

Second Team Test - Grade 12 - 2020
Chemistry Answer Script - Part A

Part I

✓ (1) - 4	(11) - 3	(21) - 2	(31) - 2	(41) - 1
✓ (2) - 1	(12) - 4	(22) - 4	(32) - 4	(42) - 4
(3) - 2	(13) - 1	(23) - 2	(33) - 3	(43) - 5
(4) - 5	(14) - 3	(24) - 4	(34) - 5	(44) - 5
(5) - 3	(15) - 1	(25) - 5	(35) - 5	(45) - 2
(6) - 1	(16) - 5	(26) - 3	(36) - 1	(46) - 4
(7) - 4	(17) - 3	(27) - 1	(37) - 4	(47) - 1
(8) - 2	(18) - 4	(28) - 2	(38) - 2	(48) - 3
(9) - 5	(19) - 5	(29) - 3	(39) - 1	(49) - 2
• (10) - 3	(20) - 4	(30) - 1	(40) - 2	(50) - 3

Chemistry Answer Script - Part B

Part - A – Structured Essay

(01) a. I. The following questions are relevant to the elements of the third period of the periodic table. When answering part (i) to (vi) write the symbol of the element in the blanks given below.

- i. Identify the least electronegative element. (Ignore the noble gas.)

..... Na

- ii. Identify the uni atomic ion with the smallest size. (This ion should be stable.)

..... Al

- iii. Identify the element which has a stable configuration although it does not have *P* electrons.

..... Mg

- iv. Identify the element which has highest first ionization energy secondly

..... Cl

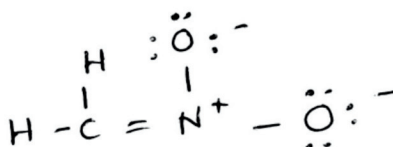
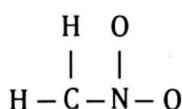
- v. Identify the element which forms electron deficient compounds and existing as dimers in gaseous state.

..... Al

(5 x 04 marks = 20)

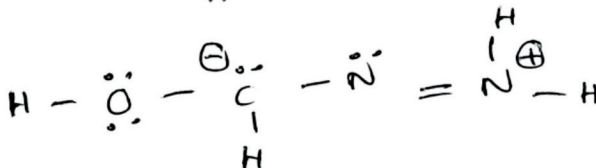
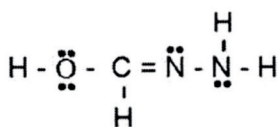
- (b) Draw the most acceptable Lewis dot - dash structure can be drawn for the ion CH_2NO_2^- . The Skelton of it is given below.

I.



(06 marks)

- II. The most acceptable lewis dot - dash structure for the molecule $\text{H}_3\text{CN}_2\text{O}$ is given below. Draw another two Lewis dot - dash structures. Write as 'unstable' under the most unstable structure which is drawn by yourself.



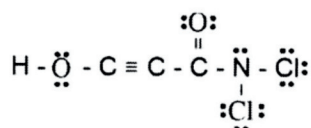
(04 marks)

(04 marks)

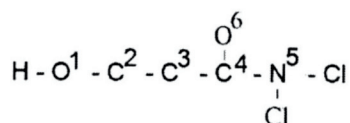
unstable (02 marks)

III. By considering the Lewis dot dash structure given below mention the followings for the atoms C, N and O ,

- VSEPR pairs around atoms.
- The electron pair geometry around the atom.
- shape around the atom.
- Mention the hybridization of the atoms.
- Mention the oxidation number of the atoms.



Atoms are numbered as follows.

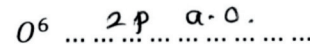
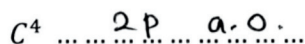
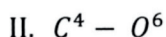
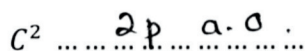
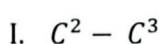


	O ¹	C ²	C ³	N ⁵
VSEPR pairs	4	2	2	4
Electron pair geometry	tetrahedral	linear	linear	tetrahedral
shape	angular	linear	linear	trigonal pyramidal
Hybridization	sp ³	sp	sp	sp ³
Oxidation Number	-2	+1	0	+1

IV. Identify the atomic / hybrid orbitals which are participated to form the following σ bonds, present in the Lewis dot dash structure of part (iii) above. [The numbering of the atoms is the same as in part (iii)]

I. H - O ¹	H 1s a.o.	O ¹ sp ³ h.o.
II. O ¹ - C ²	O ¹ sp ³ h.o.	C ² sp h.o.
III. C ² - C ³	C ² sp h.o.	C ³ sp h.o.
IV. C ³ - C ⁴	C ³ sp h.o.	C ⁴ sp ² h.o.
Vi. C ⁴ - N ⁵	C ⁴ sp ² h.o.	N ⁵ sp ³ h.o.
Vi. C ⁴ - O	C ⁴ sp ² h.o.	O 2p a.o., or sp ² h.o.

V. Identify the atomic orbitals which are participated for the formation of the following π bonds present in the Lewis dot - dash structure given in above (iii) [The numbering of the atoms is the same as in the above (iii)]



(4 x 01 mark = 4)

- VI. i. What is the orientation of the two π bonds in the triple bond of the Lewis dot dash structure in part (iii) above.

perpendicularly to each other. (02 marks)

- ii. Give an example for a molecule / an ion which is having a triple bond between 2 different atoms.

HCN or any correct answers (02 marks)

N.B. - Your example should not contain more than 3 atoms. The element present in your example should be limited to first and second periods of the periodic table.

- (c) i. The atomic orbitals are described by the 3 quantum number n, l and m_l . Write the relevant quantum number and the name of the atomic orbital in the cages, given below.

1. 4 1 -1 4p

2. 4 2 0 4d

3. 3 0 0 3s

(5 x 01 mark = 5)

- ii. Arrange the following in to the increasing order of the property mentioned inside the parenthesis is,

- I. $BeCO_3$, $MgCO_3$, $CaCO_3$ (decomposition temperature)

$BeCO_3 < MgCO_3 < CaCO_3$

- II. N^+O_2 , NO_2 , NO_2^- ($ON\hat{O}$ bond angle)

$NO_2^- < NO_2 < NO_2^+$

- III. C_2H_6 , C_2H_4 , C_2H_2 (C - C bond length)

$C_2H_2 < C_2H_4 < C_2H_6$ (3 x 06 marks = 18)

- (02) a. X is an element of S - block in the periodic table. The first second and third ionization energies of X are 519, 7300, 11800 in $kJ mol^{-1}$ respectively. X occurs a reaction which is not strong with water forming its hydroxides and liberating $H_2(g)$. The hydroxide is basic. When X reacts with diluted acids, $H_2(g)$ gas is released. X is combusted in air, a mixture of two solid compounds are formed. When those two compounds are added to water the basic gas Y is evolved.

- i. Identify X.

Li (07 marks)

- ii. Write the electron configuration of the ground state of X.

$1s^2 2s^1$ (04 marks)

- iii. Write the chemical formulae of the compounds formed in combustion of X in air.

Li_2O and Li_3N
(03 marks) (03 marks)

- iv. Consider the following compounds of the elements of the other group except the group of X in S block. Inside the given cages, mention whether the given properties below are increasing or decreasing when going down the group.

1. The water solubility of sulphites.

decreasing (03 marks)

2. The water solubility of hydroxides

Increasing (03 marks)

3. Thermal stability of metal nitrates.

Increasing (03 marks)

Give reasons for your answer for (III)

When going down the group, cationic radius is increasing (03 marks)

polarizing power is decreasing (02 marks)

covalent character is decreasing then the thermal stability increasing. (03 marks)

- v. Identify the element of s block which does not belong to the group of x of the periodic table, but reacts with $H_2(g)$, $O_2(g)$ and $N_2(g)$ in a more similar way to x.

Mg (04 marks)

- vi. What is the basic gas y?

NH_3 (04 marks)

- vii. Give an experiment to identify y?

passing the gas through moistened litmus or any correct answer (04 marks)

- viii. What is the observation of the above experiment?

Red litmus turned blue. (04 marks)

or to a correct observation.

To award marks for (i) to (v), (i) should be correct.

To award marks for (vi) to (viii), (vi) should be correct.

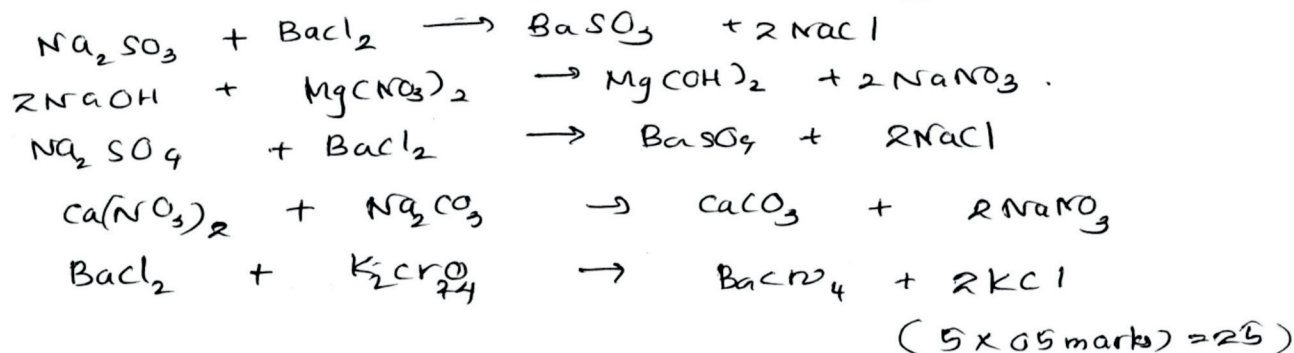
- (b) The test tubes labelled as A to E contain the aqueous solution of Na_2SO_4 , Na_2SO_3 , NaOH , K_2CrO_4 and $\text{Ca}(\text{NO}_3)_2$ (not in order) The relevant test^s carried out for each of these test tubes A to E and the relevant observations are given below.

Test Tube	Test	Observation
A	Add 1 cm^3 of BaCl_2 then add dil. HCl .	A white colour precipitate is formed and then it is dissolved.
B	Add $\text{Mg}(\text{NO}_3)_2$ solution.	A white color precipitate is obtained.
C	Add about 1 cm^3 of BaCl_2 solution then add dil. HCl .	A white colour precipitate is formed. it does not dissolve.
D	Add about 1 cm^3 of Na_2CO_3 solution then add dil. HCl .	A white colour precipitate is obtained.
E	Add 1 cm^3 of BaCl_2 solution	A yellow colour precipitate is formed.

- (i) Identify the solutions present in test tubes A to E.

A Na_2SO_3 B NaOH
 C Na_2SO_4 D $\text{Ca}(\text{NO}_3)_2$
 E K_2CrO_4 (5 x 0.5 marks = 2.5)

- (ii) Write the balanced chemical / ionic equations for the reactions taking place in A, B, D and E.



- (03) (a) I. To prepare 250 cm^3 of 1 mol dm^{-3} Na_2CO_3 solution in the laboratory, $\text{Na}_2\text{CO}_3 \cdot 5\text{H}_2\text{O}$ is provided. ($\text{Na} = 23, \text{C} = 12, \text{O} = 16, \text{H} = 1$)

- i. Calculate the number of moles of Na_2CO_3 required.

$$\begin{aligned} n &= C \cdot V \\ &= 1\text{ mol dm}^{-3} \times 250 \times 10^{-3}\text{ dm}^3 \\ &= 0.25\text{ mol} \end{aligned}$$

(5 x 2 marks = 10)

- should
 ii. What is the mass of $\text{Na}_2\text{CO}_3 \cdot 5\text{H}_2\text{O}$ that can be weighed?

$$M(\text{Na}_2\text{CO}_3 \cdot 5\text{H}_2\text{O}) = (23 \times 2) + 12 + (16 \times 3) + (5 \times 18) = 196 \checkmark$$

$$m = n \cdot M \checkmark = 0.25 \text{ mol} \times 196 \text{ g mol}^{-1} \checkmark \checkmark$$

$$m = 49 \text{ g} \checkmark \checkmark$$

$$0.2 \text{ marks} \times 7 = 14$$

for the unit $\frac{1}{1} = 1$
 of the final answer $\int (15 \text{ marks})$

- iii. What is known as a standard solution.

A solution with a known concentration

(05 marks)

- iv. What is known as a primary standard solution?

For the preparation of a standard solution, if extremely pure, stable, highly water soluble substance with a high molecular mass should be used. Also that substance should not be hydrated. That type of a solution

is known as a primary standard solution (15 marks)

- v. Give 2 examples for the primary standards?

Na_2CO_3 , $\text{K}_2\text{Cr}_2\text{O}_7$, KIO_3

For any 2, (2 x 05 marks = 10)

- vi. Why is it impossible to prepare a standard NaOH solution with an accurate concentration?

The concentration can be changed due to the dissolution of CO_2

(10 marks)

- vii. The concentration of $1 \text{ mol dm}^{-3} \text{Na}_2\text{CO}_3$ solution prepared above can be changed in a slightly small value. Give 2 reasons for that.

• $\text{Na}_2\text{CO}_3 \cdot 5\text{H}_2\text{O}$ is not very pure.

• The number of water molecules bonded can be changed. (2 x 05 marks = 10)

- viii. What is the glassware which is used to prepare a solution with a known concentration?

Volumetric flask

(10 marks)

- i x. Calculate the volume should be measured from the above $1 \text{ mol dm}^{-3} \text{ Na}_2\text{CO}_3$ solution to prepare 100 cm^3 of $0.25 \text{ mol dm}^{-3} \text{ Na}_2\text{CO}_3$ solution.

$$C_1 V_1 = C_2 V_2 \quad (5 \text{ marks})$$

* if calculated using the statements award the marks

$$1 \text{ mol dm}^{-3} \times V = 0.25 \text{ mol dm}^{-3} \times 100 \text{ cm}^3 \quad (0.4 + 1) \text{ marks}$$

$$V = 25 \text{ cm}^3 \quad (0.4 + 1) \text{ marks}$$

- (04) In a certain compound, 30.46% of oxygen and 69.54% of nitrogen are present by mass. The relative molecular mass of the compound is within 90-95.

- i. Determine the empirical formula of the compound. ($N = 14, O = 16$)

	N	O	
	30.46%	69.54%	
mass	30.46	69.54	
$n = \frac{m}{M}$	$\frac{30.46}{14 \text{ g mol}^{-1}}$	$\frac{69.54}{16 \text{ g mol}^{-1}}$	Empirical formula = NO_2
	2.17 mol	4.34 mol	
ratio	1	2	

- ii. Determine the molecular formula of the compound.

$$(\text{mass of the empirical formula}) n = \text{r.a.m} \quad \checkmark$$

$$[14 + (16 \times 2)] n = 90-95 \quad \checkmark$$

$$46 n \approx 90-95$$

$$n \approx \frac{90-95}{46} = 2 \quad \checkmark$$

$$\therefore \text{molecular formula} = \text{NO}_2 \times 2 = \text{N}_2\text{O}_4 \quad \checkmark$$

- iii. Calculate the accurate molar mass of the compound.

$$\text{N}_2\text{O}_4 = [(14 \times 2) + (16 \times 4)] \text{ g mol}^{-1} \quad \checkmark$$

$$= 92 \text{ g mol}^{-1} \quad \checkmark$$

$$(0.2 \text{ marks} \times 10 = 20)$$

- (b) I. KMnO_4 is a colourful compound.

- i. Write the IUPAC name of KMnO_4 .

potassium permanganate (05 marks)

For the reaction,

- (c) At 298 K, $2\text{NH}_3(\text{g}) \rightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$, the standard molar enthalpy is 90 kJ mol^{-1} . At 298 K the standard entropy change $250 \text{ J mol}^{-1} \text{ K}^{-1}$.

- i. Calculate ΔG^θ for the reaction.

$$\Delta G^\theta = \Delta H^\theta - T \Delta S^\theta \quad (05 \text{ marks})$$

$$= (90 \text{ kJ mol}^{-1} - 298 \text{ K} \times 250 \times 10^{-3} \text{ kJ mol}^{-1} \text{ K}^{-1})$$

$$= 15.5 \text{ kJ mol}^{-1} \quad (04 \text{ marks} + 1)$$

- ii. Explain the spontaneity of the reaction at 298 K.

$$\Delta G^\theta = (+) \text{ve}$$

$\therefore$ The reaction is not spontaneous.

(03 marks)

- iii. Calculate the minimum temperature required, for the reaction to be spontaneous.

To be spontaneous $\Delta G < 0$ (03 marks)

$$\Delta H - T \Delta S < 0 \quad (03 \text{ marks})$$

$$\Delta H < T \Delta S$$

$$\frac{\Delta H}{\Delta S} < T$$

$$\frac{\Delta H}{\Delta S}$$

(03 marks)

$$\frac{90 \text{ kJ mol}^{-1}}{0.25 \text{ kJ mol}^{-1} \text{ K}^{-1}} < T$$

(02 + 1) marks

$$360 \text{ K} < T$$

(03 marks)

Chemistry - 2020

Grade - 12 - 2nd term
test

Answers - Essay

⑤ (a). (i). Applying, $PV = nRT$ to the vessel A, ✓
 $1.6 \times 10^5 \text{ Nm}^{-2} \times 4.157 \times 10^{-3} \text{ m}^3 = n_A \times 8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 400 \text{ K}$

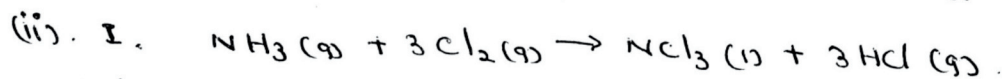
moles of NH_3 (n_A) = 0.2 mol ✓

To the vessel B,

$$2.4 \times 10^5 \text{ Nm}^{-2} \times 8.314 \times 10^{-3} \text{ m}^3 = n_B \times 8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 400 \text{ K}$$

moles of Cl_2 (n_B) = 0.6 mol. ✓

(5 x 3 marks = 15)



Initial moles 0.2 0.6

Final moles 0.2 ✓ 0.6 ✓

Total number of gaseous moles } = 0.6 mol
in the vessels

II. Apply $PV = nRT$ to the (3 x 5 marks = 15).

final system,
 $p \times 12.471 \times 10^{-3} \text{ m}^3 = 0.6 \text{ mol} \times 8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 400 \text{ K}$

$$p = 1.6 \times 10^5 \text{ Pa. } \checkmark$$

(20 marks)

III. All $\text{Cl}_2(\text{g})$ and $\text{NH}_3(\text{g})$ were reacted completely inside the system, when $\text{NH}_3(\text{g})$ is added. Since ^{unreacted} $\text{Cl}_2(\text{g})$ is not existing, a reaction does not take place. But because of the addition of 0.4 mol of $\text{NH}_3(\text{g})$, its partial pressure adds to the total pressure. ∴ The total pressure is increasing. (10 marks)

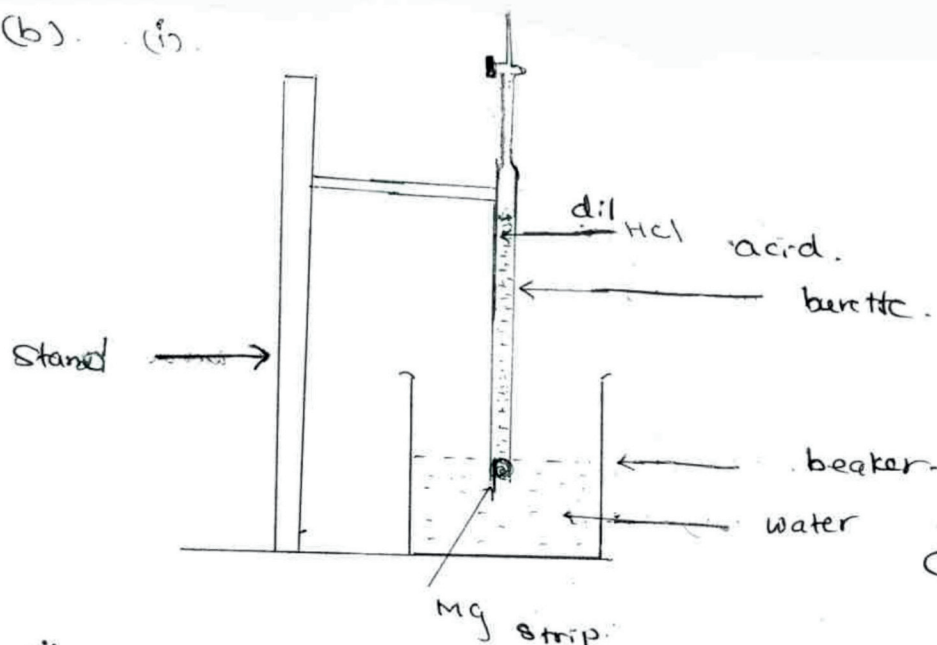
IV. $PV = nRT$ to the system,

$$p \times 12.471 \times 10^{-3} \text{ m}^3 = 1 \text{ mol} \times 8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 400 \text{ K}$$

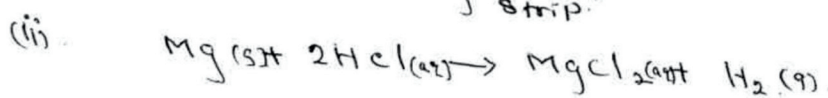
$$p = 2.66 \times 10^5 \text{ Nm}^{-2}. \checkmark \quad (\text{marks: 8})$$

(7 marks)

(b). (i).



(20 marks)



(5 marks)

(iii)
$$P_{\text{H}_2} = P_T - P_{\text{H}_2\text{O}}$$

$$= 1.013 \times 10^5 \text{ Pa} - 0.036 \times 10^5 \text{ Pa}$$

$$= \underline{0.977 \times 10^5 \text{ Pa}}$$
 ✓

For $\text{H}_2 \text{ (g)}$, $PV = nRT$

$$0.977 \times 10^5 \text{ Pa} \times 50 \times 10^{-6} \text{ m}^3 = n \times 8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 300$$
 ✓

$$n = 0.002 \text{ mol.} \quad (0.0019)$$

molar ratio, $\text{Mg} : \text{H}_2$

is 1 : 1

so,

moles of $\text{Mg} = 0.002 \text{ mol}$ ✓

mass of $\text{Mg} = \frac{\text{Mg mass}}{\text{Mg r.a.m.}}$

$$0.002 \text{ mol} = \frac{0.05 \text{ g}}{\text{Mg r.a.m.}}$$

$$\text{r.a.m. of Mg} = 25$$

(5 marks = 25)

(iv)

Assumption - H_2 gas behaves ideally.

(5 marks)

marks-55

(C) (i) Assumptions:-

- * The true volume of the particles are very small relative to the empty spaces existing among them.
- * All gas molecules travel in straight lines until they collide with each other or collide with the wall of the vessel.
- * The collisions ^{of the gas molecules} occurred with each other ~~of the gas~~ molecules or the collisions occurred with the walls of the container is perfectly elastic.
- * The attractive forces or repulsive forces do not exist among the gas particles.
- * A pressure is exerted by the gas because of the all collisions occurred by the gas molecules with the walls of the container. (marks 2x5 = 10)

(ii) $PV = \frac{1}{3} mN\overline{c^2}$ (05 marks)

P = pressure.

V = volume of the gas.

m = mass of a particle/molecule of the gas.

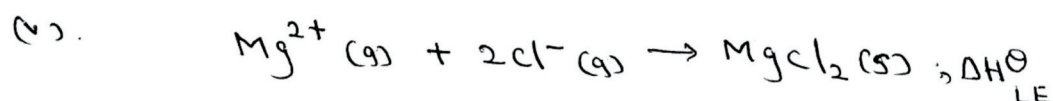
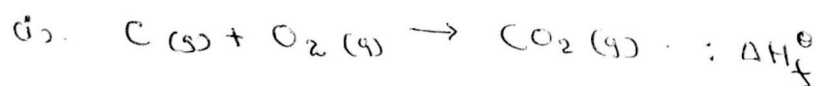
N = the total number of gas particles/molecules.

$\overline{c^2}$ = Mean square speed

(05 marks)

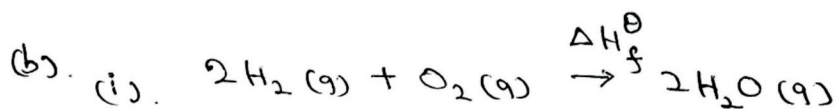
20 marks

6. (a).



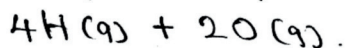
(5x5 marks = 25).

marks = 25



$2 \times 432 \text{ kJ mol}^{-1}$
 $+ 494 \text{ kJ mol}^{-1}$

$4 \times 460 \text{ kJ mol}^{-1}$



substitution of values - $2 \times 3 = 06$
 balanced equations - $2 \times 2 = 04$

By applying Hess's law,

$$\Delta H_f^\ominus + 4 \times 460 \text{ kJ mol}^{-1} = 2 \times 432 \text{ kJ mol}^{-1} + 494 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\ominus + 1840 = 864 + 494$$

$$\Delta H_f^\ominus = 1358 - 1840$$

$$\Delta H_f^\ominus = -482 \text{ kJ mol}^{-1}$$

OR

(2x5 marks = 10)

$$\Delta H_f^\ominus = \sum \Delta H_D^\ominus(\text{products}) - \sum \Delta H_D^\ominus(\text{reactants})$$

$$= 2 \times 432 \text{ kJ mol}^{-1} + 494 \text{ kJ mol}^{-1} - 4 \times 460 \text{ kJ mol}^{-1}$$

$$= 864 + 494 - 1840$$

For Educational Purpose Only

(ii) $\Delta S_r^\ominus = S^\ominus_{(\text{Products})} - S^\ominus_{(\text{Reactants})}$

$$= 2 \times 188.8 \text{ J K}^{-1} \text{ mol}^{-1} - \{2 \times 130.7 \text{ J K}^{-1} \text{ mol}^{-1} + 205.1 \text{ J K}^{-1} \text{ mol}^{-1}\}$$

$$= 377.6 - \{261.4 + 205.1\}$$

$$= 377.6 - 466.5$$

$$= \underline{-88.9 \text{ J K}^{-1} \text{ mol}^{-1}} \quad (5 \times 4 \text{ marks} = 20)$$

(iii) $\Delta G_r^\ominus = \Delta H_r^\ominus - T \Delta S_r^\ominus$

$$= -482 \text{ kJ mol}^{-1} - 298 \text{ K} \times (-88.9 \text{ J mol}^{-1} \text{ K}^{-1})$$

$$= -482 \text{ kJ mol}^{-1} + 26492.2 \text{ J mol}^{-1}$$

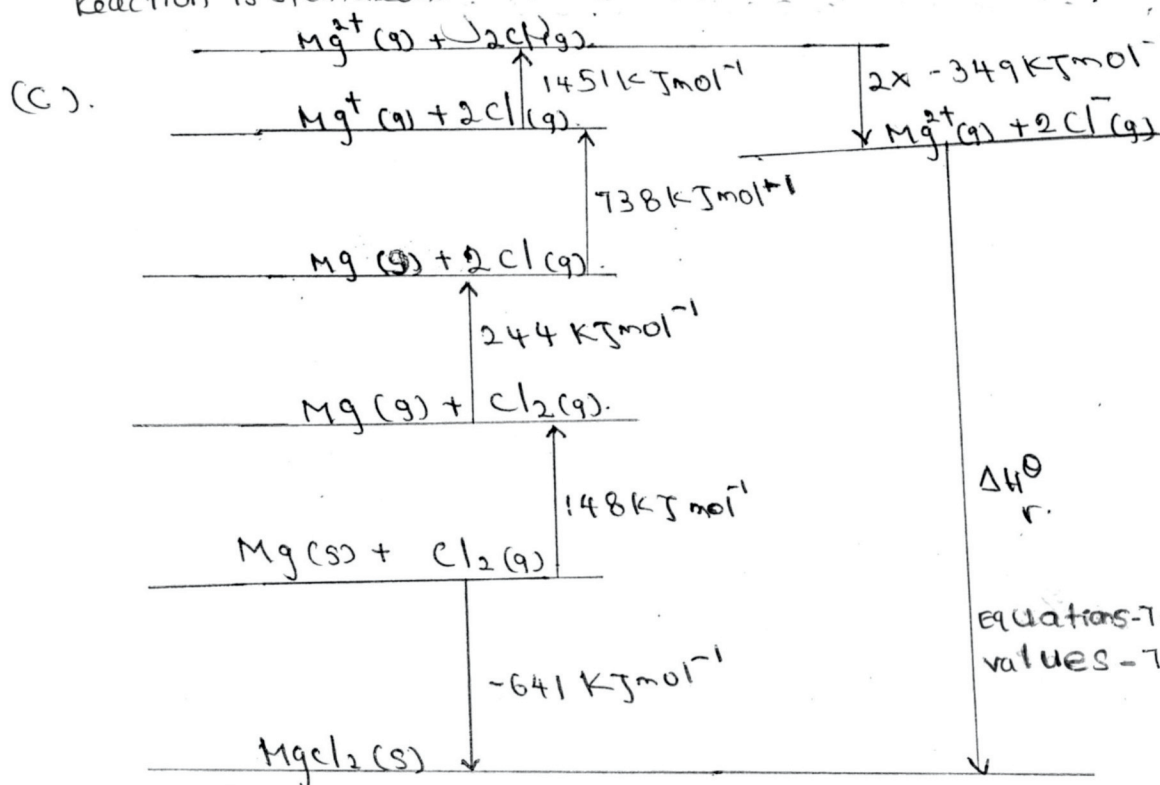
$$= (-482 + 26.49) \text{ kJ mol}^{-1}$$

$$= \underline{-455.51 \text{ kJ mol}^{-1}} \quad (5 \times 2 \text{ marks} = 10)$$

Since $\Delta G_r^\ominus < 0$,
Reaction is spontaneous.

(05 marks)

55 marks



$$\Delta H_r^\ominus + 2 \times (-349 \text{ kJ mol}^{-1}) + 1451 \text{ kJ mol}^{-1} + 738 \text{ kJ mol}^{-1} + 244 \text{ kJ mol}^{-1} + 148 \text{ kJ mol}^{-1} = -641 \text{ kJ mol}^{-1}$$

$$\Delta H_r^\ominus = \underline{-2224 \text{ kJ mol}^{-1}} \quad (2 \times 7 \text{ marks} = 14)$$

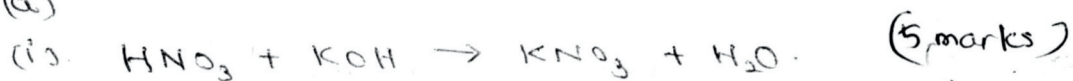
70 marks

SLGURU.LK

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(7)

(7) (a)



(ii) $Q = mc\Delta T$ ✓ (4 marks)

$$= 250 \text{ cm}^3 \times 1 \text{ g cm}^{-3} \times 4.2 \text{ J K}^{-1} \text{ g}^{-1} \times (313 - 300) \text{ K}$$

$$= 13650 \text{ J}$$

$$= \underline{13.65 \text{ KJ}}$$
 ✓

(5 × 2 marks = 10)

(iii)

$$\text{HNO}_3 \text{ moles added} = \frac{2 \times 125}{1000}$$

$$= 0.25 \text{ mol}$$
 ✓

Heat liberated

by 0.25 mol of HNO_3

$$= 13.65 \text{ KJ}$$

Heat liberated by 1 mol of HNO_3

$$= \frac{13.65 \text{ KJ}}{0.25 \text{ mol}}$$
 ✓

$$= 54.6 \text{ KJ mol}^{-1}$$

∴ The standard enthalpy of neutralisation = $\underline{-54.6 \text{ KJ mol}^{-1}}$ ✓

(3 × 5 marks = 15)

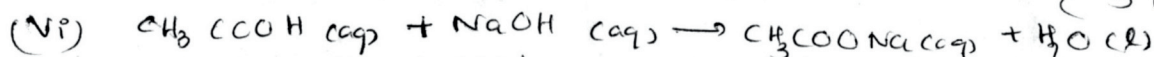
(iv) I. The total heat released by the reaction is absorbed by the completely by the solution. (no heat loss to the surroundings and the plastic vessel is heat insulated.)

II. The consideration of the density of the final solution is equal to that density of water and s.h.c of the solution is equal to the s.h.c. of the water.

(marks 5 × 2 = 10)

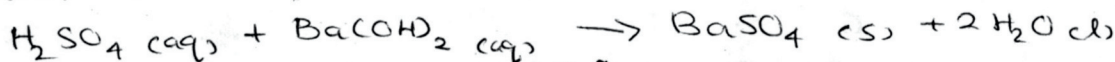
(v). The reasons to deviate from the standard value are the heat loss to the surrounding and a part of the heat evolved by the reaction exchanges to the plastic vessel.

(5 marks)



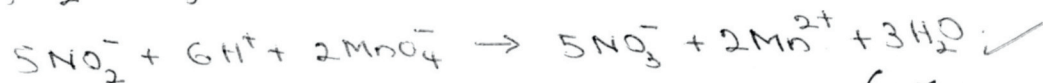
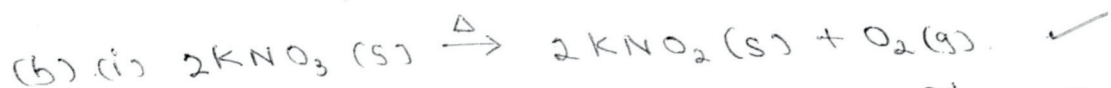
Since acetic acid is a weak acid a part of the heat evolved is gained to its dissociation.

Then the standard enthalpy of neutralisation takes a lower value than -57 KJ mol^{-1}



Here the standard enthalpy takes a value greater than -114 KJ mol^{-1} because of the formation of 2 moles of $\text{H}_2\text{O (l)}$ and the precipitation of $\text{BaSO}_4 \text{ (s)}$

65 marks



$$(ii) \text{ moles of } KMnO_4 \text{ required} = \frac{0.015 \times 30}{1000} \quad (2 \times 10 \text{ marks} = 20) \quad \checkmark$$

$$= 4.5 \times 10^{-4} \text{ mol} \quad \checkmark$$

$$\therefore \text{ number of moles of } NO_3^- \text{ present in } 25 \text{ cm}^3 \text{ of the solution} = \frac{4.5 \times 10^{-4} \text{ mol} \times 5}{2} \quad \checkmark$$

$$= 11.25 \times 10^{-4} \text{ mol}$$

$$\text{number of moles of } NO_3^- \text{ present in } 250 \text{ cm}^3 \text{ of the solution} = \frac{11.25 \times 10^{-4} \text{ mol} \times 250}{25} \quad \checkmark$$

$$= 11.25 \times 10^{-3} \text{ mol} \quad \checkmark$$

$$= 11.25 \times 10^{-3} \text{ mol} \quad \checkmark$$

$$\therefore \text{ moles of } KNO_3$$

$$\text{The number of moles of } KNO_3 \text{ decomposed} = 11.25 \times 10^{-3} \text{ mol} \quad \checkmark$$

$$\therefore \text{ the mass of } KNO_3 \text{ decomposed} = 11.25 \times 10^{-3} \text{ mol} \times 101 \text{ g mol}^{-1} \quad \checkmark$$

$$= 1.13 \text{ g} \quad \checkmark$$

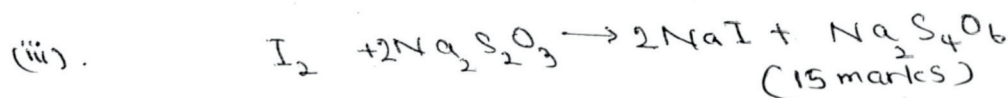
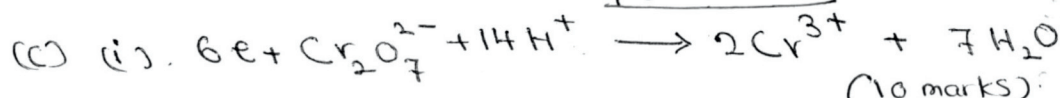
$$\text{Remaining mass of } KNO_3$$

$$= 1.55 \text{ g} - 1.13 \text{ g} \quad \checkmark$$

$$= 0.42 \text{ g} \quad \checkmark$$

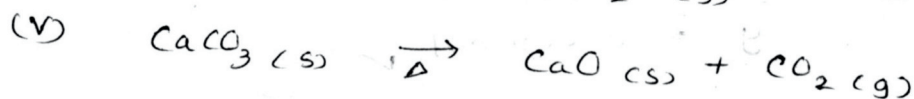
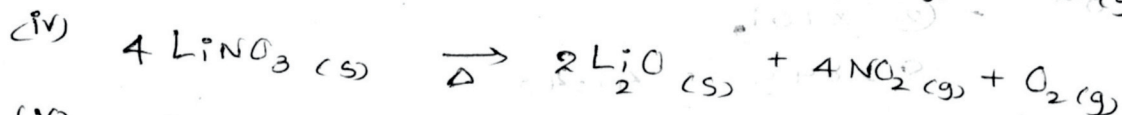
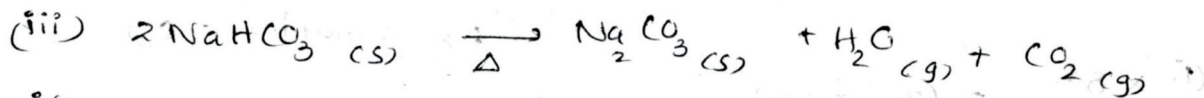
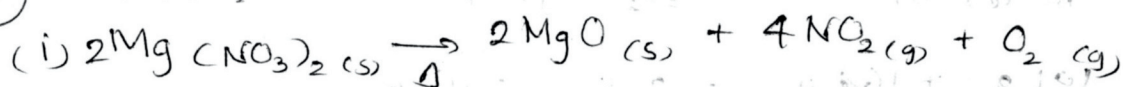
50 marks

(10 x 3 marks = 30)



35 marks

(8) (a)



(5 x 10 marks = 50)

(b) I. (i) It contains Ba^{2+} or Sr^{2+} ✓

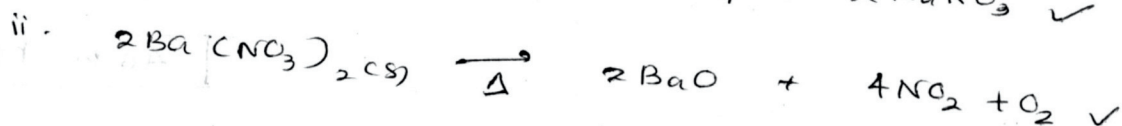
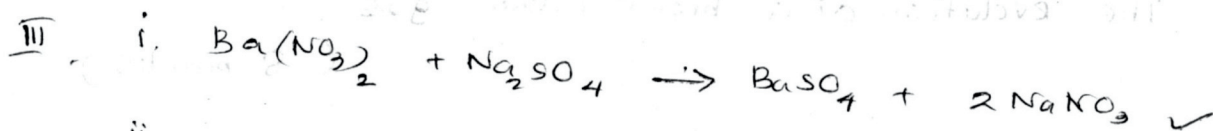
50 marks

(ii) The gas is NO_2 ✓The salt should be $Ba(NO_3)_2$ or $Sr(NO_3)_2$ ✓(iii) ✓ Ba^{2+} ion gives a yellowish green to the flame

(6 x 5 marks = 30)

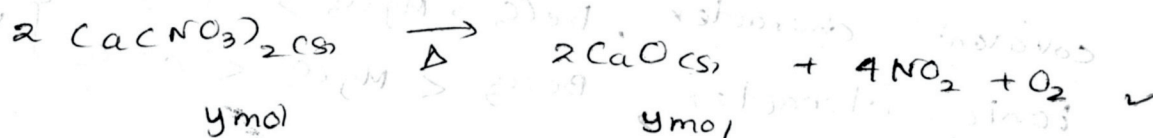
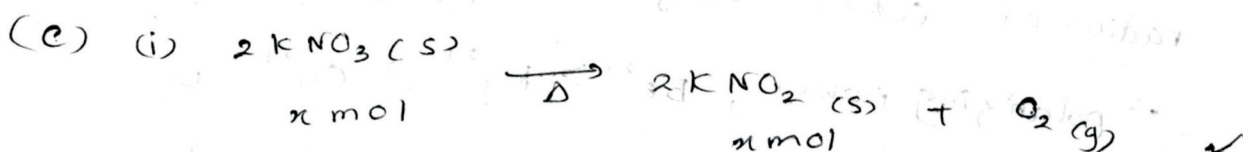
II. Salt - $Ba(NO_3)_2$

(10 marks)



(2 x 10 marks = 20)

60 marks



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(2 x 3 marks = 6)

moles of $\text{KNO}_3 = x \text{ mol}$

moles of $\text{Ca}(\text{NO}_3)_2 = y \text{ mol}$

$$101x + 164y = 2.84 \quad \text{--- (1) } \checkmark$$

$$85x + 56y = 1.98 \quad \text{--- (2) } \checkmark$$

(2 x 4 marks = 8)

$$\text{(1)} \times 85 - \text{(2)} \times 101,$$

$$8284y = 41.42$$

$$y = 0.005 \text{ mol} \quad \checkmark$$

$$\begin{aligned} \therefore \text{mass of } \text{Ca}(\text{NO}_3)_2 &= 0.005 \text{ mol} \times 164 \text{ g mol}^{-1} \\ &= 0.82 \text{ g} \quad \checkmark \end{aligned}$$

$$\text{mass percentage of } \text{Ca}(\text{NO}_3)_2 = \frac{0.82 \text{ g}}{2.84 \text{ g}} \times 100\% \quad \checkmark$$

$$= 28.87\% \quad \checkmark$$

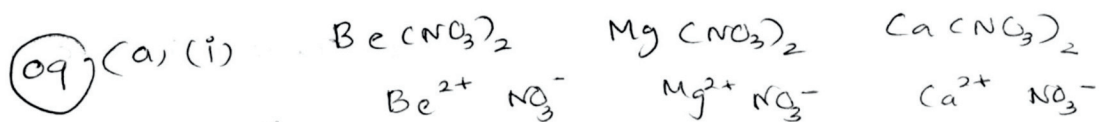
$$\therefore \text{mass percentage of } \text{KNO}_3 = 100 - 28.87$$

$$= 71.13\% \quad \checkmark$$

(ii) The evolution of a brown colour gas (6 x 3 marks = 18)

(8 marks)

40 marks



Here the anion is common (NO_3^-) $\checkmark$

radius of cations varies as, $\text{Be}^{2+} < \text{Mg}^{2+} < \text{Ca}^{2+} \quad \checkmark$

$\therefore$ polarizing power, $\text{Be}^{2+} > \text{Mg}^{2+} > \text{Ca}^{2+} \quad \checkmark$

covalent character, $\text{BeCO}_3 > \text{MgCO}_3 > \text{CaCO}_3 \quad \checkmark$

ionic character, $\text{BeCO}_3 < \text{MgCO}_3 < \text{CaCO}_3 \quad \checkmark$

$\therefore$ The thermal stability, $\text{BeCO}_3 < \text{MgCO}_3 < \text{CaCO}_3 \quad \checkmark$

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- (ii) NaOH KOH Mg(OH)_2
 Here OH^- anion is common ✓
 cationic radius $\text{Mg}^{2+} < \text{Na}^+ < \text{K}^+$ ✓
 $\therefore$ Polarizing power $\text{Mg}^{2+} > \text{Na}^+ > \text{K}^+$ ✓
 $\therefore$ the covalent character, $\text{Mg(OH)}_2 > \text{NaOH} > \text{KOH}$ } ✓
 ionic character, $\text{Mg(OH)}_2 < \text{NaOH} < \text{KOH}$ } ✓
 $\therefore$ the basicity $\therefore \text{Mg(OH)}_2 < \text{NaOH} < \text{KOH}$ ✓
 * The correct answer can be obtained based on the electronegativity values
 (5 × 2 marks = 10)

(iii)	PF_3	PCl_3	PI_3
hybridization	sp^3	sp^3	sp^3 ✓
charge	0	0	0 ✓
Oxidation number	+3	+3	+3 ✓

Therefore to compare the electronegativities of P, the electronegativity of the other atoms bonded to P should be considered. ✓
 The electronegativity, $\text{F} > \text{Cl} > \text{Br}$ ✓
 varies as ✓

So S^+ of P is increasing as, $\text{PF}_3 > \text{PCl}_3 > \text{PI}_3$

$\therefore$ the electronegativity, $\text{PF}_3 > \text{PCl}_3 > \text{PI}_3$ ✓

(7 × 2 marks = 14)

- (iv) Hydrogen bonds are present in H_2O . ✓ Dipole-Dipole attractions are present among the molecules of H_2S and H_2Se . ✓

But since the molar mass of H_2Se is greater than that of H_2S , dipole-dipole interactions of H_2Se is greater than that of H_2S . ✓
 Since hydrogen bonds present in H_2O is stronger than the dipole-dipole

attractions present in H_2S and H_2Se , it is difficult to vaporize.

∴ boiling points vary as $H_2O > H_2Se > H_2S$

(6 x 2.5 marks = 15)

total marks 49

(b) (i)

	$Na_2CO_3(aq)$	$Na_2SO_4(aq)$	$BaCl_2(aq)$	$NaNO_3(aq)$	
$Na_2CO_3(aq)$	-	-	$BaCO_3(s)$ white	-	✓
$Na_2SO_4(aq)$	-	-	$BaSO_4(s)$ white	-	✓
$BaCl_2(aq)$	$BaCO_3(s)$ white	$BaSO_4(s)$ white	-	-	✓
$NaNO_3(aq)$	-	-	-	-	✓

In mixing solution pairs as above (10 marks)
is added, two white colour precipitates are obtained. When dil HNO_3 is added, if the white precipitates formed, are insoluble it should be $BaSO_4(s)$, the presence of Na_2SO_4 can be concluded.

If the white precipitate dissolves in dil HNO_3 , it can be concluded that $BaCO_3(s)$ is present and the solution contains $Na_2SO_4(aq)$. When solutions pairs are mixing as above, $NaNO_3$ does not give any precipitate.

(7 x 2 marks = 14)

(c) (i) $NaHCO_3$ - sodium hydrogen carbonate ✓

(ii) $CuSO_4$ - copper(II) sulfate ✓

(iii) $CuCl$ - copper(I) chloride ✓

(iv) $Fe_2(SO_4)_3$ - Iron(III) sulfate ✓

(v) $KMnO_4$ - potassium permanganate ✓

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(5 x 5 marks = 25)

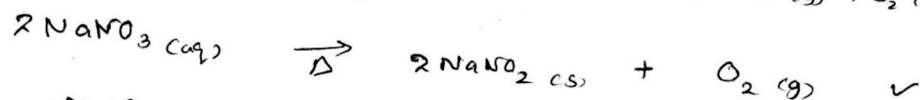
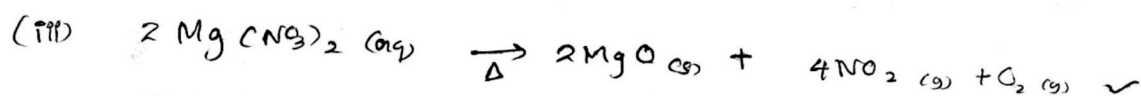
(b) ii

	$\text{Na}_2\text{Cr}_2\text{O}_7 (\text{aq})$	$\text{MgCl}_2 (\text{aq})$	$\text{Ba}(\text{NO}_3)_2 (\text{aq})$	$\text{Na}_2\text{CO}_3 (\text{aq})$
$\text{Na}_2\text{Cr}_2\text{O}_7 (\text{aq})$	—	—	$\text{BaCrO}_4 (\text{s})$ yellow	— ✓
$\text{MgCl}_2 (\text{aq})$	—	—	—	$\text{MgCO}_3 (\text{s})$ white ✓
$\text{Ba}(\text{NO}_3)_2 (\text{aq})$	$\text{BaCrO}_4 (\text{s})$ yellow	—	—	$\text{BaCO}_3 (\text{s})$ white ✓
$\text{Na}_2\text{CO}_3 (\text{aq})$	—	$\text{MgCO}_3 (\text{s})$ white	$\text{BaCO}_3 (\text{s})$ white	— ✓

(4 x 2.5 marks = 10)

In mixing solution pairs as above, if only a yellow colour precipitate ✓ is formed, the added solution should be $\text{Na}_2\text{Cr}_2\text{O}_7 (\text{aq})$. ✓ If only a white colour ✓ precipitate is obtained it is $\text{MgCl}_2 (\text{aq})$. ✓ If two ^{white} precipitates ✓ are formed, the added solution should be $\text{Na}_2\text{CO}_3 (\text{aq})$. ✓ upon the addition of $\text{Ba}(\text{NO}_3)_2 (\text{aq})$ ✓ a white colour precipitate and a yellow colour precipitate is are formed ✓

(9 x 2 marks = 18)



In heating, Na_2CO_3 does not occur any change. ✓
If a brown colour gas is evolved upon heating that is $\text{Mg}(\text{NO}_3)_2$. ✓

When it is heating, a solid residue and a colourless gas is given by $\text{NaNO}_3 (\text{aq})$ ✓

(6 x 4 marks = 24)

Total marks = 76

(C) (i) NaHCO_3 - Sodium hydrogencarbonate ✓

(ii) CuSO_4 - Copper(II) sulfate ✓

(iii) CuCl - Copper(I) chloride ✓

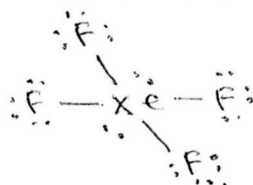
(iv) $\text{Fe}_2(\text{SO}_4)_3$ - Iron(III) sulfate ✓

(v) KMnO_4 - Potassium permanganate ✓

(5 x 5 marks = 25)

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(10) (a).

(i) XeF_4 

Total number of electron pairs around the central atom = 6 ✓

VSEPR pairs = 6 ✓

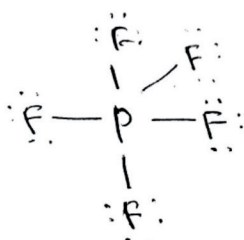
 σ bonds = 4 ✓

lone pairs = 2 ✓

(3 × 2 marks = 6)

∴ the shape is square planar ✓

(4 marks)

(ii) PF_5 

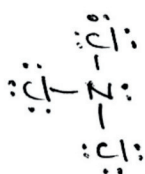
total e pairs around P = 5

VSEPR pairs = 5

 σ bonds = 5

lone pairs = 0

∴ the shape is trigonal bipyramidal

(iii) NCl_3 

The total number of e pairs around N = 4

VSEPR pairs = 4

 σ bonds = 4

lone pairs = 0

∴ The shape is trigonal pyramidal

(iv) ClO_4^-

The number of total e pairs around Cl = 7

VSEPR pairs = 4

 σ bonds = 4

lone pairs = 0

∴ The shape is tetrahedral

The total number of e pairs around N = 4

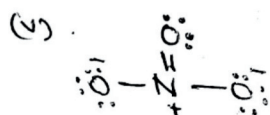
VSEPR pairs = 3

 σ bonds = 3

lone pairs = 0

(5 × 10 marks)

total marks = 50



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$$\begin{aligned} \text{(b). moles of } \text{Cr}_2\text{O}_3 &= \frac{1.52\text{g}}{152\text{g mol}^{-1}} \\ &= 0.01\text{ mol} \quad \checkmark \end{aligned}$$

$$\begin{aligned} \text{moles of } \text{H}_2\text{O} &= \frac{0.72\text{g}}{18\text{g mol}^{-1}} \\ &= 0.04\text{ mol} \quad \checkmark \end{aligned}$$

$$\begin{aligned} \text{moles of } \text{N}_2 &= \frac{0.28\text{g}}{28\text{g mol}^{-1}} \\ &= 0.01\text{ mol} \quad \checkmark \end{aligned}$$

molar ratio of,
 $\text{Cr}_2\text{O}_3 : \text{H}_2\text{O} : \text{N}_2$

$$0.01 : 0.04 : 0.01$$

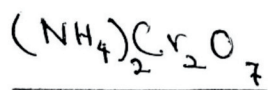
$$1 : 4 : 1 \quad \checkmark$$

$\therefore$ atomic molar ratio,
 $\text{Cr} : \text{H} : \text{N} : \text{O}$
 $2 : 8 : 2 : 7$

$\therefore$ Empirical formula $\text{Cr}_2\text{H}_8\text{N}_2\text{O}_7$ $\checkmark$

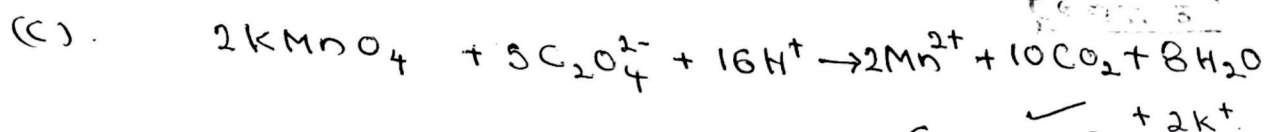
(5 x 4 marks = 20)

molecular formula of X_2 , $\text{Cr}_2\text{H}_8\text{N}_2\text{O}_7$



(10 marks)

30 marks



molar ratio, $\text{KMnO}_4 : \text{C}_2\text{O}_4^{2-}$

$$2 : 5 \quad \checkmark$$

(15 marks)

number of moles of $\text{C}_2\text{O}_4^{2-}$ consumed to titrate 25cm^3 of the solution $\int = \frac{0.02 \times 15}{1000} \quad \checkmark$

$\therefore$ The number of KMnO_4 present in 25cm^3 of the solution $\int = \frac{3 \times 10^{-4} \text{ mol} \times 2}{5} \quad \checkmark$
 $= 1.2 \times 10^{-4} \text{ mol.} \quad \checkmark$

The number of moles of KMnO_4 present in 100 cm^3 of the solution $\left\{ \frac{1.2 \times 10^{-4} \text{ mol} \times 100 \text{ cm}^3}{25 \text{ cm}^3} \right\}$
 $= 4.8 \times 10^{-4} \text{ mol}$ ✓

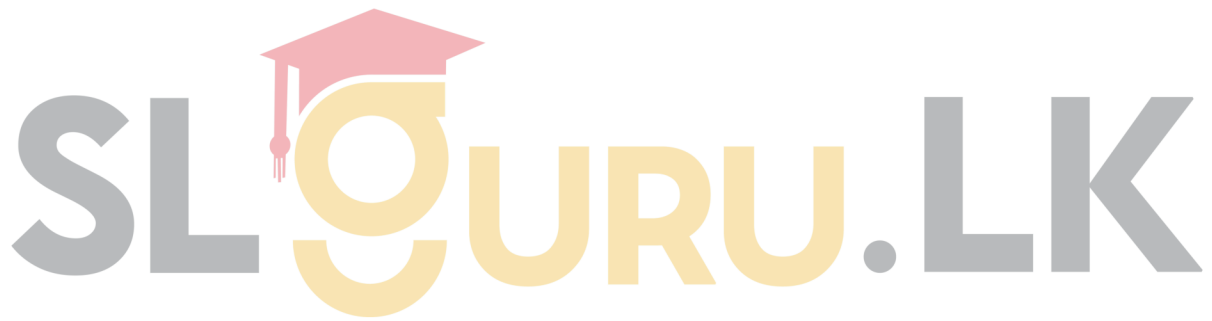
$\therefore$ The mass of KMnO_4 present in the sample $= 4.8 \times 10^{-4} \text{ mol} \times 158 \text{ g mol}^{-1}$
 $= 0.07584 \text{ g}$
 $= 75.84 \text{ mg}$ ✓

mass percentage of $\text{KMnO}_4 = \frac{75.84 \text{ mg} \times 100\%}{200 \text{ mg}}$ ✓
 $= \underline{\underline{37.92\%}}$ ✓

(11 x 5 marks = 55)

70 marks.

“Education is simply the soul of a society as it passes from one generation to another.” – G.K. Chesterton



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