



Topic 2

$$V = U + at$$

$$S = \frac{U + V}{2} t$$

$$S = Ut + \frac{1}{2} at^2$$

$$V^2 = U^2 + 2as$$

Chemistry TOP 100

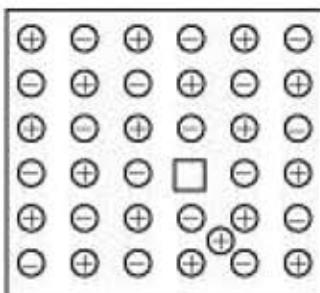
Questions & Solutions

Class 12

Meritnation Top 100 Questions Grade - 12 (Chemistry)

Solid State

1. Which type of packing is the most efficient? What is its packing efficiency in terms of percentage?
2. A metal crystallizes into two cubic phases i.e., Face-Centred Cubic (FCC) and Body-Centred Cubic (BCC) phase whose unit cell lengths are 3.5 and 3.0 Å respectively. Calculate the ratio of the densities of FCC and BCC.
3. Answer the following questions using the given illustration for a defective crystal.



- a. Which interstitial defect is depicted in the given ionic crystal?
- b. Why is a cation usually dislocated from its normal site to an interstitial site?
4. (i) What type of non-stoichiometric point defect is responsible for the pink colour of LiCl?
(ii) What type of stoichiometric defect is shown by NaCl? **(All India 2016)**
5. (a) What type of semiconductor is obtained when silicon is doped with boron?
(b) What type of magnetism is shown in the following alignment of magnetic moments?
(c) What type of point defect is produced when AgCl is doped with CdCl₂? **(Delhi 2013)**
6. Iron has a body centred cubic unit cell with a cell dimension of 286.65 pm. The density

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of iron is 7.874 g cm^{-3} . Use this information to calculate Avogadro's number (At. Mass of Fe = 55.845 u) **(Delhi 2012)**

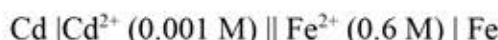
Solutions

7. Why is Raoult's law considered a special case of Henry's law?
8. Derive a relationship between osmotic pressure and molar mass of a solute.
9. (i) Gas (A) is more soluble in water than Gas (B) at the same temperature. Which one of the two gases will have the higher value of K_H (Henry's constant) and why? **(All India 2016)**
(ii) In non-ideal solution, what type of deviation shows the formation of maximum boiling azeotropes?
10. (a) Define the term 'molality'.
(b) Calculate the molality of 20% (mass/mass) aqueous KI solution.
(Molar mass of KI = 166 g mol^{-1})
11. (a) Define molal elevation constant.
(b) If 0.2 molal aqueous solution of a substance is boiled at 100.042°C , then calculate the molal elevation constant of water.
12. A 1.00 molal aqueous solution of trichloroacetic acid (CCl_3COOH) is heated to its boiling point. The solution has the boiling point of 100.18°C . Determine the van't Hoff factor for trichloroacetic acid. (K_b for water = $0.512 \text{ kg mol}^{-1}$) **(Delhi 2012)**
13. The depression in the freezing point of a solution containing 50 cm^3 of ethylene glycol in 50 g water is found to be 34 K. Assuming ideal behaviour, calculate the density of ethylene glycol? (K_f for water = $1.86 \text{ K kg mol}^{-1}$).
14. Calculate the osmotic pressure of a decimolar solution of potassium ferrocyanide that is 50% dissociated at 300 K.

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Electrochemistry

- 15.** a. What will happen if no salt bridge is used in an electrochemical Zn – Cu cell?
b. Why does a dry cell become dead after a period of time even when it has not been used?
c. Calculate the e.m.f for the given cell at 25°C.



The standard reduction potential of Cd | Cd²⁺ and Fe | Fe²⁺ electrodes are – 0.403 V and – 0.441 V respectively.

- 16.** Give reason for the following

In a cell Zn | Zn²⁺ || Cu²⁺ | Cu with E_{cell} = 1.1 V, the application of opposite potential greater than 1.1 V results in the flow of electrons from cathode to anode.

- 17.** A copper rod is dipped in a 0.1 M solution of CuSO₄. The salt is 80% dissociated at this dilution at a temperature of 298 K. What is the standard reduction potential of copper at 0.34 V?
18. Write the name of the cell which is generally used in transistors. Write the reactions taking place at the anode and the cathode of this cell. **(All India 2017)**

- 19.** Why is the value of E⁰ for $\text{Sc}^{3+} / \text{Sc}^{2+}$ couple low and the value of E⁰ for $\text{Mn}^{3+} / \text{Mn}^{2+}$ couple comparatively high?

- 20.** a. Is there any change observed in the variation of molar conductivity of KCl and CH₃COOH with concentration?

- b. What will be the solubility of a saturated solution of KBr that has a conductivity of $2.642 \times 10^{-6} \text{ S cm}^{-1}$?

(Given: ionic conductances of K⁺ and Br⁻ at infinite dilution are 73.5 S cm² mol⁻¹ and 78.1 S cm² mol⁻¹ respectively)

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21. a. Give the Nernst equation for the cell in which the given reaction takes place.



b. Some standard electrode potentials at 298 K are given below.

$$\text{Cu}^{2+}/\text{Cu} = 0.34 \text{ V}$$

$$\text{Ca}^{2+}/\text{Ca} = -2.87 \text{ V}$$

$$\text{Na}^+/\text{Na} = -2.71 \text{ V}$$

$$\text{Ag}^+/\text{Ag} = 0.80 \text{ V}$$

Write the order of metals in the decreasing order of their reducing power.

c. Calculate the molar ratio of the cations deposited at the cathode if 3F of electricity is passed through the solution of AgNO_3 , CuSO_4 and AuCl_3 ?

22. A solution of sodium chloride is a better conductor of electricity at a temperature of 50°C than at room temperature. Why?

Chemical Kinetics

23.a. For a reaction between A and B, the initial rate of reaction was measured for different initial concentrations of A and B which are given in the table below:

A / mol L^{-1}	0.20	0.20	0.40
B / mol L^{-1}	0.30	0.10	0.05
$r_0 / \text{mol L}^{-1} \text{s}^{-1}$	5.07×10^{-5}	5.07×10^{-5}	7.16×10^{-5}

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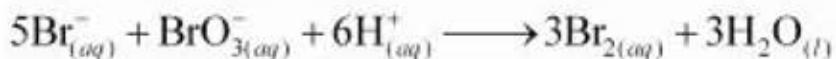
What is the order of reaction with respect to A and B?

b. Draw a graphical representation to show the effect of a positive catalyst on the activation energy.

24. Can the activation energy for a reaction be zero? Explain.

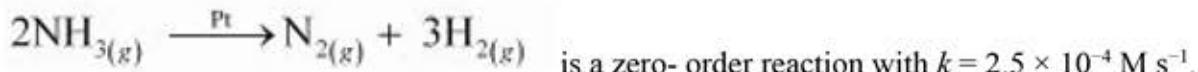
25. The rate law for a reaction is Rate $= k = [A][B]^{1/2}$. Can this reaction be elementary?

26. Write the rate expression for the given reaction in terms of each reactant and product.



27. Write the equation for the rate constant of a first order reaction.

28. a. The decomposition of NH_3 on platinum surface,



What are the rates of production of N_2 and H_2 ?

b. What are the units of k for a

(i) zero-order reaction

(ii) first-order reaction

29. What will be the rate constant for the thermal decomposition reaction of N_2O_5 at 373 K if half-life period of the reaction is 4.6 sec and the rate of reaction is independent of the initial concentration of N_2O_5 ?

Surface Chemistry

30. Gold sol exhibits different colours. Why?

31. Why are lyophilic colloidal sols more stable than lyophobic colloidal sols?

32. Account for the following statements.

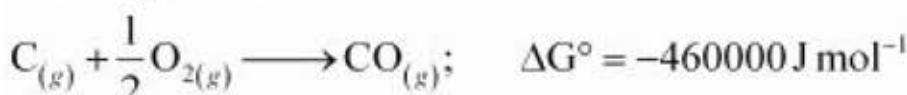
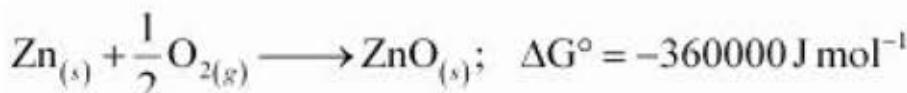
Meritnation Top 100 Questions Grade - 12 (Chemistry)

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- a. Hydrophilic sols are relatively more stable than hydrophobic sols.
- b. Gold sol is a multimolecular colloid.
- c. SO_2 is adsorbed to a greater extent on charcoal than H_2 at same temperature.
- 33.** Name the two groups into which phenomenon of catalysis can be divided. Give an example of each group with the chemical equation involved.
- 34.** Explain what is observed when
- (i) an electric current is passed through a sol
 - (ii) a beam of light is passed through a sol
 - (iii) an electrolyte (say NaCl) is added to ferric hydroxide sol

General Principles and Processes Of Isolation Of Elements

- 35.** a. What are the basic principles involved in the separation of components by column chromatography?
- b. The degree of adsorption of compounds A, B and C is $A > B > C$. The mixture of these compounds is separated by column chromatography. Show the relative positions of these components when the solvent is added with the help of suitable diagram.
- 36.** Account for the following statements.
- a. ΔG° vs. T plot in the Ellingham diagram slopes downward for $\text{C} \rightarrow \text{CO}$.
 - b. Extraction of copper from Cu_2S is difficult than from Cu_2O through reduction.
- 37.** The oxidation reactions of zinc and graphite at 1273 K are given below.

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Will graphite reduce ZnO to Zn?

38. Suggest a suitable method by which the given ores can be converted into their oxides.

(i) $\text{CaCO}_3 \cdot \text{MgCO}_3$

(ii) ZnS

39. Which reducing agent is employed to get copper from the leached low-grade copper ore?
(Delhi 2014)

40. A sulphide ore of copper is to be heated in a reverberatory furnace. However, it was observed that this ore also contains iron. How can iron be removed from the ore?

The p-Block Elements

41. What are the oxidation states displayed by the group-15 elements? What happens to the stability of these oxidation states on moving down the group?

42. Why does F_2 exist as gas while Br_2 exists as liquid at room temperature?

43. Why is PCl_5 ionic in the solid state?

44. Orthophosphoric acid forms NaH_2PO_4 , Na_2HPO_4 and Na_3PO_4 while orthophosphorus acid forms only two salts NaH_2PO_3 and Na_2PO_3 . Explain.

45. Predict the shape and hybridisation of XeO_2F_2 molecule.

46. Write the formula of the compound of iodine which is obtained when conc. HNO_3 oxidises I_2 .
(All India 2017)

Meritnation Top 100 Questions Grade - 12 (Chemistry)

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- 47.** a. Why does the addition of Cl_2 to KI solution give it a brown colour but excess of Cl_2 turns it colourless?
b. ClF_3 exists but FCl_3 does not. Why?
- 48.** Among OF_2 and Cl_2O , which has a higher bond angle?
- 49.** Explain the order of acidic strength of various oxoacids of chlorine.
- 50.** Why does PCl_3 fume in the presence of moist air?
- 51.** What is the reason for the existence of $(\text{CH}_3)_3\text{P} = \text{O}$, and non-existence of $(\text{CH}_3)_3\text{N} = \text{O}$?
- 52.** Why is neon generally used in warning signals?

The d-Block And f-Block Elements

- 53.** A deep blue solution is formed when H_2O_2 is added to acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution. Which compound is responsible for the deep blue colour? Also draw its structure.
- 54.** a. Why is the atomic size of Zn^{2+} larger than that of Co^{2+} ?
b. Show graphically the variation of melting point of the first transition series metals.
- 55.** Why is the separation of lanthanide elements difficult?
- 56.** Why is the d^1 configuration unstable in ions?
- 57.** Name the species obtained when V_2O_5 reacts with alkalis and acids.
- 58.** a. How does the atomic size vary along the first transition series elements?
b. Why do transition elements exhibit higher enthalpies of atomization?
c. Comment on the magnetic properties of the following elements:
 Zn^{2+} , Mn^{2+} , Cr^{2+}
- 59.** (a) Following are the transition metal ions of 3d series: (All India 2017)
 Ti^{4+} , V^{2+} , Mn^{3+} , Cr^{3+}

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(Atomic numbers: Ti = 22, V = 23, Mn = 25, Cr = 24)

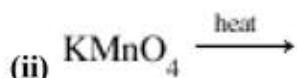
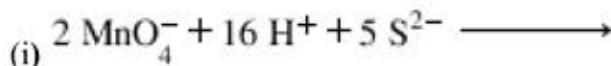
Answer the following:

(i) Which ion is most stable in an aqueous solution and why?

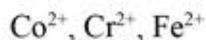
(ii) Which ion is a strong oxidising agent and why?

(iii) Which ion is colourless and why?

(b) Complete the following equations:



60. a. Giving reasons arrange the given transition metal ions in increasing order of their reducing powers.



Given that $E_{\text{Fe}^{3+}/\text{Fe}^{2+}}^\circ = 0.77 \text{ V}$, $E_{\text{Cr}^{3+}/\text{Cr}^{2+}}^\circ = -0.41 \text{ V}$, $E_{\text{Co}^{3+}/\text{Co}^{2+}}^\circ = 1.81 \text{ V}$

b. Why do transition metals act as catalysts?

61. Predict the magnetic behaviour of the complex $[\text{Ni}(\text{CN})_4]^{2-}$.

Coordination Compounds

62. What is the hybridisation involved in $[\text{Fe}(\text{CN})_6]^{4-}$? Mention the geometric and magnetic nature of the complex. Is it an inner or an outer orbital complex?

63. What will be the oxidation number of cobalt in the complex $[\text{Co}(\text{NH}_3)_5\text{Cl}] \text{Cl}_2$?

64. A coordination compound has the formula $\text{Co}(\text{NH}_3)_5 \text{SO}_4 \text{Br}$. It gives a white precipitate with BaCl_2 . Write the IUPAC name and the structural formula for the compound.

Meritnation Top 100 Questions Grade - 12 (Chemistry)

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65. What is the coordination number of Fe in $\left[\text{Fe}(\text{C}_2\text{O}_4)_3\right]^{3-}$ and $\left[\text{Fe}(\text{CN})_6\right]^{4-}$?
66. Draw the geometrical isomers of the complex $[\text{CoCl}_2(\text{en})_2]^+$. Which isomer will be optically active?
67. Arrange the given complexes in decreasing order of the wavelengths of the light absorbed.
 $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Co}(\text{CN})_6]^{3-}$
68. a. Compare and contrast double salts and complex compounds with the help of examples.
b. How does the magnitude of A_0 and P decide the actual configuration of d orbital in a d^6 ion?
c. Give one limitation of the crystal field theory.
69. Classify the following ligands as unidentate, bidentate, or hexadentate ligands.
 H_2O , $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$, EDTA^{4-} , NH_3

Haloalkanes and Haloarenes

70. Why are different products obtained when ethyl chloride reacts with silver nitrite and potassium nitrite?
71. An organic compound of molecular formula $\text{C}_7\text{H}_7\text{Cl}$, on reaction with alcoholic AgNO_2 , gives a compound 'A', which on reduction with Sn/HCl gives compound 'B'. 'B' is also obtained by the degradation of an amide. 'B' on reaction with CHCl_3/KOH gives compound 'C', which has an unpleasant odour.

Identify compounds A to C. Write the chemical reactions involved

- 72.a. Carry out the following conversions:
- Toluene to benzyl alcohol
 - Bromobenzene to benzene

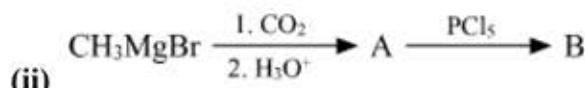
Meritnation Top 100 Questions Grade - 12 (Chemistry)

iii. Propan-2-ol to 1-bromopropane

b. Identify X, Y, and Z in the following reactions.



73. (a) Write the structures of A and B in the following reactions: (All India 2016)



(b) Distinguish between:

(i) $\text{C}_6\text{H}_5 - \text{COCH}_3$ and $\text{C}_6\text{H}_5 - \text{CHO}$

(ii) CH_3COOH and HCOOH

(c) Arrange the following in the increasing order of their boiling points:

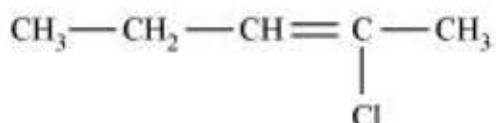
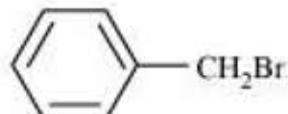


74. a. Name the products formed in the chlorination of methane in the presence of heat.

b. What is the drawback of this reaction?

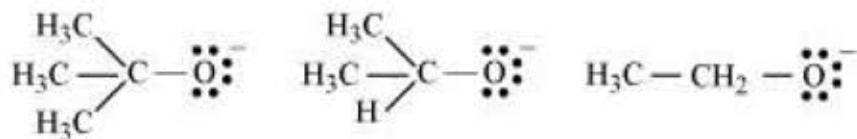
75. Classify the following compounds as allylic, benzylic, or vinylic halides.

**Meritnation Top 100 Questions
Grade - 12 (Chemistry)**

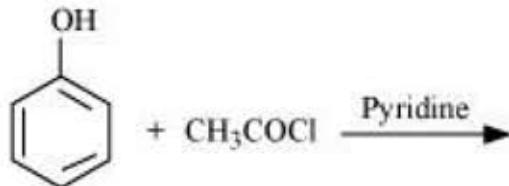


Alcohols, Phenols and Ethers

76. Why C – O – C bond angle in diethyl ether greater than the tetrahedral angle, $109^\circ 24'$?
77. Arrange the given alkoxides in order of their decreasing basic strengths.

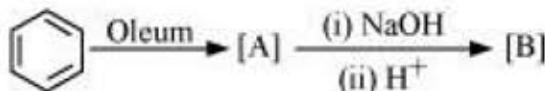


78. Consider the reaction given below.



- a. What would be the product formed?
 b. Why is pyridine added in this reaction?
79. a. Identify A and B in the following reactions.

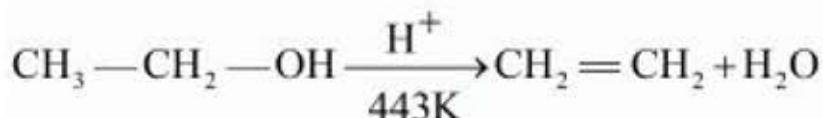
Meritnation Top 100 Questions Grade - 12 (Chemistry)



b. Write the reaction involved in the acetylation of salicylic acid.

80. Write one step conversion of propene to isopropyl alcohol.

81. Explain the mechanism of the following reaction: (All India 2013)



Aldehydes, Ketones and Carboxylic Acids

82. a. Write the equation for the reaction of propanone with ethylene glycol in the presence of dry HCl gas.

b. Why is dry HCl gas used in the above process?

83. Give chemical tests to distinguish between the following pairs of compounds:

(i) Propanal and propanone

(ii) Methyl acetate and ethyl acetate

(iii) Benzaldehyde and benzoic acid (Delhi 2007)

84. a. Carry out the following conversions.

i. Acetyl chloride to ethane

ii. Acetic acid to malonic acid

iii. Ethanol to 3-hydroxybutanal

b. Write short notes on the following:

i. Stephen reaction

Meritnation Top 100 Questions Grade - 12 (Chemistry)

ii. Gatterman-Koch reaction

85. a. What happens when *p* – methyl benzaldehyde reacts with the following reagents?

(i) Tollen's reagent

(ii) KMnO_4

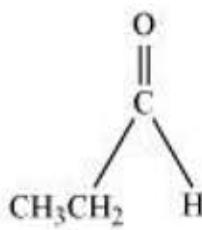
(iii) 2, 4 – dinitrophenylhydrazine

b. Why carboxylic acids do not react with hydroxylamine to form oxime, although carbonyl group is present in acids?

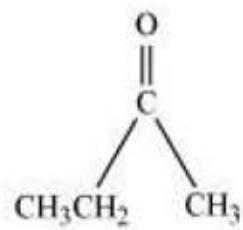
86. a. Giving reasons, arrange the following in order of their reactivities towards alcohols.



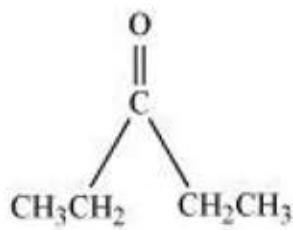
Methanal



Propanal



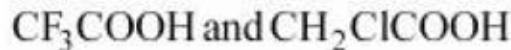
Butan-2-one



Pentan-3-one

b. Write the reaction involved when acetone reacts with semicarbazide.

c. Which of the given compounds will undergo Hell – Volhard – Zelinsky reaction and why?



(i)

(ii)

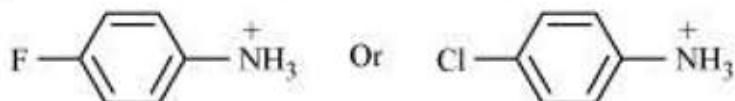
Amines

87. Why do nitro compounds have high boiling points in comparison with other compounds of same molecular mass?

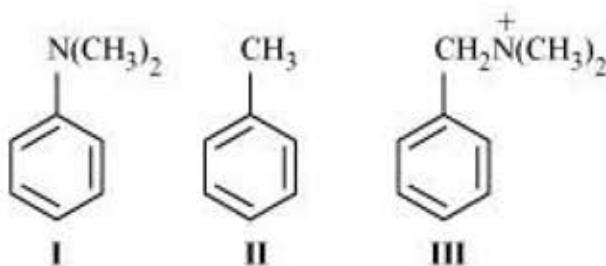
88. Write the name of the purine and pyrimidine bases present in RNA.

89. a. Which of the given compounds is more acidic?

Meritnation Top 100 Questions Grade - 12 (Chemistry)



b. Arrange the given compounds in increasing order of their reactivities towards electrophilic substitution reaction.



90. a. How can we convert methylamine to ethylamine?
- b. Obtain an expression for the k_b value of ethylamine.
- c. Between ethanamine and ethanamide, which is a stronger base and why?
91. Write the structure of the position isomer and the functional isomer of $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{NH}_2$.

Biomolecules

92. Explain how a peptide linkage is formed.
93. a. What would be the effect on a protein when its pH is increased from its normal value?
b. Show the peptide linkages in α -helical structure of proteins.
94. a. A base 'B' is only found in RNA and not in DNA. When this base is attached to 1' position of sugar moiety present in RNA, then a unit 'C' is formed. On linking phosphoric acid at 5' position of 'C', a unit 'D' is obtained?

Identify B, C, and D?

Meritnation Top 100 Questions Grade - 12 (Chemistry)

b. What happens when two units of 'D' are joined between 5' and 3' carbon atoms?

95. How many peptide linkages are present in Gly-Ala-Val?

Polymers

96. a. How does vulcanisation change the character of natural rubber?

b. What do the number 66 and 6 signify in the names of nylon 66 and nylon 6?

97. What type of bonding helps in stabilizing the α -helix structure of proteins? (Delhi 2013)

Chemistry In Everyday Life

98. What are the following substances? Give one example of each.

(i) Food preservatives

(ii) Synthetic detergents

(iii) Antacids

99. What are bactericidal and bacteriostatic antibiotics? Give an example of each.

100. Name the medicine developed by Paul Ehrlich for the treatment of syphilis.

Topic 2

$$V = U + at$$

$$S = \frac{U + V}{2} t$$

$$S = Ut + \frac{1}{2} at^2$$

$$V^2 = U^2 + 2as$$

splacement

time

initial speed



meritnation

a: acceleration

T: 10 Waves

Solutions

Nm⁻²

$$F = \frac{\Delta P}{\Delta t}$$

metre

$$\Delta E_p = MgAh$$

(A)

$$F = Kx$$

Barometer

$$E_{\text{elas}} = \frac{1}{2} Kx^2$$



$$\text{power} = \frac{\text{work}}{\text{time}} = FV = \frac{FV}{V^2} = \frac{4\pi r^2}{T^2} \frac{\sin \theta_1}{\sin \theta_2} = \frac{V_1}{V_2}$$

Symbol

g

G

N_A

R

K

Aprox Value

9.81 m⁻²

6.67 N

6.02 x 10²³

8.31 J K⁻¹

1.38 x 10³⁴

$$\text{Impulse} = FAt = m\Delta v$$

$$E_K = \frac{P^2}{2m}$$

$$f = \frac{1}{T}$$

$$v = f\lambda$$

$$\frac{V_1}{V_2}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

Meritnation Top 100 Questions (Solutions) Grade - 12 (Chemistry)

Solid State

1. *Hcp(fcc)* and *ccp* structures are equally efficient. Each has a packing efficiency of 74%.

2. The density of the unit cells can be calculated using the given formula.

$$\begin{aligned}\frac{\rho_{FCC}}{\rho_{BCC}} &= \frac{Z_{FCC} \times (a^3)_{BCC}}{Z_{BCC} \times (a^3)_{FCC}} \\ &= \frac{4 \times (3.0)^3}{2 \times (3.5)^3} \\ &= \frac{108}{85.75} \\ &= \frac{126}{100} = \frac{63}{50}\end{aligned}$$

Hence, the ratio of the densities of FCC and BCC is **63:50**.

3. a. The interstitial defect shown in the given ionic crystal is known as **Frenkel defect**. In the given crystal lattice, an ion has left its correct lattice site and occupied an interstitial site.

b. Cations are usually smaller than anions in size. As a result, they can easily occupy an interstitial site.

4. (i) The metal excess defect caused by anionic vacancies is responsible for the pink colour of LiCl.

(ii) The Schottky defect is found in NaCl. In this defect, an equal number of cations and anions are missing from their regular sites.

5. (a) When crystals of LiCl is heated in presence of excess of lithium, Cl ions from crystal diffuse on surface and combine with ionised Li to form LiCl. The released unpaired electrons occupy the anionic sites known as F-centres. The pink colour results by excitation of these electrons when they absorb energy from visible light falling on them.

(b) Ferromagnetism is shown in the following alignment of magnetic moments

$\uparrow \uparrow \uparrow \uparrow \uparrow \uparrow \uparrow \uparrow \uparrow \uparrow$.

Meritnation Top 100 Questions (Solutions) Grade - 12 (Chemistry)

Ferromagnetism: The substances that are strongly attracted by a magnetic field are called ferromagnetic substances. Ferromagnetic substances can be permanently magnetised even in the absence of a magnetic field. Some examples of ferromagnetic substances are iron, cobalt, nickel, gadolinium, and CrO_2 .



Schematic alignment of magnetic moments in ferromagnetic substances

6.

$$a = 286.65 \text{ pm} = 286.65 \times 10^{-10} \text{ cm}$$

$$\text{Density } (\rho) = 7.874 \text{ g cm}^{-3}$$

$$\text{At mass of Fe} = 55.845 \text{ u}$$

$$Z = 2 \text{ (For body centred cubic unit cell)}$$

$$\text{Avogadro Number } (N_A) = ?$$

Since,

$$\rho = \frac{Z \times M}{N_A \times a^3}$$

$$N_A = \frac{Z \times M}{\rho \times a^3}$$
$$= \frac{2 \times 56}{7.84 \times (286.65 \times 10^{-10})^3}$$
$$= 6.04 \times 10^{23}$$

Solutions

7. According to Raoult's law, the vapour pressure of a volatile component in a given solution is $p_i = y p_{i^*}$ (Where p_{i^*} is the proportionality constant).

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According to Henry's law, the partial vapour pressure of gas (the component is so volatile that it exists as gas) in a liquid is

$$p = K_H x \quad (\text{Where } K_H \text{ is the proportionality constant})$$

It can be observed that in both the equations, the partial vapour pressure of the volatile component varies directly with its mole fraction. Only the proportionality constants K_H and p_i^* are different. As a result, Raoult's law became a special case of Henry's law, where K_H is equal to p_i^* .

8. Osmotic pressure is directly proportional to the molarity, C , of the solution at a given temperature, T .

$$\text{i.e., } \pi = CRT \quad (\text{where, R = Gas constant})$$

$$\Rightarrow \pi = \left(\frac{n_2}{V} \right) RT$$

Where,

n_2 = Number of moles of solute

V = Volume of the solution in litres

$$n_2 = \frac{w_2}{M_2}$$

Again,

Where, w_2 = Mass of the solute

M_2 = Molar mass of the solute

$$\pi = \left(\frac{\frac{w_2}{M_2}}{V} \right) RT$$

Now,

$$\pi V = \frac{w_2 RT}{M_2}$$

Or,

$$M_2 = \frac{w_2 RT}{\pi V}$$

Or,

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9. (i) According to Henry's law, the solubility of a gas is inversely related to the Henry's constant (K_H) for that gas. Hence, gas (B), being less soluble, would have a higher K_H value.

(ii) A maximum boiling azeotrope shows negative deviation from the Raoult's law.

10. (a) Molality is a measure of the concentration of a solute in a solution in terms of amount of substance in a specified amount of a mass of the solvent.

(b) 20% (mass/mass) aqueous KI solution means 20 g of KI is present in 80g of water.

$$\text{Molality} = \frac{\text{Number of moles of KI}}{\text{Mass of solvent (in grams)}} \times 1000$$

$$\frac{20}{166} \times \frac{1000}{80}$$

$$1.51\text{ m}$$

\

11. (a) Molal elevation constant (K_b) is defined as the elevation of the boiling point of a solution when the molality of the solution is unity. The units of K_b are K/m or $^{\circ}\text{C}/\text{m}$ or K Kg mol^{-1} .

(b) It is given that

$$m = 0.2$$

Boiling point of the solution (T_b) = 100.042°C

Boiling point of water (T_b^0) = 100°C

Therefore, elevation of boiling point,

$$\begin{aligned}\Delta T_b &= T_b - T_b^0 \\ &= (100.042 - 100)^{\circ}\text{C} \\ &= 0.042^{\circ}\text{C}\end{aligned}$$

It is known that

$$\begin{aligned}\Delta T_b &= K_b m \\ K_b &= \frac{\Delta T_b}{m} \\ &= \frac{0.042^{\circ}\text{C}}{0.2\text{ m}} \\ &= 0.21^{\circ}\text{C/m}\end{aligned}$$

12. Molality of solution = $m = 1.00\text{ m}$

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Boiling points of solution = $T_b = 100.18^\circ\text{C} = 373.18\text{ K}$

Boiling point of water (solvent) = $T_b^o = 100.00^\circ\text{C} = 373\text{ K}$

Elevation in boiling point = $T_b - T_b^o$

Observed boiling point = $373.18\text{ K} - 373\text{ K} = 0.18\text{ K}$

K_b water = $0.512\text{ K kg mol}^{-1}$

$$\therefore \Delta T_b = K_b m$$

$$= 0.512 \times 1 = 0.512\text{ K}$$

$$\therefore \text{Calculated boiling point} = 0.512\text{ K}$$

$$\begin{aligned}\text{Van't Hoff Factor (i)} &= \frac{\text{Observed colligative property}}{\text{Calculated colligative property}} \\ &= \frac{0.18\text{ K}}{0.512\text{ K}} \\ i &= 0.35\end{aligned}$$

$$w_2 = \frac{M_2 \times \Delta T_f \times w_1}{1000 \times K_f}$$

13. Weight of ethylene glycol,

$$\begin{aligned}&= \frac{62\text{ gmol}^{-1} \times 34\text{ K} \times 50\text{ g}}{1000 \times 1.86\text{ Kgmol}^{-1} \times 1000} \\ &= 0.0567\text{ g}\end{aligned}$$

Now, the density (d) of solute i.e., ethylene glycol can be calculated as follows:

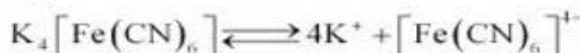
$$\frac{w_2}{V} = \frac{0.0567\text{ g}}{50\text{ cm}^3} = 1.13 \times 10^{-3}\text{ gcm}^{-3}$$

Hence, the density of ethylene glycol is $1.13 \times 10^{-3}\text{ gcm}^{-3}$.

14. Degree of dissociation, $\alpha = 0.5$

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Total number of moles = $1 + 4\alpha$



Number of moles initially 1

Number of moles after dissociation $1 - \alpha$ 4α α

\therefore van't Hoff factor, $i = 1 + 4\alpha = 1 + 4 \times 0.5 = 3$

Now osmotic pressure, $\pi = i C RT$

Now, $C = 0.1 \text{ M} = 10^2 \text{ mol m}^{-3}$

So, $\pi = 3 \times 10^2 \times 8.314 \times 300 = 7.48 \times 10^5 \text{ Nm}^{-2}$

Electrochemistry

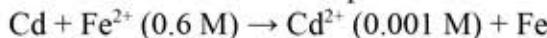
15. a. If there is no salt bridge in a Zn – Cu electrochemical cell, then the metal ions (Zn^{2+}) formed by the loss of electrons will accumulate on one electrode and the negative ions (SO_4^{2-}) will get accumulated on the other. The solution will develop charge and hence, the current will stop flowing. Also, the circuit will not be completed.

b. A dry cell becomes dead after a period of time even when it has not been used because the acidic NH_4Cl corrodes the zinc container.

c. The e.m.f of the given cell can be calculated by the following relation:

$$E_{\text{Cell}}^{\circ} = E_{\text{Fe}^{2+}|\text{Fe}}^{\circ} - E_{\text{Cd}^{2+}|\text{Cd}}^{\circ} = 0.441 - (-0.403) = -0.441 + 0.403 = -0.038 \text{ V}$$

The cell reaction can be represented as



Now,

$$E_{\text{Cell}} = E_{\text{Cell}}^{\circ} - \frac{0.0591}{n} \log \left[\frac{\text{Cd}^{2+}}{\text{Fe}^{2+}} \right] = -0.038 - \frac{0.0591}{2} \log \frac{0.001}{0.6} = 0.0441 \text{ V}$$

Therefore, the e.m.f of the given cell is 0.0441 V.

16. When an external voltage greater than 1.1 V is applied to a Daniel cell, then the electrons flow in the reverse direction, i.e., from cathode ($Cu^{2+} | Cu$) to anode ($Zn | Zn^{2+}$). Hence, the reverse reaction takes place.

17. The electrode reduction reaction can be represented as

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According to Nernst's equation,

$$E = E^\circ - (0.059 \frac{1}{2}) \log (1/[\text{Cu}^{2+}])$$

$$E = 0.34 - (0.059 \frac{1}{2}) \log (1/[\text{Cu}^{2+}])$$

Now, 0.1 M CuSO_4 solution is 80% dissociated.

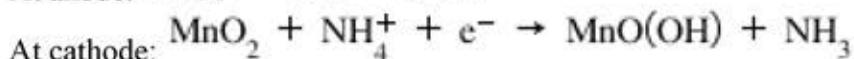
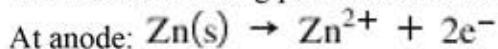
$$\therefore [\text{Cu}^{2+}] = \{(80/100) \times 0.1\} = 0.08 \text{ M}$$

$$E = 0.34 - (0.059 \frac{1}{2}) \times \log (1/0.08)$$

$$E = 0.34 - 0.032 = 0.308 \text{ V}$$

Therefore, the standard reduction potential of copper is 0.308 V.

- 18.** The dry cell (also known as Leclanche cell) is used in transistors. The reactions taking place at the anode and cathode are given below.



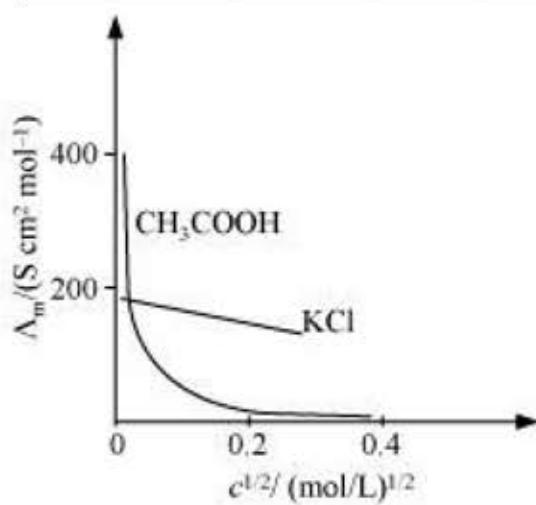
- 19.** The low value of E° for $\text{Sc}^{3+}/\text{Sc}^{2+}$ indicates that Sc^{3+} is much more stable than Sc^{2+} . This is because, Sc^{3+} has a noble gas configuration. The high value of E° for $\text{Mn}^{3+}/\text{Mn}^{2+}$ indicates that Mn^{2+} is much more stable than Mn^{3+} . This is because of the stable half-filled configuration of Mn^{2+} ($3d^5$).

- 20. a.** KCl is a strong electrolyte while CH_3COOH is a weak electrolyte. Both the electrolytes show a decrease in molar conductivity with increase in temperature.

However, for KCl there is small increase in conductance with dilution because it is completely dissociated in solution. Hence, the number of ions remains constant. As the concentration increases, the conductance reduces because of greater inter-ionic interactions that retard the motion of ions.

In case of CH_3COOH , it is dissociated to a much lesser extent as compared KCl. Therefore, the conductance of CH_3COOH is lower than that of KCl at same concentration.

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b.

$$\Lambda_m^\circ(KBr) = \lambda^\circ(K^+) + \lambda^\circ(Br^-) = 73.5 + 78.1 = 151.6 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\text{Solubility} = \frac{\kappa \times 1000}{\Lambda_m^\circ} = \frac{2.642 \times 10^{-6} \times 1000}{151.6} = 1.742 \times 10^{-5} \text{ mol L}^{-1}$$

Molecular mass of KBr = 119 g

$$\text{Solubility} = 1.742 \times 10^{-5} \times 119 \text{ g L}^{-1} = 2.072 \times 10^{-3} \text{ g L}^{-1}$$

21. a. The Nernst equation for the given cell is as follows:

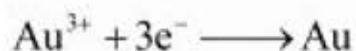
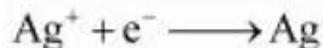
$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{2.303RT}{6F} \left(\log \frac{[\text{Cr}^{3+}]^2}{[\text{Cd}^{2+}]^3} \right)$$

b. The lower the reduction potential, the more easily it can reduce and the greater is the reducing power. Hence, the correct order of metals in the decreasing order of their reducing power is as follows:



c. On passing electricity through the solutions of AgNO₃, CuSO₄, and AuCl₃, the following reactions take place.

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 $\frac{3}{2}$

Hence, passing 3 Faradays of electricity will deposit 3 moles of Ag, $\frac{3}{2}$ mole of Cu and 1 mole of Au.

$$= 3 : \frac{3}{2} : 2 = 6 : 3 : 2$$

∴ Molar ratio

22. A solution of NaCl shows greater conduction of electricity at a temperature of 50°C than at room temperature because the ionic mobility of a strong electrolyte such as NaCl increases with an increase in temperature.

Chemical Kinetics

23. a. The rate equation for a reaction between A and B can be shown as:

$$r_0 = K[A]^\alpha[B]^\beta$$

Where,

α and β are the order of reaction w.r.t. A and B respectively.

Now, writing the initial rate of reactions measured for different given initial concentrations of A and B, we get:

$$(r_0)_1 = 5.07 \times 10^{-5} = K(0.20)^\alpha(0.30)^\beta \quad (\text{i})$$

$$(r_0)_2 = 5.07 \times 10^{-5} = K(0.20)^\alpha(0.10)^\beta \quad (\text{ii})$$

$$(r_0)_3 = 7.16 \times 10^{-5} = K(0.05)^\alpha(0.40)^\beta \quad (\text{iii})$$

On dividing equation (i) by (ii), we get:

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$$(r_0)_1 / (r_0)_2 = 1 = (0.30 / 0.10)^\beta = (3)^\beta$$

$$(3)^\beta = 1$$

$$(3)^\beta = (3)^0$$

Or, $\beta = 0$

On dividing equation (iii) by (ii), we get:

$$(r_0)_3 / (r_0)_2 = \frac{7.16}{5.07} = \left(\frac{0.40}{0.20}\right)^\alpha \left(\frac{0.05}{0.10}\right)^\beta$$

$$1.415 = (2)^\alpha \left(\frac{1}{2}\right)^\beta$$

Or,

$$\text{Now } \beta = 0$$

$$\therefore 1.412 = (2)^\alpha$$

$$\text{Or, } \alpha \log 2 = \log 1.415$$

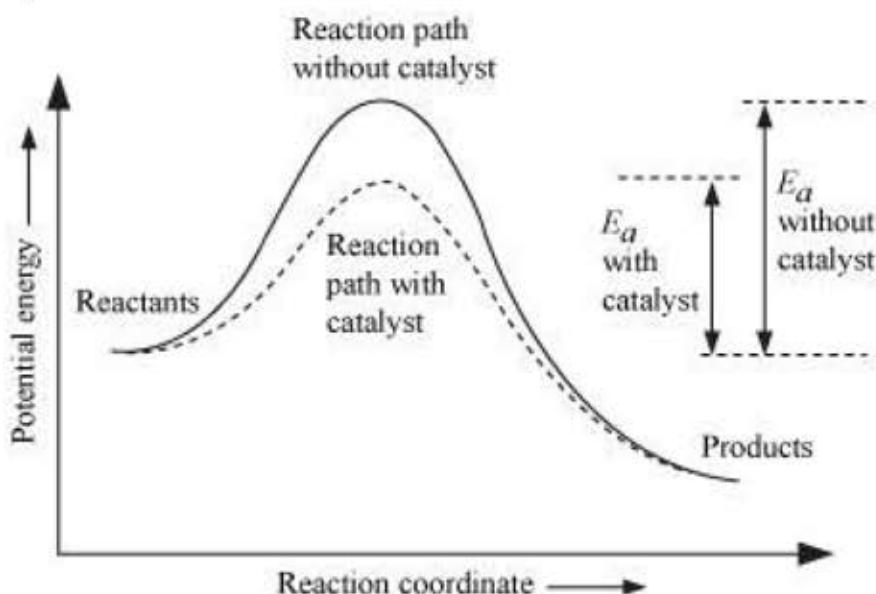
$$\alpha = 0.150 / 0.301$$

$$\alpha = 0.5$$

Hence, the order of reaction *w.r.t.* A is 0.5 and B is 0.

- b. The energy required to form an unstable intermediate (called activated complex) is called activation energy. A positive catalyst reduces the activation energy between the reactants and products and hence, lowers the potential energy barrier (shown in figure). The lower the value of activation energy, the faster will be the rate of reaction.

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24. The activation energy for a reaction cannot be zero. This is because if the activation energy (E_a) = 0, then according to the Arrhenius equation, $K = Ae^{-E_a/RT} = Ae^0 = A$. Thus, the rate constant is equal to the Arrhenius factor, which is directly proportional to the collision frequency. Hence, the rate constant becomes directly proportional to the collision frequency. This means that every collision leads to product formation, which cannot be true. Therefore, $E_a \neq 0$.

25. A reaction is said to be elementary or simple if the order of the reaction is equal to its

$$1 + \frac{1}{2} = \frac{3}{2}$$

molecularity and also, the molecularity is integral. The given reaction has the order 1.5. However, the molecularity of a reaction cannot be fractional. Hence, for the given reaction, the order of the reaction is not equal to its molecularity. Hence, the given reaction is not elementary.

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26.

$$\text{Rate} = \frac{\text{Decrease in concentration of reactant}}{\text{Time taken}}$$

$$= \frac{\text{Increase in concentration of product}}{\text{Time taken}}$$

Thus, rate of the given reaction

$$= \frac{-1}{5} \frac{\Delta [\text{Br}^-]}{\Delta t} = \frac{-\Delta [\text{BrO}_3^-]}{\Delta t} = \frac{-1}{6} \frac{\Delta [\text{H}^+]}{\Delta t} = \frac{1}{3} \frac{\Delta [\text{Br}_2]}{\Delta t} = \frac{1}{3} \frac{\Delta [\text{H}_2\text{O}]}{\Delta t}$$

27. The rate constant (K) of a first order reaction is given by the following equation:

$$K = \frac{2.303}{t} \log \frac{[\text{R}]_0}{[\text{R}]}$$

Where, $[\text{R}]_0$ is the initial concentration of the reactant and $[\text{R}]$ is the concentration of the reactant after time ' t '.

28. a. Rate for the given reaction is $k = 2.5 \times 10^{-4} \text{ M s}^{-1}$

Therefore, for the given reaction, rate is given by:

$$-\frac{1}{2} \frac{d[\text{NH}_3]}{dt} = \frac{d[\text{N}_2]}{dt} = \frac{1}{3} \frac{d[\text{H}_2]}{dt} = k = 2.5 \times 10^{-4} \text{ M s}^{-1}$$
$$\frac{d[\text{N}_2]}{dt}$$

Hence, the rate of production of N_2 is $\frac{dt}{dt} = 2.5 \times 10^{-4} \text{ M s}^{-1}$

$$\frac{d[\text{H}_2]}{dt}$$

And, the rate of production of H_2 is $\frac{dt}{dt} = 3 \times 2.5 \times 10^{-4} \text{ M s}^{-1} = 7.5 \times 10^{-4} \text{ M s}^{-1}$

b. For a zero-order reaction:

Unit for ' k ' = $\text{mol}^{-1} \text{ L s}^{-1}$

For a first-order reaction:

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Unit for ' k ' = s^{-1}

- 29.** The half-life period is independent of the initial concentration; hence, it is a first-order reaction.

$$t_{\frac{1}{2}} = \frac{0.693}{k}$$

For a first-order reaction,

$$k = \frac{0.693}{t_{\frac{1}{2}}} = \frac{0.693}{4.6 \text{ s}}$$

Or, $\frac{1}{2} = 0.1507 \text{ s}^{-1}$

Thus, the rate constant for the given reaction is 0.1507 s^{-1} .

Surface Chemistry

- 30.** The colour of gold sol depends upon the size of the dispersed particles. The finest gold sol is red in colour. As the size of particle increases it appears purple, then blue and finally golden.

- 31.** Lyophilic colloidal sols are more stable than lyophobic colloidal sols because the former are highly solvated in solutions.

32. a. The hydrophilic colloids are more stable than hydrophobic colloids because of the fact that the hydrophilic colloids are highly hydrated in solution. Hence, they do not precipitate easily.

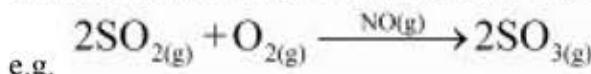
b. Gold sol consists of aggregates of different sizes of gold atoms held together by van der Waals forces. Hence, it is a multimolecular colloid.

c. The critical temperature of SO_2 is greater than H_2 . As a result, the SO_2 gas is easily liquefied and hence more readily adsorbed on a solid.

- 33.** The phenomenon of catalysis can be divided into two groups.

(i) Homogeneous catalysis

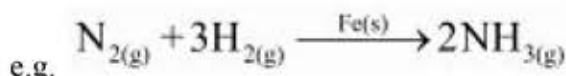
When the reactant and catalyst are in same phase



(ii) Heterogeneous catalysis

When the reactant and catalyst are in different phase

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34. (i) The colloidal particles are charged and carry either a positive or a negative charge. The dispersion medium carries an equal and opposite charge. This makes the entire system neutral. Under the influence of an electric current, the colloidal particles move towards the oppositely charged electrode. When they come in contact with the electrode, they lose their charge and coagulate.

(ii) When a beam of light is passed through a colloidal solution, scattering of light is observed. This is known as Tyndall effect. This scattering of light illuminates the path of the beam in the colloidal solution.

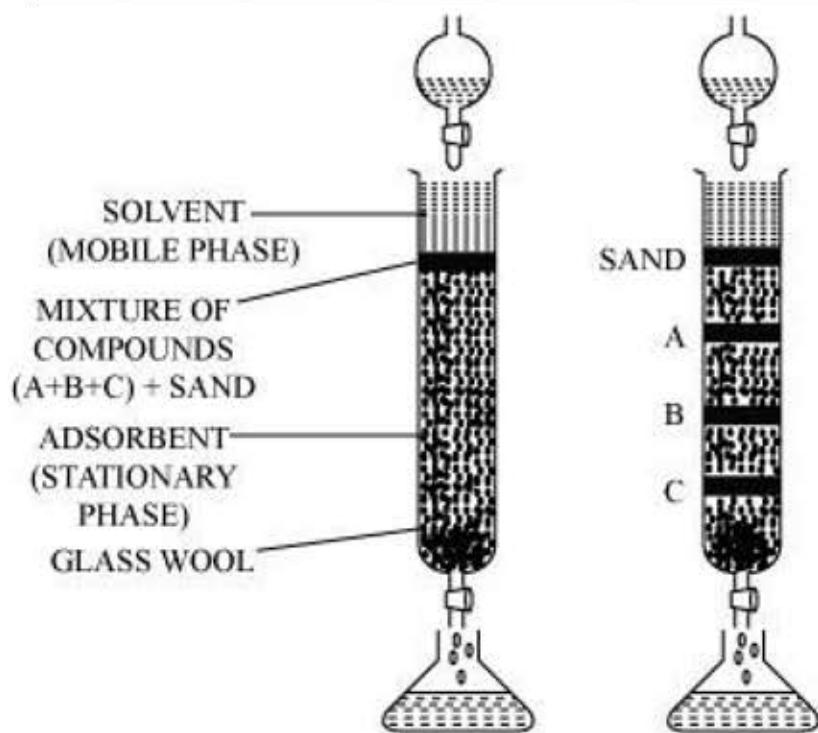
(iii) When NaCl is added to hydrated ferric hydroxide sol, it dissociates to give Na^+ and Cl^- ions. Particles of ferric hydroxide sol are positively charged. This neutralises the colloidal particles which then unite to form bigger particles that are consequently precipitated. Thus, they get coagulated in the presence of negatively charged Cl^- ions.

General Principles and Processes Of Isolation Of Elements

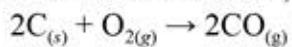
35. a. Separation of components by column chromatography is based on the principle that different components of a mixture are differently adsorbed on an adsorbent.

b.

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36. a. For the reaction,



In the given reaction, ΔS is positive. Now, the relationship between ΔG and ΔS can be expressed as follows:

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

Thus, the value of ΔG decreases and becomes more negative as the temperature increases.

Consequently, ΔG° vs. T plot in the Ellingham diagram slopes downward for $C \rightarrow CO$.

b. The Gibbs free energy of formation ($\Delta_f G$) of Cu_2S is less than that of H_2S and CS_2 . Therefore, H_2 and C cannot reduce Cu_2S to Cu . On the other hand, the Gibbs free energy of formation of

Cu_2O is greater than that of CO . Hence, C can reduce Cu_2O to Cu .



Hence, the extraction of copper from its pyrite ore is difficult than from its oxide ore through reduction.

37. Yes, graphite will reduce ZnO to Zn because, $\Delta G^\circ_{(C, CO)}$ is lower than $\Delta G^\circ_{(Zn, ZnO)}$.

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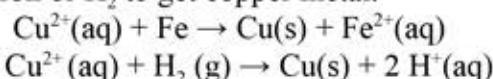
38. (i) The given carbonate ore can be converted into its oxide by the process of calcination. In this process, the ore is heated in the absence of air.



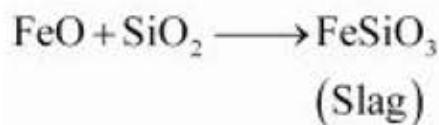
(ii) The process of roasting is used for the conversion of the given sulphide ore into its oxide. In this process, the ore is heated in the presence of air.



39. Copper can be obtained from low-grade ore through the process of leaching using acid or bacteria (leaching is a process in which ore is treated with suitable reagent that dissolves ore but not the impurities). The solution containing copper can be reduced with the help of reducing agents such as scrap iron or H₂ to get copper metal.



40. The sulphide ore of copper containing iron should be mixed with silica before heating. Iron oxide will form slag (iron silicate) and copper will be produced in the form of copper matte.



The p-Block Elements

41. The oxidation states displayed by the group-15 elements are -3, +3 and +5.

The stability of the -3 oxidation state decreases on moving down the group. This is because metallic character increases down the group.

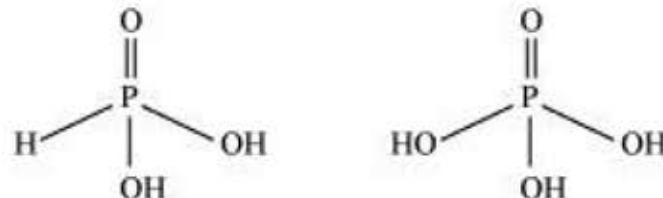
On moving down the group, the stability of the +3 oxidation state increases while that of the +5 oxidation state decreases. This is because of the inert pair effect.

42. The size of bromine is more than fluorine. As a result, the van der Waals forces of attraction are more in bromine. Hence, it exists as liquid at room temperature.

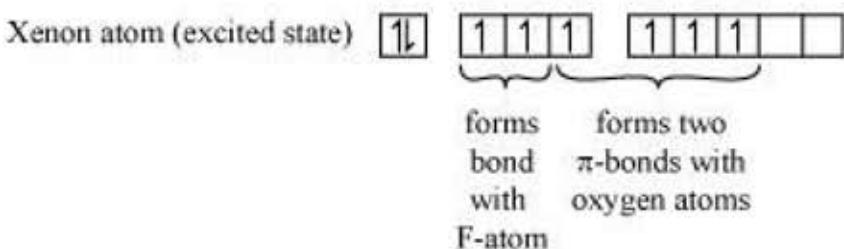
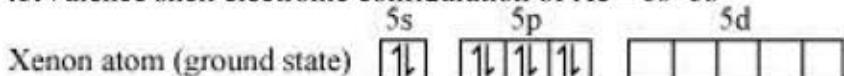
43. PCl₅ is ionic in the solid state because it exists as $[\text{PCl}_4]^+ [\text{PCl}_6]^-$ in which the cation is tetrahedral and the anion is octahedral.

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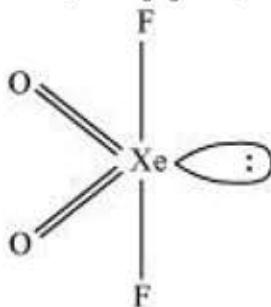
44. Three $-\text{OH}$ groups are present in orthophosphoric acid (H_3PO_4). Hence, it is tri-basic in nature and forms salts NaH_2PO_4 , Na_2HPO_4 and Na_3PO_4 . On the other hand, orthophosphorus acid (H_3PO_3) has two $-\text{OH}$ groups. Hence, it is dibasic and forms two salts NaH_2PO_3 and Na_2PO_3 .



45. Valence shell electronic configuration of Xe = $5s^2 5p^6$



Thus, XeO_2F_2 adopts trigonal bipyramidal geometry.



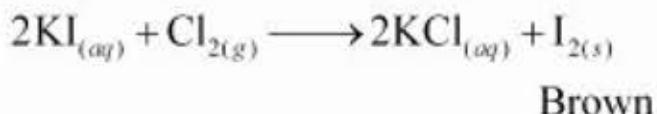
Thus, the hybridisation is sp^3d and the shape is see-saw.

46. Iodine is oxidised to iodic acid when it reacts with conc. HNO_3 .

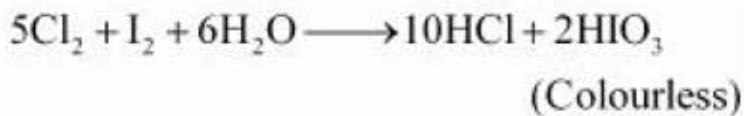
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47. a. Cl_2 is a stronger oxidising agent than I_2 . Hence, it first oxidises KI to give I_2 , which imparts brown colour to the solution.



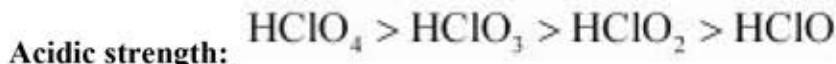
If Cl_2 is passed in excess, then the I_2 thus formed gets further oxidized to iodic acid (KIO_3), which is colourless.



b. Cl has vacant d -orbitals. Hence, it can show an oxidation state of +3. On other hand, F has no d -orbitals. Also, owing to bigger size, Cl can accommodate three small F atoms around it. F being smaller in size cannot accommodate three large-sized Cl atoms around it. Hence, ClF_3 exists but FCl_3 does not.

48. Cl_2O has a higher bond angle than OF_2 because on moving down the group the size of the elements increases. In this case, chlorine has a greater size than fluorine. Consequently, chlorine atoms suffer greater repulsion. Therefore, the bond angle increases owing to the steric crowding by the two bulky chlorine atoms.

49. The acidic strength the oxoacids of chlorine increases with increase in the oxidation number of the halogen.

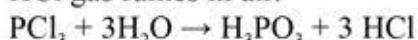


This can be explained on the basis of the stabilities of the oxoanions.



As the stability of oxoanion increases, its tendency to decompose and give O_2 decreases. Hence, the oxidising power of oxoanion decreases.

50. PCl_3 undergoes hydrolysis in the presence of moisture (present in air) forming HCl gas. This HCl gas fumes in air.



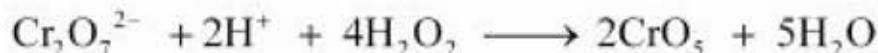
**Meritnation Top 100 Questions
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51. Phosphorus has an empty d -orbital; hence, it can form $p\pi-d\pi$ bonding resulting in the formation of $(\text{CH}_3)_3\text{P}=\text{O}$. On the other hand, owing to the absence of d -orbital in nitrogen atom, it cannot form $p\pi-d\pi$ bonding. Hence, $(\text{CH}_3)_3\text{N}=\text{O}$ does not exist.

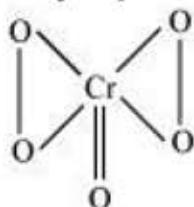
52. Neon is generally used in warning signals as neon lights are visible from long distances even in mist and fog.

The d-Block And f-Block Elements

53. CrO_5 is formed when H_2O_2 is added to acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution. The reaction takes place as:



CrO_5 adopts the following structure:



54. a. The electronic configuration of Zn^{2+} is $[\text{Ar}] 3d^{10}$. This shows that all d -electrons are paired.

1L	1L	1L	1L	1L
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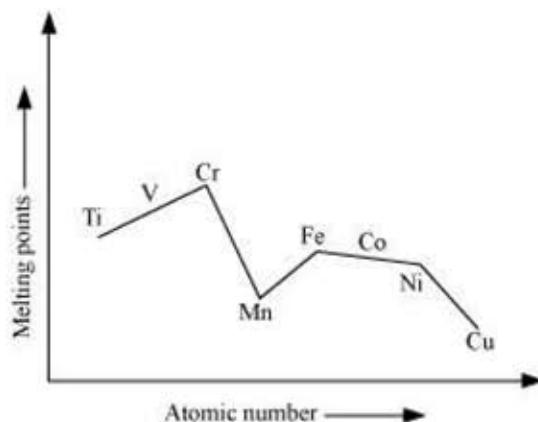
Owing to the pairing of electrons, there are increased electron-electron repulsions. These repulsions are greater than the attractive forces because of the increased nuclear charge. Hence, the atomic size of Zn^{2+} is large. On the other hand, in case of Co^{2+} , the electronic configuration is $3d^7$.

1L	1L	1	1	1
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Hence, in Co^{2+} lesser number of d -orbitals are paired. As a result, it is smaller in size than Zn^{2+} .

**Meritnation Top 100 Questions
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- b.** The melting points of first transition series elements first increase till Cr. After that, a dip is observed at Mn. Then, the melting point rises till Fe. Again it decreases and a final dip is observed at Cu.



55. Due to lanthanide contraction, the change in the atomic or ionic radii of transition elements is very small. Thus, their chemical properties are similar. This makes their separation difficult.

56. The d^1 configuration is unstable in ions as it has a greater tendency to acquire more stable d^0 configuration by losing one d -electron.

57. V_2O_5 reacts with alkalis as well as acids to give VO_4^{3-} and VO_4^+ respectively.

58. a. The atomic size decreases in the beginning i.e., from Sc to Cr due to an increase in the nuclear charge. However, the increased nuclear charge is counter balanced by the screening effect and the atomic radii become almost constant (in Mn and Fe). The atomic radii increase towards the end due to the electron-electron repulsion, arising because of the pairing of electrons.

b. Transition elements have very strong interatomic bonds due to their small size and also due to the presence of large number of unpaired electrons in their atoms. As a result, they have high enthalpies of atomization.

c. The outer shell electronic configuration of Zn^{2+} is $3d^{10}$. In this shell, all the d -electrons are paired. Hence, it is diamagnetic.

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In the case of Mn^{2+} , the outer shell electronic configuration is $3d^5$. The electrons are unpaired. Hence, it is paramagnetic.

In the case of Cr^{2+} , the outer shell electronic configuration is $3d^4$. Hence, it is paramagnetic due to the presence of unpaired electrons.

59. (a)

(i)

	Gaseous ions	Number of unpaired electrons
(i)	Ti^{4+} , [Ar] $3d^0$	0
(ii)	V^{2+} , [Ar] $3d^3$	3
(iii)	Mn^{3+} , [Ar] $3d^4$	4
(vi)	Cr^{3+} , [Ar] $3d^3$	3

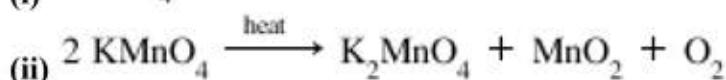
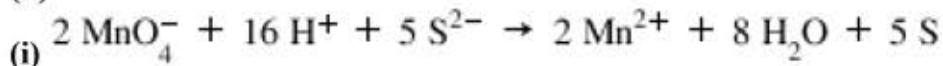
V^{2+} and Cr^{3+} are the most stable ions in aqueous solutions owing to a t_{2g}^3 configuration.

(ii) An examination of the E° values for the redox couple M^{3+}/M^{2+} (from electrode potential table) shows that Mn^{3+} ion are the strongest oxidising agents in aqueous solutions.

(iii) Only the ions that have electrons in d-orbital and in which d-d transition is possible will be coloured. The ions in which d-orbitals are empty or completely filled will be colourless as no d-d transition is possible in those configurations.

From the given transition metal ions, it can be easily observed that only Ti^{4+} has an empty d-orbital, so, it is colourless ion.

(b)



**Meritnation Top 100 Questions
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60. a. Following is the increasing order of reducing power of the given ions.

$$\text{Co}^{2+} < \text{Fe}^{2+} < \text{Cr}^{2+}$$

This is because of the fact that, lower the value of reduction potential, more easily the ion can be oxidised and therefore, it has more reducing power.

$$E^\circ_{\text{Cr}^{3+}/\text{Cr}^{2+}} = -0.41\text{V}$$

Among the given reduction potentials, $E^\circ_{\text{Cr}^{3+}/\text{Cr}^{2+}}$ is the lowest.

Therefore Cr^{2+} is a stronger reducing agent than Fe^{2+} which, in turn, is stronger than Co^{2+} .

b. The transition metal acts as a catalyst because of the presence of unpaired electrons in their incomplete d -subshells.

61. Nickel is in +2 oxidation state in the complex $[\text{Ni}(\text{CN})_4]^{2-}$.

Ni atom ($Z = 28$) in ground state

3d	4s	4p
1↓ 1↓ 1↓ 1 1	1↓	

Ni^{2+} ion

1↓ 1↓ 1↓ 1 1		
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Since CN^- is a strong field ligand

$[\text{Ni}(\text{CN})_4]^{2-}$

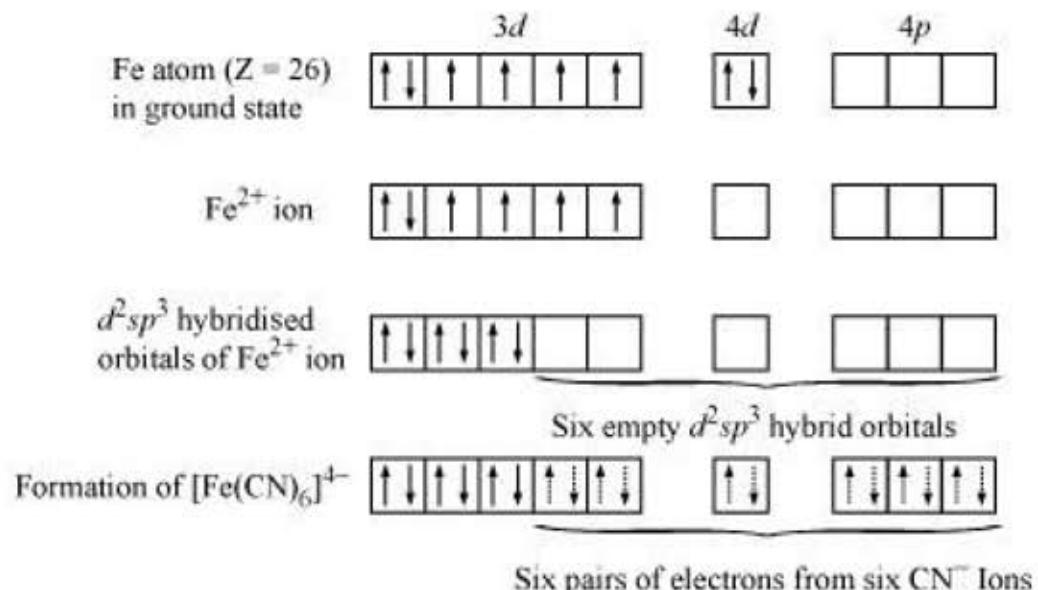
1↓ 1↓ 1↓ 1 1		1↑	1↑	
--------------	--	----	----	--

Hence, the complex $[\text{Ni}(\text{CN})_4]^{2-}$ will be diamagnetic as there are no unpaired electrons.

Coordination Compounds

62. In $[\text{Fe}(\text{CN})_6]^{4-}$, Fe is in the +2 oxidation state. The electronic configuration of Fe is [Ar] $3d^6$ $4s^2$.

**Meritnation Top 100 Questions
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The hybridisation involved in this complex is d^2sp^3 , and does not contain any unpaired electron. Therefore, it is an octahedral complex and diamagnetic in nature.

Since the inner d -orbital [$(n-1)d$ -orbital] is used in hybridisation, it is an inner orbital complex.

63. Let the oxidation number of Co in the complex $[\text{Co}(\text{NH}_3)_3\text{Cl}] \text{Cl}_2$ be x .

$$\text{Thus, } x + 3 \times 0 + 3(-1) = 0$$

$$x - 3 = 0$$

$$x = +3$$

Hence, in the given complex the oxidation number of Co is +3.

64. Since, the compound gives white precipitate with BaCl_2 solution; hence, SO_4^{2-} must be present outside the coordination sphere.

Therefore, the structural formula of the compound is $[\text{Co}(\text{NH}_3)_5\text{Br}] \text{SO}_4$.

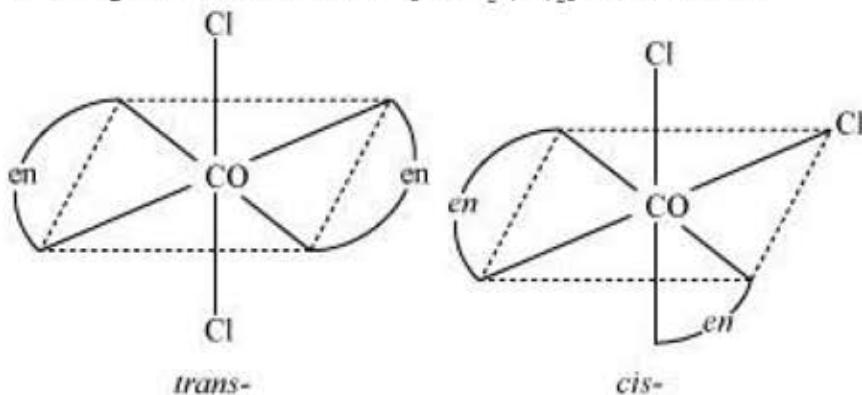
Its IUPAC name is pentamminebromidocobalt (III) sulphate.

65. The coordination number of Fe in $[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$ is 6 because it is bonded to the donor atoms by 6 sigma bonds (as oxalate is a bidentate ligand).

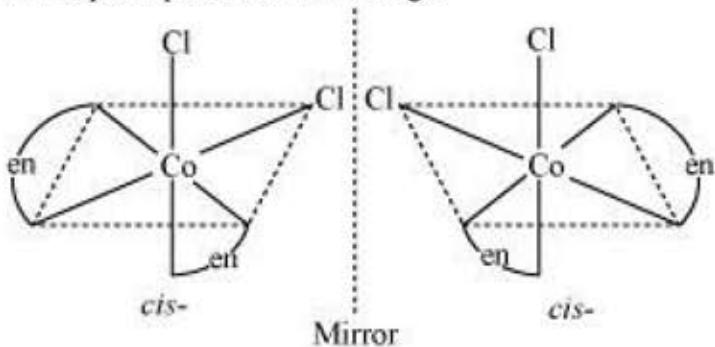
The coordination number of Fe in $[\text{Fe}(\text{CN})_6]^{4-}$ is 6 because it is bonded to the donor atoms by 6 sigma bonds (as cyanide is a monodentate ligand).

**Meritnation Top 100 Questions
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66. The geometrical isomers of $[\text{CoCl}_2(\text{en})_2]^+$ are shown as:



Of the geometrical isomers, only the *cis* isomer will be optically active as it forms non-superimposable mirror image.



67. Following is the arrangement in decreasing order of the wavelengths of the light absorbed by the given complexes:



The above order is observed because the field strength of the ligands is in the order:



As field strength of the ligands is directly proportional to the excitation energies, the wavelengths

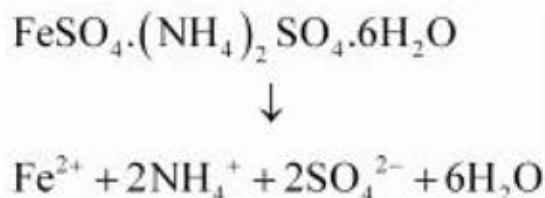
$$\left(E = \frac{hc}{\lambda} \right)$$

will be in the reverse order of the excitation energies i.e.,

68. a. Both double salts and complexes are formed by the combination of two or more stable compounds in stoichiometric ratio.

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They differ in the fact that double salts such as Mohr's salt, $\text{FeSO}_4 \cdot (\text{NH}_4)_2 \cdot \text{SO}_4 \cdot 6\text{H}_2\text{O}$ dissociate into simpler substances or ions completely when dissolved in water as:



On the other hand, in complexes, the ions do not dissociate. For example, $K_4[Fe(CN)_6]$ does not dissociate into Fe^{2+} and CN^- .

b. For a d^6 ion, if $\Delta_g < P$, then the first three electrons enter the t_{2g} orbital. The fourth and fifth

electrons enter the e_g orbital and the sixth enters the t_{2g} orbital, giving configuration $t_{2g}^4 e_g^2$. On the other hand, if $A_g < P$, then all the six electrons enter the t_{2g} orbital, giving configuration

$$t_{\nu}^{-6} e_g^0$$

c. Limitation of the crystal field theory:

i. The crystal field theory assumes the ligands as point charges. It follows that anionic ligands should exert the greatest splitting effect. But, these were found at the low end of the spectrochemical series.

69. The given ligands can be classified as follows:

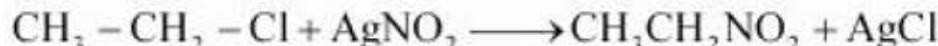
Unidentate ligands: H_2O , NH_3

Bidentate ligands: H₂O, NH₃

Hexadentate ligands: EDTA⁴⁻

Haloalkanes and Haloarenes

70. Ethyl chloride reacts with silver nitrite to form nitro ethane, while it reacts with potassium nitrite to form ethyl nitrite.



Ethyl chloride

Nitroethane



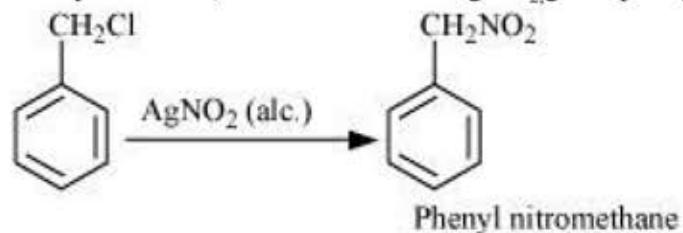
Ethyl chloride

Ethylnitrite

**Meritnation Top 100 Questions
(Solutions)
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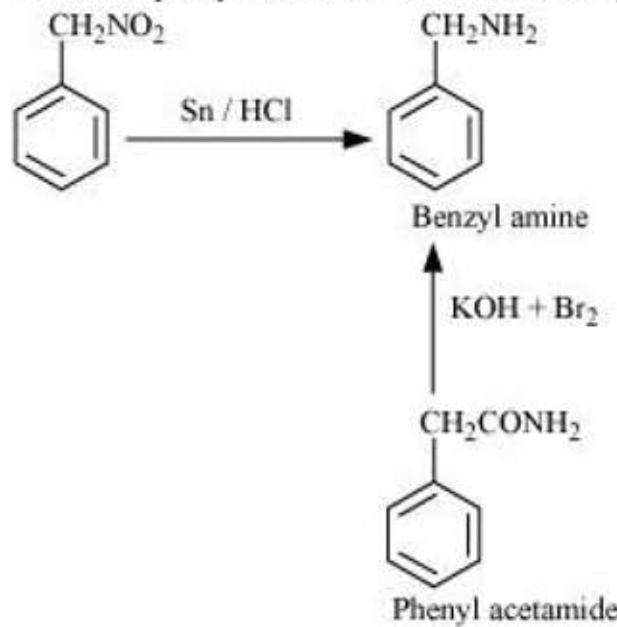
Nitrite ion ($-O - N = O$) is an ambident nucleophile with two attacking sites O and N. KNO_2 is predominantly ionic and the nucleophilic attack on ethyl chloride takes place through negatively charged oxygen atom forming ethyl nitrite. On the other hand, silver nitrite is a covalent compound and nitrogen is free to donate lone pair of electron forming nitroethane.

- 71.** The compound having molecular formula C_7H_7Cl is benzyl chloride. Benzyl chloride, on reaction with $AgNO_2$ gives phenyl nitromethane.



Hence, compound 'A' is phenyl nitromethane.

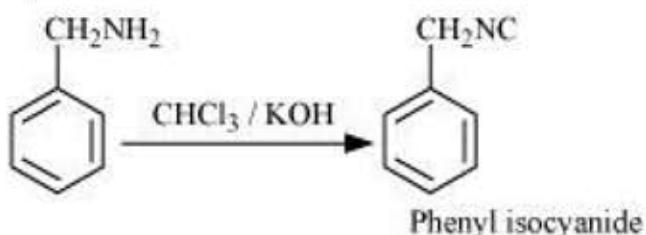
Phenyl nitro methane, on reduction with Sn/HCl, forms benzyl amine that is obtained by the reaction of phenyl acetamide with KOH and Br_2 .



Hence, compound 'B' is benzyl amine.

Benzylamine, on reaction with $CHCl_3$ and KOH, forms phenyl isocyanide that has an unpleasant odour.

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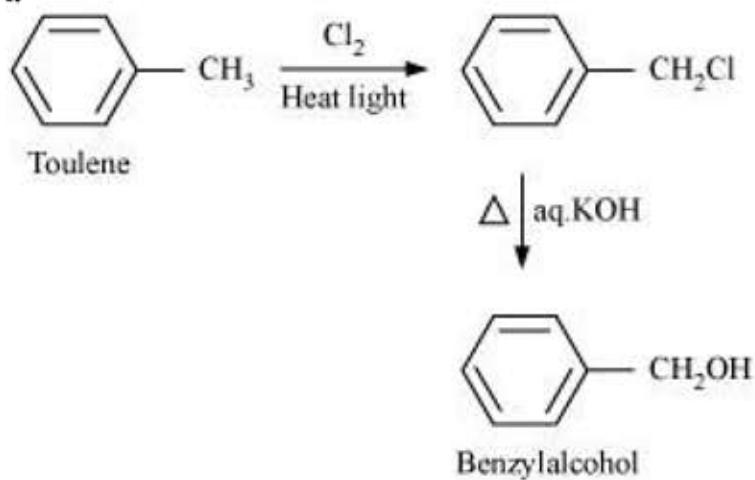


This reaction is known as Carbylamine reaction.

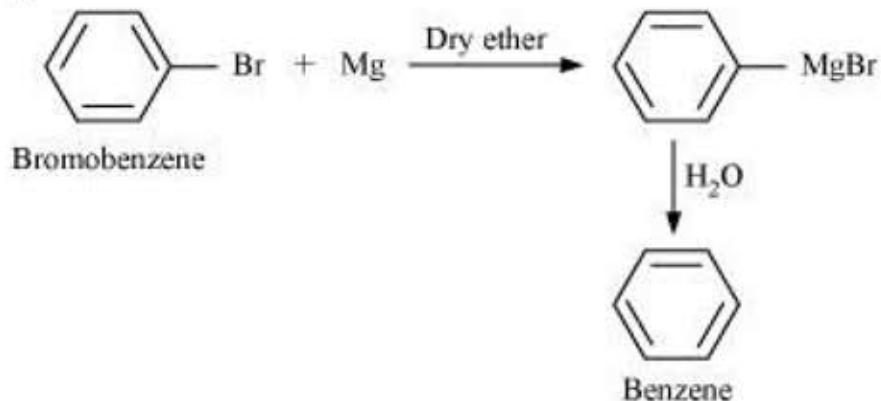
Hence, compound 'C' is phenyl isocyanide.

72. a.

i.

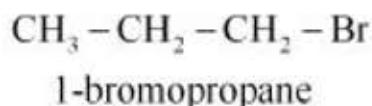
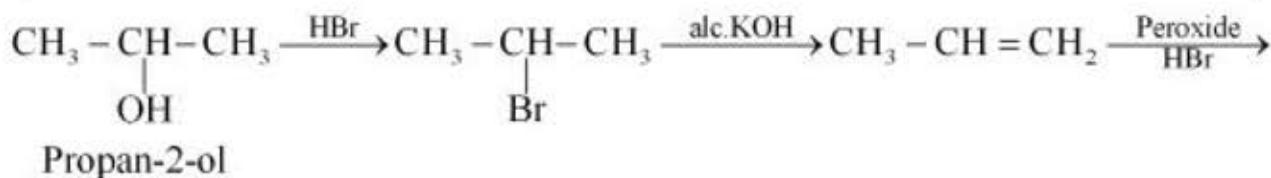


ii.

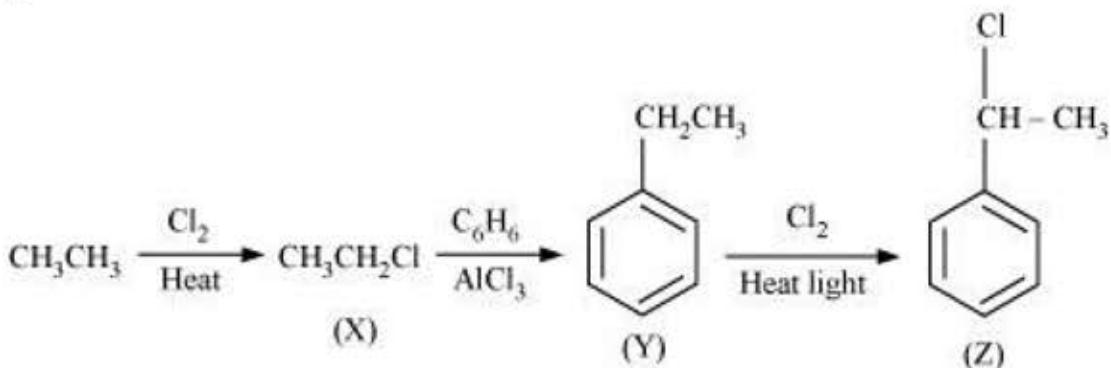


iii.

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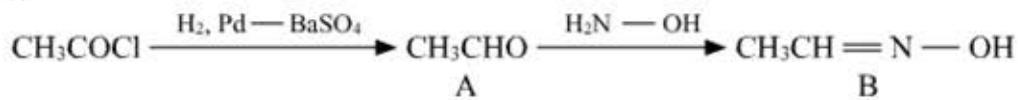
b.



73.

(a)

(i)

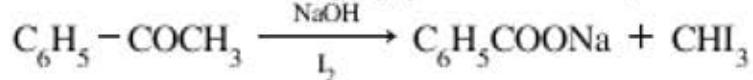


(ii)



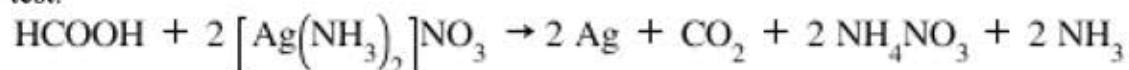
(b)

(i) $C_6H_5-COCH_3$ is a methyl ketone and therefore, gives a yellow precipitate of iodoform when reacted with NaOH and I_2 . C_6H_5-CHO does not give this reaction.



**Meritnation Top 100 Questions
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(ii) As shown below, methanoic acid gives silver mirror test, while ethanoic acid will not give this test.

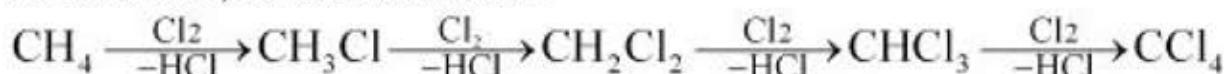


(c) The boiling point of the given compounds can be compared on the basis of the extent of intermolecular hydrogen bond formation. Hydrogen bonding is the most extensive in acetic acid, followed by ethanol. It is the least in acetaldehyde.

Hence, the increasing order of boiling points of the given compounds is as follows:



74. a. The products obtained on chlorination of methane are methyl chloride, dichloromethane, trichloromethane, and tetrachloromethane.

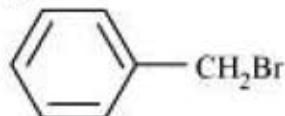


b. The method is not of much practical use because the mixture of products obtained is difficult to separate.

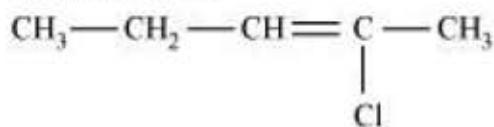


Allylic halide

75.



Benzyllic halide

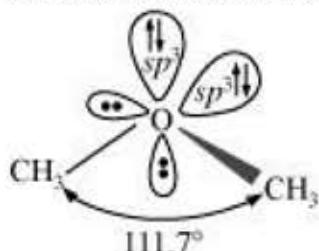


Vinylic halide

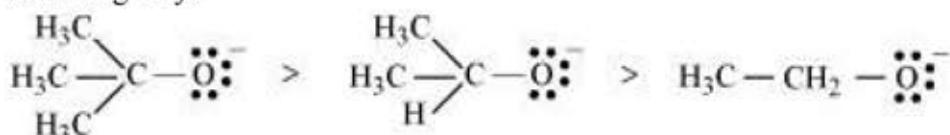
Alcohols, Phenols and Ethers

**Meritnation Top 100 Questions
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76. The C–O–C bond angle in ethers is greater than the tetrahedral angle because of the repulsive interactions between the two bulky methyl groups.

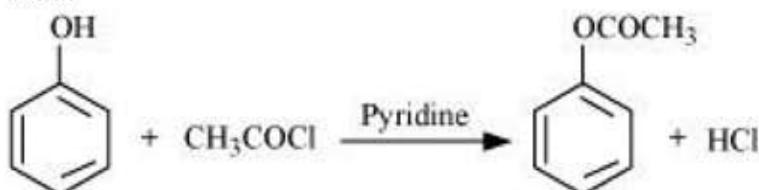


77. The given alkoxides can be arranged in order of their decreasing basic strengths in the following way:



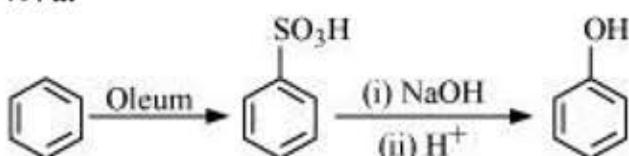
The decrease in +I (inductive) effect with decrease in alkyl group results in decrease in basicity of the alkoxides.

78. a.



b. This reaction is carried out in the presence of pyridine (base) so as to neutralise HCl that has been formed during the reaction. This shifts the equilibrium in the forward direction.

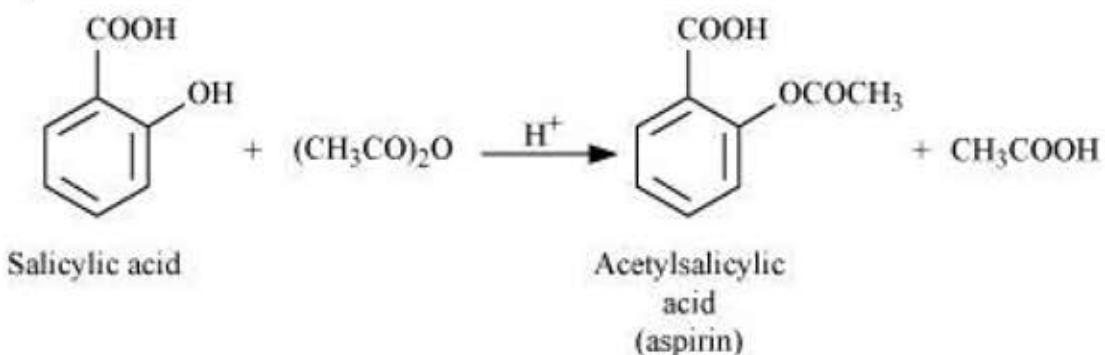
79. a.



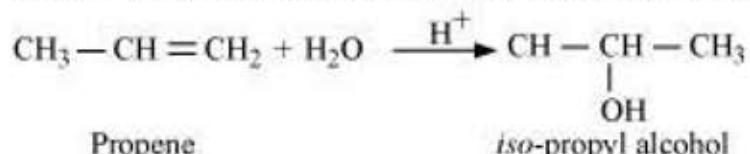
In the above reaction, A is **benzene sulphonic acid** and B is **phenol**.

b. The following reaction is involved in the acetylation of salicylic acid..

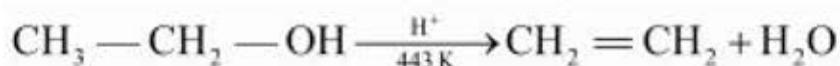
Meritnation Top 100 Questions (Solutions) Grade - 12 (Chemistry)



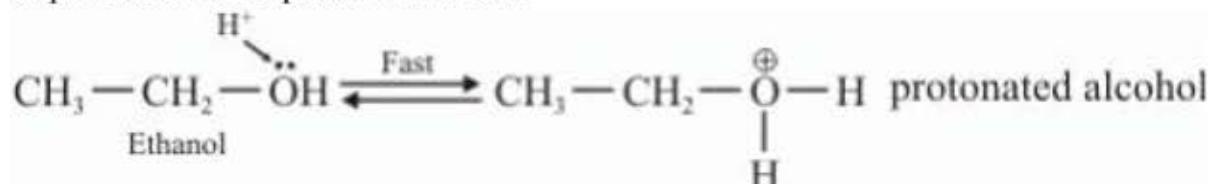
80. Propene can be converted into *iso*-propyl alcohol by the following chemical reaction.



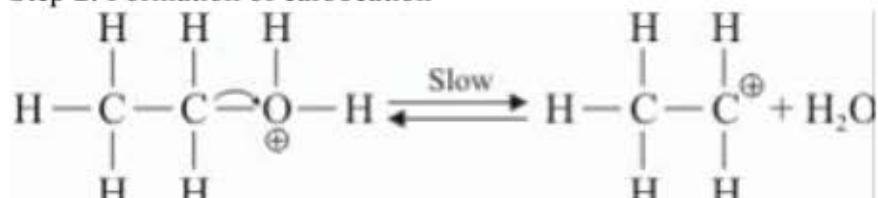
81. Mechanism of the following reaction is given below:



Step 1: Formation of protonated alcohol

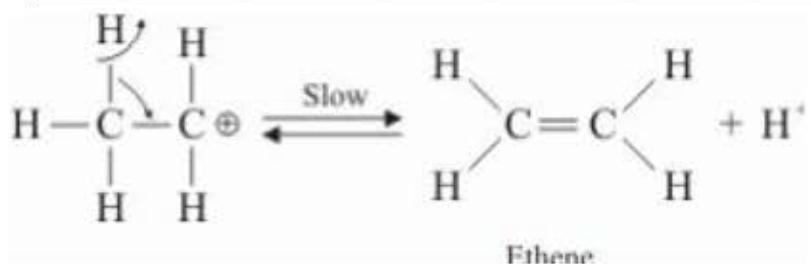


Step 2: Formation of carbocation



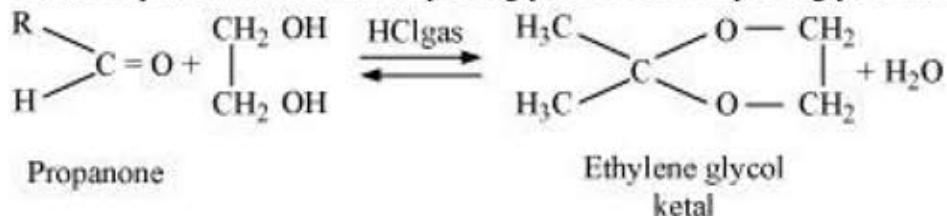
Step 3: Formation of ethene by removal of proton

**Meritnation Top 100 Questions
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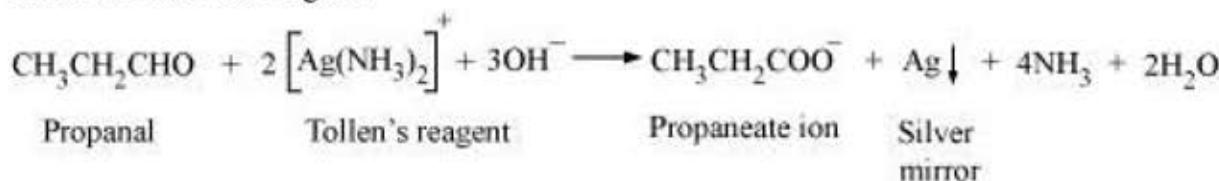
Aldehydes, Ketones and Carboxylic Acids

82. a. Propanone reacts with ethylene glycol to form ethylene glycol ketal.



b. Dry HCl gas increases the electrophilicity of the carbonyl group by protonation of the oxygen atom, thus facilitating the attack of ethylene glycol.

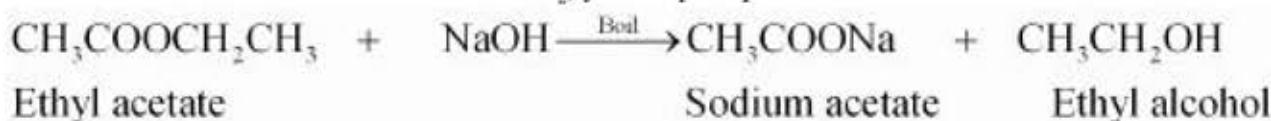
83. (i) Propanal is an aldehyde. Thus, it reduces Tollen's reagent. Being a ketone, propanone does not reduce Tollen's reagent.



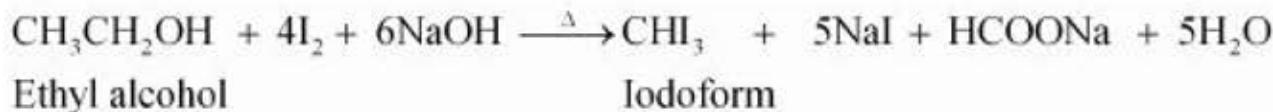
(ii) Methyl acetate and ethyl acetate can be distinguished by the iodoform test of their hydrolysis products.

When ethyl acetate is boiled with excess of NaOH, ethyl alcohol and sodium acetate is formed.

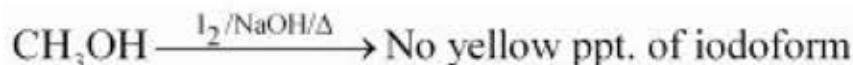
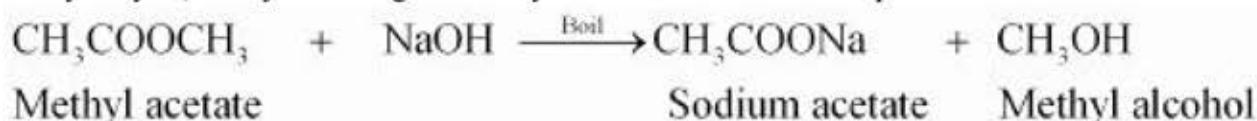
When this alkaline solution is heated with I₂, yellow precipitate of iodoform is formed.



**Meritnation Top 100 Questions
(Solutions)
Grade - 12 (Chemistry)**



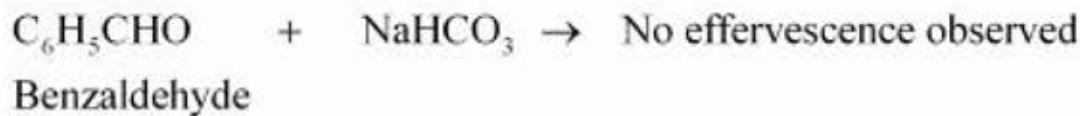
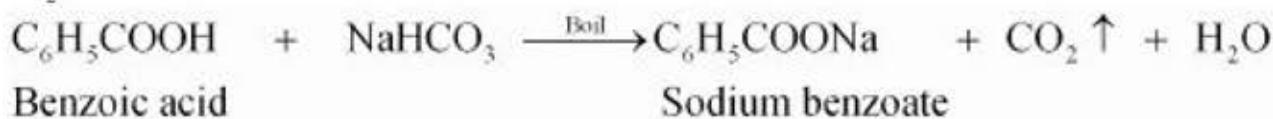
On hydrolysis, methyl acetate gives methyl alcohol that does not respond to the iodoform test.



Methanol

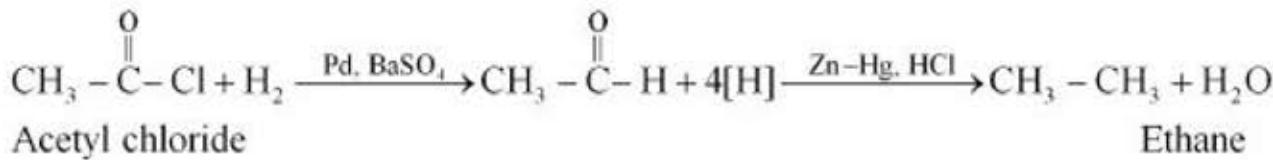
(iii) Benzaldehyde and benzoic acid can be distinguished by the NaHCO_3 test. Being an acid, benzoic acid responds to this test, but benzaldehyde does not.

Benzoic acid reacts with NaHCO_3 solution to produce a brisk effervescence with the evolution of CO_2 .

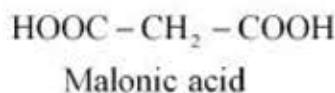


84.a.

i.

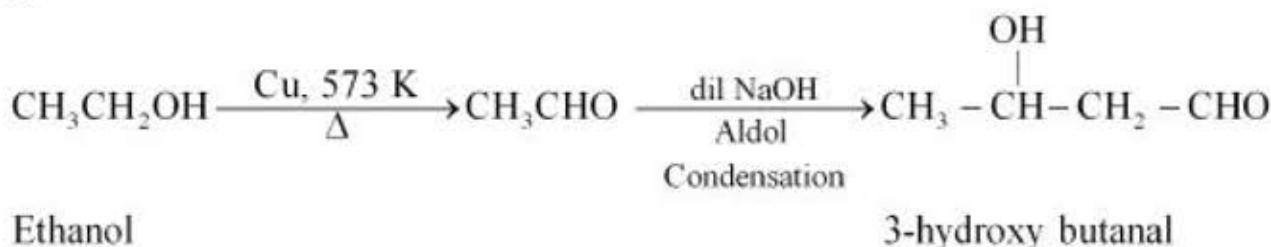


ii.



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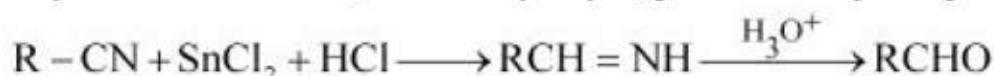
iii.



b.

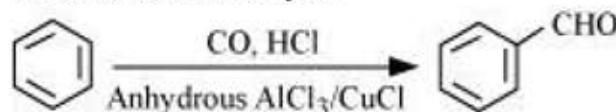
i. Stephen reaction:

In this reaction, nitriles are reduced to corresponding imines with stannous chloride in the presence of hydrochloric acid. Imine, on further hydrolysis, gives the corresponding aldehydes.



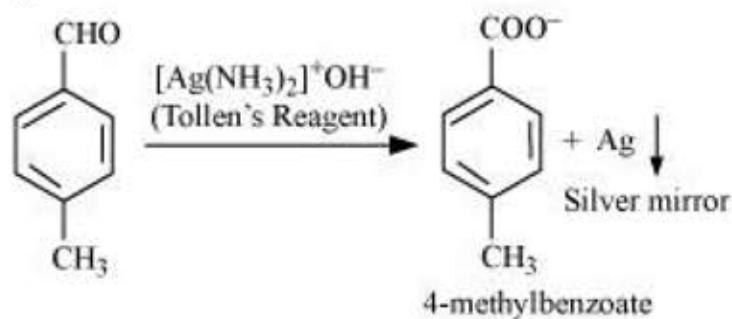
ii. Gatterman-Koch reaction:

In this reaction, benzene or its derivative is treated with carbon monoxide and hydrogen chloride in the presence of anhydrous aluminium chloride or cuprous chloride forming benzaldehyde or substituted benzaldehyde.



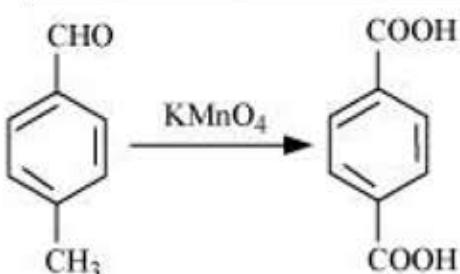
85. a.

(i)



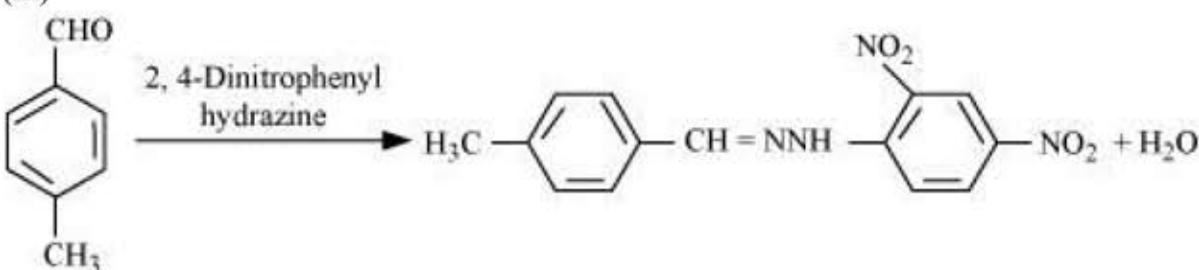
(ii)

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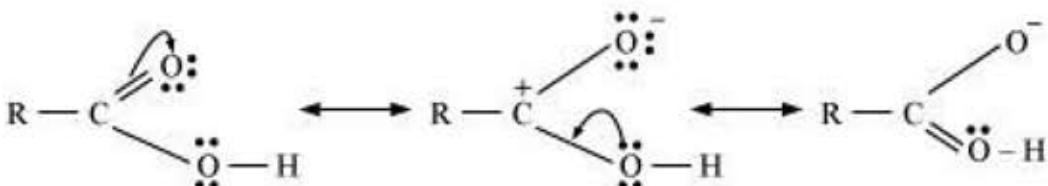


1, 4-benzenedicarboxylic acid

(iii)



b. The carboxylic acid is considered to be the resonance hybrid of the following structures:



As a result of resonance, the carboxyl carbon is less positive and hence less electrophilic towards the attack of nucleophile.

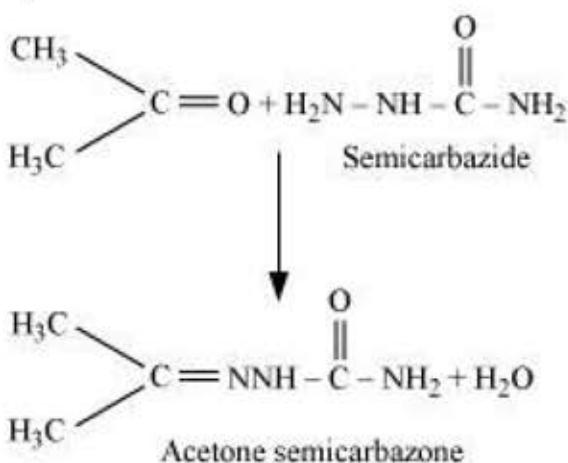
86. a. In the given compounds, the inductive effect of alkyl group increases in the following order:
Methanal < Propanal < Butanone < Pentan - 3 - one

With increase in $+I$ effect, the electron density on the carbon atom of the carbonyl group increases. As a result, the attack by nucleophile is not easily possible. Hence, the reactivity of the given compounds towards alcohols increases in the following order

Pantan - 3 - one < Butanone < Propanal < Methanal

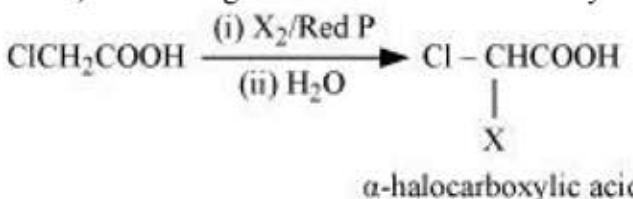
b. Acetone reacts with semicarbazide to form acetone semicarbazone.

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c. Carboxylic acids having α - hydrogen are halogenated at α - position on reaction with chlorine in the presence of red phosphorus to yield α - halo carboxylic acids. This reaction is termed as Hell – Volhard – Zelinsky reaction.

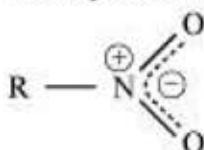
Among the given compounds, compound (ii) i.e., $\text{CH}_2\text{Cl COOH}$ has an α - hydrogen atom and hence, will undergo Hell – Volhard – Zelinsky reaction. The following reaction takes place as:



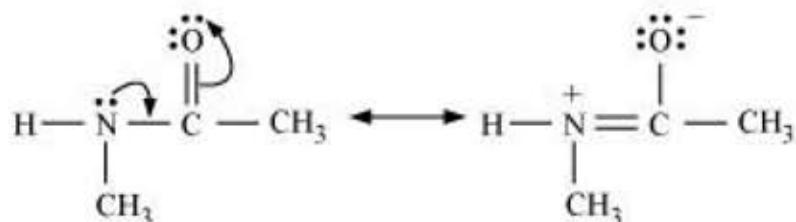
The compound (i) i.e., CF_3COOH does not have any α - hydrogen atom. Therefore, it does not undergo Hell – Volhard – Zelinsky reaction.

Amines

87. Nitro compounds are highly polar in nature; therefore, there is strong electrostatic attraction between the nitrogen and oxygen atoms of a nitro group. As a result, a large amount of energy is required to break the nitrogen and oxygen bonds. Hence, nitro compounds have high boiling points in comparison with other compounds of same molecular mass.

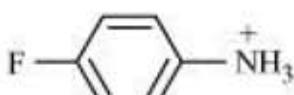


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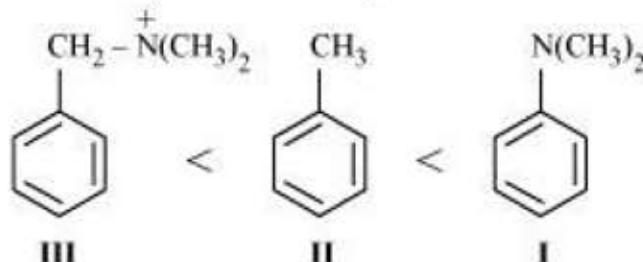


88. Purine bases: Adenine and guanine

Pyrimidine bases: Cytosine and uracil

89. a.  is more acidic than  because fluorine is more electronegative than chlorine atom, thus facilitating the release of proton and increasing the acidity.

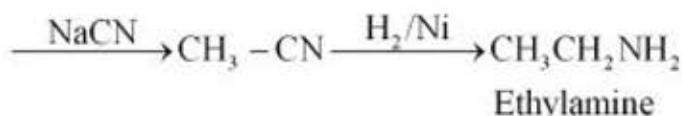
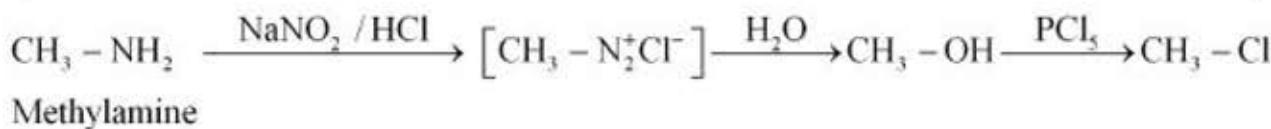
b. Following is the increasing order of the reactivities of given compounds:



Higher the electron-density on the benzene ring, higher would be its reactivity towards electrophilic substitution reaction. The structure I contains two electron releasing methyl groups, that increase the electron density on benzene ring and facilitate the electrophilic substitution; while in structure III, nitrogen atom contains the positive charge. Hence, it withdraws electrons and decreases the reactivity towards electrophilic substitution reaction.

90. a.

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b.

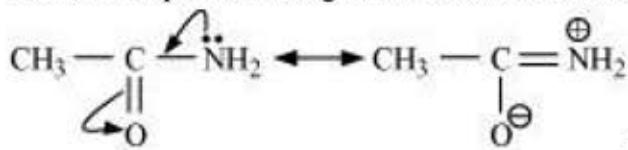


$$k = \frac{[\text{CH}_3\text{CH}_2\overset{+}{\text{NH}_3}] [\text{OH}^-]}{[\text{CH}_3\text{CH}_2\text{NH}_2] [\text{H}_2\text{O}]}$$

$$\text{or, } k [\text{H}_2\text{O}] = \frac{[\text{CH}_3\text{CH}_2\overset{+}{\text{NH}_3}] [\bar{\text{O}}\text{H}]}{[\text{CH}_3\text{CH}_2\text{NH}_2]}$$

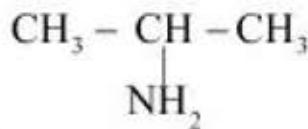
$$\text{or, } k_b = \frac{[\text{CH}_3\text{CH}_2\overset{+}{\text{NH}_3}] [\text{OH}^-]}{[\text{CH}_3\text{CH}_2\text{NH}_2]}$$

c. Ethanamine is a stronger base than ethanamide because of the +I effect of C_2H_5 groups. The lone pair of electrons can be easily donated in $\text{CH}_3\text{CH}_2\text{NH}_2$, while in case of ethanamide (CH_3CONH_2), the electron pair on nitrogen is withdrawn towards carboxyl group due to resonance.



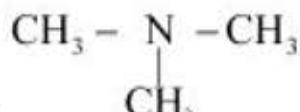
Hence, the lone pair of electrons is not available

for donation.



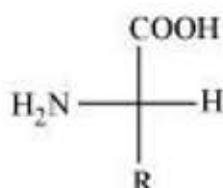
91. Position isomer:

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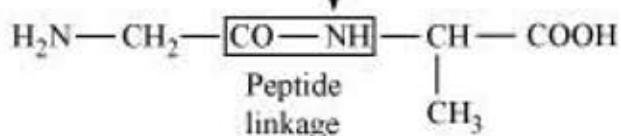
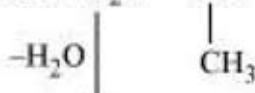
Functional isomer: $\text{CH}_3\text{CH}_2\text{NHCH}_3$ and

Biomolecules



92. The general formula of amino acids is

A peptide bond or linkage is formed when two amino acids combine. Amino acids combine using their carboxyl and amino groups. A water molecule is lost in the process. Hence, the formation of a peptide bond is a condensation reaction.

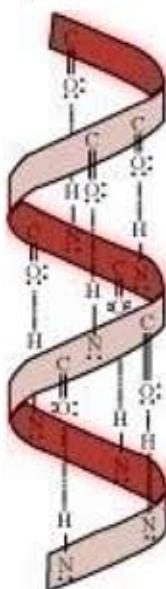


Glycylalanine (Gly – Ala)

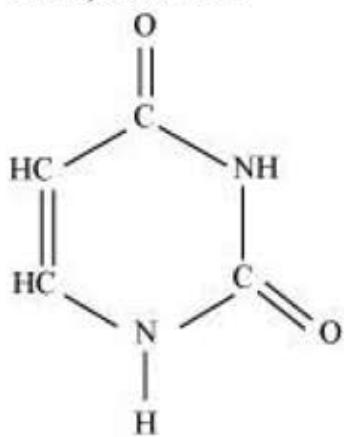
93. a. As the pH value of a protein is increased from its normal value, it will get denatured and the globules will unfold and the helix will get uncoiled. This will result in the loss of biological activity of the protein.

b. The peptide linkages in α -helical structure of proteins can be shown as follows:

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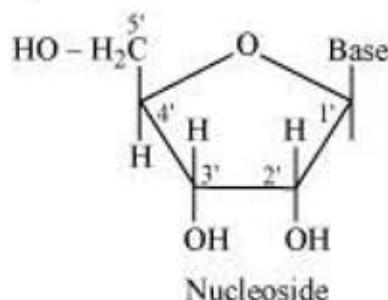
94. a. The base uracil is only found in RNA.
Hence, **B** is **uracil**.



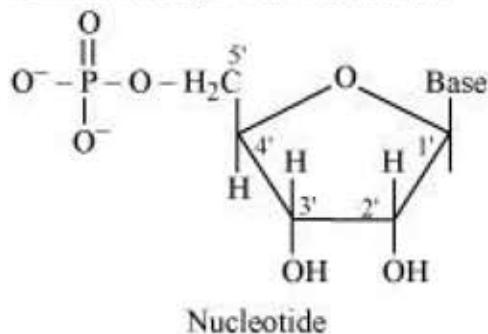
Uracil

The sugar moiety present in RNA is β -D-2-deoxy ribose. When the base uracil is attached to 1' position of the sugar moiety, it forms a nucleoside. Hence, **C** is a **nucleoside**.

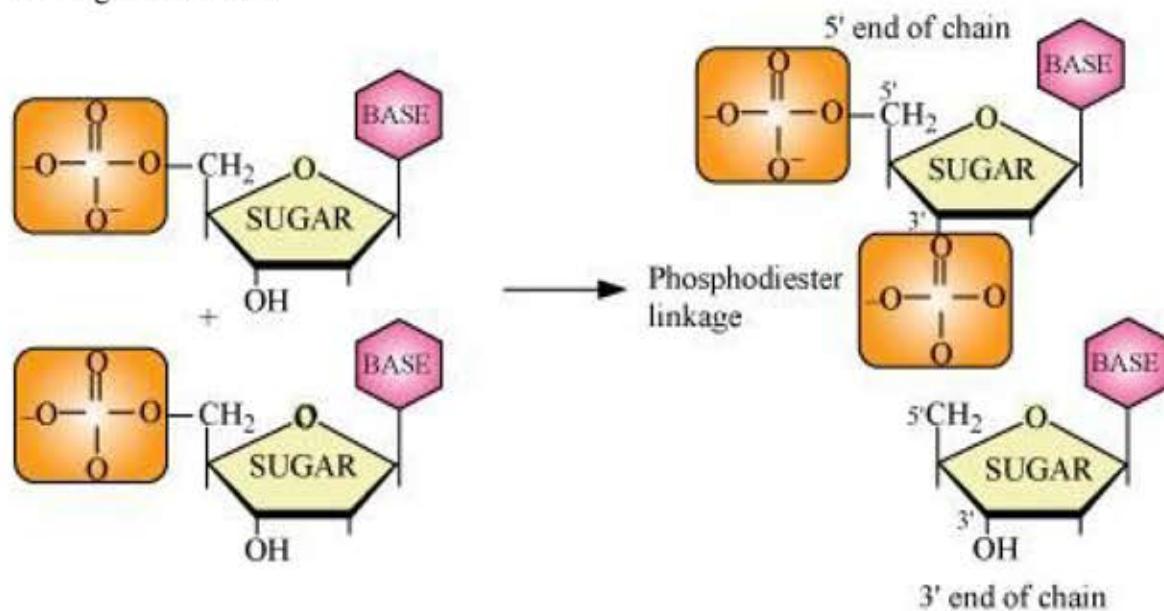
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When nucleoside is linked to phosphoric acid at 5' position of the sugar moiety, a nucleotide is formed. Hence, **D** is a **nucleotide**.



- b.** Nucleotides are joined together by phosphodiester linkage between 5' and 3' carbon atoms, forming dinucleotide.



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95. Two peptide linkages are present in Gly-Ala-Val.

Polymers

- 96. a.** The rubber obtained by the vulcanisation of natural rubber has excellent elasticity over a long range of temperature because when rubber is heated with sulphur, cross-linking of polymer chains occur through disulphide bonds. This prevents the tearing of the polymers on stretching. Thus, vulcanised rubber has low water-absorption tendency and is resistant to the action of organic solvents and oxidising agents.
- b.** Nylon-66 is derived from two monomer units, hexamethylenediamine and adipic acid. Each of these monomeric units contains six carbon atoms. Hence, the two '6's in nylon-66 represent the number of carbon atoms present in these monomers (adipic acid and hexamethylenediamine). Nylon-6 is derived from the monomer, caprolactam. Caprolactam contains six carbon atoms. Thus, the number 6 in nylon-6 represents the number of carbon atoms present in this monomer.

97. Hydrogen bonding between the $-NH$ group of each amino acid residue and the $>C=O$ of an adjacent turn of the helix helps in stabilizing the α -helix structure of proteins.

Chemistry In Everyday Life

- 98. (i) Food preservatives:** Food preservatives are chemicals that prevent food from spoilage due to microbial growth. Table salt, sugar, vegetable oil, sodium benzoate (C_6H_5COONa), and salts of propanoic acid are some examples of food preservatives.
- (ii) Synthetic detergents:** Synthetic detergents are sodium alkyl sulphates or sodium alkyl benzene sulphonates with alkyl groups having more than ten carbon atoms. Three types of synthetic detergents are cationic, anionic and non-ionic detergents. For example: Sodium dodecylbenzene sulfonate
- (iii) Antacids:** Any drug that is used to counteract the effects of excess acid in the stomach and raise the pH to an appropriate level is called an antacid.
Example: Omeprazole

99. Antibiotics that have cidal (killing) effect on microbes are called **bactericidal antibiotics**.
Example: penicillin
Antibiotics that have a static (inhibitory) effect on microbes are called **bacteriostatic antibiotics**.
Example: chloramphenicol

100. Salvarsan is the medicine developed by Paul Ehrlich for the treatment of syphilis.