TANZANIA HEAD OF ISLAMIC SCHOOL COUNCIL
FORM SIX INTER-ISLAMIC MOCK EXAMINATION
CHEMISTRY – 01

132/1

MARKING SCHEME

1 a) i) This is because the discharge tube there are very large number of hydrogen atoms and electron in their atoms are excited differently as they absorb different quanta of energy. If electron move back to the ground state, they may jump directly to the ground state or may move step by step hence different lines are produced. (04 marks) 04

(ii) Magnesium gives three peaks in its spectrum because it has three isotopes with atomic mass 24, 25 and 26 (01 mark) 01

iii) Line spectrum is regarded as a finger print of a chemical element because each element gives its own spectrum/ radiations which differentiate it from the spectrum of other element (01 mark) 01

(b) Dalton's atomic theory is regarded as primitive (outdated) because of the following

i) Dalton proposed that matter is made up of small indivisible particles called atoms. This is not valid because, atom itself has sub-atomic particles which are protons, neutrons and electrons.

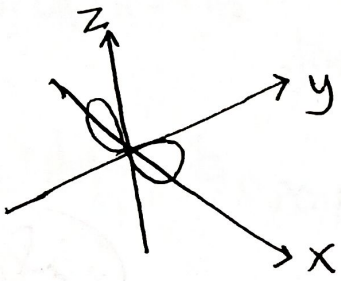
ii) He proposed that atom is neither created nor destroyed in cause of reaction. This is not valid because atoms are created through nuclear reactions.

iii) He proposed that atoms of the same element have mass and properties. This is not valid because due to the presence of isotopes like in carbon, chlorine and hydrogen (04 marks) @ 04

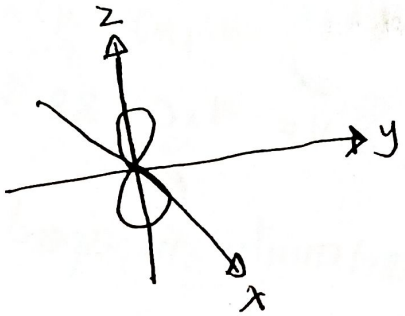
@ 1 marks

1 (b) He proposed that atoms of different element have different mass and properties. This is not valid due to presence of isoba-
Like $A_r = 40$ and $Ca = 40$

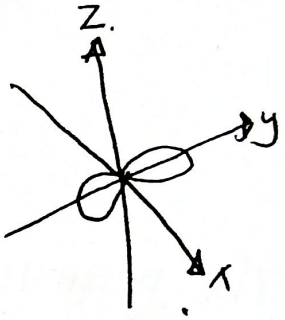
c(i) The shape of p orbital is dumb bell shape i.e



P_x-orbital (00½ marks)



P_z-orbital (00½ marks)



P_y-orbital (00½ marks)

(ii) solution
Data given

$h = 6.626 \times 10^{-34}\ kgm^2s^{-1}$

$\Delta x = 0.53 \times 10^{-10}\ m$

$\Delta p = ?$

from

$$\Delta p = \frac{h}{4\pi \Delta x} \quad (00\tfrac{1}{2}\ marks)$$

$$\Delta p = \frac{6.626 \times 10^{-34}\ kgm^2s^{-1}}{4 \times 3.14 \times 0.53 \times 10^{-10} m} \quad (00\tfrac{1}{2}\ marks)$$

$\Delta p = 9.9537 \times 10^{-25} \text{ kgms}^{-1}$

$\Delta p = m\Delta v$

$\Delta v = \frac{\Delta p}{m} = \frac{9.9537 \times 10^{-25} \text{ kgms}^{-1}}{9.1 \times 10^{-31} \text{ kg}}$ (60% marks)

$\Delta v = 1.0938 \times 10^{6} \text{ m/s}$

The minimum uncertainity in speed is $1.0938 \times 10^{6} \text{ m/s}$

2. (a) In alkenes there is restriction rotation about carbon-carbon double bond which is responsible for the geometrical isomerism, in alkynes there no restriction of carbon to carbon triple bond. (02 marks)

(b) (i) $(CH_3)_2CHCH=CH_2 \xrightarrow[H_2O]{H_2SO_4} (CH_3)_2CH\underset{OH}{CH}CH_3$ (A)

(ii) $CH_3CH_2CH=CH_2 + \underset{THF}{Hg(OAc)_2} \rightarrow CH_3CH_2\underset{OH}{CH}CH_2-HgOAc \xrightarrow{NaBH_4}$

$CH_3CH_2\underset{H}{CH}CH_3$ (C)

(iii) $(CH_3)_2CH-CH=CH_2 \xrightarrow[THF]{BH_3} (CH_3)_2CHCH_2CH_2-BH_2 \xrightarrow[NaOH]{H_2O_2}$ (D)

$(CH_3)_2CHCH_2CH_2OH$ (E)

(05 marks)
1@ each. A→E

(c) (i) pyrolysis of natural gas is the thermal decomposition of organic materials in absence of air. In this method, methane undergoes combustion under limited supply of oxygen. The heat evolved in this reaction is used as a source of energy for conversion of methane to ethyne. (00½ marks)

$$2CH_{4(g)} + O_{2(g)} \longrightarrow 2CO_{(g)} + 4H_{2(g)} + Heat$$

$$2CH_{4(g)} \xrightarrow[(700-800)^oC]{} CH\equiv CH_{(g)} + 3H_{2(g)}$$ (01 marks)

2 (c) (ii) Action of water on carbide of calcium.

calcium carbide reacts with water to form ethyne and calcium hydroxide (0½ marks)

$$CaC_2 + 2H_2O \longrightarrow CH \equiv CH_{(g)} + Ca(OH)_2$$

(0½ marks).

3. (a) (i) Endothermic, energy is required to remove electron from the outermost valency shell. (01 marks)

(ii) Exothermic, energy is released as the process involves attraction of electrons to the nucleus which is thermodynamically favoured process. (01 marks)

(iii) 1st electron of oxygen is exothermic as the same reason in 3(a)(ii), but second electron affinity of oxygen is always positive (endothermic) as energy absorbed to overcome repulsion of the 2nd added electron. (01 marks)

(b) (i) The reaction is endothermic as temperature fell from 22.7°C to 19.4°C which gives positive heat change (00½ marks)

(ii) From:

$\Delta H = -(mc\Delta T)$ (01 marks)

$\Delta H = -(359 \times 4.18 J/g^{o}C \times (-3.3^{o}C))$

Note $\Delta T = (19.4 - 22.7)^{o}C = -3.3^{o}C$

$\Delta H = 483.252 J = 0.483252 kJ$ (00½ marks)

$n_{NH_4NO_3} = \frac{m}{Mr} = \frac{1.5g}{80g/mol}$.

$n_{NH_4NO_3} = 0.01875 moles.$ (00½ marks)

Then

$\text{Heat of solution} = \frac{\text{Heat change}}{n_{NH_4NO_3}}$

$\text{Heat of solution} = \frac{0.483252 kJ}{0.01875 moles} = 25.7344$ (01 marks)

Molar Heat of solution $= 25.7344 kJ/mol$

3 (c) Equation for combustion of methane is :-

$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$, $\Delta H_c = -890$ kJ/mol.

But ΔH_c (carbon) = $\Delta H_f(CO_2) = -393$ kJ/mol

ΔH_c (Hydrogen gas) = $\Delta H_f(H_2O) = -285.8$ kJ/mol

(01/2 marks)

And $\Delta H_f(O_2) = 0$ kJ/mol.

From $\Delta H_r = \sum \Delta H_f$ (product) $- \sum \Delta H_f$ (reactants)

$\Delta H_c(CH_4) = \Delta H_f(CO_2) + 2\Delta H_f(H_2O) - \Delta H_f(CH_4)$.

$-890 = -393 + (2 \times -285.8) - \Delta H_f(CH_4)$ (01 marks)

$\therefore \Delta H_f(CH_4) = -74.6$ kJ/mol. (01 marks)

Thermochemical equation to show formation of methane

$C_{(s)} + 2H_{2(g)} \longrightarrow CH_{4(g)}$.

Using

$\Delta H_r = \sum$ B.E (reactants) $- \sum$ B.E (products).

Heat of reaction = Heat of formation of CH_4

$-74.6 = 720 + (431 \times 2) - 4(C-H)$ ~~1656.6~~

$\frac{4(C-H)}{4} = \frac{1656.6}{4}$

$C-H = 414.15$ kJ/mol. (01 marks)

Hence bond energy of C-H bond is 414.15 kJ/mol.

4 (a) (i) Boyle's Law is applicable when amount of air is constant. During the inflation of weather ballons the amount of air is progressively increased in the ballons.ie mass of the gas not fixed and therefore boyle's Law not applicable (01 marks)

ii) In making bakery products like bread, yeast is mixed with dough where it release carbondioxide through fermentation of sugar present in the daugh; once the bread is baked, the heat causes the temperature to raise which inturn cause the carbondioxide in the daugh to increase its volume in accordance with charles Law and hence the bread becomes fluffy. (01 marks)

iii) In the summer the temperature increases and therefore the pressure of the gas inside the bottle tend to increase according to gay-Lussacs Law. so decrease in temperature avoid the explosion of the bottle as they kept under water (01 marks)

iv) High temperature inside the tyres increase the pressure of the gas and ventually if the pressure exceed the pressure limit they can ~~explose~~ explode (01 marks).

(b)

4 (b) ~~from~~ solution

Data given

$V_1 = 20L$

$P_1 = 150\ atm$

$T_1 = 30 + 273 = 303K$

$P_2 = 755\ mmHg = 0.9934\ atm$

$T_2 = 22 + 273 = 295K$

from

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \quad (01\ marks)$$

$$V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{150\ atm \times 20L \times 295K}{0.9934\ atm \times 303K} \quad (01\ marks)$$

$$V_2 = 2940.135L$$

1 ballons $\longrightarrow$ 50L

? $\longleftarrow$ 2940.135L

$$= \frac{1\ ballons \times 2940.135L}{50L}$$

$$= 588\ ballons \quad (01\ marks)$$

solution

Data given

$V_1 = 275ml$

$V_2 = ?$

n_1 = moles of air = 0.012 mol

moles of CO_2 gas = $\frac{1.0g}{44g/mol}$ = 0.02273 mol (01 marks)

n_2 = moles of air + moles of CO_2 = 0.012 + 0.02273 mol = 0.03473 mol

from

$\frac{V_1}{n_1} = \frac{V_2}{n_2}$ $\quad V_2 = \frac{V_1 \times n_2}{n_1}$ (01 marks)

$V_2 = \frac{275ml \times 0.03473 mol}{0.012 mol}$ = 795.9 ml (01 marks)

Therefore the volume of the container is 795.9 ml

5. (a) (i) Equilibrium law describes that:- If a chemical system is allowed to reach the equilibrium at a particular temperature there is a fixed ratio of product of concentration of products to that of reactants raised to a power equal to their stoichiometric coefficient regardless of the original concentration of the reactants present in the system.

while

Le-chatellier's principle describes that: a change in one of the variables that describe a system at equilibrium produces a shift in the position of equilibrium so as to counteracts the effects of this change. (01½ marks)

(ii) Catalyst do not affect the position of equilibrium but helps the equilibrium to reach very fast. (01½ marks)

(b) solution

Given data

$K_C = 6 \times 10^{-2}$

$K_P = ?$

Temperature, $T = 773K$.

from $K_P = K_C(RT)^{\Delta n}$

Given reaction

5(b) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

$\Delta n = 2 - 4 = -2$.

$K_p = K_c(RT)^{-2}$ (01 marks)

$K_p = 6 \times 10^{-2} (0.0821 \times 773)^{-2}$ (01 marks)

$K_p = \frac{6 \times 10^{-2}}{(0.0821 \times 773)^2} = 1.489 \times 10^{-5}$

$\therefore K_p = 1.489 \times 10^{-5}$ (01 marks)

5 (c) $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$

$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]}$ (01 marks)

Initial concentration $[CO] = [H_2O] = \frac{0.25 mol}{0.5 dm^3}$

Initial concentration $[CO] = [H_2O] = 0.5M$

$CO_{(g)}$	+ $H_2O_{(g)}$	$\rightleftharpoons$ $H_{2(g)}$	+ $CO_{2(g)}$	
0.5	0.5	0	0	Initially (02 marks)
0.5−X	0.5−X	X	X	At Equilibrium

$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]}$$ (00½ marks)

5 (c)

$$K_c = \frac{x^2}{(0.5-x)(0.5-x)}$$

$$K_c = \frac{x^2}{(0.5-x)^2}$$ (00½ marks)

$$0.56x^2 - 1.56x + 0.39 = 0$$

$$x = 2.5 \text{ or } 0.278M$$

$$\therefore x = 0.278 \text{ mol/dm}^3$$

Then, the concentration at equilibrium will be;-

$[H_2O] = 0.5 - x = 0.5 - 0.278 = 0.222M$ (00½ marks)

$[CO] = 0.5 - x = 0.222 \text{ mol/dm}^3$ (00½ marks)

$[CO_2] = x = 0.278 \text{ mol/dm}^3$ (00½ marks)

$[H_2] = x = 0.278 \text{ mol/dm}^3$. (00½ marks).

6. (a) Importance of dipole moment.

(i) To determine whether molecule is polar or non-polar
(ii) To determine molecular geometry (03 marks @ each)
(iii) To differentiate cis and trans-isomer.

(b) (i) Carbon dioxide is linear in geometry due to absence of lone pair make the dipole moment to cancel each other, making it non-polar molecule. whereby

water has H-O bond, it is V-shaped due to presence of lone pairs which cause the resultant dipole moment hence becomes polar molecule. (01½ marks)

(ii) NH_3, H_2O and HF have higher boiling point than those of PH_3, H_2S and HBr, This is due to high possibility of forming hydrogen bond as compared to PH_3, H_2S and HBr. N, F and O are stronger electronegative than P, S and B and therefore form strong hydrogen bonding making these molecules to boil at higher temperature as compared to PH_3, H_2S and HBr (01½ marks)

6 (c).

Sigma bond	pie bond
(i) It is formed due to axial (head to head overlap)	It is formed due to lateral (side to side overlap) of two p-orbitals
(ii) There can be only one sigma bond between atoms	There can be more than one sigma bond between atoms
(iii) The bond is relatively stronger	The bond is relatively weak
(iv) Free rotation at sigma bond is possible	Free rotation at pie bond is not possible
(v) It can be formed independently	It is formed only after sigma bond has been formed.

(04 marks)

(01 each).

7 (a) formation of ozone

oxygen in the stratosphere absorbs ultra-violet (UV) radiations with wavelength less than 240nm, it dissociate into two atoms of oxygen.

$$O_2 \xrightarrow{UV} 2O_{(g)} \quad (01\frac{1}{2} \text{ marks})$$

The resulting oxygen atom combines with oxygen

$$2O_{2(g)} + 2O_{(g)} \longrightarrow 2O_{3(g)} \quad (01\frac{1}{2} \text{ marks})$$

ozone layer depletion

CFCs are the primary cause of ozone layer depletion In the upper atmosphere CFCs breakdowns into highly reactive free radicals of chlorine (01/2 marks)

$$CF_3Cl_{2(g)} \xrightarrow{U.V} \dot{C}l_{(g)} + \dot{C}ClF_{2(g)} \quad 01\frac{1}{2} \text{ marks}$$

The highly reactive chlorine free radical reacts with ozone to form chlorine monoxide radical.

$$\dot{C}l_{(g)} + O_{3(g)} \longrightarrow \dot{C}lO_{(g)} + O_{2(g)} \quad (01\frac{1}{2} \text{ marks})$$

in the presence of chlorine monoxide free radical some atomic oxygen will react with ClO free radical to form oxygen molecule and regenerate free radical chlorine.

$$\dot{C}lO_{(g)} + O_{(g)} \longrightarrow \dot{C}l + O_{2(g)} \quad (01\frac{1}{2} \text{ marks})$$

The regenerated chlorine radical re-enter the chain to destroy more ozone

7 (a) Effects of ozone layer depletion:

(i) Damage of crops and reduction of primary products

(ii) Exposure of the earth to UVB (ultraviolet blue radiation) may cause skin cancer and genetic deformities like eye contracts.

(iii) Global climatic change. (03 marks) 1@each.

7 (b) Solution

Total exchangeable cation CEC = 3.83 meq/100g

Total exchangeable base = ~~(3.83 - 10) meq/100g =~~

$\sum EB = (0.28 + 0.12 + 1 + 0.03) = 1.43$ meq/100g

CEC = 3.83meq/100g

% Basa saturation $PBS = \frac{\sum EB}{CEC} \times 100\%$

$PBS = \frac{1.43}{3.83} \times 100\% = 37.336\%$ (01 marks)

Percentage base saturation is 37.336%.

The soil is audic in nature and infertile because it has higher percentage of audic saturation (63%). (01 marks)

7 (c) from equivalent weight of Ca = $\frac{\text{R.M.M}}{\text{valency}}$

eqv weight = $\frac{40g}{2}$ = 20g

1 eqv of Ca ≡ 20g.

1 meq of Ca ≡ 0.02g :

x meq of Ca ≡ 0.0015g

$x = \frac{0.0015 \times 1}{0.02}$ (01 marks)

$x = 0.075$ meq.

7 (c)

20g of soil sample contain 0.075meq Ca^{2+}

100g of soil ?!

$x = \frac{100 \times 0.075}{20} = 0.375$ meq/100g

∴ Concentration of Ca^{2+} in the soil sample is 0.375meq/100g of the soil sample. (01 marks)

8(a). (i) Tertiary haloalkane cannot undergo S_N2 reaction mechanism due to bulkness of its structure (it is more hindered by bulky groups), that makes back side attack of nucleophile impossible.

$$CH_3-\overset{CH_3}{\underset{CH_3}{C}}-Br + \text{conc } KOH \xrightarrow{C_2H_5OH} \text{No reaction}$$

(02 marks)

(ii) Nitrobenze is less reactive than benzene because nitro group withdraw electron away from benzene and makes it less nucleophilic (destabilize the benzene) and became less reactive toward electrophilic substitution reaction than benzene. (02 marks)

Methyl benzene is more reactive because, methyl group is activator which release electron toward benzene and makes it more nucleophilic and more reactive towards electrophilic substitution reaction.

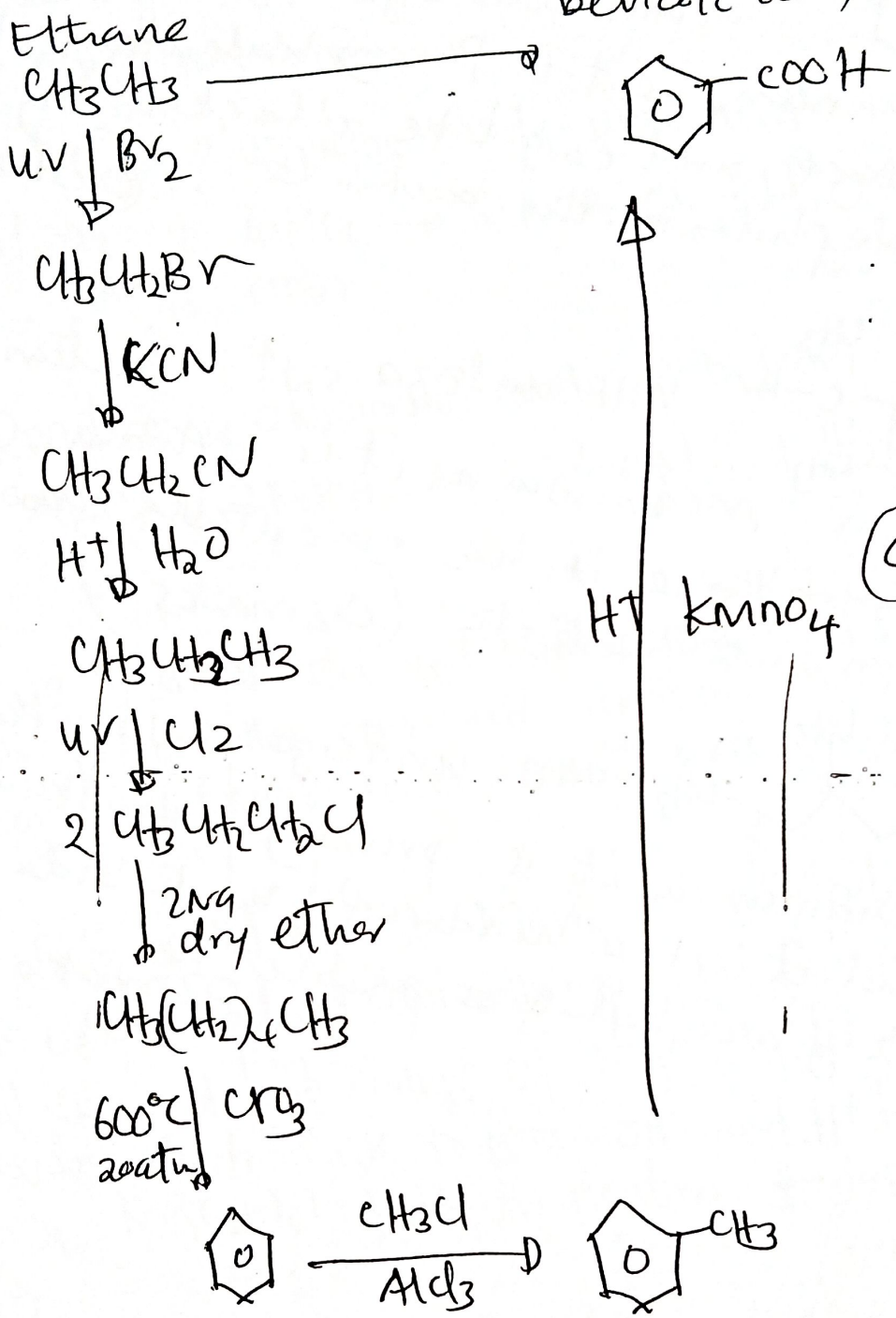
(b). (i) OH is ortho and para director, NO_2 is meta director. Since OH is in meta position, NO_2 will enter first in the benzene ring. (01 marks)

(ii) OH is ortho and para director the same as CH_3 and Cl. CH_3 at para position with respect to OH. OH will enter first in the benzene ring (strong activator) (01 marks)

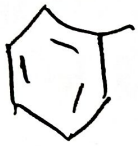
(iii) NH_2 is ortho and para director while COOH is meta director. Since COOH is at para position with respect to NH_2, therefore (01 marks)

NH_2 will enter first in benzene ring.

8 (c) Ethane



8 (d) (i)  will undergo SN2 reaction mechanism, as it is primary haloalkane, less hindered and easy to be attacked by nucleophile at the back side. (02marks)

(ii)  will undergo SN1 reaction mechanism as it is tertiary haloalkane, it has more stable carbo cation intermediate. (02marks)

(iii)  will undergo SN1 reaction mechanism as it is primary haloalkane and it is less hindered, back side attack of nucleophile is possible (02marks)

9(a) i) Aluminium oxide is amphoteric because it reacts with both acid and base

Reaction of aluminium oxide with acid

$$Al_2O_3(s) + 6HCl(aq) \rightarrow 2NaAlO_2 + H_2O(l)$$ (01 marks)

(b) Reaction of aluminium oxide with base

$$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$$ (01 marks)

ii) Due to small size and high charge of Fe^{2+}, will highly polarize the carbonate radicals, thus iron(II) carbonate is unstable and cannot exist (02 marks)

iii) When heated strongly $MgCl_2 \cdot 6H_2O$ produce magnesium oxide and not anhydrous $MgCl_2$. This is due to small size and high charge of Mg^{2+} which polarizes H_2O molecules which break to form OH^- and H^+ hence formation of $Mg(OH)Cl$ which on heating dissociates to form MgO.

$$MgCl_2 \cdot 6H_2O \rightarrow Mg(OH)Cl + HCl \rightarrow MgO + 2HCl + 5H_2O$$ (02 marks)

iv) Cu^{2+} has small size and high charge therefore it polarizes water in solution to form OH^- and H_3O^+ in solution cause it to be acidic hence change Litmus paper from blue to red (02 marks)

9(a) v) Fe_3O_4 is a mixed oxide because it's a mixture of iron (II) oxide and iron (III) oxide (02 marks)

(b) Uses of metal nitrates

i) Manufacturing of explosives eg ANFO (Ammonium nitrate fuel oil)

ii) Manufacturing of drugs eg $AgNO_3$ and sulfadiazine have been used to prevent infections

iii) Manufacture food preservatives eg K and Na nitrates

iv) ~~the~~ production of photographic films

v) Agricultural uses of metal nitrates eg Nitrogenous fertilizers are mainly nitrates

(05 marks)
(01 each)

10 (a) The mixtures containing toluene and xylene are expected to obey Raoult's law. In the mixtures containing other pairs, strong intermolecular hydrogen bonding would lead to strong attractions causing deviations from Raoult's law.

10 (a)(i) The increasing order of their boiling points
0.001M urea < 0.001M NaCl < 0.001M $MgCl_2$ < 0.01M NaCl; This is because (01 marks)

- Urea is a non-electrolyte
- NaCl gives two ions in the solution
- $MgCl_2$ gives three ions in the solution and
0.01M NaCl solution has higher concentration. (01 marks)

(ii) Glycol lowers the freezing point of water. Therefore, the coolant in radiator will not freeze even in colder places. (02 marks)

1 (b) Solution
$K_f = 4.9 kg\,mol^{-1}$, w_2 of se = 3.26g, w_1 of solvent = 226g = 0.226kg, Mass of se = 78.8g/mol

$\Delta T_f = 0.112^{\circ}C = 0.112K$

$$\Delta T_f = \frac{k_f \times w_2}{w_1 \times M_2}$$ (01 marks)

$$M_2 = \frac{4.9 kg\,mol^{-1} \times 3.26g}{0.226 \times 0.112} = 631.1 g/mol$$ (01 marks)

$$x = \frac{\text{Molar mass}}{\text{Atomic mass}} = \frac{631.1 g/mol}{78.8 g/mol}$$ (01 marks)

$x = 8$

10. (b) The molar mass of $Se_X = 631.1$ and formula of se is Se_8. (6 marks)

(c)(i) The magnetude of osmotic pressure is propo
(i) tional to the number of ~~moles~~ solute parti cles present in a given volume of solution.

$\pi \propto \frac{n_{solute}}{V_{solution}}$ or, $\pi \propto C$ (6 marks)

(ii) The Van't Hoff- Boyle's law

The law state that; the osmotic pressure (π) of a dilute solution is directly proportional to its molar concentration (M) at constant temperature or inversely proportional to the volume of the solution provided that the temperature and numbers of moles remain constant $\pi V = k$ (6 marks)

(iii) The vant Hoff- charle's law.

The law states that the osmotic pressure of a dilute solution is directly proportional to the absolute temperature provided that the concentration remains constant (6 marks)

$\frac{\pi}{T} = k$

10 C(ii) Solution

Data given

Temperature = 298k

mass of $BaCl_2$ = 0.39g

Volume = 60ml, From

$\pi = iMRT$

i = Van't Hoff factor

$\text{Molarity} = \frac{\text{Conc}(g/dm^3)}{\text{Molar mass}(g/mol)}$

10 C(ii)

$\text{Molarity} = \frac{0.39\,g}{208\,g/mol \times 0.06\,L} = 0.03125\,mol\,L^{-1}$ (01 marks)

From dissociating $BaCl_2$

$BaCl_{2(aq)} \rightleftharpoons Ba^{2+}_{(aq)} + 2Cl^-_{(aq)}$ (01 marks)

$1-\alpha \qquad \alpha \qquad 2\alpha$

Total number of particles $= 1+2\alpha$

$i = \frac{1+2\alpha}{1} = 1+2\alpha$ (01 marks)

Since α is equal to $\frac{1+2\times0.6}{1} = 2.2$

10(c)(ii) From,

$\pi = iMRT$

$\pi = 2.2 \times 0.0313 \text{ mol L}^{-1} \times 0.0821 \times 298$

$\pi = 1.68 \text{ atm.}$ (@ 1 marks)

Therefore, the osmotic pressure of an aqueous solution of $BaCl_2$ is equal to 1.68 atm.