Conducted by Field Work Centre, Thondaimanaru

In Collaboration with Provincial Department of Education

Northern Province

FWC

Term Examination, March - 2020

Grade – 13 (2020)	Chemistry I	Time : 2 Hours

Part - I

Answer all questions.

$N_A = 6.022 \times 10^{23} mol^{-1}$ $h = 6.626 \times 10^{-34}$ Js $C = 3 \times 10^{8}$ ms^{-1} $R = 8.314 J\, mol^{-1}\, K^{-1}$

1. Consider the following statements

   (I) When electrons fill the orbitals of the same energy, they first occupy the orbitals singly to the maximum extent possible and then get paired.

   (II) Small particles under appropriate conditions show the properties of waves as well as particle

   The theory / scientist who proposed the theories related to the above statements are respectively.

   1. Lewis de – Broglie, Niels Bohr
   2. Max Plank, Lewis de – Broglie
   3. Hund's rule, Lewis de – Broglie.
   4. Pauli, Niels Bohr
   5. Lewis de – Broglie, Albert Einstein

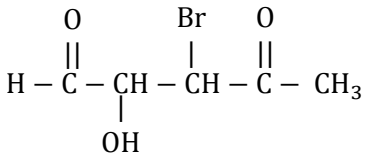
2. The statement which is incorrect regarding the second period elements.

   1. The electron configuration of the element showing the highest oxidation state is $1S^2 2S^2 2P^5$
   2. The electron configuration of the element having the least third ionization energy is $1S^2 2S^2 2P^1$
   3. Be and N are the elements which have position electron gain enthalpy.
   4. The electron configuration of the element having the highest melting point is $1S^2 2S^2 2P^2$
   5. The ionic radii of the stable ionc formed by the elements N, O and F follows the order $N^{3-} > O^{2-} > F^-$

3. $20.00\ cm^3$ an aqueous solution of $Na_2S_2O_3$ having density $1.2\ g\ cm^{-3}$ and a mass percent of 79% is taken in a volumetric flask and diluted up to $250.00\ cm^3$. The concentration of the resulting solution ($moldm^{-3}$)

   1. 0.048 2. 0.48 3. 4.80 4. 0.096 5. 0.96

4. The IUPAC name of the above compound



   1. 3 – bromo – 4 – hydroxy – 5 – oxopentan – 2 – one
   2. 3 – bromo – 2 – hydroxy – 4 – oxopentanal
   3. 3 – bromo – 4 – formyl – 4 – hydroxypentan – 2 – one
   4. 3 – bromo – 4 – formyl – 4 – hydroxypent – 2 – one
   5. None of the above

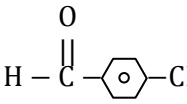
5. Which one of the following has an electron pair geometry different from the rest?

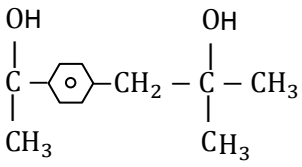
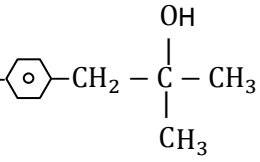
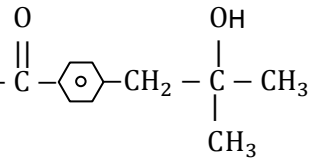
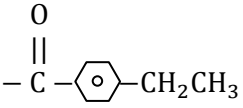
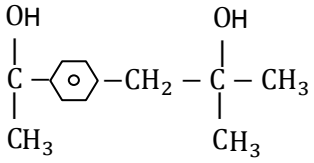
   1) NCl_3 2. BF_4^- 3. MnO_4^- 4. ClO_3^- 5. XeF_4

6. Which of the following statements regarding gases is true?
   1. If the temperature of a constant mass of an ideal gas under constant pressure is raised from 30^0 Cto to 60^0 C, the volume will double.
   2. Ideal gases may be liquified by increasing the pressure and decreasing the temperature.
   3. Under similar conditions $\frac{V_{ideal}}{V_{real}} = Z$, where Z is the compressibility factor.
   4. Under very high pressure, the repulsive forces of real gases become more dominant than the attractive forces.
   5. When a certain amount of gas is expelled from a real gas system at constant temperatures the value of $\overline{C^2}$ will decrease.

7. Three metallic ions give precipitates with ammonia solution. All the precipitates formed dissolve is an excess of $NH_{3(aq)}$ and the resulting solutions when exposed to air, do not undergo any colour change. The three ions may be

   1. $Ni^{2+}, Co^{2+}, Zn^{2+}$
   2. $Ni^{2+},, Cu^{2+}, Zn^{2+}$
   3. $Cr^{3+}, Zn^{2+}, Ni^{2+}$
   4. $Zn^{2+}, Cr^{3+}, Co^{2+}$
   5. $Co^{2+}, Ni^{2+}, Cu^{2+}$

8. The final product which could be obtained when the compound  is allowed to react with PCl_5 and then treated with CH_3MgBr followed by hydrolysis is

   1. 
   2. 
   3. 
   4. 
   5. 

9. $15.00\ cm^3$ of $0.1\ moldm^{-3}$ NaOH is added to $20.00\ cm^3$ of a monobasic weak acid HA of concentration $0.1\ moldm^{-3}$ which is used as an indicator in the acid – base titration
   If the pH of the resulting solution is 5.5, the colour change pH range of theat indicator is (log 30 =1.5)
   1. *5 – 7*
   2. *4 – 6*
   3. *3 – 5*
   4. *7 – 9*
   5. *4.5 – 6.5*

10. When the concentration of Mg^{2+} ions in a saturated solution of $Mg(OH)_2$ at 25^0C was $1.7 \times 10^{-4} moldm^{-3}$ the pH of the solution was found to be 10. If a solution of pH = 9 at the same temperature is saturated with $Mg(OH)_2$, what would be the Mg^{2+} ion concentration (in $moldm^{-3}$) at the equilibrium.
    1. 1.7×10^{-7}
    2. 1.7×10^{-6}
    3. 1.7×10^{-3}
    4. 1.7×10^{-2}
    5. 1.7×10^{2}

11. Which of the following is the correct order of the basicity of the species concerned?

1. $OH^- > NH_2^- > CH_3C \equiv C^- > C_6H_5O^-$
2. $NH_2^- > CH_3C \equiv C^- > OH^- > C_6H_5O^-$
3. $CH_3C \equiv C^- > C_6H_5O^- > OH^- > NH_2^-$
4. $C_6H_5O^- > OH^- > NH_2^- > CH_3C \equiv C^-$
5. $CH_3C \equiv C^- > NH_2^- > OH^- > C_6H_5O^-$

12. Standard enthalpy of formation of $N_2O_{5(s)}$ is $11.3 kJmol^{-1}$. Which of the following regarding ΔG^θ and Δs^θ for the reaction $2N_{2(g)} + 5O_{2(g)} \rightarrow 2N_2O_{5(s)}$ is true?

	ΔG^θ	ΔS^θ
1.	Positive	Positive
2.	negative	negative
3.	Positive	negative
4.	negative	Positive
5.	Positive	Zero

13. The incorrect statement regarding a titration is

1. potassium hydrogen phthalate can be used as a primary standard in acid – base titration.
2. Addition of an indicator is not always essential for a titration.
3. NaOH may be used as a primary standard for the standardization of an acid as it is a strong base.
4. $K_2Cr_2O_7$ and KIO_3 may be used as primary standards in redox titration reactions.
5. Volume of the titrant required to react completely with the analyte in accordance with the stoichiometric ratio of the reactants in the balanced equation is the equivalence point whereas the end point is what the indicator signals.

14. Two ideal solutions consisting of liquids A and B which are completely miscible were prepared at a particular temperature. When each of the solutions were in equilibrium with their respective vapour phases, the mole fractions of A were 0.6 and 0.3 and the vapour pressures were P_1 and P_2 respectively. If at the given temperature, vapour pressures of pure liquids A and B were P_A^0 and P_B^0, which one of the following relationships is correct?

1. $P_B^0 = 2P_2 - P_1$
2. $P_A^0 + P_B^0 < P_1 + P_2$
3. $P_A^0 = 2P_2 - P_1$
4. $P_A^0 = \frac{1}{2}(5P_1 - 4P_2)$
5. $P_B^0 = 2P_1 - P_2$

15. Consider the following statements regarding multi step reactions?

(A) If the order with respect to a reactant is zero, the concentration of that reactant will remain constant when the reaction proceeds.

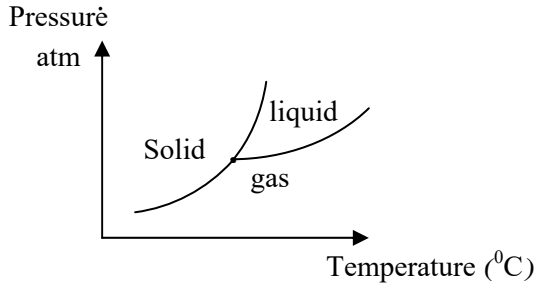
(B) In a reaction consisting of two steps, if the second step is slow, the concentration of the intermediate increases to a considerable extent and then will decrease.

(C) In general, if the order with respect to reactant is zero, that reactant involves in the step that succeeds the rate determining step of the reaction

The correct statement / s among the above

1. A and C only
2. A only
3. B and C only
4. A, B and C
5. A and B only.

16. Given below is the phase diagram of a pure substance. The values of pressure and temperature at the triple point are 4 atm and 590^0C respectively.



If the pressure is reduced gradually from 50 atm at a temperature of 500^0C, the change that could occur in the system is

1. evaporation
2. condensation
3. Sublimation
4. melting
5. Freezing

17. Which of the following statements regarding aluminium chloride is incorrect?

1. When $AlCl_3$ is dissolved in water, an acidic solution is obtained with the formation of $[Al(H_2O)_5(OH)]^{2+}$
2. It forms a precipitate with aqueous ammonia which dissolves in excess of $NH_{3(aq)}$
3. It undergoes dimerization in gaseous state and is found as Al_2Cl_6
4. The high charge density of Al^{3+} ion accounts for the covalent nature of $AlCl_3$
5. $AlCl_3$ may act as a Lewis acid.

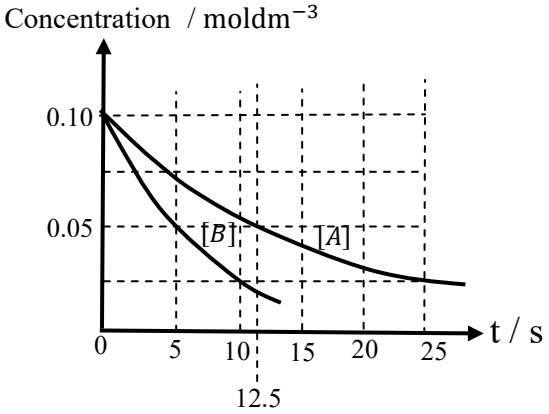
18. The incorrect statement regarding anilene $(C_6H_5NH_2)$ is

1. It dissolves in dilute HCl forming a clear solution
2. It reacts with CH_3COCl to give a substituted amide.
3. It may react both as a nucleophile and an electrophile.
4. It forms a white precipitate with $Br_{2(aq)}$
5. Its basicity is greater than that of paranitonanilene.

19. Consider the following reaction

$A + 2B + C \rightarrow$ Products

At a particular temperature, the rate constant for the above reaction is $0.64\ mol^{-2}dm^6s^{-1}$. The variation of the concentration of A and B with time is given in the following graph.



The rate raw expression possible for the above reaction is

1. $R = k[A][B]$
2. $R = k[A][B][C]$
3. $R = k[A][B][C]^2$
2. $R = k[A][C]$
5. $R = k[A]^2[B]$

20. The incorrect statement regarding 3d elements of the periodic table is

1. Their densities are higher than those belonging to S – block of the 4^{th} period.
2. Since the ability of Mn to release electrons for the formation of metallic bond is relatively small, melting point of Mn is comparatively less.
3. Of them, the elements having the highest and the lowest values for melting point are V and Zn respectively.
4. They are less electronegative compared to the corresponding S – block elements in the 4^{th} period.
5. Among the elements, Cu has the highest second ionization energy.

21. The correct statement about phenol is

1. Alkylation can be possible for phenol with CH_3Cl in the presence of anhydrous $AlCl_3$.
2. The acidity of phenol will decrease when any electron withdrawing group is attached to its benzene ring.
3. Phenol undergoes nitration with dilute HNO_3 at 20^0C
4. Phenol may easily undergo nucleophilic substitution reactions with the breaking of the C – O bond.
5. Phenol reacts with CH_3COCl to give an electrophilic substitution product.

22. Standard enthalpy changes of two reactions are given below.

$$2C_2H_{2(g)} + 5O_{2(g)} \rightarrow 4CO_{2(g)} + 2H_2O_{(g)} \qquad \Delta H^\theta = -2598\ kJmol^{-1}$$
$$2C_6H_{6(l)} + 15O_{2(g)} \rightarrow 12CO_{2(g)} + 6H_2O_{(g)} \qquad \Delta H^\theta = -6568\ kJmol^{-1}$$

From the above data, the standard enthalpy change (in $kJmol^{-1}$) for the reaction $3C_2H_{2(g)} \rightarrow C_6H_{6(l)}$

1. – 239 2. -392 3. – 512 4. - 613 5. – 854

23. A non – volatile solid X dissolves completely in water forming an ideal solution. The solution is prepared by dissolving 90.0 g of X in 90.0 g of H_2O.
If the vapour pressure of this solution at 25^0C is 45.5 mm Hg, the relative molecular mass of X is (Given that the saturated vapour pressure of water at 25^0C is 50 mm Hg)

1. 182 *2. 162* *3. 180* *4. 112* *5. 60*

24. Consider the following equilibrium reactions.

$$A_{(g)} \rightleftharpoons 2C_{(g)} + 2D_{(g)} \ ; \qquad K_C = K_1$$
$$B_{(g)} \rightleftharpoons C_{(g)} + D_{(g)} \ ; \qquad K_C = K_2$$

The equilibrium constant for the equilibrium $2B_{(g)} \rightleftharpoons A_{(g)}$ which can exist under the same condition is

1. $K_1 - K_2$ 2. $K_1 - \frac{1}{{K_2}^2}$ 3. $\frac{K_1}{{K_2}^2}$ 4. $\frac{{K_2}^2}{K_1}$ 5. $\frac{K_2}{K_1}$

25. Which of the following species has London dispersive forces as the only inter molecular forces operating among the molecules?

1. O_3 2. C_2H_4 3. NO 4. CO 5. CH_4

26. In which of the following reactions doubling the volume of container cause a shift to right?

1. $2\,CO_{(g)} + O_{2(g)} \rightleftharpoons 2CO_{2(g)}$
2. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$
3. $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$
4. $H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2HCl_{(g)}$
5. $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$

27. Which of the following compounds is capable of acting as oxidizing and reducing agents?

1. SO_3 2. SO_2 3. CO_2 4. $KMnO_4$ 5. MnO_2

28. The enthalpy of formation of $C_2H_{4(g)}$, $CO_{2(g)}$ and $H_2O_{(l)}$ at 25^0C and 1 atm pressure are 52, -394 and - 286 $kJmol^{-1}$ respectively. The enthalpy of combustion of $C_2H_{4(g)}$ is

1. $1412\ kJmol^{-1}$
2. $-1412\ kJmol^{-1}$
3. $141.2\ kJmol^{-1}$
4. $-14.12\ kJmol^{-1}$
5. $-141.2\ kJmol^{-1}$

29. The ratio of the mean square speed of $H_{2(g)}$ at 500 K and that of $O_{2(g)}$ at 800 K is.

1. 10 : 1 2. 1 : 10 3. 5 : 2 4. 2 : 5 5. 2 : 10

30. Which of the following represent the correct order of the acidic character

1. $H_2O > C_2H_2 > C_2H_6 > C_2H_4$
2. $H_2O > C_2H_6 > C_2H_4 > C_2H_2$
3. $H_2O > C_2H_2 > C_2H_4 > C_2H_6$
4. $C_2H_2 > H_2O > C_2H_4 > C_2H_6$
5. $C_2H_2 > C_2H_4 > H_2O > C_2H_6$

❖ **For each of the question 31 to 40 one or more response out of four responses (a), (b), (c) and (d) given is / are correct. Select the correct responses / responses. In accordance with the instruction given on your answer sheet mark.**

1	2	3	4	5
Only (a) (b) are correct	Only (b) (c) are correct	Only (c) (d) are correct	Only (a) (d) are correct	The other numbers correct

31. Which statement / s is / are correct about the molecular Kinetic theory of gases.

(a) Actual volume of the molecule is negligible in comparison to the empty space between them.

(b) Each particles in a gas is in random, straight line motion and undergoes perfectly elastic collisions with another particles or with the wall of the container.

(c) Particles of gas behave independently of one another

(d) The pressure of a gas arises from the sum of the collisions of the particles with the wals of the container.

32. Which statement / s is / are correct about the Hydrogen line spectrum (related to wave length)

(a) Since the energy differences in Lymen series are comparatively large, the wave lengths of lines become closer successively.

(b) Since Balmer series corresponds to relatively less energy differences, the lines become far apart from, each other.

(c) ΔE gets negative value if the electrons falls from higher energy level to lower energy level.

(d) Only the Plank's idea the energies are quantized was capable of explain the line spectrum of hydrogen

33. Which of the following statements regarding styrene is / are correct

Styrene

(a) lengths of all C – C bonds are equal to each other.

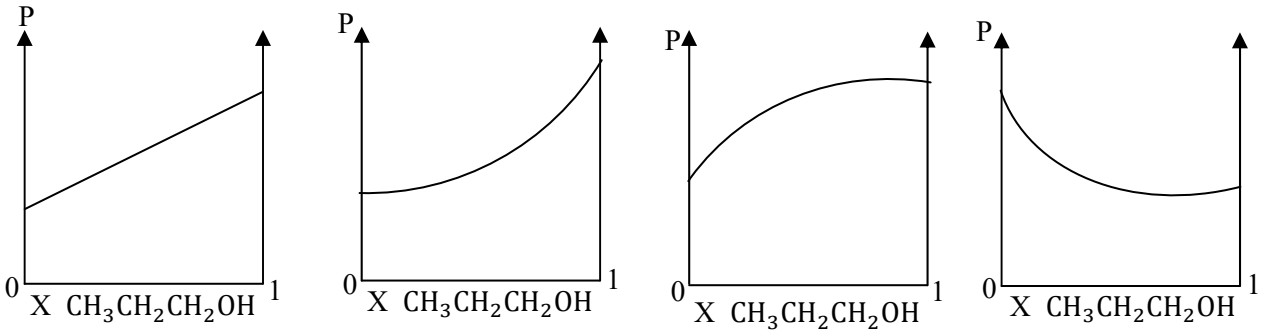
(b) All carbons atoms are in the same plane.

(c) Any $C-C-C$ bond angle is nearly 120^0

(d) Styrene does not declourise the colour of $Br_{2(l)}$

34. Which of the following diagram is most appropriate to show the variation of vapour pressure of a mixture of $CH_3CH_2\overset{\overset{O}{||}}{C}-CH_3$ and $CH_3CH_2CH_2OH$ at a certain temperature?

Boiling point of $CH_3CH_2COCH_3$ is 79.64^0C , and Boiling point of $CH_3CH_2CH_2OH$ is 97^0C.



a) b) c) d)

35. Aqueous solution of M^{2+} ion is coloured and $M^{2+}_{(aq)}$ is formed as a fixed precipitate with excess of NaOH solution. M^{2+} ion may be

(a) $Fe^{2+}_{(aq)}$ (b) $Co^{2+}_{(aq)}$ (c) $Ca^{2+}_{(aq)}$ (d) $Mn^{2+}_{(aq)}$

36. Which of the following is / are true regarding electrochemical cell?

(a) E_{Cell} increase when the concentration of ions in the solution increase in anode side.

(b) E_{Cell} decrease when the concentration of ions in the solution increase in anode side.

(c) E_{Cell} increase when the temperature of the system decrease.

(d) E_{Cell} increase when the temperature of the system increase.

37. Which of the following is / are correct regarding the titration between weak base and strong acid?

(a) At the equivalente point, the pH of the solution is determined by the Ka of the conjugate acid.

(b) Before the equivalence is reached a buffer solution will be formed.

(c) pH of the equivalence of this titration is higher than that of the titration between a strong acid and strong base. with equal concentration.

(d) When the equivalence point is exceeded, the pH of the solution is mainly determined by the Ka of the weak acid.

38. Which of the following is / are true regarding the 3d elements?

(a) Cr has the highest melting point compared with other 3d elements.

(b) Vanadium forms only basic oxide.

(c) Co, Ni and Cu have the highest density.

(d) Zn has the lowest melting point compared with other 3d elements.

39. Consider the equilibrium $P_{2(g)} + Q_{2(g)} \rightleftharpoons 2PQ_{(g)}$ Activation energy of its forward and backward reactions are 190 KJ and 200 KJ respectively. True statement /s regarding this equilibrium system is / are

(a) Forward reaction is favourable , when increasing the volume of the vessel by twice.
(b) Forward reaction is exothermic.
(c) Equilibrium constant is increased by decreasing the temperature.
(d) Forward reaction is favourable when increasing the pressure of the system by twice.

40. Which of the following statements regarding a catalyst is / are true.

(a) Catalyst provides an alternative path for the reaction with lower activation energy.
(b) Catalyst accelerating the rate of the reaction
(c) A small non stoichiometric amount of the catalyst is required to speed the reaction
(d) A catalyst is a substance that accelerates a reaction but undergoes no net chemical changes.

❖ **Instructions for questions 41 – 50.**

Response	First statement	Second statement
1)	True	True and correctly explains the first statement.
2)	True	True, but not explain the first statement correctly
3)	True	False
4)	False	True
5)	False	False

	First statement	Second statement
41)	Ionization energy of fourth period "d" block elements are higher than that of the 'S' block elements in the same period.	Reactivity of d block elements is less then the reactivity of 'S' block elements in the same periods.
42)	Molar volume of the gas at standard ambient temperature 25^0C and pressure 100 K Pa is $24.790 dm^3 mol^{-1}$	Volume of the gas is inversely proportional to the number of moles.
43)	Solubility of sodium halides increases in the following trends NaF < NaCl < NaBr < NaI	Free energy change gets more negative from sodium fluoride to sodium chloride.
44)	All type of electromagnetic radiation move through a vacuum at a speed of $2.988 \times 10^8 ms^{-1}$	Speed of light (c) have wave character and waves are periodic
45)	Phenol does not undergo friedel – craft alkylation and acyiation reactions	OH group of phenol form complex with friedel – craft catalyst.

46)	The rate of an elementry reaction increases with increasing concentration of reactants.	When the concentration of the reactant increases collisions in favourable orientation of the reactant molecules increase.
47)	Zn^{2+}, Mn^{2+} are precipitated as its sulfides when H_2S gas is passed into a solution of the ions acidified with dilute HCl	ZnS and MnS are not soluble in dilute HCl
48)	When the pH of an aqueous solution changes, the pOH also changes by the same number of units.	When the H^+ concentration of a solution changes, the OH^- concentration also changes by the same.
49)	Addition of a few drops of diluted HCl increase the electrical conductance of water.	Diluted HCl increases the dissociation of water molecules.
50)	The properties of one O – H bond in the H_3O^+ ion are different from those of the other two O – H bond	One O – H bond in the H_3O^+ ion can be identified as a co – ordinated bond.

Conducted by Field Work Centre, Thondaimanaru

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FWC

Term Examination, March - 2020

Grade – 13 (2020)	**Chemistry - II**	**Time :- 3 hours 10 minutes**

Part - II A

Structure Questions

Answer all four questions.

(10 marks will be awarded to each questions)

1) (A) Arrange the following in the descending order of the property given in Paranthesis.

(i) HCHO, CO_2, CH_3Br, HCN (Electro negativity of carbon)

……..

(ii) $LiNO_3$, $NaNO_3$, $RbNO_3$, KNO_3 (Solubility in water)

……..

(iii) Be, F, S, P (First ionization energy)

……..

(iv) (3, 0, 0, +1/2) , (3, 1, 0, +1/2), (2, 0, 0, +1/2), (2, 1, 0, +1/2) (Energy states of orbitals filled by electrons)

……..

(v) $SO_2, SO_3, SO_3^{2-}, SO_4^{2-}$ (Bond angle)

……..

(vi) P, Cl, Al, Na (Electron gain enthalpy)

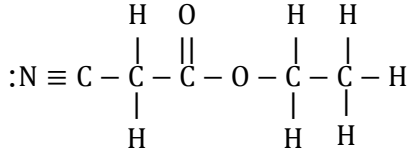
……..

(6 x 5 = 30 Marks)

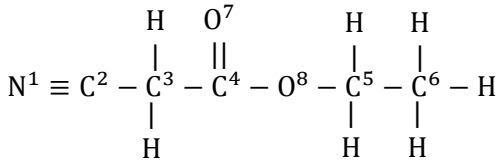
(B)

(i) Based on the following Lewis structure mention the following with regard to the atoms C, N, O and H.

1. VSEPR pairs around the atom.
2. Electron pair geometry around the atom.
3. Shape around the atom.
4. Hybridization of the atom.



The atoms are numbered as follows.



		N^1	C^3	C^4	O^8
(i)	VESPR pairs				
(ii)	Electron pair geomatry				
(iii)	Shape				
(iv)	Hybridization				

(6 x 1 = 16 Marks)

(ii) Identify the atomic / hybride orbitals involve in the formation of σ bonds in the lewis structure given in part (i) above. The atoms are numbered as in part (i).

(i) N^1 - C^2 N^1 ..... C^2 .....

(ii) C^4 - O^7 C^4 ..... O^7 .....

(iii) C^4 - O^8 C^4 ..... O^8 .....

(iv) C^5 - C^6 C^5 ..... C^6 .....

(8 x 1 = 08 Marks)

(iii) Identify the atomic orbitals involve in the formation of π bonds in the Lewis structure given in part (i)

i. N^1 - C^2 N^1 ..... C^2 .....

ii. C^4 - O^7 C^4 ..... O^7 .....

(4 x 1 = 04 Marks)

(iv) Draw the Lewis dot – dash structure of the following molecules and deduce their shapes.

i. SO_3 ii. CH_2Cl_2

(7 x 2 = 14 Marks)

(C) The following questions are related to the σ and π bonds between carbon atoms (C – C) in ethyne molecule ($CH \equiv CH$). Underline the correct choice of answer.

i. Which type of overlaping is formed by the contribution of the hybride orbitals of two carbon atoms in ethyne molecule.
(Linear over laping / Latteral over laping)

ii. The type of bond involve in the above overlaping
(σ bond / π bond)

iii. Which type of overlaping is involved with the contribution of the two carbon atoms in ethyne molecule
(Linear overlap / latteral overlap)

iv. Type of bond involve in the above overlaping
(σ bond / π bond)

(4 x 3 = 12 Marks)

(D) Mention the type / s of secoundary interactions that exists between the following pairs.

I. $HCl_{(g)}$ உம் $Ar_{(g)}$ உம் .....

II. $C_6H_5OH_{(l)}$ உம் $H_2O_{(l)}$ .....

III. $KCl_{(s)}$ உம் $H_2O_{(l)}$ உம் .....

(8 x 2 = 16 Marks)

100

2) (A) The following question is based on the chlorides of group 15 elements.

(i) Write all possible chlorides that can be formed by group 15 elements. and write balanced equations for their reactions with excess water.

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(6 x 1 = 06 Marks)

(6 x 3 = 18 Marks)

(ii) Although the shapes of the tri chlorides of the element Q belonging to second period (QCl_3) and element R belonging to thired period (RCl_3) are similartheir bond angles are different explain this statement briefly.

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(10 Marks)

(B) The table below is related to the complex ions formed by the cations of sum 3d elements. Complete the table given below by writting the formula of the cations is formed and their relevant colours with each of the given ligands.

Metal cation	Type of Ligans.		
	H_2O	NH_3	Cl^-
Cr^{3+}			
Colour of the complex ion			
Mn^{2+}			
Colour of the complex ion			
Ni^{2+}			
Colour of the complex ion			
Zn^{2+}			
Colour of the complex ion			

Complex ions : 12 x 02 = 24 Marks

Colour : 12 x 01 = 12 Marks

(C) Write balance chemical equations for the following species acting as an oxidizing agent and reducing agent

SO_2

Oxidizing agent :- .....

Reducing agent :- .....

H_2S

Oxidizing agent:- .....

Reducing agent :- .....

NH_3

Oxidizing agent:- .....

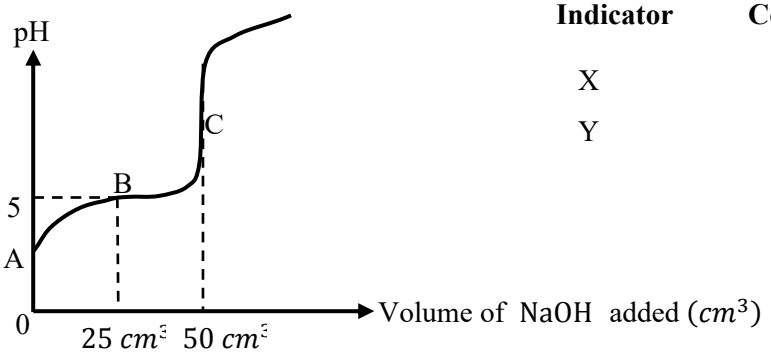
Reducing agent :- .....

(6 x 5 = 30 Marks)

100

03) (A) At 25^0C, $25\ cm^3$ of a mono – basic weak acid HA of an unknown concentration was titrated against $0.1\ moldm^{-3}$ NaOH and the following graph shows the change in pH during the titration (At 25^0C, $K_w = 1 \times 10^{-14} mol^2 dm^{-6}$)

The colour changing pH range of two indicators X and Y are also given below.



Indicator	Colour change pH range
X	4 – 6
Y	8.5 – 10

(i) What is the initial concentration of the weak acid HA?

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(05 marks)

(ii) Find the ionization constant Ka of the weak acid.

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(10 marks)

(iii) Calculate the pH relevant to the point A.

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(05 marks)

(iv) If the equivalence point of this titration is indicated by point C, calculate the pH corresponding to point C.

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(15 marks)

(v) Explain briefly the difference between the end point and equivalence point with regard to a titration

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(10 marks)

(vi) Of the indicators X and Y, which one is suitable for the given titration? Explain your answer.

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(05 marks*)*

(B) $25\ cm^3$ of $4\ moldm^{-3}$ HCl solution was taken in a vessel of negligible heat capacity and 2.1 g of a powdered sample of $MgCO_3$ solid was put into it and dissolved well.
(Mg = 24 , O = 16, C = 12)

$$MgCO_{3(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)} \qquad \Delta H = -40 kJmol^{-1}$$

(i) Calculate the heat liberated during the above process.

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(10 marks*)*

(ii) Assuming the density of the solution to be $1.19\ g\ cm^{-3}$ and the specific heat capacity as $4200 Jkg^{-1}K^{-1}$, find the rise in temperature in the above process.

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(10 marks*)*

(iii) You are informed that the standard enthalpies of combustion of graphite and $H_{2(g)}$ are $-393\ kJmol^{-1}$ and $-286\ kJmol^{-1}$ respectively.
It is also given that the standard enthalpy change for the reaction.
$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$ is $-470\ kJmol^{-1}$
Calculate the enthalpy of formation of $MgCO_{3(s)}$ using the above data.

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(10 marks)

(iv) If the enthalpy change for the reaction $Zn_{(s)} + 2\,HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$ is $-270\ kJmol^{-1}$, what would be the enthalpy change for the reaction $Mg_{(s)} + 2\,ZnCl_{2(aq)} \rightarrow MgCl_{2(aq)} + Zn_{(s)}$

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(10 marks)

(C) Suppose that the reaction $A \rightarrow P$ takes place via the following two steps

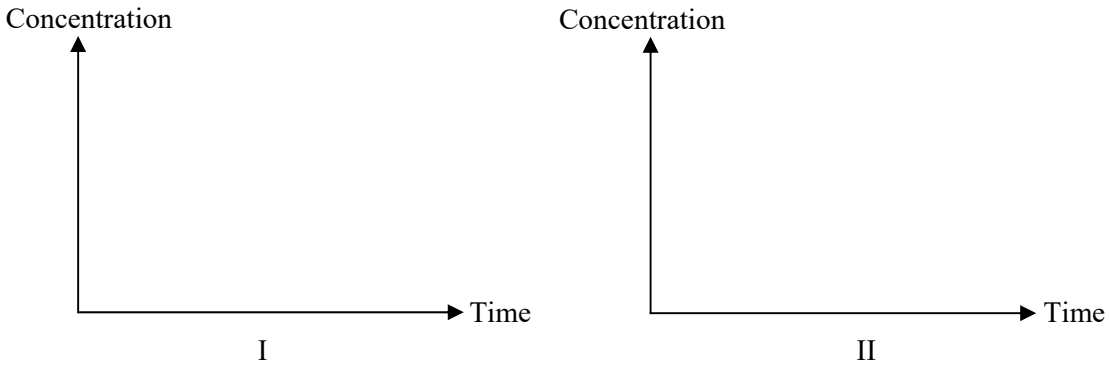
Step I : $A \rightarrow I$

Step II : $I \rightarrow P$ Where I is the reaction intermediate.

Draw suitable plots to indicate the variation of the concentrations of each of A, P and I. with time in the following circumstances.

I. Step I is fast whereas step II is comparatively slow.

II. Step II is slightly faster than step I



(2 x 5 = 10 marks)

100

04) (A) P is a non – cyclic compound having the empirical formula C_3H_4O. The molar mass of P is accurately $112\ g\ mol^{-1}$.

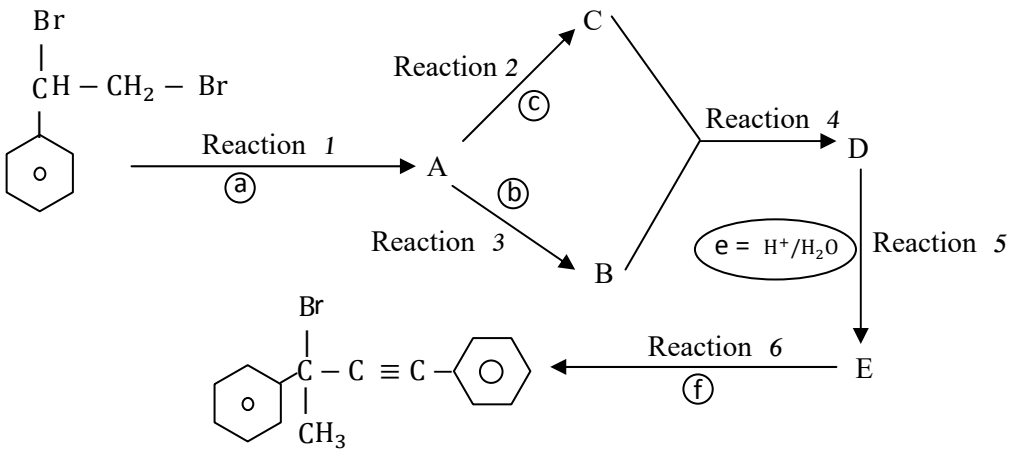
P shows both optical isomerism and geometrical isomerism. 1 mole of compound P reacts with 3 moles of Na but it does not react with NaOH. When treated with $NH_3 / AgNO_3$, P gave a white precipitate but it did not give silver mirror. 1 mol of P reacted with 3 mol H_2 / Pd to give the compound Q. When Q was treated with $H^+/KMnO_4$, compound R was formed which gave orange precipitate with 2, 4 - DNP. The compound R also produced a gaseous product with $NaHCO_3$. When treated with Zn / Hg and con. HCl, R produced S. Compound R reacted with PCl_5 to give compound T. When the compound T was reacted with CH_3MgCl followed by hydrolysis, another compound U was obtained. U showed optical activity.

(i) Write the structures of the compounds from P – U in the relevant boxes below.

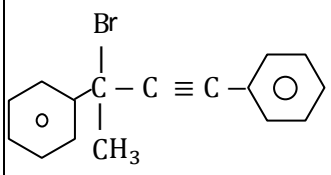
P	Q	R
S	T	U

(6 x 5 = 30 Marks)

(B) Consider the following reaction scheme in which the products obtained in each step is indicated by A, B, C, D and E whereas the reagents for each steps are demoted by a, b, c and f.



(i) Identify the products A, B, C, D and E and also the reagents a, b, c and f and write the type of mechanism for each of the reactions in the relevant cages of the following table.

Reaction	Reagent	Type of mechanism	Product
Reaction 1	a =		A =
Reaction 2	b =	Acid – base reaction	B =
Reaction 3	c =		C =
Reaction 4			D =
Reaction 5	e = H^+/H_2O		E =
Reaction 6	f =		

(60 Marks)

(ii) Write the mechanism for the reaction B + C ⟶ E .

(10 marks)

100

FWC

Conducted by Field Work Centre, Thondaimanaru

In Collaboration with Provincial Department of Education

Northern Province

Term Examination, March - 2020

Grade – 13 (2020)	Chemistry - II B	

Part - II B

Essay Questions

Answer any two questions from this part.

5) (A)

(i) Write the equilibrium reaction that can exist at 25^0C in a saturated solution of $Ag_2CrO_{4(s)}$ and hence derive the expression for the solubility product (K_{sp}) of Ag_2CrO_4.

(ii) If the molar solubility of $Ag_2CrO_{4(s)}$ at 25^0C is $1 \times 10^{-4} moldm^{-3}$, find the solubility product of Ag_2CrO_4 at 25^0C.

(iii) Calculate the maximum mass of Ag_2CrO_4 (in mg) that could be dissolved in $100\ cm^3$ of water at 25^0C [molar mass of Ag_2CrO_4 is $332\ g\ mol^{-1}$]

(iv) What would be the number of moles of Ag_2CrO_4 that gets precipitated if $250\ cm^3$ of $2\ moldm^{-3}$ Na_2CrO_4 is added into $250\ cm^3$ of a saturated solution of Ag_2CrO_4.

(v) When concentrated NH_3 solution is added to a saturated solution of Ag_2CrO_4, the yellow colour of the supernatant liquid increases. Explain this observation using your knowledge regarding the concept of chemical equilibrium.

(B) A and B are two completely miscible, volatile liquids that can form an ideal solution. 1 mol of each of A and B are placed in a closed container at 27^0C and allowed to attain equilibrium. Total pressure of the gaseous phase at the equilibrium with its liquid was found to be 1.2×10^5 Pa. The partial pressures of A and B were found to be in the ratio $P_A : P_B = 3 : 1$ and the volume of the gaseous phase was $8.314\ dm^3$ at the temperature of 27^0C.

Calculate the following during the equilibrium state

(i) Total number of moles in the gaseous phase.

(ii) Mole fractions of A and B in the liquid phase.

(iii) Saturated vapour pressures of pure A and B.

(C) A solution contains $0.1\ moldm^{-3}$ Zn^{2+} and $0.1\ moldm^{-3}$ Fe^{2+} ions. What should be the pH of the solution, if they are to be separated by passing H_2S gas through the solution?

Give that K_{sp} for $ZnS = 1.6 \times 10^{-24} mol^2dm^{-6}$ and K_{sp} for $FeS = 6.3 \times 10^{-18}\ mol^2dm^{-6}$

In a saturated solution, $H_2S_{(aq)}$ has a concentration of $0.10\ moldm^{-3}$. First and second ionization constants of H_2S are $K_{a_1} = 9.1 \times 10^{-8} moldm^{-3}$, $K_{a_2} = 1 \times 10^{-19} moldm^{-3}$

6) (A) $2\,A_{(aq)} + B_{(aq)} \longrightarrow C_{(aq)} + 3\,D_{(aq)}$

The following experiments were carried out at 300 K by a group of students to investigate the kinetics of the above reaction. The rate constant for the reaction at 300K is $3.3 \times 10^{-3} S^{-1}$

Experiment 1 :- $200\ cm^3$ of $0.2\ moldm^{-3}$ aqueous solution of A was mixed with $200\ cm^3$ of $0.4\ moldm^{-3}$ aqueous solution of B and the resulting solution was diluted to $1\ dm^3$ with distilled water. 12 seconds after the reaction was started, the concentration of B in the solution was found to be $0.032\ moldm^{-3}$

(i) Calculate the rates of consumption of the reactants A and B and the rate of formation of the product D.

Experiment 2 :- The table below shows the variation of the concentration of A with time while keeping the concentration of B a constant.

Time t / s	[A] / $moldm^{-3}$
0	0.40
120	0.20
180	0.10
210	0.05

Note :- The expressions for the half – life of a zero order and first order reactions are given by $t_{\frac{1}{2}} = \frac{[X]_0}{2K}$ and $t_{\frac{1}{2}} = \frac{0.693}{K}$ where $[X]_0$ = initial concentration of X. K = rate constant X.

(ii) Deduce the orders with respect to A and B giving reasons.

(iii) Under the conditions of experiment 1, calculate the following

(I) half – life of the reaction.

(II) Percentage of the rate of consumption of B of its initial value after a time of $3 \times t_{\frac{1}{2}}$

(iv) Under the conditions of experiment 2.

(I) Indicate the variation of the concentration (C) with time in a rough sketch.

(II) Calculate the initial rate and explain how the rate of this reaction varies with time.

(III) Find the time taken for the completion of the reaction

(IV) Time required for the completion of the reaction

(B) (I) What do you understand by a buffer solution?

(II) Calculate the mass of $NH_4Cl_{(s)}$ that is necessary to be added to $1\ dm^3$ of $0.1\ moldm^{-3}$ NH_3 solution to prepare a buffer solution with pH = 9?
($K_{b(NH_3)} = 1.8 \times 10^{-5}\ moldm^{-3}$) (N = 14, Cl = 35.5, H = 1)

(III) Calculate the pH of $0.5\ moldm^{-3}$ NH_4Cl solution. K_b of $NH_4OH = 1.8 \times 10^{-5}\ moldm^{-3}$

(C) Consider the following equilibrium reaction

$$X_{(g)} \rightleftharpoons Y_{(g)} + Z_{(g)}$$

At 127^0C, in a vessel of variable volume, a known amount of $X_{(g)}$ was placed and was allowed to attain the above equilibrium. During the equilibrium, if was found that $[X_{(g)}] = 0.2\ moldm^{-3}$, $[Y_{(g)}] = [Z_{(g)}] = 0.4\ moldm^{-3}$

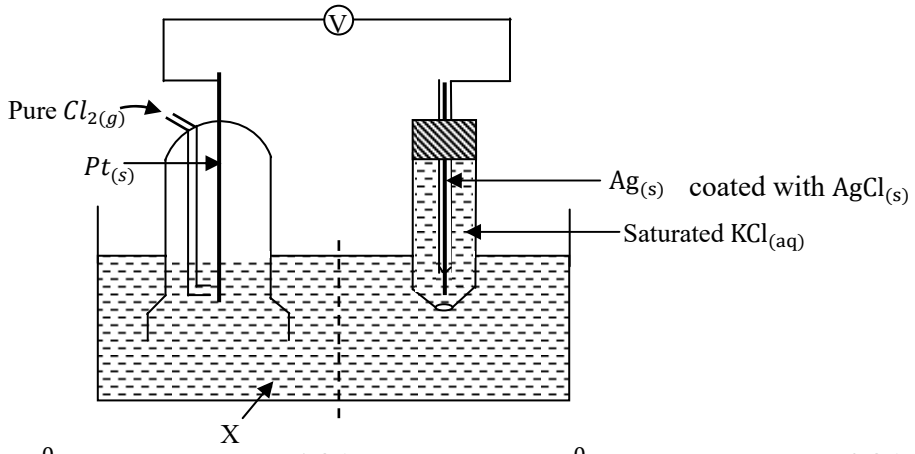
(i) Calculate the K_C at 127^0C for the above equilibrium.

(ii) If the pressure inside the vessel was suddenly decreased to half, find the value Q_C, reaction quotient, at that moment.

(iii) On the basis of the value of Q_C obtained in part (ii) above, predict the direction in which the reaction would proceed?

(iv) Calculate the concentration of each of the gases when the new equilibrium is attainess.

7) (A) The diagram below represents an electrochemical cell constructed by a student using a gas electrode and a metal – insoluble salt type electrode.



$E^{\theta}_{Pt_{(s)}/Cl_{2(g)}/\ Cl^-_{(aq)}} = +1.36\ V$ $\qquad$ $E^{\theta}_{AgCl_{(s)}/Ag_{(s)}/\ Cl^-_{(aq)}} = +0.26\ V$

(i) Mention a substance which is suitable for X.

(ii) Identify the cathode and anode.

(iii) Write the IUPAC notation for the above cell

(iv) Write half – ionic equations taking place in cathode and anode.

(v) Hence, write the equation for the cell reaction

(vi) What is the emf of the cell?

(vii) If ΔG^{θ} of the above cell can be given by $\Delta G^{\theta} = -nFE^{\theta}$, calculate ΔG^{θ}.

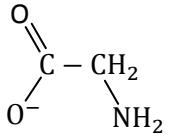
(viii) What would happen to the E_{Cell} if the concentration of X is increased?

(B) (i) A coordination compound of cobalt (III) contains four molecules of ammonia, one sulfate ion and a Cl^- ion only. When $BaCl_{2(aq)}$ is added to an aqueous solution of the above compound, no precipitate is formed.

When $AgNO_{3(aq)}$ is added to another portion of the above solution, formation of a white precipitate is observed.

Write a suitable structure for the given coordination compound.

(ii) The structure of the anion glycinato, formed by the ionization of an amino acid, glycine, is given below.



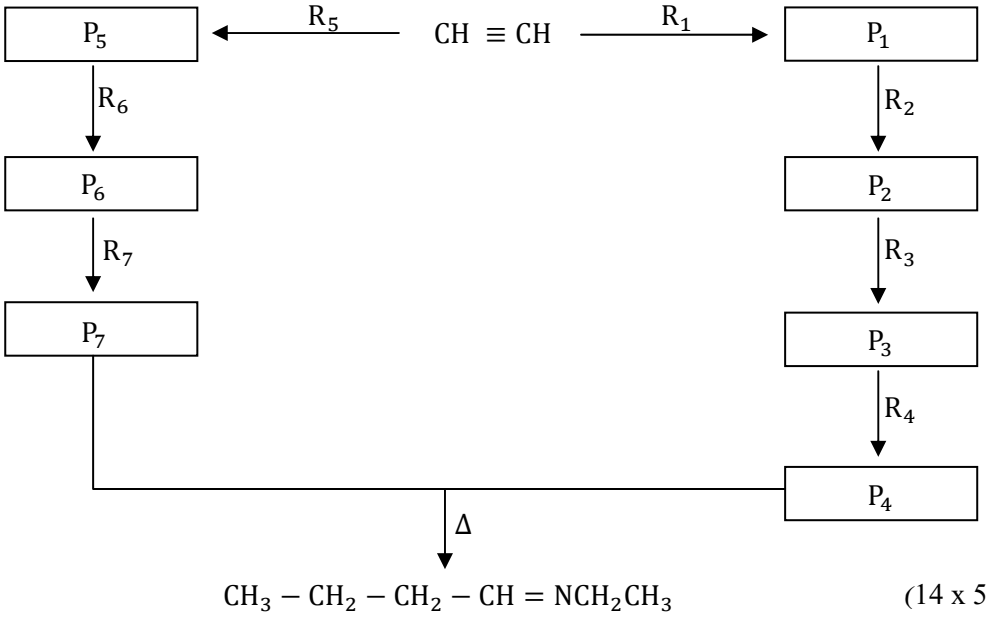
The above ion can act as a bidentate ligand by forming dative bond by the negatively charged O and N atom with the cation of cobalt in the oxidation state mentioned in part (i) above giving an octahedral complex – ion.

Draw the structure of this ion.

Part - II C

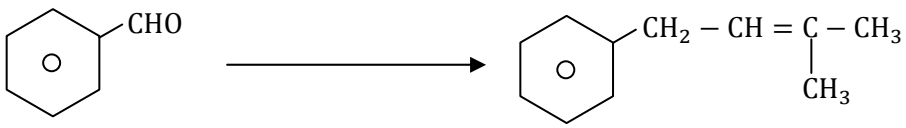
Answer any two questions only.

08) (A) Identify $R_1 - R_7$ and $P_1 - P_7$ in order to complete the following reaction Scheme.



$CH_3 - CH_2 - CH_2 - CH = NCH_2CH_3$ (14 x 5 = 70 Marks)

(B) Using only the chemicals given in the list show how you would carry out the following conversion.



List of chemical reagents.

$CH_3 - C \equiv C^- Na^+$, CH_3MgCl, PCl_5, $HgSO_4$, dilute H_2SO_4 $NaBH_4$, CH_3OH, Al_2O_3 , Water and heating facilities are available.

(Your conversion should not exceed 7 steps)

(11 x 4 = 44 Marks)

(C) Give the mechanism for the following reaction

(i) $CH_3 - CH_2 - CHO \xrightarrow{\text{dil NaOH}} CH_3 - CH_2 - \underset{\displaystyle OH}{\underset{|}{CH}} - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CHO$ *(18* Marks *)*

(ii) Mention, whether the above reaction type is nucleophilic substitution reaction or electrophilic substitution reaction or self. Condensation reaction.

(4 Marks*)*

(iii) Mention which of the compound prophylamine $(CH_3CH_2CH_2NH_2)$ and proponamide. $(CH_3 - CH_2 - \underset{\displaystyle O}{\underset{\|}{C}} - NH_2)$ has high basicity and explaine your answer briefly and giving reason.

(14 Marks *)*

(150 Marks *)*

9) (A) 'A' solution 'Q' contain H^+, Cu^{2+}, SO_4^{2-} ions. The following procedures were used to determine the concentration of the above ions.

(a) Excess $BaCl_2$ solution was added to $50.00\ cm^3$ of solution Q to precipitate SO_4^{2-} ions as $BaSO_4$. The precipitate was filtered washed and dried till a constant mass was observed. The mass of precipitate was 4.670 g. Determine the concentration of SO_4^{2-} ions in solution Q in $moldm^{-3}$. (O = 16, S = 32, Ba = 137)

(b) H_2S gas was bubbled through other $50.00\ cm^3$ of solution Q to precipitate Cu^{2+} ions as CuS. The precipitate was filtered washed with water and the filtrate was kept to be used in procedure (C). The precipitate was transferred into a titration flask containing $30.00\ cm^3$ of $0.56\ moldm^{-3}$ acidic $KMnO_4$ to produce $Cu^{2+}_{(aq)}$, $Mn^{2+}_{(aq)}$ and SO_2. The solution was boiled to remove $SO_{2(g)}$ and the excess $KMnO_4$ was titrated with $0.20\ moldm^{-3}$ Fe^{2+} solution. The burette reading at the end point was $11.00\ cm^3$. Determine the concentration of Cu^{2+} in solution Q in $moldm^{-3}$.

(c) The filtrate from procedure (b) above was placed in a titration flask, boiled to remove H_2S and cooled to room temperature to this both KIO_3 and KI aqueous solutions were added in excess. The volume of $0.6\ moldm^{-3}$ $Na_2S_2O_3$ solution required to titrate the librated iodine was $40.00\ cm^3$. Determine the concentration of H^+ ions in solution Q in $moldm^{-3}$

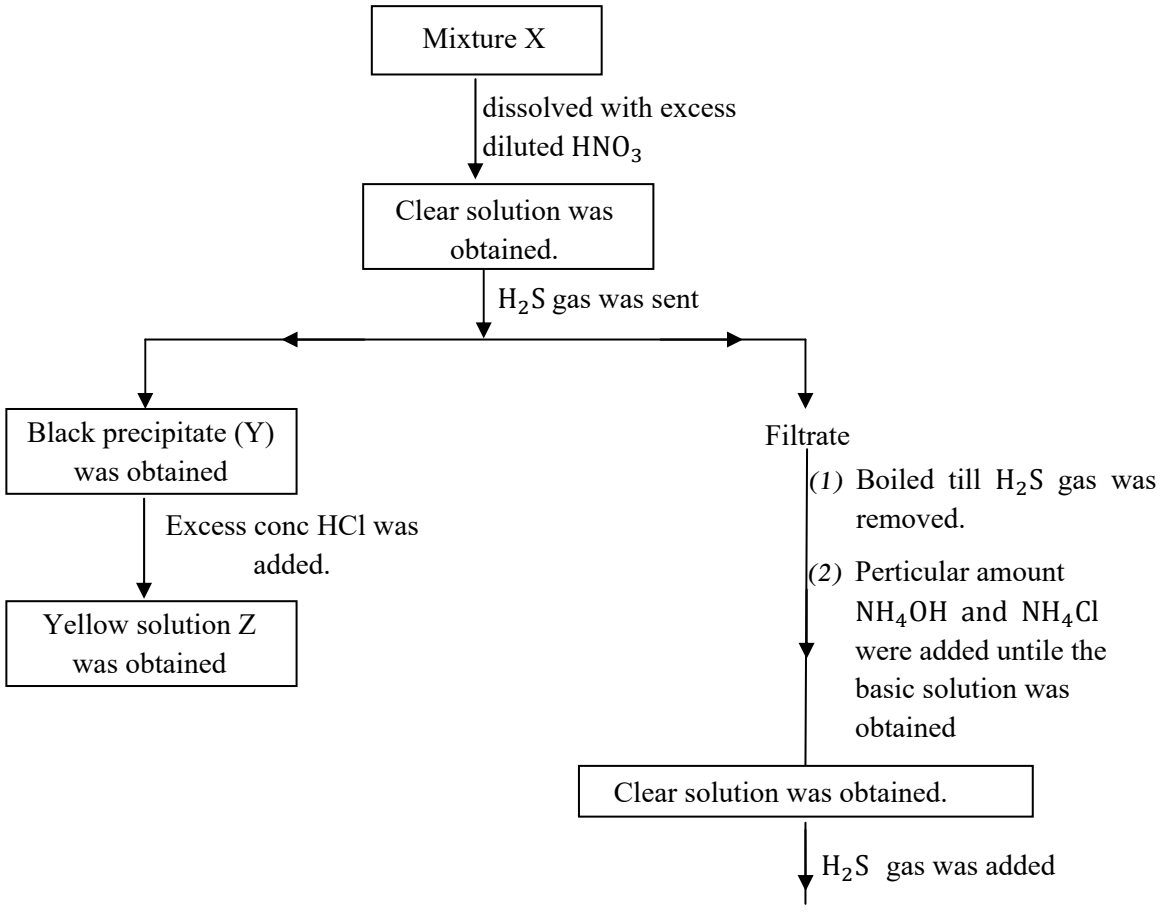
100

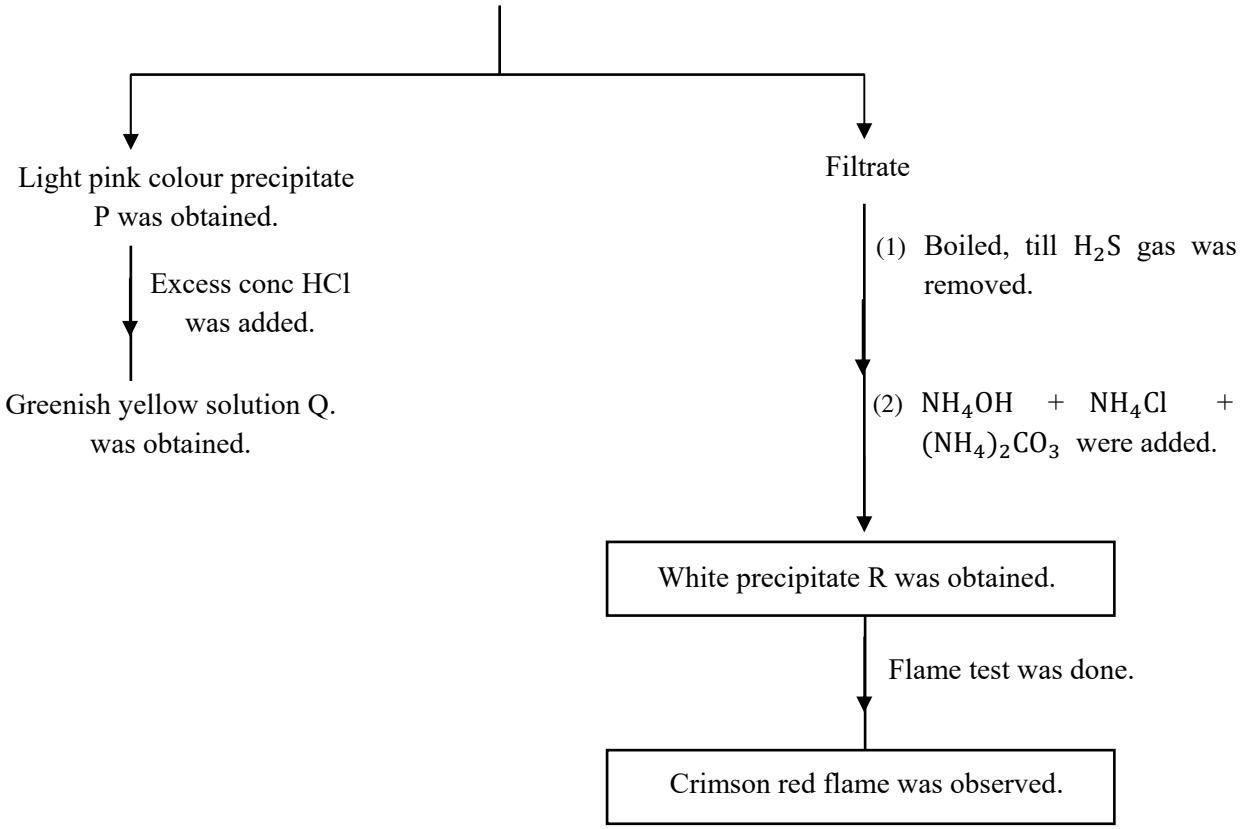
(B) The following tests (a) and (b) were carried out with a colourless gas X. Tests and observations are given below.

	Test	Observation
(1)	Gas X was sent into the acidify $KMnO_4$ solution	Pale yellow colour turbidity precipitate 'Y' and clear solution was obtained.
(2)	Gas X was sent into the concentrated H_2SO_4 solution.	Pale Yellow colour turbidity precipitate 'Y' and colourless acid gas 'Z' were obtained.
(3)	Gas X and Z were allowed to react.	Pale yellow colour turbidity precipitate 'Y' was obtained as one of the products.

(i) Identify gas X and Z.
(ii) Identify the species 'Y' form the pale yellow colour precipitate.
(iii) Give the balance chemical equations to the above tests (1), (2) and (3)
(iv) What is the shape of 'Y' in molecular stage.

10) (A) In 3d group metals mixture 'X' contain three metal chlorides. The details of quantitative test to the mixture X contain the species is given below.
(The test is to identify cations in the mixture X)





(i) Identify the species Y, Z, P, Q and R

(ii) Mention three cations in the mixture X.

(iii) Give the colour of complex ion and complex compound of cation in yellow colour solution Q.

(B) The following Questions related with the cations A, B, C and D which is in 3d group element solution

1) $A_{(aq)}$ $\xrightarrow{\text{Excess dilute } NH_3 \text{ solution}}$ Blue – green precipate (P)

2) $B_{(aq)}$ $\xrightarrow{\text{Excess conc } NH_3 \text{ Solution}}$ redish brown precipitate (Q)

3) $C_{(aq)}$ $\xrightarrow{\text{Excess conc HCl solution}}$ brownish red solution (R)

4) $D_{(aq)}$ $\xrightarrow{\text{Excess } NaOH_{(aq)}}$ White / cream precipitate (S)

I. Identify A, B, C, D, P, Q, R and S.

(C) Give the IUPAC names of the following complex compounds.

I. i. $K_3\,[(CN)(NH_3)_5]$

ii. $[Ni(NH_3)_6]Cl_2$

II. Give the possible oxides of Mn in 3d group element and mention the oxidation state and acid, base and neutral property of this oxides.