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

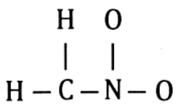
v. Identify the element which forms electron deficient compounds and existing as dimers in gaseous state.

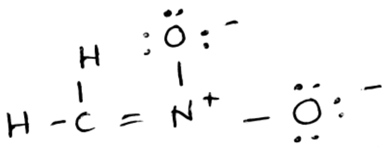
Al

(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.

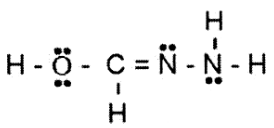
I.

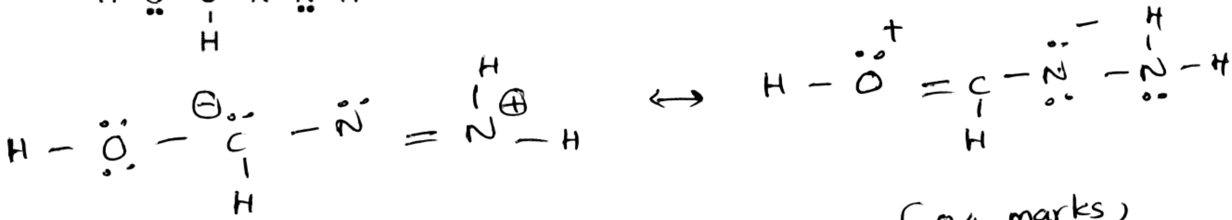




(06 marks)

II. The most acceptable lewis dot - dash structure for the molecule H_3CN_2O 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 ,

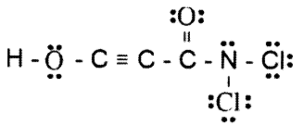
i. $VSEPR$ pairs around atoms.

ii. The electron pair geometry around the atom.

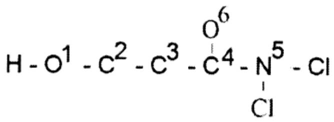
iii. shape around the atom.

iv. Mention the hybridization of the atoms.

v. 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

(20x 01mark = 20)

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.

(12x01 mark = 12)

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)]

I. $C^2 - C^3$ C^2 ......2p a.o. ...... C^3 ......2p a.o. ......

II. $C^4 - O^6$ C^4 ......2p a.o. ...... O^6 ......2p a.o. ......

(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 answer (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

(6 x 01 mark = 6)

ii. A 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^- ($O\hat{N}O$ 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 (3x 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 (03 marks) and Li_3N (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 hydroxids [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)

vi. Give an experiment to identify y?

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

vii. 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 $Ca(NO_3)_2$ (not in order) The relevant tests 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 $Mg(NO_3)_2$ 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 $Ca(NO_3)_2$

E K_2CrO_4

(5 x 05 marks = 25)

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

$Na_2SO_3 + BaCl_2 \rightarrow BaSO_3 + 2NaCl$

$2NaOH + Mg(NO_3)_2 \rightarrow Mg(OH)_2 + 2NaNO_3$

$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$

$Ca(NO_3)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaNO_3$

$BaCl_2 + K_2CrO_4 \rightarrow BaCrO_4 + 2KCl$

(5 x 05 marks = 25)

(03) (a) I. To prepare $250\ cm^3$ of $1\ moldm^{-3}$ Na_2CO_3 solution in the laboratory, $Na_2CO_3.5H_2O$ is provided. $(Na = 23, C = 12, O = 16, H = 1)$

i. Calculate the number of moles of Na_2CO_3 required.

$n = C \cdot V$ ✓

$= 1\ moldm^{-3} \times 250 \times 10^{-3}\ dm^3$ ✓✓

$= 0.25\ mol$ ✓✓

(5 x 2 marks = 10)

ii What is the mass of $Na_2CO_3.5H_2O$ that ~~can~~ should be weighed ?

M $(Na_2CO_3 . 5H_2O)$ = (23 x 2) + 12 + (16 x 3) + (5 x 16) = 196 ✓

m = n . M ✓ = 0.25 mol x 196 g mol⁻¹ ✓✓

m = 49 g ✓✓

02 marks x 7 = 14

for the unit of the final answer = 1 (15 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 types of a solution is known as a primary standard solution (15 marks)

v. Give 2 examples for the primary standards?

Na_2CO_3, $K_2Cr_2O_7$, 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 $1\ mol\ dm^{-3}$ Na_2CO_3 solution prepared above can be changed ~~in a small value~~ slightly. Give 2 reasons for that.

- $Na_2CO_3 . 5H_2O$ 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 $1\ mol\ dm^{-3}\ Na_2CO_3$ solution to prepare $100\ cm^3$ of $0.25\ mol\ dm^{-3}\ Na_2CO_3$ solution.

$C_1V_1 = C_2V_2$ (5 marks)

$1\ moldm^{-3} \times V = 0.25\ moldm^{-3} \times 100\ cm^3$ (04+1) marks

$V = 25\ cm^3$ (04+1) marks.

* If calculated using the statements award the 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
$n = m/M$	$30.46 / 14\ g\ mol^{-1}$	$69.54 / 16\ g\ mol^{-1}$ ✓
	2.17 mol	4.34 mol ✓
ratio	1	2 ✓

Empirical formula $= NO_2$ ✓

ii. Determine the molecular formula of the compound.

(mass of the empirical formula) n = r.a.m ✓

$[14 + (16 \times 2)]n = 90\text{-}95$ ✓

$46n \approx 90 - 95$

$n \approx \frac{90-95}{46} = 2$ ✓

$\therefore$ molecular formula $= NO_2 \times 2 = N_2O_4$ ✓

iii. Calculate the accurate molar mass of the compound.

$N_2O_4 = [(14 \times 2) + (16 \times 4)]\ g\ mol^{-1}$ ✓

$= 92\ g\ mol^{-1}$ ✓

(02 marks x 10 = 20)

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

i. Write the *IUPAC* name of $KMnO_4$.

potassium permanganate (05 marks)

ii. Write the chemical formula of the oxide derived from the oxidation number of Mn in $KMnO_4$.

Mn_2O_7 (05 marks)

iii. Write the election configuration of Mn as $1s^2\ 2s^2$ … … …

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$ (05 marks)

iv. In acidic medium $KMnO_4$ reacts with $K_2C_2O_4$

$(Cr_2O_7^{2-} \rightarrow Cr^{3+})$

$(C_2O_4^{2-} \rightarrow CO_2)$

1. Write the oxidation half reaction.

$C_2O_4^{2-} \rightarrow 2CO_2 + 2e$ (10 marks)

+3 +4

2. Write the reduction half reaction.

$14H^+ + Cr_2O_7^{2-} + 6e \rightarrow 2Cr^{3+} + 7H_2O$

+6 +3 (10 marks)

3. Write the balanced ionic reaction.

$14H^+ + Cr_2O_7^{2-} + 3C_2O_4^{2-} \rightarrow 6CO_2 + 2Cr^{3+} + 7H_2O$

(05 marks)

4. Write the balanced chemical equation if dil. H_2SO_4 is used as the acidic medium.

$7H_2SO_4 + K_2Cr_2O_7 + 3K_2C_2O_4 \rightarrow 6CO_2 + Cr_2(SO_4)_3 + 4K_2SO_4 + 7H_2O$

(05 marks)

For the reaction,

(c) At 298 K, $2NH_3(g) \rightarrow N_2(g) + 3\,H_2(g)$, the standard molar enthalpy is $90\ kJmol^{-1}$. At 298 K the standard entropy change $250\,J\ mol^{-1}K^{-1}$.

i. Calculate ΔG^{θ} for the reaction.

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

$= (90\,kJ\ mol^{-1} - 298\,K \times 250 \times 10^{-3}\,kJ\,mol^{-1}K^{-1})$ (04 marks +1)

$= 15.5\ kJmol^{-1}$ (04 marks +1)

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

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

∴ The reaction is not spontaneous. (05 marks)

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

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

$\Delta H - T\Delta S < 0$ (03 marks)

$\Delta H < T\Delta S$

$\frac{\Delta H}{\Delta S} < T$ (03 marks)

$\frac{90\,kJ\,mol^{-1}}{0.25\,kJ\,mol^{-1}K^{-1}} < T$ (02+1) marks

$360\,K < T$ (03 marks)

Chemistry - 2020
Grade - 12 - 2nd term test

Answers - Essay

(5) (a). (i). Applying, $PV = nRT$ to the vessel A, ✓

$1.6 \times 10^5\ Nm^{-2} \times 4.157 \times 10^{-3}\ m^3 = n_A \times 8.314\ J mol^{-1} K^{-1} \times 400 K$ ✓

moles of NH_3 $(n_A) = 0.2$ mol ✓

To the vessel B,

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

moles of Cl_2 $(n_B) = 0.6$ mol. ✓

(5 x 3 marks = 15)

(ii). I. $NH_{3(g)} + 3Cl_{2(g)} \rightarrow NCl_{3(l)} + 3HCl_{(g)}$

	NH_3	Cl_2	NCl_3	HCl
Initial moles	0.2	0.6	-	-
Final moles	-	-	0.2 ✓	0.6 ✓

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

(3 x 5 marks = 15).

II. Apply $PV = nRT$ To the final system,

$P \times 12.471 \times 10^{-3}\ m^3 = 0.6\ mol \times 8.314\ J mol^{-1} K^{-1} \times 400 K$ ✓

$P = 1.6 \times 10^5$ pa. ✓

(20 marks)

III. All $Cl_{2(g)}$ and $NH_{3(g)}$ were reacted completely inside the system, when $NH_{3(g)}$ is added, since unreacted $Cl_{2(g)}$ is not existing, a reaction doesnot take place. But because of the addition of 0.4 mol of $NH_{3(g)}$, its partial pressure adds to the total pressure. ∴ The total pressure is increasing.

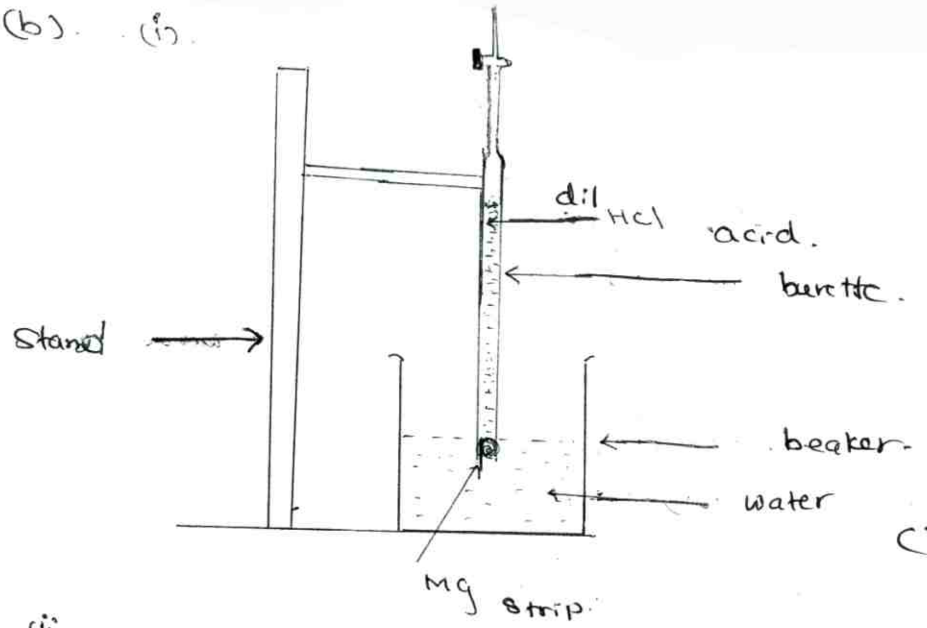
(10 marks)

IV. $PV = nRT$ to the system,

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

(marks : 8)

$P = 2.66 \times 10^5\ Nm^{-2}$. ✓ (7 marks) (b). (i)



(20 marks)

(ii) $Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

(5 marks)

(iii) $P_{H_2} = P_T - P_{H_2O}$

$= 1.013 \times 10^5 pa - 0.036 \times 10^5 pa$

$= 0.977 \times 10^5 pa$ ✓

To $H_2(g)$, $PV = nRT$

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

$n = 0.002 mol$ ✓ (0.0019)

molar ratio, Mg : H_2

is 1 : 1 so,

moles of Mg = 0.002 mol ✓

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

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

∴ r.a.m of Mg = 25 ✓

(5×5 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 donot 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 2 x 5 = 10)

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

P = Pressure.

V = Volume of the gas.

m = mass of a ~~partikle~~/molecule of the gas.

N = the total number of gas particles / molecules.

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

(05 marks)

20 marks

(6) (a).

(i). $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$; $\Delta H_f^\ominus$

(ii). $Na_{(s)} \rightarrow Na_{(g)}$; $\Delta H_S^\ominus$

(iii) $O_{2(g)} \rightarrow 2O_{(g)}$; $\Delta H_D^\ominus$

(iv). $\frac{1}{2}Cl_{2(g)} \rightarrow Cl_{(g)}$; $\Delta H_{atm}^\ominus$

(v). $Mg^{2+}_{(g)} + 2Cl^-_{(g)} \rightarrow MgCl_{2(s)}$; $\Delta H_{LE}^\ominus$

(5x5 marks = 25).

marks - 25

(b). (i). $2H_{2(g)} + O_{2(g)} \xrightarrow{\Delta H_f^\ominus} 2H_2O_{(g)}$

$2 \times 432\ kJmol^{-1} + 494\ kJmol^{-1}$ ↓ ✓ ; $4 \times 460\ kJmol^{-1}$ ✓ ↓

$4H_{(g)} + 2O_{(g)}$.

substitution of values - 2x3 = 06

balanced equations 2x2 = 04

By applying Hess's law,

$$\Delta H_f^\ominus + 4 \times 460\ kJmol^{-1} = 2 \times 432\ kJmol^{-1} + 494\ kJmol^{-1}$$ ✓

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

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

$$\Delta H_f^\ominus = -482\ kJmol^{-1}$$ ✓

OR

(2x5 marks = 10)

$$\Delta H_f^\ominus = \Sigma \Delta H^\ominus_{D(ප්‍රතික්‍රියක)} - \Sigma \Delta H^\ominus_{D(ඵල)}$$ ✓

$$= 2 \times 432\ kJmol^{-1} + 494\ kJmol^{-1} - 4 \times 460\ kJmol^{-1}$$

$$= 864 + 494 - 1840$$

(ii) $\Delta S^\theta_r = S^\theta_{(Products)} - S^\theta_{(Reactants)}$

$= 2 \times 188.8\ JK^{-1}mol^{-1} - \{2 \times 130.7\ JK^{-1}mol^{-1} + 205.1\ JK^{-1}mol^{-1}\}$

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

$= 377.6 - 466.5$

$= -88.9\ JK^{-1}mol^{-1}$ (5×4 marks = 20)

(iii) $\Delta G^\theta_r = \Delta H^\theta_r - T\Delta S^\theta_r$

$= -482\ kJmol^{-1} - 298\ K \times (-88.9\ Jmol^{-1}K^{-1})$

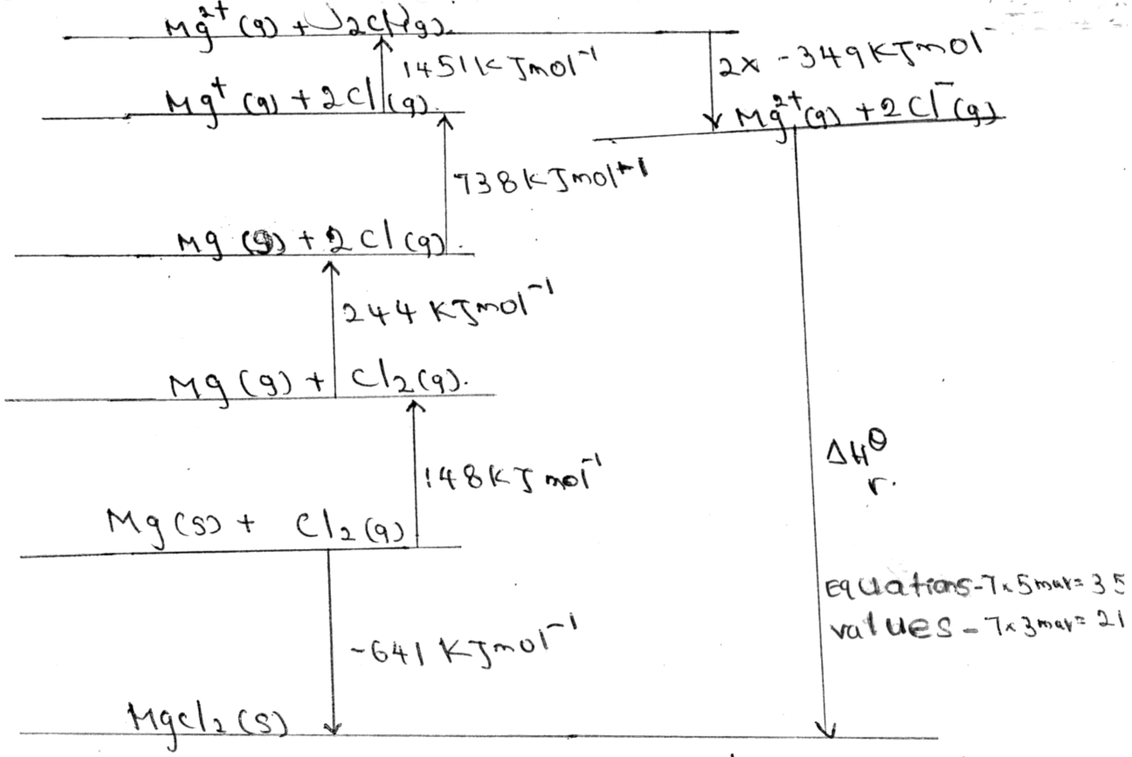
$= -482\ kJmol^{-1} + 26492.2\ Jmol^{-1}$

$= (-482 + 26.49)\ kJmol^{-1}$

$= -455.51\ kJmol^{-1}$ (5×2 marks = 10)

Since $\Delta G^\theta_r < 0$,
Reaction is spontaneous. (05 marks) [55 marks]

(c).



$\Delta H^\theta_r + 2 \times (-349\ kJmol^{-1}) + 1451\ kJmol^{-1} + 738\ kJmol^{-1} + 244\ kJmol^{-1}$
$+ 148\ kJmol^{-1} = -641\ kJmol^{-1}$ (2×7 marks = 14)

$\Delta H^\theta_r = -2224\ kJmol^{-1}$

[70 marks]

(7) (a)

(i) $HNO_3 + KOH \rightarrow KNO_3 + H_2O$. (5 marks)

(ii) $Q = mc\Delta T$ ✓ (4 marks)

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

$= 13650\,J$

$= 13.65\,kJ$ ✓

(5 × 2 marks = 10)

(iii) HNO_3 moles added $= \frac{2 \times 125}{1000}$

$= 0.25\,mol$ ✓

Heat liberated by 0.25 mol of HNO_3 $= 13.65\,kJ$

Heat liberated by 1 mol of HNO_3 $= \frac{13.65\,kJ}{0.25\,mol}$ ✓

$= 54.6\,kJ\,mol^{-1}$

∴ The standard enthalpy of neutralisation $= -54.6\,kJ\,mol^{-1}$ ✓

(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)

(vi) $CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$

Since acetic acid is a weak acid ~~the~~ a part of the heat evolved is gained to its dissociation. Then the standard enthalpy of neutralisation takes a lower value than $-57\,kJ\,mol^{-1}$

$H_2SO_{4(aq)} + Ba(OH)_{2(aq)} \rightarrow BaSO_{4(s)} + 2H_2O_{(l)}$

Here the standard enthalpy takes a value greater than $-114\,kJ\,mol^{-1}$ because of the formation of 2 moles of $H_2O_{(l)}$ and the precipitation of $BaSO_{4(s)}$

[65 marks]

(b) (i) $2KNO_3 (s) \xrightarrow{\Delta} 2KNO_2 (s) + O_2 (g)$ ✓

$5NO_2^- + 6H^+ + 2MnO_4^- \rightarrow 5NO_3^- + 2Mn^{2+} + 3H_2O$ ✓

(2 × 10 marks = 20)

(ii) moles of $KMnO_4$ required $= \frac{0.015}{1000} \times 30$ ✓

$= 4.5 \times 10^{-4}$ mol ✓

∴ number of moles of NO_2^- present in 25 cm³ of the solution $= \frac{4.5 \times 10^{-4} \text{mol} \times 5}{2}$ ✓

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

number of moles of NO_2^- present in 250 cm³ of the solution $= \frac{11.25 \times 10^{-4} \text{mol} \times 250}{25}$ ✓

$= 11.25 \times 10^{-3}$ mol ✓

∴ moles of KNO_2 $= 11.25 \times 10^{-3}$ mol ✓

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

∴ the mass of KNO_3 decomposed $= 11.25 \times 10^{-3}$ mol $\times$ 101 g mol^{-1} ✓

$= 1.13$ g ✓

Remaining mass of KNO_3 $= 1.55\text{g} - 1.13\text{g}$

$= \underline{0.42 \text{ g}}$ ✓

(10 × 3 marks = 30)

[50 marks]

(c) (i) $6e + Cr_2O_7^{2-} + 14H^+ \longrightarrow 2Cr^{3+} + 7H_2O$

(10 marks)

(ii) $2H_2O + MnO_4^- + 3e \longrightarrow MnO_2 + 4OH^-$

(10 marks)

(iii) $I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$

(15 marks)

[35 marks]

6

(8) (a)

(i) $2Mg(NO_3)_{2(s)} \xrightarrow{\Delta} 2MgO_{(s)} + 4NO_{2(g)} + O_{2(g)}$

(ii) $2NaNO_{3(s)} \xrightarrow{\Delta} 2NaNO_{2(s)} + O_{2(g)}$

(iii) $2NaHCO_{3(s)} \xrightarrow{\Delta} Na_2CO_{3(s)} + H_2O_{(g)} + CO_{2(g)}$

(iv) $4LiNO_{3(s)} \xrightarrow{\Delta} 2Li_2O_{(s)} + 4NO_{2(g)} + O_{2(g)}$

(v) $CaCO_{3(s)} \xrightarrow{\Delta} CaO_{(s)} + CO_{2(g)}$

(5 x 10 marks = 50)

50 marks

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

(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)

III. i. $Ba(NO_3)_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaNO_3$ ✓

ii. $2Ba(NO_3)_{2(s)} \xrightarrow{\Delta} 2BaO + 4NO_2 + O_2$ ✓

(2x 10 marks = 20)

60 marks

(c) (i) $2KNO_{3(s)} \xrightarrow{\Delta} 2KNO_{2(s)} + O_{2(g)}$ ✓

x mol → x mol

$2Ca(NO_3)_{2(s)} \xrightarrow{\Delta} 2CaO_{(s)} + 4NO_2 + O_2$ ✓

y mol → y mol

(2 x 3 marks = 6)

moles of KNO_3 = x mol

moles of $Ca(NO_3)_2$ = y mol

$101x + 164y = 2.84$ — ① ✓

$85x + 56 = 1.98$ — ② ✓

(2x 4 marks = 8)

① × 85 − ② × 101,

$8284y = 41.42$

$y = 0.005$ mol ✓

∴ mass of $Ca(NO_3)_2$ = 0.005 mol × 164 g mol^{-1} ✓

= 0.82g ✓

mass percentage of $Ca(NO_3)_2$ = $\frac{0.82g}{2.84g} \times 100\%$ ✓

= <u>28.87 %</u> ✓

∴ mass percentage of KNO_3 = 100 − 28.87

= <u>71.13 %</u> ✓

(6x 3marks = 18)

(ii) The evolution of a brown colour gas

(8 marks)

40 marks

(09) (a) (i) $Be(NO_3)_2$ $Mg(NO_3)_2$ $Ca(NO_3)_2$

Be^{2+} NO_3^- Mg^{2+} NO_3^- Ca^{2+} NO_3^-

Here the anion is common (NO_3^-) ✓

radius of cations varies as, $Be^{2+} < Mg^{2+} < Ca^{2+}$ ✓

∴ polarizing power, $Be^{2+} > Mg^{2+} > Ca^{2+}$ ✓

covalent character, $BeCO_3 > MgCO_3 > CaCO_3$ }

ionic character, $BeCO_3 < MgCO_3 < CaCO_3$ } ✓

∴ The thermal stability, $BeCO_3 < MgCO_3 < CaCO_3$ ✓

(5x2marks = 10)

(ii) NaOH KOH $Mg(OH)_2$

Here OH^- anion is common ✓

cationic radius $Mg^{2+} < Na^+ < K^+$ ✓

∴ Polarizing power $Mg^{2+} > Na^+ > K^+$ ✓

∴ the covalent character, $Mg(OH)_2 > NaOH > KOH$

ionic character, $Mg(OH)_2 < NaOH < KOH$ } ✓

∴ the basicity, $Mg(OH)_2 < NaOH < KOH$ ✓

* 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 varies as, F > Cl > Br ✓

So $\delta+$ of P is increasing as, $PF_3 > PCl_3 > PI_3$ ✓

∴ the electronegativity, $PF_3 > PCl_3 > PI_3$ ✓

(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

8

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

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

(10 marks)

In mixing solution pairs as above, when $BaCl_2$(aq) 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 solution pairs are mixing as above, $NaNO_3$ does not give any precipitate. ✓

(7 x 2 marks = 14)

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

(ii) $CuSO_4$ - copper(II) sulfate ✓

(iii) $CuCl$ - Co(I) Chloride ✓

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

(v) $KMnO_4$ - Potassium permanganate ✓

(5 x 5 marks = 25)

(b) ii

	Na_2CrO_4 (aq)	$MgCl_2$ (aq)	$Ba(NO_3)_2$ (aq)	Na_2CO_3 (aq)
Na_2CrO_4 (aq)	—	—	$BaCrO_4$ (s) yellow	— ✓
$MgCl_2$ (aq)	—	—	—	$MgCO_3$ (s) white ✓
$Ba(NO_3)$ (aq)	$BaCrO_4$ (s) Yellow	—	—	$BaCO_3$ (s) White ✓
$Na_2(CO_3)$ (aq)	—	$MgCO_3$ (s) White	$BaCO_3$ (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 Na_2CrO_4 (aq). ✓ If only a white colour ✓ precipitate is is obtained it is $MgCl_2$ (aq). ✓ If two white precipitates ✓ are formed, the added solution should be Na_2CO_3 (aq). ✓. upon the addition of $Ba(NO_3)_2$ (aq) ✓ a white colour precipitate and a yellow colour precipitate is are formed ✓

(9 x 2marks = 18)

(iii) $2Mg(NO_3)_2 (aq) \xrightarrow{\Delta} 2MgO (s) + 4NO_2 (g) + O_2 (g)$ ✓

$2NaNO_3 (aq) \xrightarrow{\Delta} 2NaNO_2 (s) + O_2 (g)$ ✓

$Na_2CO_3 (aq) \xrightarrow{\Delta}$ X ✓

In heating, Na_2CO_3 does not occur any change. ✓ If a brown colour gas is evolved upon heating that is $Mg(NO_3)_2$. ✓ When it is heating, a solid residue and a colourless gas is given by $NaNO_3$ (aq) ✓

(6 x 4 marks = 24)

total marks = 76

(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 ✓

(5 x 5 marks = 25)

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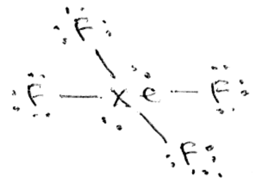
(10) (a).

(i) XeF_4



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

VSEPR pairs = 6 ✓

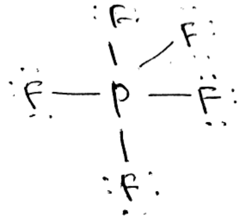
σ bonds = 4

lone pairs = 2 } ✓ (3×2 marks = 6)

∴ the shape is Square planer ✓

(4 marks)

(ii). PF_5



total e pairs around P = 5

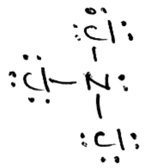
VSEPR Pairs = 5

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

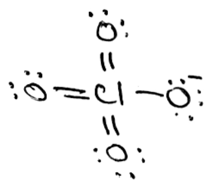
σ bonds = 4

lone pairs = 0

∴ The shape is trigonal pyramidal

(iv). ClO_4^-

The number of total e· pairs around Cl } = 7



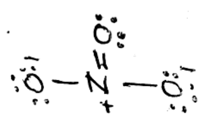
VSEPR pairs = 4

σ bonds = 4

lone pairs = 0

∴ The shape is tetrahedral

(v).



The total number of e pairs around N } = 4

(5×10 marks)

VSEPR pairs = 3

Totalmarks = 50

σ bonds = 3

lone pairs = 0

(b). moles of Cr_2O_3 = $\frac{1.52g}{152gmol^{-1}}$

= 0.01 mol ✓

moles of H_2O = $\frac{0.72g}{18gmol^{-1}}$

= 0.04 mol ✓

moles of N_2 = $\frac{0.28g}{28gmol^{-1}}$

= 0.01 mol ✓

molar ratio of,

Cr_2O_3 : H_2O : N_2

0.01 : 0.04 : 0.01

1 : 4 : 1. ✓

∴ atomic molar ratio,

Cr : H : N : O

2 : 8 : 2 : 7

∴ Empirical formula $Cr_2H_8N_2O_7$. ✓

(5× 4 marks = 20)

molecular formula of X, $Cr_2H_8N_2O_7$

$(NH_4)_2Cr_2O_7$ ✓ (10 marks)

[30 marks]

(c). $2KMnO_4 + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O + 2K^+$ ✓

(15 marks)

molar ratio, $KMnO_4$: $C_2O_4^{2-}$

2 : 5 ✓

number of moles of $C_2O_4^{2-}$ consumed to titrate 25cm³ of the solution } = $\frac{0.02 \times 15}{1000}$ ✓

= 3×10^{-4} mol ✓

∴ The number of $KMnO_4$ present in 25cm³ of the solution } = $\frac{3 \times 10^{-4} mol \times 2}{5}$ ✓

= 1.2×10^{-4} mol. ✓

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

$= 4.8 \times 10^{-4} \text{ mol}$ ✓

∴ 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 $KMnO_4$ $= \frac{75.84 \text{ mg}}{200 \text{ mg}} \times 100\%$ ✓

$= 37.92\%$ ✓

(11 x 5 marks = 55)

70 marks.