

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. (01 mark)

01

(b) 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 elements. (01 mark)

(b) Dalton's atomic theory is regarded as primitive (outdated) because of the following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 course 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 H₂ is carbon, chlorine and hydrogen

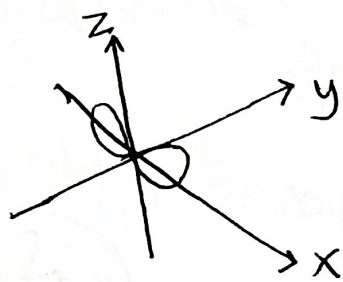
(04 marks)

04

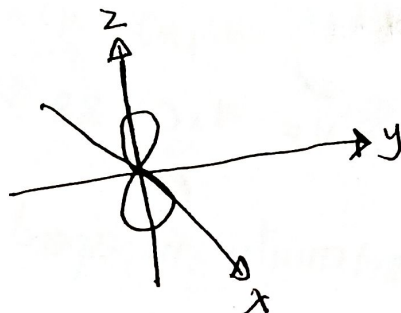
@ 1 mark

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

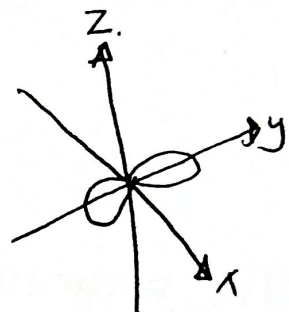
(i) The shape of p orbital is dumb bell shape i.e



P_x -orbital
(00.5 marks)



P_z -orbital
(00.5 marks)



P_y -orbital
(00.5 marks)

(ii) solution
Data given

$$h = 6.626 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}$$

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

$$\Delta p = ?$$

from

$$\Delta p = \frac{h}{4\pi \Delta x} \quad (00.5 \text{ marks})$$

$$\Delta p = \frac{6.626 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}}{4 \times 3.14 \times 0.53 \times 10^{-10} \text{ m}} \quad (00.5 \text{ marks})$$



$$\Delta p = 9.9537 \times 10^{-25} \text{ kg m s}^{-1}$$

$$\Delta p = m \Delta v$$

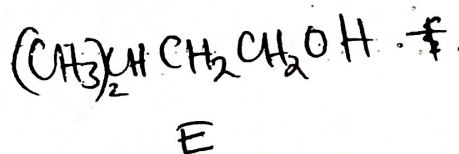
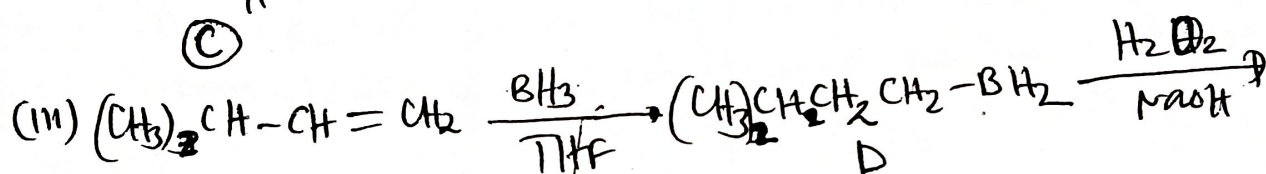
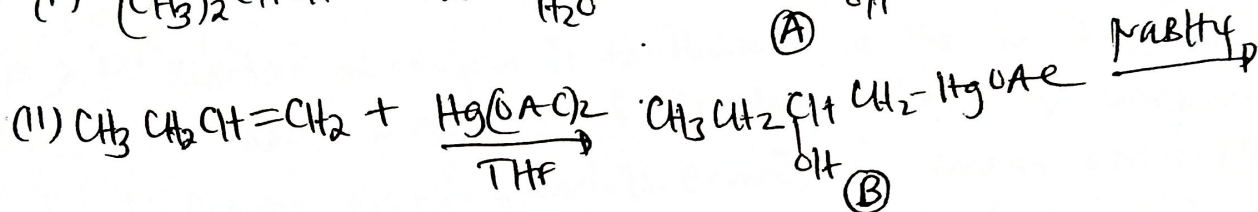
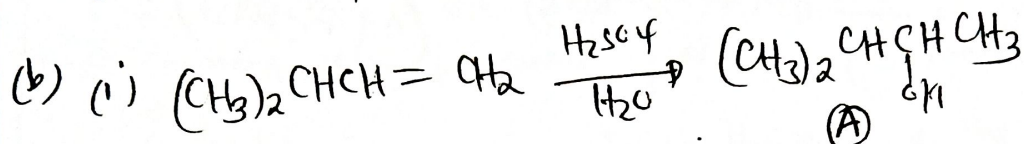
$$\Delta v = \frac{\Delta p}{m} = \frac{9.9537 \times 10^{-25} \text{ kg m s}^{-1}}{9.1 \times 10^{-31} \text{ kg}} \quad (80 \frac{1}{2} \text{ marks})$$

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

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

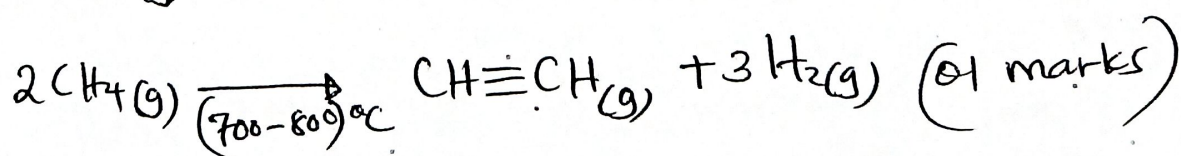
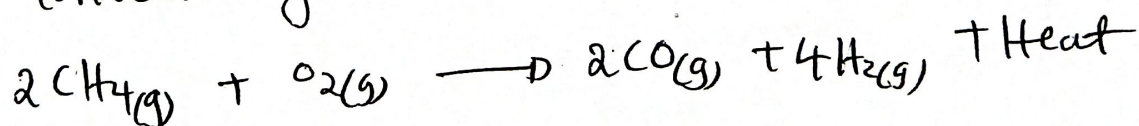
OK

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



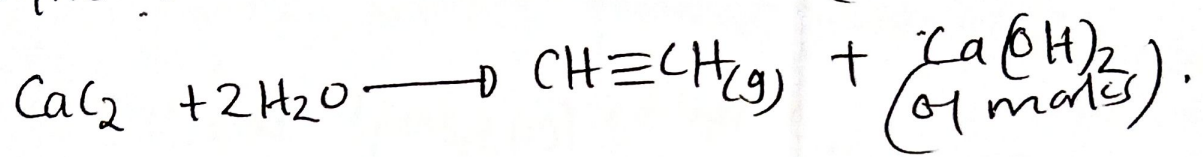
(05 marks)
1 @ each. A-E

(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. (00.5 marks)



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

calcium carbide reacts with water to form ethyne and calcium hydroxide (0.5 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. (00.5 marks)

(ii) From:

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

$$\Delta H = - (359 \times 4.18 \frac{J}{g^{\circ}C} \times (-3.3^{\circ}C)) \quad (01 \text{ marks})$$

$$\text{note } \Delta T = (19.4 - 22.7)^{\circ}C = -3.3^{\circ}C$$

$$\Delta H = 483.252 J = 0.483252 kJ \quad (00.5 \text{ marks})$$

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

$$n_{NH_4NO_3} = 0.01875 \text{ moles.} \quad (00.5 \text{ marks})$$

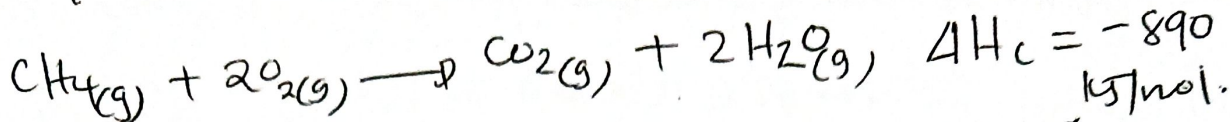
Then

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

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

$$\text{Molar Heat of solution} = 25.7344 kJ/mol$$

3



But $\Delta H_c(\text{carbon}) = \Delta H_f(\text{CO}_2) = -393 \text{ kJ/mol}$

$$\Delta H_c(\text{Hydrogen gas}) = \Delta H_f(\text{H}_2\text{O}) = -285.8 \text{ kJ/mol}$$

(50 1/2 marks)

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

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

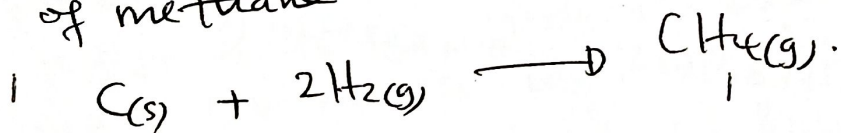
$$\Delta H_c(\text{CH}_4) = \Delta H_f(\text{CO}_2) + 2\Delta H_f(\text{H}_2\text{O}) - \Delta H_f(\text{CH}_4)$$

$$\Delta H_c(\text{CH}_4) = \Delta H_f(\text{CO}_2) + 2\Delta H_f(\text{H}_2\text{O}) - \Delta H_f(\text{CH}_4) \quad (\text{O/meng})$$

$$-890 = -393 + (2 \times -285.8) - \Delta H_f(\text{CH}_4)$$

$$\Delta H_f^\circ(\text{CH}_4) = -74.6 \text{ kJ/mol} \quad (21 \text{ marks})$$

Thermochemical equation to show formation of methane



using

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

Heat of reaction = Heat of formation of CH_4

$$-74.6 = 720 + (431 \times 2) - 4(c-4) \quad \text{---} \quad \cancel{+4} \quad \cancel{1656.6}$$

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

$$C-H = 414.15 \text{ kJ/mol. (4 marks)}$$

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. ~~But~~ During the inflation of weather balloons the amount of air is progressively increased in the balloon & the mass of the gas not fixed and therefore Boyle's Law is not applicable. (01 marks)

(ii) In making bakery products like bread, yeast is mixed with dough where it releases carbon dioxide through fermentation of sugar present in the dough. Once the bread is baked, the heat causes the temperature to rise which in turn causes the carbon dioxide in the dough 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 tends to increase according to Gay-Lussac's Law. So decrease in temperature avoids the explosion of the bottle as they are kept under water. (01 marks)

(iv) High temperature inside the tires increases the pressure of the gas and eventually if the pressure exceeds the pressure limit they can ~~explor~~ explode. (01 marks)

(b)

4 (b) from solution

Data given

$$V_1 = 20L$$

$$P_1 = 150 \text{ atm}$$

$$T_1 = 30 + 273 = 303K$$

$$P_2 = 755 \text{ mmHg} = 0.9934 \text{ atm}$$

$$T_2 = 22 + 273 = 295K$$

from

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

(01 marks)

$$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1} = \frac{150 \text{ atm} \times 20L \times 295K}{0.9934 \text{ atm} \times 303K} \quad (01 \text{ marks})$$

$$V_2 = 2940.135L$$

$$1 \text{ balloons} \rightarrow 50L$$

$$? \leftarrow 2940.135L$$

$$= \frac{1 \text{ balloons} \times 2940.135L}{50L}$$

$$= 588 \text{ balloons} \quad (01 \text{ marks})$$

solution

Data given

$$V_1 = 275 \text{ ml}$$

$$V_2 = ?$$

$$n_1 = \text{moles of air} = 0.012 \text{ mol}$$

$$\text{moles of CO}_2 \text{ gas} = \frac{1.0 \text{ g}}{44 \text{ g/mol}} = 0.02273 \text{ mol} \quad (01 \text{ marks})$$

$$n_2 = \text{moles of air} + \text{moles of CO}_2 = 0.012 + 0.02273 \text{ mol} = 0.03473 \text{ mol}$$

from

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

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

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-chatelier'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 counteract the effects of this change. (0½ marks)

(ii) Catalyst do not affect the position of equilibrium, but helps the equilibrium to reach very fast. (0½ marks)

(b) solution
Given data

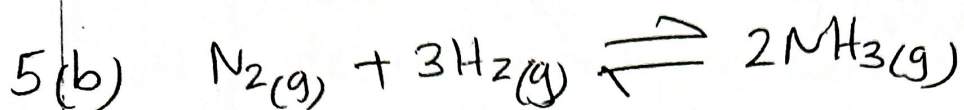
$$K_c = 6 \times 10^2$$

$$K_p = ?$$

$$\text{Temperature, } T = 773 \text{ K.}$$

$$\text{from } K_p = K_c(RT)^{\Delta n}$$

Given reaction



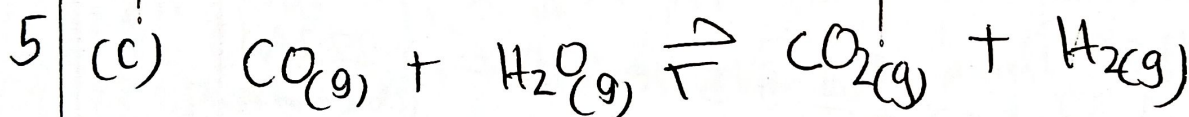
$$\Delta n = 2 - 4 = -2.$$

$$K_p = K_c(RT)^{-2} \quad (1 \text{ mark})$$

$$K_p = 6 \times 10^2 (0.0821 \times 773)^{-2} \quad (1 \text{ mark})$$

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

$$\therefore K_p = 1.489 \times 10^{-5} \quad (1 \text{ mark})$$



$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]} \quad (1 \text{ mark})$$

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

Initial concentration $[CO] = [H_2O] = 0.5 \text{ M}$



0.5	0.5	0	0	Initially
0.5-x	0.5-x	x	x	At equilibrium

(1 mark)

$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]} \quad (60\frac{1}{2} \text{ marks})$$

5 (c)

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

$$K_c = \frac{x^2}{(0.5-x)^2} \quad (60\frac{1}{2} \text{ marks})$$

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

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

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

Then, the concentration at equilibrium will be:-

$$[H_2O] = 0.5 - x = 0.5 - 0.278 = 0.222M \quad (60\frac{1}{2} \text{ marks})$$

$$[CO] = 0.5 - x = 0.222 \text{ mol/dm}^3 \quad (60\frac{1}{2} \text{ marks})$$

$$[CO_2] = x = 0.278 \text{ mol/dm}^3 \quad (60\frac{1}{2} \text{ marks})$$

$$[H_2] = x = 0.278 \text{ mol/dm}^3 \quad (60\frac{1}{2} \text{ marks})$$

6. (a) Importance of dipole moment.

- (i) To determine whether molecule is polar or non-polar (0.3 marks)
- (ii) To determine molecular geometry (1 @ 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) (0.5 marks)

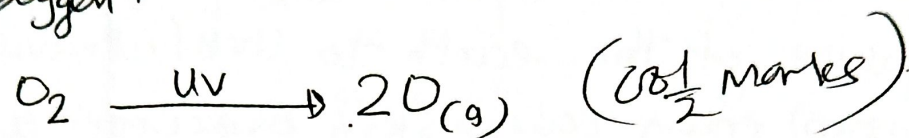
(ii) NH_3 , H_2O and HF have higher boiling point than those of PH_3 , H_2S and HBr . This is due to high possibility of forming hydrogen bond as compared to PH_3 , H_2S and HBr . N, F and O are stronger electronegative than P, S and Br and therefore form stronger hydrogen bonding making these molecules to boil at higher temperature as compared to PH_3 , H_2S and HBr (0.5 marks)

6 (c).

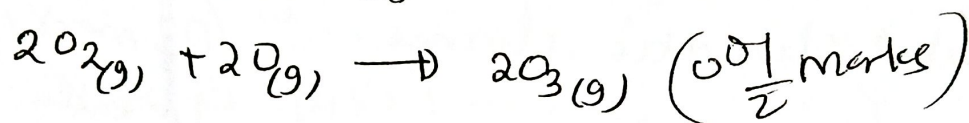
Sigma bond	pie bond
It is formed due to axial (i) (head to head overlap)	It is formed due to lateral (side to side overlap) of two p-orbitals
(ii) There can be only one sigma bond between atoms	There can be more than one sigma bond between atoms
(iii) The bond is relatively stronger	The bond is relatively 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.

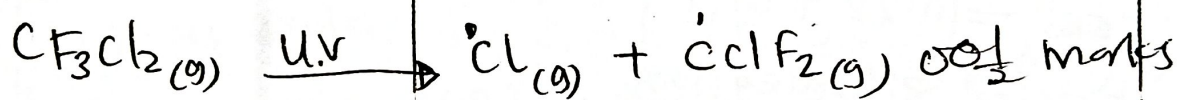


The resulting oxygen atom combines with oxygen

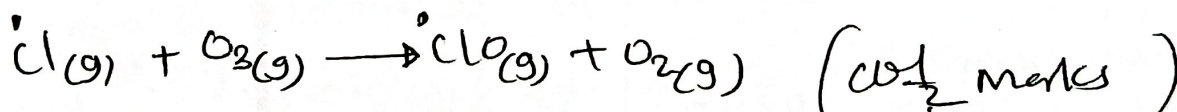


ozone layer depletion

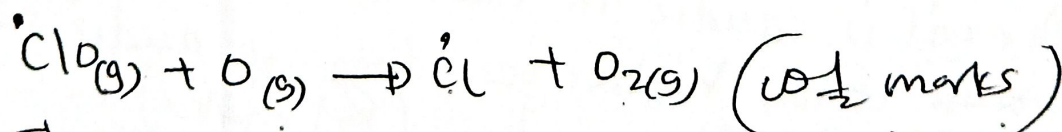
CFCs are the primary cause of ozone layer depletion. In the upper atmosphere CFCs break down into highly reactive free radicals of chlorine. (0.5 marks)



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



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



The regenerated chlorine radical re-enters 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 $CEC = 3.83 \text{ meq/100g}$

Total exchangeable base = ~~$(3.83 - 1) \text{ meq/100g}$~~

$$\Sigma EB = (0.28 + 0.12 + 1 + 0.03) = 1.43 \text{ meq/100g}$$

$$CEC = 3.83 \text{ meq/100g}$$

$$\% \text{ Base saturation } PBS = \frac{\Sigma EB}{CEC} \times 100\%$$

$$PBS = \frac{1.43}{3.83} \times 100\% = 37.336\%$$

(01 marks)

Percentage base saturation is 37.336%.

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

(01 marks)

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

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

$$1 \text{ eqv of Ca} \equiv 20\text{g}$$

$$1 \text{ meq of Ca} \equiv 0.02\text{g}$$

$$x \text{ meq of Ca} \equiv 0.0015\text{g}$$

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

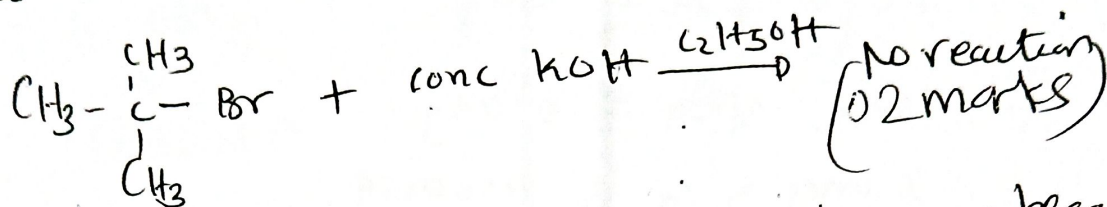
$$x = 0.075 \text{ meq}$$

7 (c) - 20g of soil sample contain 0.075 meq Ca^{2+}
100g of soil

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

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

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



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

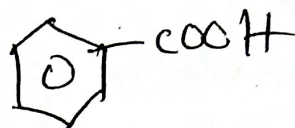
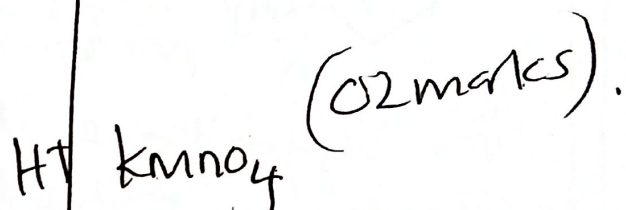
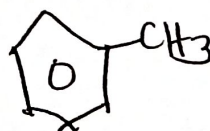
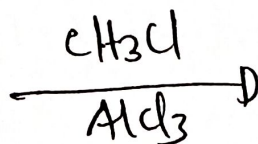
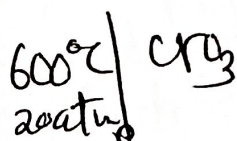
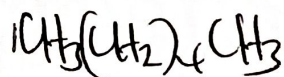
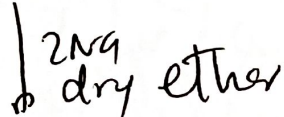
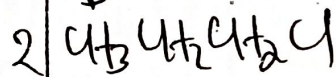
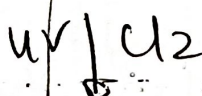
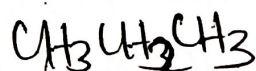
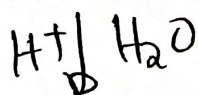
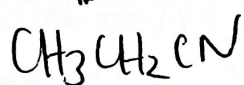
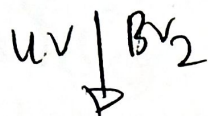
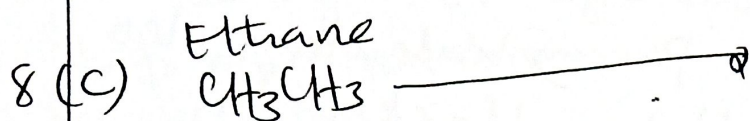
Methylbenzene is more ^{reactive} because methyl group is activator which releases electron toward benzene and makes it more nucleophilic and more reactive towards electrophilic substitution reaction.

(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)

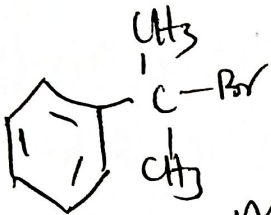
(ii) OH is ortho and para director the same as CH_3 and Cl. CH_3 at para position with respect to OH. OH will enter first in the benzene ring (strong activator). (01 marks)

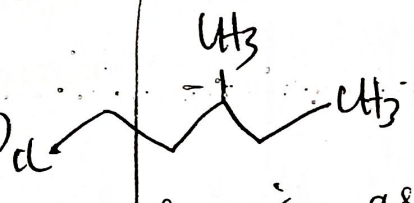
(iii) NH_2 is ortho and para director while COOH is meta director. Since COOH is at para position with respect to NH_2 , therefore (01 marks)

NH₂ will enter first in benzene ring.
benzoic acid



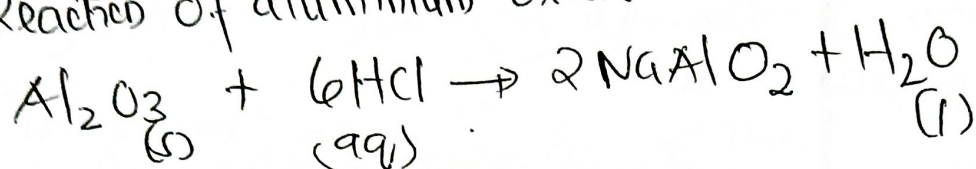
8 (d) (i)  will undergo S_N2 reaction mechanism, as it is primary haloalkane, less hindered and easy to be attacked by nucleophile at the backside. (2 marks)

(ii)  will undergo S_N1 reaction mechanism as it is tertiary haloalkane, it has more stable carbocation intermediate. (2 marks)

(iii)  will undergo S_N1 reaction mechanism as it is primary haloalkane and it is less hindered, back side attack of nucleophile is possible. (2 marks)

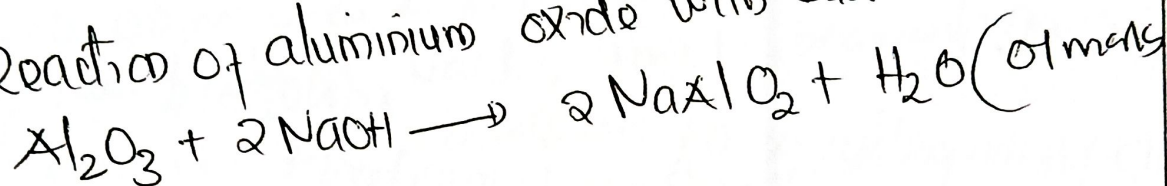
9(a) i) Aluminium oxide is amphoteric because it reacts with both acid and base

Reaction of aluminium oxide with acid



(01 marks)

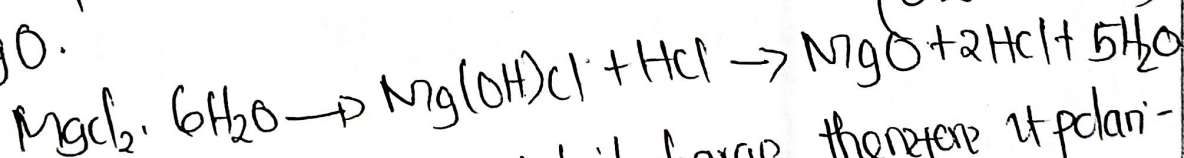
(a) Reaction of aluminium oxide with base



(01 marks)

ii) Due to small size and high charge of Fe^{3+} , will highly polarize the carbonate radicals, thus (FeCO_3) carbonate is unstable and cannot exist (02 marks)

iii) When heated strongly $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ 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 . (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 is 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 (9) 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
 $0.001\text{M urea} < 0.001\text{M NaCl} < 0.001\text{M MgCl}_2$
 $< 0.001\text{M NaCl}$; 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
0.001M NaCl solution has higher concentration. (01 marks)

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

(b) solution
 $k_f = 4.9\text{K kg mol}^{-1}$, w_2 of se = 3.26g, w_1 of solvent = 226g = 0.226kg, M_{as} of se = 78.8g/mol
 $\Delta T_f = 0.112^\circ\text{C} = 0.112\text{K}$

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

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

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

$$x = 8$$

10. (b) The molar mass of $\text{Se}_x \approx 631.1$ and formula of Se is Se_8 . (01 marks)

(c)(i) The magnitude of osmotic pressure is proportional to the number of moles of solute particles present in a given volume of solution. (01 marks)

$$\pi \propto \frac{n_{\text{solute}}}{V_{\text{solution}}} \quad \text{or} \quad \pi \propto C$$

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

The law states 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 number of moles remain constant. (01 marks)

(iii) The Van't Hoff-Charles 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. (01 marks)

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

0 C(ii) Solution
Data given

$$\text{Temperature} = 298 \text{ K}$$

$$\text{Mass of BaCl}_2 = 0.39 \text{ g}$$

$$\text{Volume} = 60 \text{ mL, From}$$

$$\pi = iMRT$$

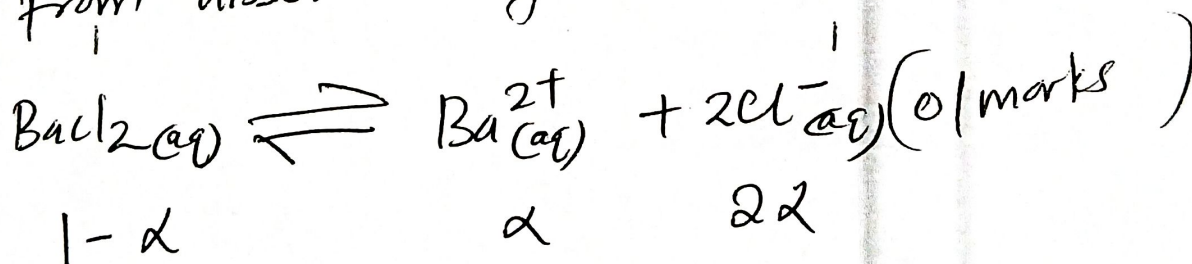
$$i = \text{Van't Hoff's factor}$$

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

10 C(ii)

$$\text{Molarity} = \frac{0.39 \text{ g}}{208 \text{ g/mol} \times 0.06 \text{ L}} = 0.03125 \text{ mol L}^{-1} \quad (0/1 \text{ marks})$$

From dissociation of BaCl₂



$$\text{Total number of particles} = 1 + 2\alpha$$

$$i = \frac{1 + 2\alpha}{1} = 1 + 2\alpha$$

$$\text{Since } \alpha \text{ is equal to } \frac{1 + 2 \times 0.6}{1} = 2.2 \quad (0/1 \text{ marks})$$

10(c)(iv)

From,

$$\pi = i M R T$$

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

$$\pi = 1.68 \text{ atm. (01 mark)}$$

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