மொறட்டுவை பல்கலைக்கழக பொறியியற் பீட தமிழ் மாணவர்கள் நடாத்தும் க.பொ.த உயர்தர மாணவர்களுக்கான 8 வது

முன்னோடிப் பரீட்சை - 2017

இரசாயனவியல் பல்தேர்வு வினா விடைகள் / Chemistry M C Q Answers

பாடமும் பாட எண்ணும் / Subject and Subject No: CHEMISTRY 02

Prepared By
DIAS *B.Sc(Hons)Spl in Chem*

(01)	① ② ● ④ ⑤	(11)	① ● ③ ④ ⑤	(21)	① ② ● ④ ⑤	(31)	● ② ③ ④ ⑤	(41)	① ● ③ ④ ⑤
(02)	① ② ③ ④ ●	(12)	● ② ③ ④ ⑤	(22)	① ② ③ ● ⑤	(32)	① ② ③ ④ ●	(42)	● ② ③ ④ ⑤
(03)	① ② ③ ● ⑤	(13)	① ② ③ ● ⑤	(23)	① ② ● ④ ⑤	(33)	① ② ③ ● ⑤	(43)	① ② ● ④ ⑤
(04)	① ② ● ④ ⑤	(14)	① ● ③ ④ ⑤	(24)	① ② ③ ④ ●	(34)	① ② ③ ④ ●	(44)	① ② ③ ● ⑤
(05)	● ② ③ ④ ⑤	(15)	● ② ③ ④ ⑤	(25)	● ② ③ ④ ⑤	(35)	① ● ③ ④ ⑤	(45)	① ② ● ④ ⑤
(06)	① ● ③ ④ ⑤	(16)	① ② ③ ④ ●	(26)	① ② ③ ● ⑤	(36)	① ② ③ ④ ●	(46)	● ② ③ ④ ⑤
(07)	① ② ● ④ ⑤	(17)	① ② ● ④ ⑤	(27)	① ② ③ ● ⑤	(37)	① ② ● ④ ⑤	(47)	① ② ③ ④ ●
(08)	① ② ● ④ ⑤	(18)	① ② ③ ● ⑤	(28)	① ② ● ④ ⑤	(38)	① ② ● ④ ⑤	(48)	① ② ● ④ ⑤
(09)	① ② ③ ④ ●	(19)	① ● ③ ④ ⑤	(29)	① ● ③ ④ ⑤	(39)	● ② ③ ④ ⑤	(49)	① ② ③ ● ⑤
(10)	① ② ③ ● ⑤	(20)	① ② ③ ● ⑤	(30)	① ② ③ ④ ●	(40)	① ② ③ ④ ●	(50)	① ② ③ ● ⑤

Mora E-Tamils 2019 | Examination Committee

BCAS CAMPUS
BRITISH COLLEGE OF APPLIED STUDIES

Part A – Structured Essay

01. (a) Arrange the following in the **increasing** order of the property indicated in parenthesis.

i. S,C,H,Br (electronegativity)

H < C < S < Br

ii. Ag^{+}, Mg^{2+}, Zn^{2+}, Fe^{2+}(Ability to act as an oxidizing agent in aqueous solution)

Mg^{2+} < Zn^{2+} < Fe^{2+} < Ag^{+}

iii. AgI, AgBr, AgCl, AgF (covalent character)

AgF < AgCl < AgBr < AgI

iv. CH_4,HCl,PH_3,H_2S (boiling point)

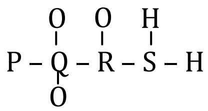
CH_4 < PH_3 < HCl < H_2S

v. $SOCl_2$, XeF_2, ICl_4^-, CO_3^{2-} (number of repulsive units around the central atom)

CO_3^{2-} < $SOCl_2$ < XeF_2 < ICl_4^- [04 marks x 5 = 20marks]

$\boxed{\text{1(a) : 20 Marks}}$

(b) Elements P, Q, R and S are nonmetals with atomic number less than 20. The corresponding maximum stable valences are 7, 6, 4 and 5. R and S have maximum electro negativity in their respective groups. The fundamental structure of the molecule H_2RQPSO_3 formed bythese elements is given below.



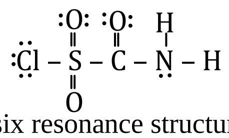
i. Identify the elements P,Q, R and S.

P –Cl/Chlorine Q –S/ Sulphur

R –C/ Carbon S – N/Nitrogen

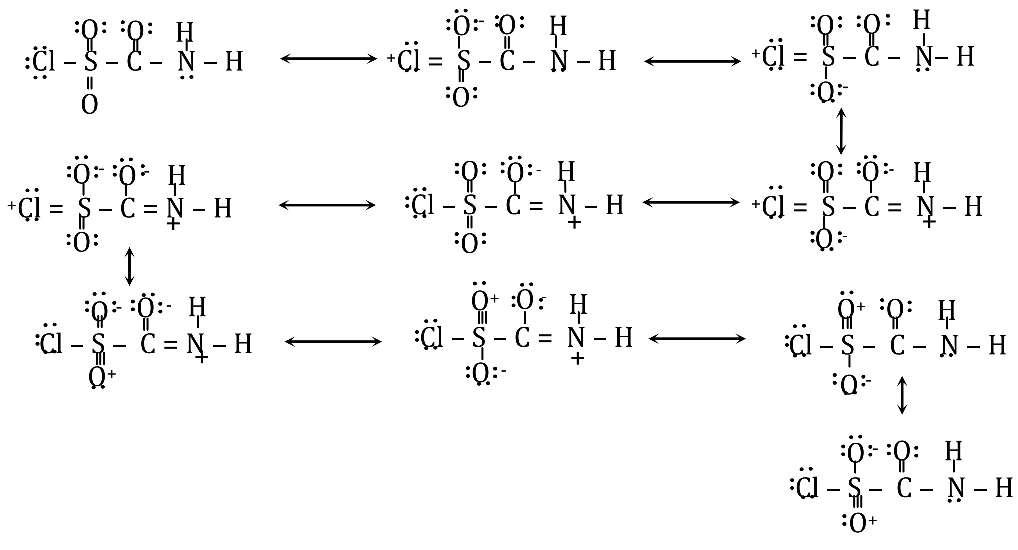
[02marks x 4 = 08marks]

ii. Draw the most acceptable Lewis structure for this molecule.



08marks

iii. Draw six resonance structures for this molecule.(excluding the structure draw in the part(ii)above)



iv. State the following regarding Q, R and S atoms in the table given below using the structure drawn in part (ii) above

1. Electron pair geometry (arrangement of electron pair) around the atom
2. Shape around the atom
3. Hybridization of the atom
4. Approximate value of bond angle around the atom

		Q	R	S
1.	Electron pair geometry	Tetrahedral	Trigonal Planer	Tetrahedral
2.	Shape	Tetrahedral	Trigonal Planer	Trigonal Pyramidal
3.	Hybridization	sp^3	sp^2	sp^3
4.	Bond angle	108^0-110^0	119^0-121^0	106^0-108^0

[01marks x12 = 12 marks]

v. Identify the atomic/hybrid orbital involved in the formation of the followingσ – bond in the Lewis structure draw in part (ii) above.

P – Q	: P 3p(a.o)	Q sp^3(h.o)
Q – R	: Q sp^3(h.o)	R sp^3(h.o)
R – S	: R sp^2(h.o)	S sp^3(h.o)

[01marks x 6 = 6marks]

vi. 1. Among the elements Q and R in the above molecule, which is more electronagative?

Sulphur(S) / Q [04 Marks]

2. State two main factors which determine the electro negativity of an atom in a molecule.

Oxidation state/ electronegativity of the combined atoms
Hybridization
Charge on atom (any two) [02marks x2 = 04 marks]

$\boxed{\text{1(b): 60Marks}}$

(c) Consider the halogen hydrides HCl,HBr and HI.

1. Give the increasing order of the strength of London forces

HCl < HBr < HI

2. Give the increasing order of the strength of dipole-dipole interactions.

HI < HBr < HCl

3. Give the increasing order of boiling points.

HCl < HBr < HI

4. Which interaction mainly contributes for the increase of boiling point.

Vanderwaals interaction / London dispersal force [05 Marks x4 = 20Marks]

02. a) S block element M dissolves in NaOH and gives solution A and a gaseous product X. When HCl is added drop by drop to the solution A a white colour precipitate B is formed even though it dissolves in excess of reagent and gives a clear solution C. At high temperatures, M reacts with gas X and gives white colour solid D. D reacts with water and gives product B and same gas X.

i. Identify the element M.

Be / Beryllium [05 Marks]

ii. Identify the compoundsA,B, C and D and gas X.

A- Na_2BeO_2 B – $Be(OH)_2$ C- $BeCl_2$ D- BeH_2 X- H_2

[04Marks x 5 = 20Marks]

iii. Give the balanced chemical equations related with the formation of the above compounds A, B, C and D.

$2Be + 2NaOH \rightarrow Na_2BeO_2 + H_2$

$Na_2BeO_2 + 2HCl \rightarrow 2NaCl + Be(OH)_2$

$Be(OH)_2 + 2HCl_{(aq)} \rightarrow BeCl_{2(aq)} + 2H_2O$

$Be + H_2 \rightarrow BeH_2$ [04Marks x 4 = 16Marks]

iv. Give three properties in which M differs from other members of the same group.

Amphoteric nature / reacts / dissolves with both acid and base

Forms the covalent compounds $BeCl_2$, BeH_2

BeH_2 and $BeCl_2$ are found as polymers, do not react with liquid state water

BeF_2 dissolves in water, high ionization potential

(any three) [03marks x3 =9 Marks]

[2(a): 50Marks]

(b) (i) Following solids/solutions are found in the given reagent bottles.

$Cr_2(SO_4)_3$, $Co(NO_3)_2$, $Na_2S_2O_3$, $(NH_4)_2Cr_2O_7$, $BiCl_3$, $Pb(CH_3COO)_2$

State the compounds related with the following observations in the cages given.

A.	When $BaCl_2$solution is added, yellow colour precipitate is obtained.	$(NH_4)_2Cr_2O_7$
B.	When excess water is added and diluted, bluish violet colour solution is observed.	$Cr_2(SO_4)_3$
C.	With dil.HCl solution Pale yellow colour turbid solution is obtained.	$Na_2S_2O_3$
D.	When diluted by adding water, thick white colour precipitate is obtained. This precipitate dissolves in dil.HCl.	$BiCl_3$
E.	Blue colour solution is obtained when con.HCl is added as excess.	$Co(NO_3)_2$
F.	When KI solution is added a precipitate is obtained. On heating precipitate dissolves and gives a clear solution.	$Pb(CH_3COO)_2$

[04 Marks x 6 = 24Marks]

(ii) Give the relevant balanced chemical equationfor the above observationsA to F.

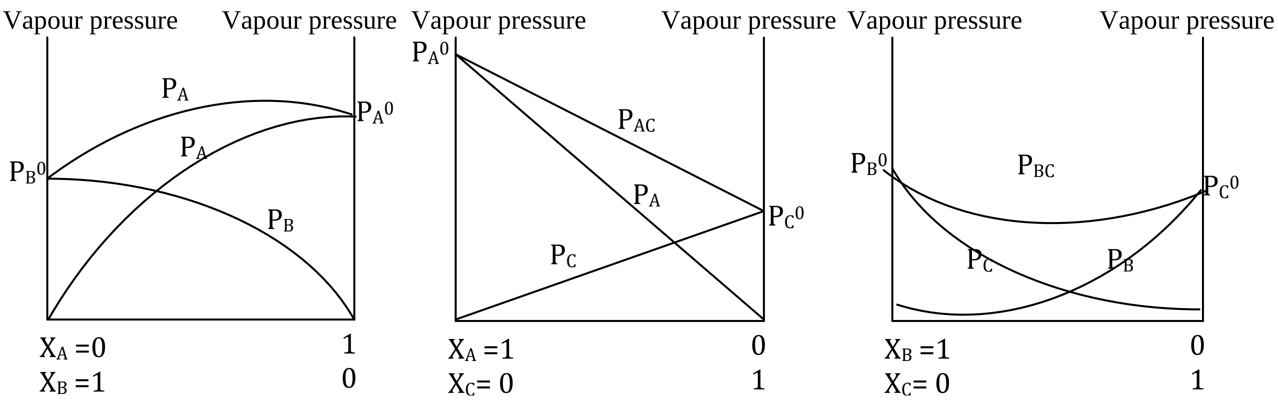
A- $BaCl_2 + (NH_4)_2\,Cr_2O_7 + H_2O \rightarrow BaCrO_4 + (NH_4)_2\,CrO_4 + 2HCl$
B- $Cr^{3+} + 6H_2O \rightarrow [Cr(H_2O)_6]^{3+}$ / $Cr(SO_4)_3 + 12H_2O \rightarrow [Cr(H_2O)_6]_2(SO_4)_3$
C- $NO_2S_2O_3 + 2HCl \rightarrow 2NaCl + S + SO_2 + H_2O$
D- $BiCl_3 + H_2O \rightleftharpoons BiOCl + 2HCl$
E- $CO^{2+} + 4HCl^{-} \rightarrow [CoCl_4]^{2-}$ / $CO(NO_3)_2 + 4HCl \rightarrow H_2[CoCl_4] + 2HNO_3$
F- $Pb(CH_3COO)_2 + 2KI \rightarrow PbI_2 + 2CH_3COO^{-}\,K^{+}$
$PbI_2(s) \rightarrow PbI_2(aq)$ (2Marks)

[6Marks x4 = 24Marks]+ (2Marks)

2(b) : 50 Marks

03. (a) A, B and C are completely miscible volatile liquids. At their pure states the vapour pressure and standard boiling points are P^0_A, P^0_B and $P^0_C$and T^0_A, T^0_B andT^0_Crespectively. Here $T^0_A < T^0_B < T^0_C$. By mixing liquids one with another, solutions A-B, A-C and B-C are obtained. The vapour pressures of these solutions are P_{AB}, P_{AC}, P_{BC} respectively. The vapour pressures calculated assuming that the above solutions are obeying the Rault's Law are x, y and z and the observed vapour pressures at the same temperature are p, q and r. The relationships between the calculated and observed vapour pressures are p> x, q = y and r < z.

i. Denote P^0_A, P^0_B and P^0_Cin the vertical axis.
ii. Draw the variation of P_A,P_B and P_C in the graph and denote them.(In the solution P_A– Vapour pressure of A , P_B –Vapour pressure of B , P_C – Vapour pressure of C)
iii. Draw the variation of total vapour pressure P_{AB}, P_{AC} and P_{BC} on the axis and denote them.



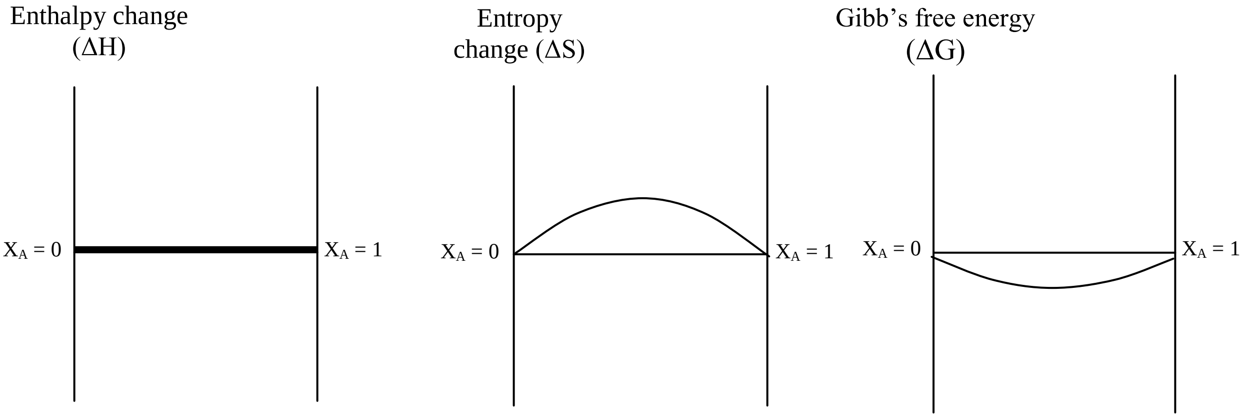
[6Marks x3 = 18Marks]

03(a):40 Marks

iv. Complete the following table regarding the above solution.

	Solution A – B	Solution A - C	Solution B – C
Type of solution	Positive deviation	Ideal solution	Negative deviation
Temperature change	Decrease	No change	Increase

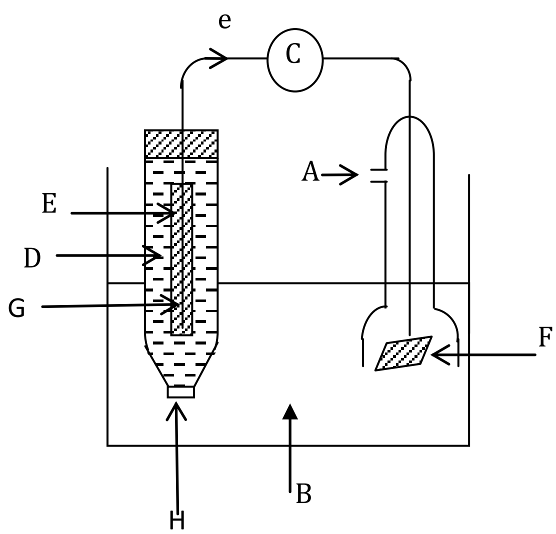
v. Draw the following graphs regarding the resultant solutions obtained by mixing liquids A and C without changing the total number of moles.
   1. Enthalpy change vs composition.
   2. Entropy vs composition.
   3. Gibb's free energy vs composition.



[03Marks + 03 Marks + 04 Marks = 10Marks]

03(a):40 Marks

(b) The following diagram shows a cell constructed using standard $Pt(s)/Cl_2(g), Cl^-_{(aq)}$ electrode and $Ag(s), AgCl(s)/Cl^-_{(aq)}$ electrode. Direction of electron flow through the external circuit is shown in the figure given below.



i. Identify the parts A to F denoted in the above standard cell. State the physical state, concentration and pressure in required places.

A – Cl_2(g, 1atm) B – HCl (aq, 1moldm^{-3})

C – Voltmeter D – KCl (aq, saturated)

E – AgCl(s) F – Pt(s)

G – Ag(s) H – Quartz / Glass fibre junction

[02 Marks x 8 = 16Marks]

ii. Give the cell reaction takes place in this cell.

$2Ag(s) + Cl_2(g) \rightarrow 2AgCl(s)$

[08Marks]

iii. State the appropriate cell notation for this cell.

$Ag(s), AgCl(s)|Cl^-_{(aq)} \vdots Cl^-_{(aq,1moldm^{-3})}, Cl_{2(g,1atm)}/, Pt(s)$ Note **:-** Here, since KCl is in saturated state in the elctrode $Ag_{(s)}AgCl(s)/Cl^-_{(aq)}$, it can also be written as $Ag(s), AgCl(s)/Cl^-_{(aq),satu})$.

[08Marks]

iv. The standard enthalpy change and standard entropy change of this cell are $-254kJmol^{-1}$ and $-116Jmol^{-1}K^{-1}$respectively. The relationship between the standard Gibb's free energy change (ΔG^θ) and standard electromotive force (E^θ_{cell}) is$\Delta G^\theta = -nFE^\theta_{cell}$

Here,

n - the number of moles of electrons participated in the oxidation or reduction in the balanced reaction.

F - Faraday constant ($96500Cmol^{-1}$)

If $E^\theta_{Cls(g)/Cl^-(aq)} = +1.36V$, then find the standard reduction potential of electrode $E^\theta_{Ag(s),AgCl(s)/Cl^-(aq)}$.

$\Delta G^\theta = \Delta H^\theta - T\Delta S^\theta$

$= -254 \times 103Jmol^{-1} - (298K \times -116Jmol^{-1}K^{-1})$

$= -219\ 432\ Jmol^{-1}$

$\Delta G^\theta = -nFE^\theta$

$-219\ 432\ Jmol^{-1} = -2 \times 96500Cmol^{-1} \times E^\theta$

$E^\theta_{Cell} = 1.13V$

$E^\theta_{cell} = E^\theta_{Cathode} - E^\theta_{Anode}$

$1.13V = 1.36V - E^\theta_{anode}$

$E^\theta_{Anode} = (1.36 - 1.13V)$

$= 0.23\ V$

[04Marks x 7 =28marks]

(03(b) : 60marks)

04.(a) A, B, C and Dare four structural isomers of $C_5H_{11}Cl$. B, C and D have the ability to rotate the plane of plane polarized light. The product Ewhich is obtained in the reaction of A with $NaOH_{(aq)}$gives immediate turbidity with anhydrous $ZnCl_2$/Con.HCl. When B, C and D are reacted with C_2H_5OH/ KOH, products F, G and H are obtained respectively. H shows geometrical isomerism. When B is reacted with $NaOH_{(aq)}$ and then oxidized by PCC/CH_2Cl_2, the product I obtainedreduces the Tollen's Reagent.

i. Draw the structures of A, B, C, D, E, F, G, H and I in the cages given below.

(It is not necessary to draw stereo isomeric forms)

CH_3
$CH_3 - C - Cl$
CH_2CH_3

A

$CH_3CH_2 - CH - CH_2Cl$
CH_3

B

Cl
$CH_3 - CH - CH - CH_3$
CH_3

C

$CH_3CH_2\ CH_2 - CH - CH_3$
Cl

D

CH_3
$CH_3 - C - OH$
CH_2CH_3

E

$CH_3CH_2 - C = CH_2$
CH_3

F

$CH_3 - C = CH - CH_3$
CH_3

G

$CH_3CH_2CH = CH - CH_3$

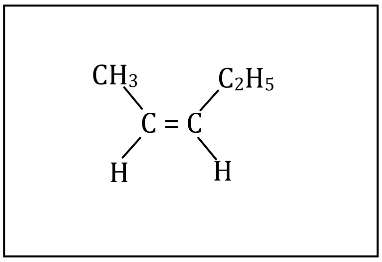
H

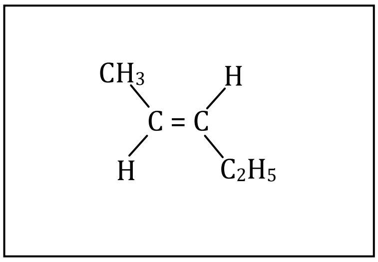
H
$CH_3CH_2 - C - CHO$
CH_3

I

(09x 5 = 45 Marks)

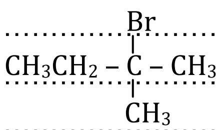
ii. Draw the stereoisomeric forms of H in the following cages.

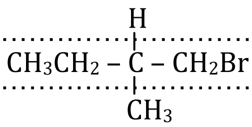




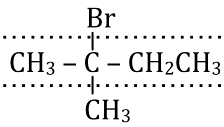
(05 Marks x 2 = 10Marks)

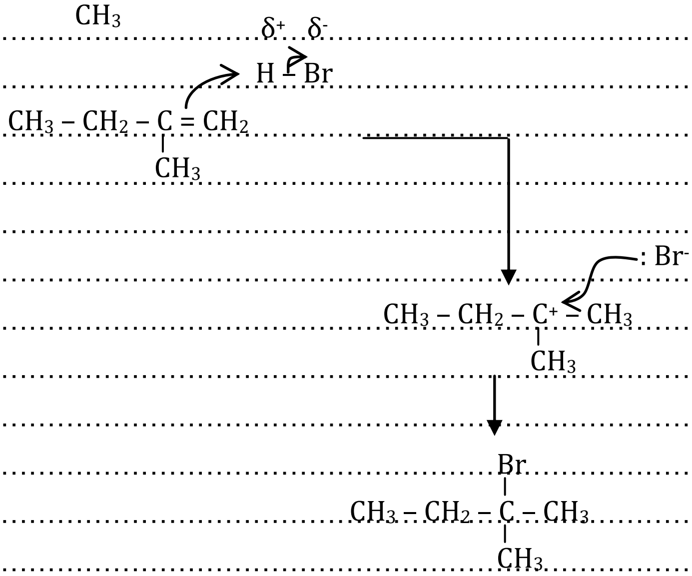
iii. What are the products obtained when F is reacted with HBr?





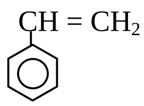
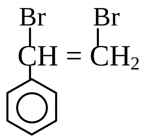
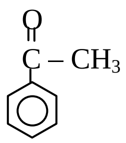
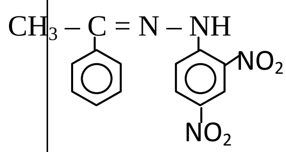
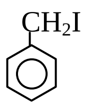
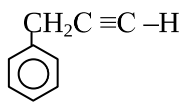
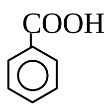
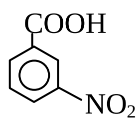
iv. Which one of the above products in part(iii) above is obtained as a main product? State the mechanism for the formation of this product.





[1Mark x11 = 11 Marks]

(b) Draw the structures of the main products of the reactions given in the table below. Classify each of the given reactions as nucleophilic addition (A_N), electrophilic addition (A_E), nucleophilic substitution (S_N), electrophilic substitution (S_E), elimination (E), and other (Mo) in the appropriate cages.

Reaction number	Reactant	Reagent	Main product	Reaction type
1		Br_2/CCl_4		A_E
2	$CH_3CH_2-\overset{\overset{O}{\|}}{C}-CH_3$	KCN/ Dil H_2SO_4	$CH_3CH_2-\underset{\underset{CN}{\vert}}{\overset{\overset{OH}{\vert}}{C}}-CH_3$	A_N
3	$CH_3-CH=CH_2$	HBr/ $(CH_3)_2O_2$	$CH_3CH_2CH_2Br$	Mo
4		2-4-DNPH		A_N+E
5		$H-C\equiv C^{-}Na^{+}$		S_N
6		C.HNO_3/ C. H_2SO_4		S_E

[12 x 2Marks = 24Marks]

Part B – Essay

05. (a) i. $V \alpha\ n$ [T][[P]
Here $V_A = V_X = V_{Ne}$
Therefore $n_A = n_X = n_{Ne}$
Mole fraction $X_A = X_X = = X_{Ne} = 1/3$
$P_A = P_X = P_{Ne} = 1/3 \times 3.6 \times 10^5 Pa = 1.2 \times 10^5 Pa$

After the dissociation
At 300K

	$2A_{(g)}$	$\rightleftharpoons$ $B_{(g)}$	+ $C_{(g)}$
Initial Pressure	$1.2 \times 10^5 Pa$		
At equilibrium	$4 \times 10^4 Pa$	$4 \times 10^4 Pa$	$4 \times 10^4 Pa$

$P\ \alpha n$ [V] [T]

Degree of Dissociation $= \dfrac{8\times10^4 Pa}{12\times10^4 Pa} = \dfrac{2}{3} = 0.67$

ii. $Kp = \dfrac{P_{B(g)} \times P_{C(g)}}{P_A{}^2}$

$= \dfrac{4\times10^4 Pa \times 4\times10^4 Pa}{(4\times10^4 Pa)^2}$

$=1$

iii. This equilibrium reaction occurs with no change in the no. of moles. Change in equilibrium does not affect the pressure.
Therefore, $P \alpha\ T$
$12 \times 10^4 Pa\ \alpha\ 300K$ ....(1)
$P\ \alpha\ 600K$ ....(2)
So, $P = 24 \times 10^4 Pa$

	$2A_{(g)}$	$\rightleftharpoons$ $B_{(g)}$	+ $C_{(g)}$
Equilibrium Pressure	$4 \times 10^4 Pa$	$10 \times 10^4 Pa$	$10 \times 10^4 Pa$

$Kp = \dfrac{(10\times10^4 Pa)(10\times10^4 Pa)}{(4\times10^4 Pa)^2}$

$= {}^{25}\!/_{4} = 6.25$

iv. Endothermic reaction
Kp(600K) > Kp(300K)
Equilibrium is shifted in forward direction.
It is endothermic according to Le Chatelier's principle.

v. Now, $P_{Ne} = 12 \times 10^4 Pa \times 2 = 24 \times 10^4 Pa$
Pressure of first equilibrium components = $24 \times 10^4 Pa$
Therefore, Pressure of second equilibrium components
$= 78 \times 10^4 Pa - (24 \times 10^4 Pa + 24 \times 10^4 Pa)$
$= 30 \times 10^4 Pa$

	$2X(g)$	$\rightleftharpoons$	$2Y(g)$ +	$Z(g)$
Initial pressure	$24 \times 10^4 Pa$			
At equilibrium	$(24 \times 10^4 Pa - 2x)$		$2x$	x

$24 \times 10^4 Pa + x = 30 \times 10^4 Pa$

$x = 6 \times 10^4 Pa$

Therefore, degree of dissociation $= \dfrac{12\times 10^4 Pa}{24\times 10^4 Pa} = 0.5$

vi. $$Kp = \frac{(P_{Y(g)})^2 \times P_{Z(g)}}{\left(P_{X(g)}\right)^2}$$

$$= \frac{(12\times 10^4 Pa)^2 \times 6\times 10^4 Pa}{\left(12\times 10^4 Pa\right)^2}$$

$$= 6\times 10^4 Pa$$

vii. $$n_{Ne} : n_{Ar} = \frac{W}{20 gmol^{-1}} : \frac{W}{40 gmol^{-1}} = 2:1$$

$P_{Ar} = 12 \times 10^4 Pa$

Ar is a noble gas. It does not affect the equilibrium.

$P_T = 78 \times 10^4 Pa + 12 \times 10^4 Pa$

$= 9 \times 10^5 Pa$

$P_B = P_C = 1 \times 10^5 Pa$ $\quad$ $P_Z = 6 \times 10^4 Pa$

$P_A = 4 \times 10^4 Pa$ $\quad$ $P_{Ar} = 12 \times 10^4 Pa$

$P_X = P_y = 12 \times 10^4 Pa$ $\quad$ $P_{Ne} = 24 \times 10^4 Pa$

05 (a): 80 marks

(b) i. $CO(g) + \frac{1}{2} O_2(g) \rightarrow CO_{2(g)}$ $\quad \Delta H^\theta = -284 kJmol^{-1}$ ....(1)

$2NO(g) + 2CO(g) \rightarrow N_{2(g)} + 2CO_{2(g)}$ $\quad \Delta H^\theta = -748 kJmol^{-1}$ ....(2)

(1) X 2 – (2) $\Longrightarrow$

$N_2(g) + O_2(g) \rightarrow 2NO(g)$

Therefore $\Delta H_f^\theta{}_{(NO(g))} \times 2 = 2\times -284 kJmol^{-1} (-748 kJmol^{-1})$

$= 180 kJmol^{-1}$

$\Delta H_f^\theta{}_{(NO(g))} = 90 KJmol^{-1}$

$\Delta H_R^\theta = \sum \Delta H_f^\theta{}_{(Products)} - \sum \Delta H_f^\theta{}_{(reactants)}$

$= \{(+90 kJmol^{-1} \times 4) + (-242 kJmol^{-1} \times 6)\} - \{-46 kJmol^{-1} \times 4) + 0.00 kJmol^{-1}\}$

$= -908 KJmol^{-1}$

ii. $\Delta S^\theta = \sum S^\theta_{(product)} - \sum S^\theta_{(reactants)}$

$= \{211Jmol^{-1}K^{-1} \times 4) + (189Jmol^{-1}K^{-1} \times 6)\} - \{193Jmol^{-1}K^{-1} \times 4) + (205Jmol^{-1}K^{-1} \times 5)\}$

$= 181Jmol^{-1}K^{-1}$

iii. $\Delta G^\theta = \Delta H_R^\theta - T\Delta S^\theta$

$= -908kJmol^{-1} - (298K \times 181 \times 10^{-3}kJmol^{-1}K^{-1})$

$= -961.9kJmol^{-1}$

v. This reaction is spontaneous because $\Delta G < 0$.

05 (b): 70 marks

06. (a) i. $NH_4Cl_{(aq)} \rightarrow NH_4^+(aq) + Cl^-(aq)$

$[NH_4^+(aq)] = [NH_4Cl(aq)] = Cmoldm^{-3}$

$NH_4^+(aq) + H_2O_{(l)} \rightleftharpoons NH_4OH(aq) + H^+_{(aq)}$

Initial concentration	$Cmoldm^{-3}$		
Equilibrium concentration	$(C-x)\ moldm^{-3}$	$x\ moldm^{-3}$	$xmoldm^{-3}$

According to law of equilibrium,

$$ka = \frac{[NH_4OH_{(aq)}][H^+{}_{(aq)}]}{[NH_4{}^+{}_{(aq)}]}$$

Here, $[NH_4OH(aq)] = [H^+(aq)]$

Therefore,

$$ka = \frac{[H^+_{(aq)}]^2}{[NH_4^+(aq)]}$$

$$[H^+_{(aq)}] = \sqrt{ka(NH_4{}^+(aq)]}$$

$$= \sqrt{ka \times (C-x]moldm^{-3}}$$

x <<< C

Therefore $[H^+_{(aq)}] = \sqrt{kaC}$

But kakb =kw

$$[H^+_{(aq)}] = \sqrt{\frac{kw}{kb} \times C}$$

$pH = -\log[H^+_{(aq)}]$

$$= -\log\sqrt{\frac{kw \times c}{kb}}$$

$= -1/2 \log kw - ½ \log c - (- ½ \log kb)$

$pH = ½ pkw - ½ pkb - ½ \log c$ [20 marks]

ii. $$n[NH_4]_2SO_4 = \frac{0.66g}{132gmol^{-1}} = 0.005mol$$

$$[NH^+_{4(aq)}] = \frac{0.005mol \times 2}{0.5dm^3}$$

$= 0.02moldm^{-3}$

$p^H = \frac{1}{2} p^{kw} - \frac{1}{2} p^{kb} - \frac{1}{2} \log C$

$= \frac{1}{2} \times 14 - \frac{1}{2} \times 5 - \frac{1}{2} \log 2 \times 10^{-2}$

$= 7 - 2.5 + 1 - \frac{1}{2} \times 0.3010$

$= 5.3495$ [08 marks]

iii. The resultant solution is buffer solution.

$$[NH_{4\,(aq)}^{+}] = \frac{0.005 mol \times 2}{1 dm^3}$$

$= 1\times10^{-2} moldm^{-3}$

$$pOH = pkb + \log 0 \frac{[salt]}{[base]}$$

$$= 5 + \log \frac{1\times10^{-2} moldm^{-3}}{0.1 moldm^{3}}$$

$= 5 - 1$

$= 4$

$pH + pOH = pkw$

$pH = 14 - 4 = 10$ [08 marks]

iv. $[OH^-_{(aq)}] = 1\times10^{-4} moldm^{-3}$

For the precipitation $[N^{2+}_{(aq)}]\,[OH^-_{(aq)}]^2 \geq 1\times10^{-10} mol^3dm^{-9}$

$$[N^{2+}_{(aq)}] \geq \frac{1\times10^{-10}}{1\times10^{-8}} moldm^{-3}$$

$[N^{2+}_{(aq)}] \geq 1\times10^{-2} moldm^{-3}$

min $nN(NO_3)_2 = 1\times10^{-2} mol$ [10 marks]

v. $IP = [M^{2+}_{(aq)}]\,[OH^-_{(aq)}]^2$

$= 0.01 moldm^{-3} \times (1\times10^{-4} moldm^{-3})^2 = 1\times10^{-10} mol^3dm^{-9}$

$4\times10^{-11} mol^3dm^{-9} = Ksp(M(OH)_2) < IP(M(OH)_2)$ Therefore, precipitation is observed.

[04marks]

06 (b): 50 marks

(b) i. $NaOH(aq) + HA(aq) \rightarrow NaA(aq) + H_2O(l)$

$nNaOH(aq) = 0.1 moldm^{-3} \times 50 \times 10^{-3} dm^3 = 5\times10^{-3} mol$

$nHA : nNaOH = 1:1$

Therefore, $nHA = 5\times10^{-3} mol$

$$[HA] = \frac{5\times10^{-3} mol}{25\times10^{-3} dm^3} = 0.2 moldm^{-3}$$

ii. 50% neutralization at point B

$[HA(aq)] = [NaA(aq)]$

The resultant solution is buffer solution.

Therefore $pH = Pka + \log \frac{[Salt]}{[Acid]}$

$pH = pka$

$-\log ka = 5$

$ka = 1\times10^{-5} moldm^{-3}$

iii. Only NaA is present at equivalent state

$A^-_{(aq)} + H_2O(l) \rightleftharpoons HA_{(aq)} + OH^-(aq)$

$$ka = \frac{[HA_{(aq)}][OH^-{}_{(aq)}]}{[A^-_{(aq)}]}$$

$$\left[A^-_{(aq)}\right] = \frac{5\times10^{-3}mol}{75\times10^{-3}dm^3} = \frac{2}{30}moldm^{-3}$$

$$kb = \frac{kw}{ka} = \frac{1\times10^{-14}mol^2dm^{-6}}{1\times10^{-5}moldm^{-3}} = 1\times10^{-9}moldm^{-3}$$

In the solution, $[HA(aq)] = [OH^-_{(aq)}]$

Therefore, $[OH^-_{(aq)}]^2 = kb \times [A^-(aq)]$

$$[OH^-_{(aq)}] = \sqrt{1\times10^{-9}moldm^{-3}\times\frac{2}{30}moldm^{-3}}$$

$$= \sqrt{\frac{2}{3}\times10^{-10}mol^2dm^{-6}}$$

$$pOH = -\log\sqrt{\frac{2}{3}\times10^{-10}mol^2dm^{-6}}$$

$= - ½ \log 2 + ½ \log 3 + 5$

$pH + pOH = pkw$

$pH = 14 + ½ \times 0.3010 – ½ \times 0.4771$

$= 8.911$

iv. Decreases

When adding NaOH, $HA + OH^- \rightarrow A^- + H_2O$

Concentration of A^- increases in the solution. In the resultant solution, $HA_{(aq)} \rightleftharpoons H^+_{(aq)} + A^-(aq)$

Equilibrium shifts in backward direction.

v. Phenolphthalein

06 (b): 50 marks

(c) i.

	A(g) →	B(g) +	C(g) +	D(g)
t=0	400kPa	--	--	---
t=400s	400kPa –P	p	p	p

400kPa - P + P + P+ P = 800kPa

P=200k Pa

	A(g) →	B(g) +	C(g) +	D(g)
t=800s	200kPa-P_1	200+P_1	200+P_1	200+P_1

800k Pa +P_1 = 1000kPa

P_1 = 100kPa

PV = nRT

P = (n/V) RT

P=CRT

While T is unchanged, $P \alpha C$

That is, if the concentration of A becomes half, partial pressure of A becomes half. As it remains unchanged for 400s, order with respect to A =1

$\therefore$ Order of the reaction = 1

ii. Half life of A is 400s.

$\therefore$ At 1200s, 100kpa x ½ = 50kPa

	A(g) →	B(g) +	C(g) +	D(g)
t=1200s	50k Pa	350 k Pa	350 k Pa	350 k Pa

P_{Total} = 50kPa + 350kPa + 350kPa + 350kPa

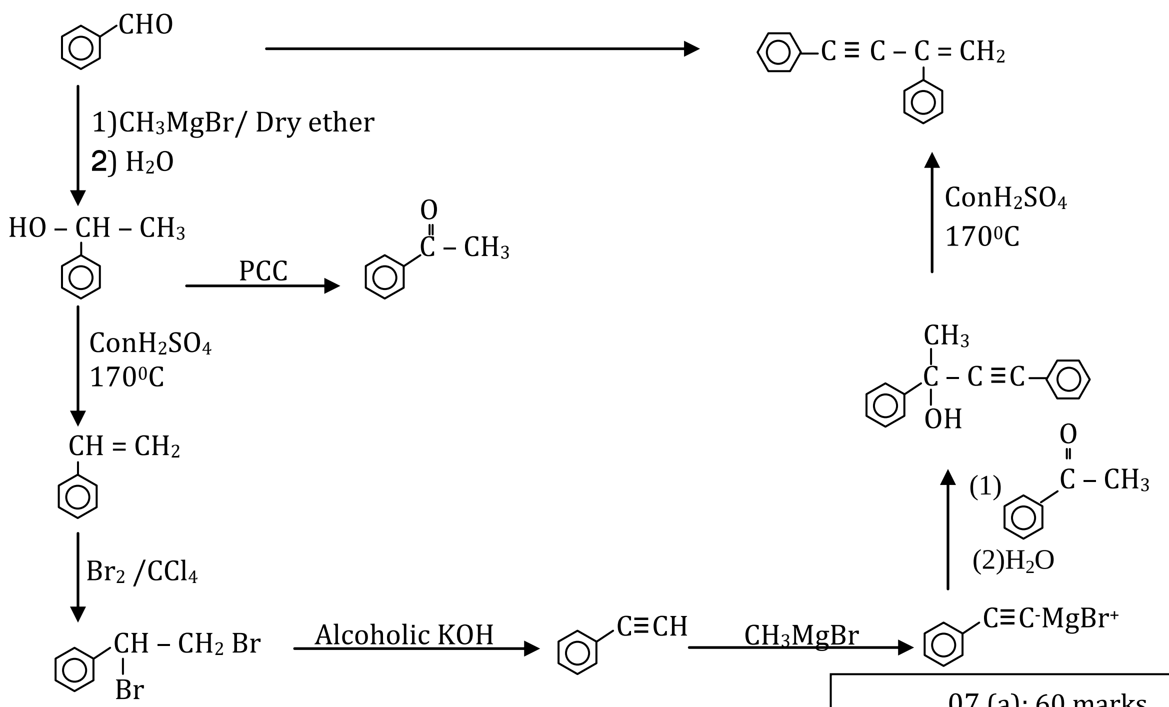
= 1200kPa

iii. $\dfrac{25kPa}{400kPa} = \dfrac{1}{16} = \left(\dfrac{1}{2}\right)^4$

Time taken = 4x400s = 1600s

06 (c): 50 marks

07. (a)



07 (a): 60 marks

(b) $R_1 = LiAlH_4$

$R_2 - H_2O$

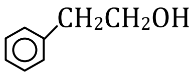
$R_3 - ConH_2SO_4/\ 170^0C$

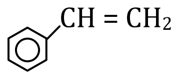
$R_4 - HBr$ Or HCl

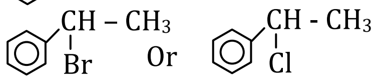
$R_5 - Mg/$ Dry ether

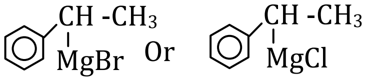
$R_6 - H^+/\ KMnO_4[DilH_2SO_4/KMnO_4]$

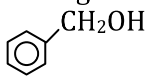
R_7- PCl_5 Or PBr_3

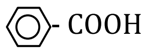
P_1 - 

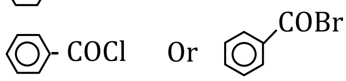
P_2 - 

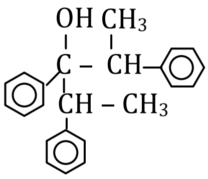
P_3 - 

P_4 - 

P_5 - 

P_6 - 

P_7 - 

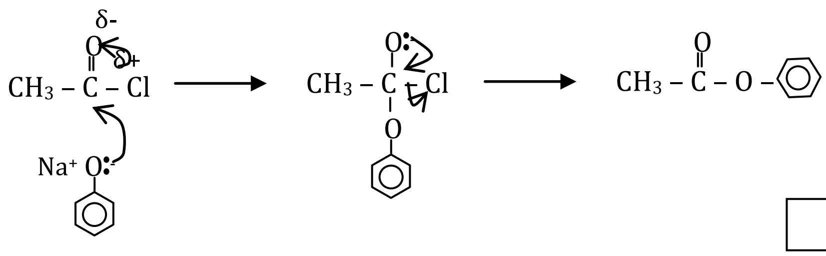
P_8 - 

07 (b): 60 marks

(c) i. $CH_3 - \overset{O}{\overset{\|}{C}} - O - C_6H_5$, $CH_3 - \overset{O}{\overset{\|}{C}} - O - CH_3$

ii. CH_3O^-

Lone pair in $C_6H_5O^-$ resonates with the Benzene ring. But, electron density of Oxygen in CH_3O^- is high due to the electron repelling ability of Methyl group. So, lone pair donating ability of CH_3O^- is greater than that of $C_6H_5O^-$. Hence, ability of CH_3O^- to act as nucleophile is high.

iii. 

07 (c): 30 marks

Part C – Essay

08. i. A – Ba E – SO_2
B – S F – H_2O
C – BaS G – $BaSO_4$
D – H_2S

ii. Na_2S, $Na_2S_2O_3$, H_2O
$3S + 6NaOH \rightarrow 2Na_2S + Na_2SO_3 + 3H_2O$
$4S + 6NaOH \rightarrow 2Na_2S + Na_2S_2O_3 + 2H_2O$

08 (a): 50 marks

(b) i. Ag_2CO_3, $PbCO_3$
ii. P_1 – Ag_2O P_2 – $PbCrO_4$ P_3 – $PbCl_2$
iii. Milky colour appears if the gas liberated by the addition of acid is passed into the limewater. Milky colour disappears by the continuous passage.

08 (b): 40 marks

(c) In procedure I
nEDTA = $0.1 moldm^{-3} \times 22 \times 10^{-3} dm^3 = 2.2 \times 10^{-3}$ mol
nEDTA : $nMIn^-$ = 1:1
nIn^- : nM^{2+} = 1:1
$nM^{2+} = 2.2 \times 10^{-3}$ = 1:1

$$[M^{2+}] = \frac{2.2\times10^{-3} mol}{50\times10^{-3} dm^3}$$
$= 0.044 moldm^{-3}$

In procedure III
$KIO_3 + 5KI + 6HCl \rightarrow 3I_2 + 3H_2O$
$I_2 + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2NaI$
$nNa_2S_2O_3 = 0.04 moldm^{-3} \times 25 \times 10^{-3} dm^3 = 1 \times 10^{-3} mol$
$nNa_2S_2O_3 : nI_2 = 2:1$
$nI_2 : nHCl = 1:2$
Therefore, $nNa_2S_2O_3 : nHCl = 1:1$
$nHCl = 1 \times 10^{-3} mol$

$$[HCl] = \frac{1\times10^{-3} mol}{20\times10^{-3} dm^3} = 0.05 moldm^{-3}$$

In procedure II
$M(HCO_3)_2 + 2HCl \rightarrow 2H_2O + 2CO_2 + 2Cl^-$
$nHCl = 0.05 moldm^{-3} \times 30 \times 10^{-3} dm^3 = 1.5 \times 10^{-3} mol$
$nHCl : nM(HCO_3)_2 = 2:1$
$n_{M(HCO_3)_2} = 1.5/2 \times 10^{-3} = 0.75 \times 10^{-3}$ mol

$$[M_{(HCO_3)_2}] = \frac{0.75\times10^{-3} mol}{25\times10^{-3} dm^3} = 0.03 moldm^{-3}$$

Concentration of $M^{2+}_{(aq)}$ cause for temporary hardness = $0.03 moldm^{-3}$
Concentration of $M^{2+}_{(aq)}$ cause for permanent hardness
$= 0.044 moldm^{-3} - 0.03 moldm^{-3}$
$= 0.014 moldm^{-3}$
Permanent hardness $= 0.014 moldm^{-3} \times 100 \times 10^3 mg$
$= 1.4 \times 10^3 mgdm^{-3}$ $CaCO_3$

08 (c): 60 marks

09. (a) i. R_1 – Sea water R_2 – Limestone
R_3 – Water R_4 – Air

ii. M_1 – Evaporating M_2 – Heating
M_3 – Electrolysis M_4 – Fractional distillation

iii. I_1 – Haber process
I_2 – Solvay process
I_3 – Production of Urea

iv. P_1 – NaCl P_2 – H_2 P_3 – Cl_2 P_4- NaOH P_5 – N_2
P_6 – NH_3 P_7 – CO_2 P_8 – CaO P_9 – $Ca(OH)_2$ P_{10} – $NaHCO_3$
P_{11} – NH_4Cl P_{12} – Na_2CO_3 P_{13} – $CO(NH_2)_2$

v. P_2 : $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_{3(g)}$
Conditions :- 250atm Pressure
450^{0}C Temperature
P_3: $2NH_{3(l)} + CO_{2(l)} \rightleftharpoons NH_2COONH_4(s)$
Conditions :- 130 – 150^{0}C Temperature
35atm Pressure
$NH_2COONH_4(s) \rightleftharpoons CO(NH_2)_{2(aq)} + H_2O(l)$

$CO(NH_2)_{2(aq)} \xrightarrow{\text{Evaporation}} CO(NH_2)_{2(s)}$

vi. $\underset{P_8}{CaO(s)} + \underset{P_{11}}{2NH_4Cl_{(aq)}} \rightarrow CaCl_{2(aq)} + 2NH_{3(aq)} + H_2O(l)$
Or
$\underset{P_9}{Ca(OH)_{2(aq)}} + \underset{P_{11}}{2NH_4Cl_{(aq)}} \rightarrow CaCl_{2(aq)} + 2NH_{3(aq)} + 2H_2O_{(l)}$

vii. $4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(g)}$
$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$
$4NO_{2(g)} + 2H_2O_{(l)} + O_{2(g)} \rightarrow 4HNO_{3(aq)}$

viii. $P_2[H_2]$:
→ Synthesis of NH_3
→ Production of HCl
→ Production of organic compounds
→ Production of Margarine
→ Used in Oxy-hydrogen flame
→ Used as reducing agent in the extraction of metals like Mo and W
→ In Hydrogen balloons
→ Eco-friendly fuel

P_4[NaOH] :
→ Manufacture of soap
→ Production of bleaching agents like NaOCl, $NaClO_3$ and bleaching powder
→ To purify Bauxite in the extraction of Al
→ Production of paper pulp
→ Manufacture of rubber, artificial silk and dyestuffs

→ Purification of petroleum
→ Manufacture of HCOOH and, $H_2C_2O_4$

$P_{12}[Na_2CO_3]$: →Used as washing soda
→ To remove the permanent hardness of water
→ Manufacture of soap
→ Manufacture of glass
→ Manufacture of detergents
→ Manufacture of paper

09 (a): 75 marks

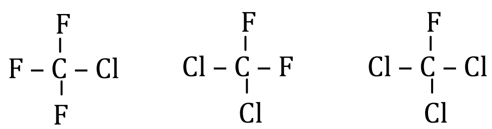
(b) i. CO_2, CFC, Hydrocarbon

ii. CO_2 - Iron extraction
Burning of fossil fuel
Lime industry
Daily cooking activities
CFC - Leaked from refrigerators
As propellant in sprayers
In foam equipments
Air conditioners
Hydrocarbon- Incomplete combustion in vehicles
Wet zone crop cultivation
Animal farms
Improper garbage disposal

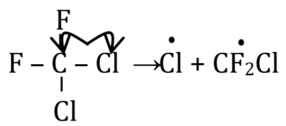
iii. Hydrocarbons

iv. PAN[Peroxyacetylnitrate], PBN [peroxybenzsyl nitrate] CH_3ONO_2 [Methyl nitrate] short carbon chain Aldehydes

v. CFC – Chloroflouro carbon



vi.



$\dot{Cl} + O_3 \rightarrow \dot{O}Cl + O_2$

$O_2 \rightarrow 2O$

$\dot{O}Cl + O \rightarrow \dot{Cl} + O_2$

$2O_3 \rightarrow 3O_2$

vii. No, because pH of dissolved state CO_2 tends to the range 5.1 -6.8/ Its acid strength is insufficient hence the pH of acid rain < 5.

09 (b): 75 marks

10. (a) i. AgBr (pale) yellow

ii. X – $[Co(Br)_2 (H_2O)_4]Br$ Y- $[Co(Br)(CH_2O)_5]Br_2$

Z – $[Co(H_2O)_6]Br_3$

iii. If the oxidation state of Co is +3

X : charge of complex is +1, one Br^-

Y : charge of complex is +2, two Br^-

Z : charge of complex is +3, three Br^-

Therefore, oxidation state of Co is +3

Or

If the oxidation state of Co is +2

X : charge of complex is O, No Br^-

Y : charge of complex is +1, one Br^-

Z : charge of complex is +2, two Br^-

Therefore, oxidation state of Co cannot be +2. It should be +3.

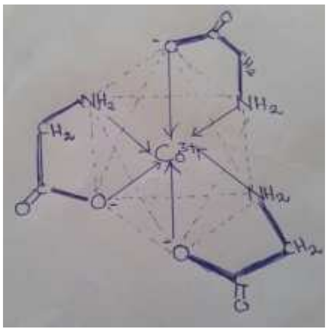
iv. X – tetraaquadibromidocobalt[iii] bromide

Y – pentaaquabromidocoalt[iii] bromide

Z – hexaaquacobalt(iii) bromide

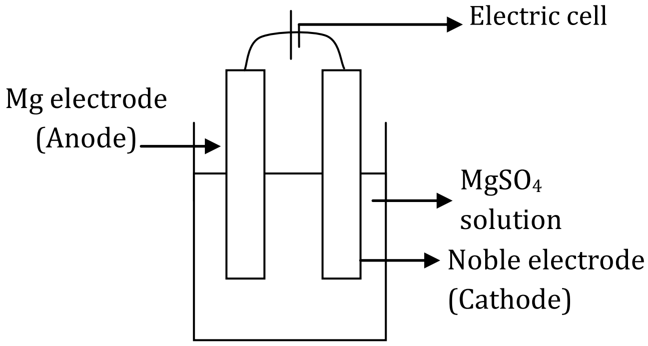
v. Violet

vi. $[Co(gl_y)_3]$



10 (b): 75 marks

(b) i.



ii. Anodic reaction : $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)} + 2e$

Cathodic reaction : $2H_2O_{(l)} + 2e \rightarrow H_{2(g)} + 2OH^-_{(aq)}$

To just precipitate,

$K_{sp} = IP$

$Ksp = [Mg^{2+}_{(aq)}]\,[OH^-_{(aq)}]^2$

$1x10^{-12}mol^3dm^{-9} = 1moldm^{-3}\,[OH^-_{(aq)}]^2$

Concentration of $Mg^{2+}_{(aq)}$ formed by the dissolution of Mg electrode can be neglected.

$[OH^-_{(aq)}]^2 = 1x10^{-12}$

$[OH^-_{(aq)}] = 1x10^{-6}moldm^{-3}$

$nOH^- = 1x10^{-6}moldm^{-3}$ x $4dm^3 = 4x10^{-6}mol$

nOH : ne = 1:1

$ne = 4x10^{-6}mol.$

$Qe = 4x10^{-6}mol$ x $96500cmol^{-1}$

$2x10^{-3}A$ x $t = 4x10^{-6}mol$ x$96500Cmol^{-1}$

t=193s.

iv. I – constant $t \propto ne$

$193s \;\alpha\; 4x10^{-6}mol$ ....(1)

965 x 60s α ne ....(2)

$$^{(2)}\!/_{(1)} \Rightarrow {}^{ne}\!/_{4\times10^{-6}\,mol} = \frac{965\times605}{1935}$$

$ne = 300$ x 4 x$10^{-6}mol$

$= 1.2$ x$10^{-3}mol$

$Mg^{2+}_{(aq)} + 2OH^-_{(aq)} \rightleftharpoons Mg(OH)_2(s)$

$nOH^- : nMg(OH)_2$ 2:1

$nMg(OH)_2 = 0.6$ x$10^{-3}mol$

$Mg(OH)_2 \rightarrow MgO + H_2O$

$nMg(OH)_2 : nMgO = 1:1$

$nMgO = 6x10^{-4}mol$

$WMgO = 6x\,10^{-4}mol$ x $40gmol^{-1}$

= 24mg

09 (b): 75 marks