nitric acid and silver nitrate solution</p> <p>Observation :</p> <p> Pale yellow precipitate</p> <p> No observable change</p>	03
(ii)	The lone pairs of electrons on the Bromine atom in Bromobenzene interact with the pie bonding system to form a partial double bond which strengthens the carbon-Bromine bond making it harder to break for substitution of the bromine atom by the hydroxide ion from sodium hydroxide.	

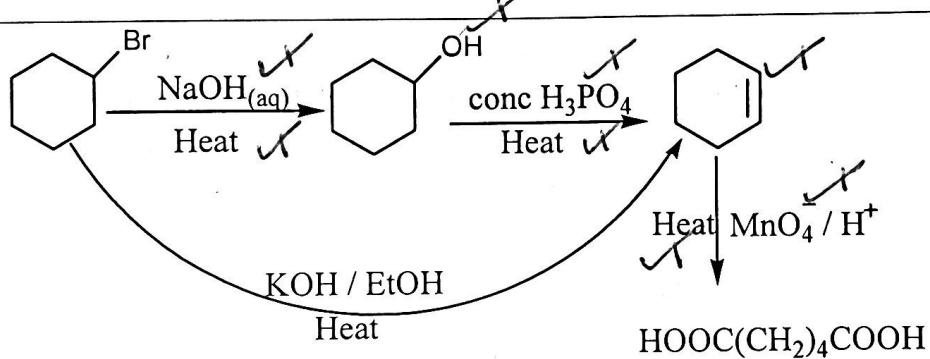


However the carbon-Bromine bond in Bromocyclohexane is weak and it is easily broken to substitute the Bromine atom forming cyclohexane and Bromide ions that react with silver nitrate solution to form silver Bromide that is observed as a yellow precipitate



CS

(d)

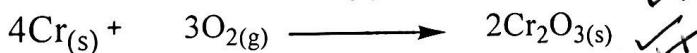


O4

20

3 (a) (i)

Chromium reacts with oxygen in air when heated to form chromium(III) oxide



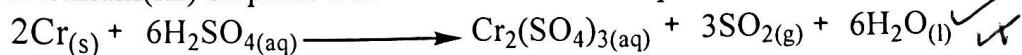
(ii)

Chromium reacts with warm dilute sulphuric acid to form chromium(II) sulphate and hydrogen gas



O4

Chromium reacts with hot concentrated sulphuric acid which oxidizes it to form chromium(III) sulphate and itself reduced to sulphur dioxide and water

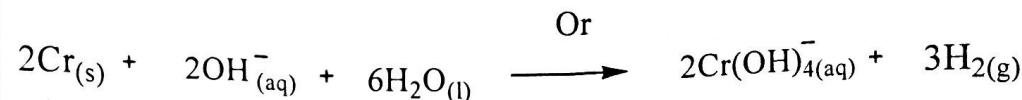


(iii)

Chromium reacts with hot sodium hydroxide solution to form a solution of a chromite and hydrogen gas



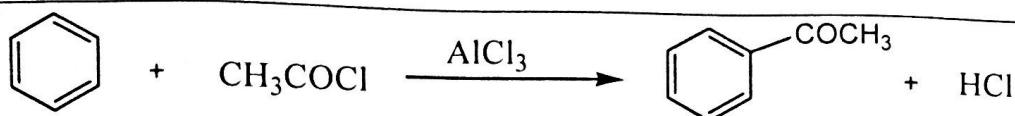
O2



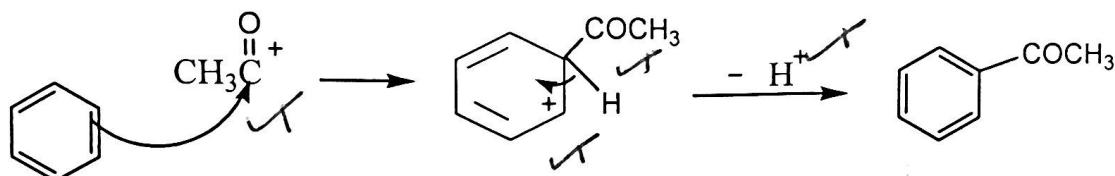
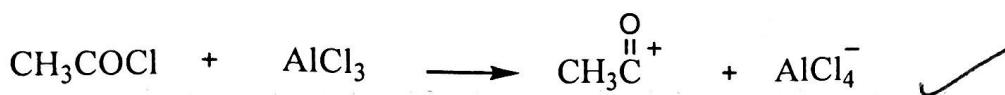
(b) (i)	The chromium atom (24) with electron configuration $(1S^2 2S^2 2P^6 3S^2 3P^6 4S^1 3d^5)$ has partially filled 3d orbital and forms several stable ions with partially filled 3d orbital e.g chromium (III) ion with electron configuration $1S^2 2S^2 2P^6 3S^2 3P^6 3d^3$	02
(ii)	<ul style="list-style-type: none"> Both Aluminium and chromium are passive to nitric acid or do not react with nitric acid Both aluminium and chromium react with air when strongly heated to form the respective oxides. The reaction slows down in both elements due to formation of a film of the oxide that is passive Both aluminium and chromium react with steam when heated to form respective oxide and hydrogen gas Both elements react with dilute warm mineral acids to form the respective salts and hydrogen gas Both aluminium and chromium react with hot concentrated sodium hydroxide to form Aluminate and chromite solutions respectively with release of hydrogen gas 	05
C (i)	Observation : The magnesium ribbon dissolves with effervescence of a colourless gas to form a green precipitate	1½
(ii)	<p>Explanation : A solution of chromium(III) sulphate contains hydrated ions of chromium(III) ions $(Cr(H_2O)_6^{3+})$, in which the chromium(III) ion has a high charge density, therefore reacts with the water molecules in solution to form chromium(III)hydroxide observed as a green precipitate and hydrogen ions that make the solution acidic</p> $Cr(H_2O)_6^{3+}_{(aq)} + 3H_2O_{(l)} \longrightarrow Cr(H_2O)_3(OH)_3(s) + 3H_3O^+_{(aq)}$ <p>Or</p> $Cr^{3+}_{(aq)} + 3H_2O_{(l)} \longrightarrow Cr(OH)_3(s) + 3H^+_{(aq)}$ <p>The hydrogen ions released in solution then react with the magnesium ribbon to dissolve it and form magnesium ions and hydrogen gas</p> $Mg_{(s)} + 2H^+_{(aq)} \longrightarrow Mg^{2+}_{(aq)} + H_2(g)$	5½
4 (a)	Fluorine atom in hydrogen fluoride has a smaller atomic radius and is more electronegative than the chlorine atom in hydrogen chloride. The hydrogen fluorine bond is therefore more polar than the hydrogen-chlorine bond. This makes the hydrogen fluoride molecules to associate through hydrogen bonding while the hydrogen chloride molecules form Van-der-waals' forces of attraction. Thus a lot of energy is required to break the stronger hydrogen bond for boiling to occur than the energy required to break the weaker van-der-waal's forces of attraction. Hence hydrogen fluoride is a liquid at room temperature.	3½

b	<p>Manganese(II) ions in solution react with the hydroxide ions from sodium hydroxide to form insoluble white precipitate of Manganese(II) hydroxide</p> <p>Equation</p> $Mn^{2+}_{(aq)} + 2OH^{-}_{(aq)} \longrightarrow Mn(OH)_{2(s)} \checkmark$ <p>The manganese (II) hydroxide is basic and doesn't react with excess sodium hydroxide.</p> <p>Atmospheric oxygen then oxidizes the manganese hydroxide on standing to form hydrated manganese(III) oxide or Manganese(IV) oxide</p> <p>Equation</p> $2Mn(OH)_{2(s)} + \frac{1}{2}O_{2(g)} \longrightarrow 2Mn_2O_3 \cdot 2H_2O_{(s)} \checkmark$ $2Mn(OH)_{2(s)} + O_{2(g)} \longrightarrow 2MnO_2 \cdot H_2O_{(s)}$	
c	<p>Chlorine atom is more electronegative than the carbon atom, it therefore attracts bonding electrons in the carbon-chlorine bond more towards itself. This makes the chlorine atom partially negative while the carbon atom becomes partially positive. This makes the carbon-chlorine bond in carbon tetrachloride polar but the molecule is non polar due to the symmetrical distribution of chlorine atoms around the carbon such that the four dipole moments cancel each other</p>	4½
d	<p>In phenol the lone pairs of electrons on the oxygen atom interact with the delocalized pie bonding system of benzene forming a partial double bond, this strengthens the the carbon oxygen bond while weakening the oxygen-hydrogen bond. As a result the phenol molecule easily releases hydrogen ions in aqueous solutions.</p> <p>Illustration</p> <p>In Cyclohexanol there is no delocalized pie bonding system therefore the oxygen – hydrogen bond is not weakened</p>	4½
e	<p>Ammonium hydroxide is a weak base that reacts with hydrochloric acid a strong acid to form ammonium chloride according to the equation below;</p> <p>Equation</p> $NH_3(aq) + HCl(aq) \longrightarrow NH_4Cl(aq) \checkmark$ <p>Ammonium chloride formed undergoes hydrolysis to form ammonia solution which poorly ionizes and hydrogen ions</p> <p>Equation</p> $NH_4^+_{(aq)} + H_2O_{(l)} \longrightarrow NH_3(aq) + H_3O^+_{(aq)} \checkmark$ <p>The hydrogen ions make the solution acidic with a pH less than seven</p>	3½

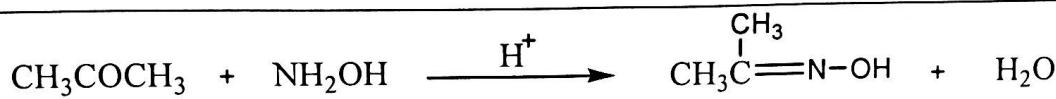
5 a (i)



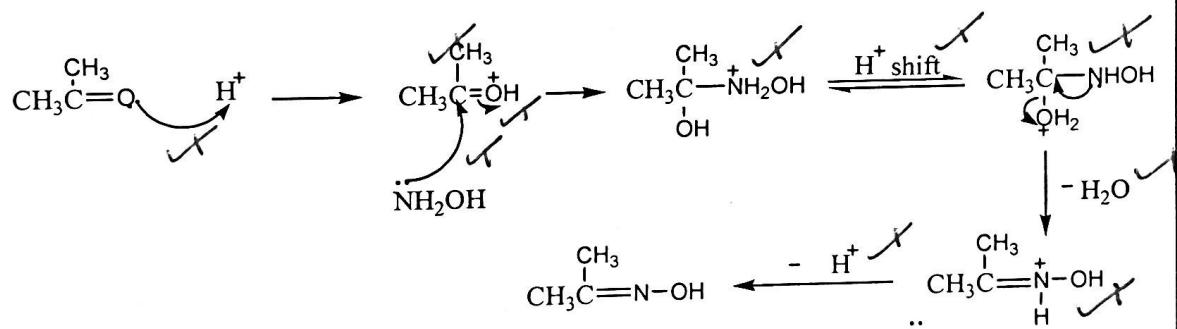
Mechanism



(ii)



Mechanism



B (i)

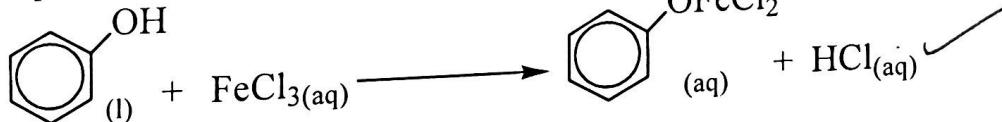
Reagent : Neutral Iron(III) chloride solution

Observation : Violet or purple colouration

phenol : No observable change

Cyclohexanol

Equation



04

(ii)

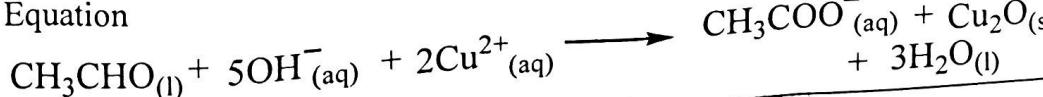
Reagent : Fehling's solution and heat

Observation : Reddish-brown precipitate

Ethanal : No observable change

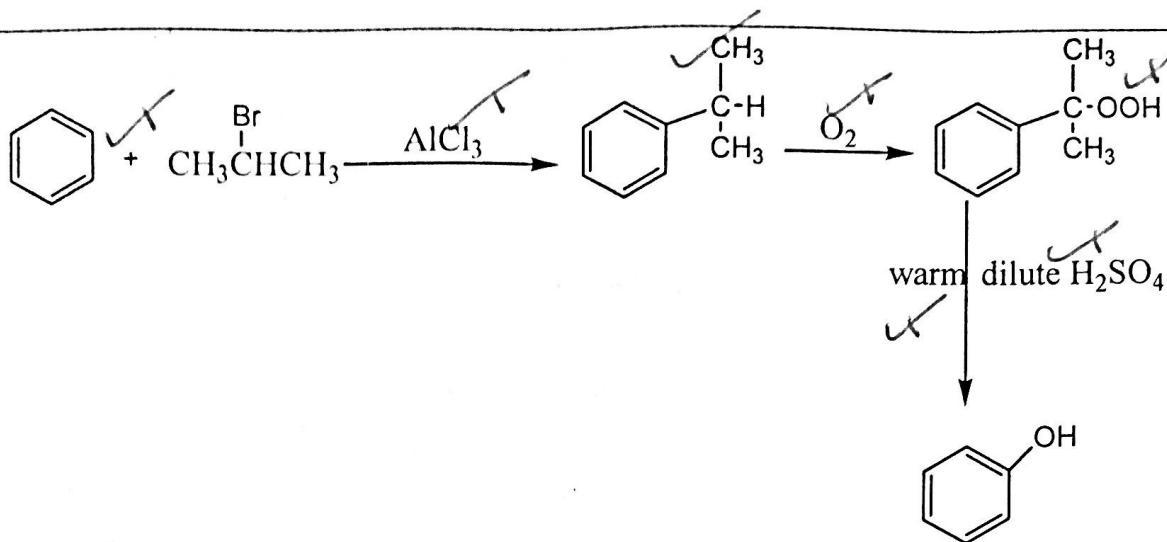
Phenylmethanal

Equation



07

c



6(a) Magnesium has a giant metallic structure in which each magnesium atom contributes two electrons to the electron cloud forming a strong metallic bond that requires a great amount of heat to melt the metal.

Silicon atoms are arranged through covalent bonding to form an infinite three dimensional giant covalent structure with many strong covalent bonds that require a lot of heat to be broken for melting to occur

Sulphur atoms are arranged to form S_8 which is a simple molecular structure in which the molecules are held by weak van-der-waal's forces of attraction that require less amount of heat to be broken for melting to occur

06

(b) (i)

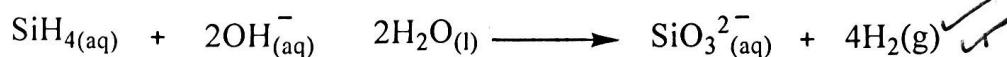
The hydride of magnesium is magnesium hydride with ionic bonding

The hydride of silicon is silicon tetra hydride with covalent bonding

The hydride of Sulphur is Hydrogen sulphide with covalent bonding

12

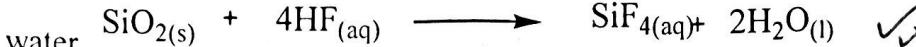
(ii)



H2

c (i)

Silicon (IV) oxide reacts with hydrofluoric acid to form silicon (IV) fluoride and water.



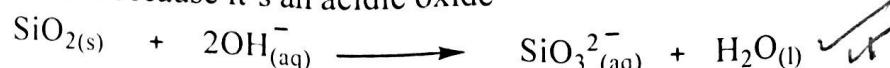
However in excess hydrofluoric acid, hexafluorosilicic acid is formed



04

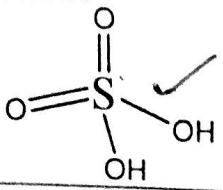
(ii)

Silicon(IV)oxide reacts with hot concentrated sodium hydroxide to form sodium silicate because it's an acidic oxide



02

(iii)	Silicon(IV) oxide doesn't react readily with water but when heated with water under pressure it slightly reacts to form an acidic solution of silicic acid $\text{SiO}_{2(\text{g})} + \text{H}_2\text{O}_{(\text{l})} \rightleftharpoons \text{H}_2\text{SiO}_{3(\text{aq})}$	or
7(a) (i)	$2\text{SO}_{2(\text{g})} + \text{O}_{2(\text{g})} \rightleftharpoons 2\text{SO}_{3(\text{g})}$ $2\text{SO}_{3(\text{g})} + \text{H}_2\text{SO}_{4(\text{l})} \rightleftharpoons \text{H}_2\text{SO}_{7(\text{l})}$ $\text{H}_2\text{SO}_{7(\text{l})} + \text{H}_2\text{O}_{(\text{l})} \rightleftharpoons 2\text{H}_2\text{SO}_{4(\text{l})}$	or
(ii)	<p>The contact process involves manufacture of sulphuric acid from sulphur trioxide.</p> $2\text{SO}_{2(\text{g})} + \text{O}_{2(\text{g})} \rightleftharpoons 2\text{SO}_{3(\text{g})}$ <p>Conditions for maximum yield of sulphur trioxide;</p> <ul style="list-style-type: none"> High pressure ; This favours the forward reaction that proceeds with decrease in volume therefore maintains the equilibrium position to the right such that more sulphur trioxide is produced as sulphur dioxide reacts with oxygen Low temperature ; since the reaction is exothermic, the forward reaction is favoured by low temperature vanadium (v) oxide catalyst; Since the reaction is favoured by low temperature a catalyst is used in this reaction, which does not affect the amount of sulphur trioxide formed and position of equilibrium but increases the rate at which sulphur trioxide is obtained Excess oxygen to increase the rate of reaction with sulphur dioxide due to increased frequency of collision between the reactant molecules 	CS
b	$K_p = \frac{P_{\text{H}_2\text{O}} \cdot P_{\text{SO}_3}}{P_{\text{H}_2\text{SO}_4}}$ units = atmospheres (atm) or pa or NM^{-2}	4k
c (i)	<p>At 400k</p> $K_p = \frac{(3.2) \cdot (2.9)}{(4.5)} = 2.062 \text{ atm}$ <p>At 493k</p> $K_p = \frac{(300) \cdot (270)}{(470)} = 172.34 \text{ atm}$ <p>The reaction is endothermic because K_p increases with increase in temperature from 400k to 493K</p>	or
(ii)	Increasing pressure favours the backward reaction that proceeds with decrease in volume; therefore steam reacts with sulphur trioxide to form more of sulphuric acid vapour. This increases the concentration of sulphuric acid at equilibrium while decreasing the concentration of steam and sulphur trioxide shifting the equilibrium position from right to left while keeping the value of K_p constant at 400k	2k

d (i)	Structure  Shape Tetrahedral ✓	02
(ii)	Sulphur the central atom forms four bonding pairs, two with oxygen ($\text{S}=\text{O}$) and two with hydroxyl group ($\text{S}-\text{OH}$) and has no lone pairs of electrons. The bonding pairs of electrons repel each other such that minimum repulsion occurs when the molecule adopts a tetrahedral shape.	02
8(a) (i)	An ore is a naturally occurring inorganic substance with a crystalline structure from which a metal can be extracted ✓	01
(ii)	<ul style="list-style-type: none"> • Copper pyrites , CuFeS_2 ✓ • Malachite , $\text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$ 	01
b	<p>The copper pyrites is crushed into powder and added to water containing a frothing agent in a floatation tank.. The oil wets the ore particles while the water wets the earthly impurities.</p> <p>Compressed air is blown through the mixture for agitation producing froth. The low density oiled particles rise and float to the surface with in the froth while the earthly impurities sink to the bottom of the tank.</p> <p>The froth containing the ore is skimmed off and dilute sulphuric acid added to break it down, filtered and the ore washed and dried</p> <p>The dried ore is then roasted in controlled amount of air to convert to copper(I) sulphide and sulphur dioxide</p> $2\text{CuFeS}_{2(s)} + 4\text{O}_{2(g)} \longrightarrow \text{Cu}_{2S}_{(s)} + 2\text{FeO}_{(s)} + 3\text{SO}_{2(g)}$ <p>The products are heated with silicon (IV) oxide in the absence of air to form Iron (II) silicate liquid which is tapped off.</p> $\text{FeO}_{(s)} + \text{SiO}_{2(s)} \longrightarrow \text{FeSiO}_{3(l)}$ <p>The copper(I)sulphide is heated in controlled amount of heat and air to form copper(I) oxide and sulphur dioxide</p> $2\text{Cu}_{2S}_{(s)} + 3\text{O}_{2(g)} \longrightarrow 2\text{Cu}_{2O}_{(s)} + 2\text{SO}_{2(g)}$ <p>The copper(I)oxide is then heated with the unreacted copper(I)sulphide in absence of air to form impure copper and sulphur dioxide gas</p> $\text{Cu}_{2S}_{(s)} + 2\text{Cu}_{2O}_{(s)} \longrightarrow 6\text{Cu}_{(s)} + \text{SO}_{2(g)}$ <p>The impure copper is made the anode and pure copper made the cathode in an electrolysis cell in which acidified copper (II) sulphate is the electrolyte. Current is passed through the solution and the copper anode dissolves to form copper (II) ions and pure copper is deposited at the cathode</p> <p>Anode : $\text{Cu}_{(s)} \longrightarrow \text{Cu}_{(aq)}^{2+} + 2e$ ✓</p> <p>Cathode : $\text{Cu}_{(aq)}^{2+} + 2e \longrightarrow \text{Cu}_{(s)}$ ✓</p>	11½

C(i)	Copper reacts with hot concentrated hydrochloric acid to form copper(I)chloride and hydrogen gas $2Cu_{(s)} + 2HCl_{(aq)} \longrightarrow Cu_2Cl_2 + H_2(g)$	1½
(ii)	Copper reacts with dilute nitric acid to form copper(II) nitrte , nitrogen monoxide and water $3Cu_{(s)} + 8HNO_3(aq) \longrightarrow 3Cu(NO_3)_2(aq) + 2NO(g) + 4H_2O(l)$ copper reacts with concentrated nitric acid to form copper(II) nitrate, nitrogen dioxide and water $Cu_{(s)} + 4HNO_3(aq) \longrightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$	5½
d(i)	Brown precipitate	0½
(ii)	$2Cu^{2+}_{(aq)} + Fe(CN)_6^{4-}_{(aq)} \longrightarrow Cu_2Fe(CN)_6(s)$	1½

Copper reacts with concentrated nitric acid to form copper(II) nitrate, nitrogen dioxide and water
END