CBSE
Class XII Chemistry - Set 1
Board Paper - 2013

Time: 3 hours **Total Marks: 70**

General instructions:

1. All questions are compulsory.
2. Marks for each question are indicated against it.
3. Question numbers 1 to 8 are very short- answer questions carrying1mark each. Answer these in one word or about one sentence each.
4. Question numbers 9 to 18 are short-answer questions, carrying 2 marks each. Answer these in about 30 words each.
5. Question numbers 19 to 27 are short answer questions, carrying 3 marks each. Answer these in about 40 words each.
6. Question numbers 28 to 30 are long answer questions of carrying 5 marks each. Answer these in about 70 words each.
7. Use Log Tables, if necessary. Use of calculators is not permitted.

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1. How many atoms constitute one unit cell of a face-centered cubic crystal? [1]

2. Name the method used for the refining of Nickel metal. [1]

3. What is the covalency of nitrogen in N_2O_5 ? [1]

4. Write the IUPAC name of the

$$CH_3-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_2-CH=CH_2$$

[1]

5. What happens when CH_3Br is treated with KCN? [1]

6. Write the structure of 3-methyl butanal. [1]

7. Arrange the following in increasing order of their basic strength in aqueous solution:
CH_3NH_2, $(CH_3)_3N$, $(CH_3)_2NH$ [1]

8. What are three types of RNA molecules which perform different functions? [1]

9. 18 g of glucose, $C_6H_{12}O_6$(Molar mass = 180 g mol^{-1}) is dissolved in 1 kg of water in a sauce pan. At what temperature will this solution boil?
(Kb for water = 0.52 k kg mol^{-1}, boiling points of pure water =373.15K) [2]

10. The conductivity of 0.20 M solution of KCl at 298 K is 0.025 S cm^{-1}. Calculate its molar conductivity. [2]

11. Write the dispersed phase and dispersion medium of the following colloidal systems: [2]

(i) Smoke

(ii) Milk

OR

What are lyophilic and lyophobic colloids? Which of these sols can be easily coagulated on the addition of small amounts of electrolytes?

12. Write the differences between physisorption and chemisorption with respect to the following: [2]

(i) Specificity

(ii) Temperature dependence

(iii) Reversibility and

(iv) Enthalpy change

13.

(a) Which solution is used for the leaching of silver metal in the presence of air in the metallurgy of silver?

(b) Out of C and CO, which is a better reducing agent at the lower temperature range in the blast furnace to extract iron from the oxide ore? [2]

14. What happens when

(i) PCl_5 is heated?

(ii) H_3PO_3 is heated?

Write the reaction involved. [2]

15.

(a) Which metal in the first transition series (3d series) exhibits + 1 oxidation state most frequently and why?

Which of the following cations are coloured in aqueous solutions and why?

Sc^{3+}, V^{3+}, Ti^{4+}, Mn^{2+}

(At. Nos. Sc = 21, V = 23, Ti = 22, Mn = 25) [2]

16. Chlorobenzene is extremely less reactive towards a nucleophillic substitution reaction. Give two reasons for the same [2]

17. Explain the mechanism of the following reaction. [2]

$$2CH_3\text{-}CH_2\text{-}OH \xrightarrow[413k]{H^+} CH_3CH_2\text{-}O\text{-}CH_2\text{-}CH_3 + H_2O$$

18. How will you convert:

(i) Propene to Propan - 2-ol?

(ii) Phenol to 2, 4,6-trinitrophenol? [2]

19. After watching a programme on TV about the adverse effects of junk food and soft drinks on the health of school children, Sonali, a student of Class XII, discussed the issue with the school principal. Principal immediately instructed the canteen contractor to replace the fast food with the fibre and vitamins rich food like sprouts, salad, fruits etc. This decision was welcomed by the parents and the students. After reading the above passage, answer the following questions:

(a) What values are expressed by Sonali and the Principal of the school?

(b) Give two examples of water-soluble vitamins. [3]

20. How would you account for the following?

(i) Transition metals exhibit variable oxidation states.

(ii) Zr (Z = 40) and Hf (Z = 72) have almost identical radii.

(iii) Transition metals and their compounds act as catalyst.

OR

Complete the following chemical equations:

(i) $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow$

(ii) $2CrO_4^{2-} + 2H^+ \rightarrow$

(iii) $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow$ [3]

21.

(i) Which one of the following is a food preservative?
Equanil, Morphine, Sodium benzoate

(ii) Why is bithional added to soap?

(iii) Which class of drugs is used in sleeping pills? [3]

22.

(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 dopedwith$CdCl_2$? [3]

23. Give the structures of products A, B and C in the following reactions: [3]

(i) $CH_3CH_2Br \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow[0°C]{HNO_2} C$

(ii) $CH_3COOH \xrightarrow[\Delta]{NH_3} A \xrightarrow{NaOH+Br_2} B \xrightarrow{CHCl_3+AicKOH} C$

24. Write the IUPAC names of the following coordination compounds:

(i) $[Cr(NH_3)_3Cl_3]$

(ii) $K_3[Fe(CN)_6]$

(iii) $[CoBr_2(en)_2]^+$, (en=ethylenediamine) [3]

25. Determine the osmotic pressure of a solution prepared by dissolving 2.5×10^{-2} g of K_2SO_4 in 2L of water at 25°C, assuming that it is completely dissociated.

(R = 0.0821 L atm K–1 mol–1, Molar mass of K_2SO_4 = 174gmol^{-1}) [3]

26. Calculate the emf of the following cell at 298 K:

Fe(s) | Fe^{2+} (0.001M)|| H+(1M) | H_2(g) (1bar), Pt(s)

(Given $E°_{cell}$ =+0.44V) [3]

27. Write the names and structures of the monomers of the following polymers: [3]

(i) (i)Bakelite

(ii) Nylon-6

(iii) Polythene

28.

(a) Give reasons for the following:

(i) Bond enthalpy of F_2 is lower than that of Cl_2.

(ii) PH_3 has lower boiling point than NH_3.

(b) Draw the structures of the following molecules:

(i) BrF_3

(ii) $(HPO_3)_3$

(iii) XeF_4

OR

(a) Account for the following:

(i) Helium is used in diving apparatus.

(ii) Fluorine does not exhibit positive oxidation state.

(iii) Oxygen shows catenation behavior less than sulphur.

(b) Draw the structures of the following molecules:

(i) XeF_2

(ii) $H_2S_2O_8$ [5]

29.

(a) Although phenoxide ion has more number of resonating structures than Carboxylate ion, Carboxylic acid is a stronger acid than phenol. Give two reasons.

(b) How will you bring about the following conversions?

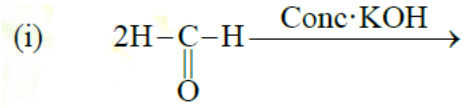
(i) Propanone to propane

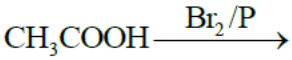
(ii) Benzoyl chloride to benzaldehyde

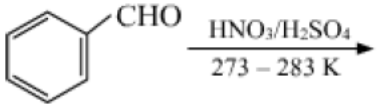
(iii) Ethanal to but-2-enal

OR

(a) Complete the following reactions:

(i) 

(ii) 

(iii) 

(b) Give simple chemical tests to distinguish between the following pairs of compounds:

(i) Ethanal and Propanal

(ii) Benzoic acid and Phenol

30.

(a) A reaction is second order in A and first order in B.

(i) Write the differential rate equation.

(ii) How is the rate affected on increasing the concentration of A three times?

(iii) How is the rate affected when the concentrations of both A and B are doubled?

(b) A first order reaction takes 40 minutes for 30% decomposition. Calculate $t_{1/2}$ for this reaction. (Given log 1.428 =0.1548)

OR

(a) For a first order reaction, show that time required for 99% completion is twice the time required for the completion of 90% of reaction.

(b) Rate constant 'k' of a reaction varies with temperature 'T' according to the equation:

$$\log K = \log A - \frac{Ea}{2.303R}\left(\frac{1}{T}\right)$$

Where E_a is the activation energy. When a graph is plotted for log k Vs $\left(\frac{1}{T}\right)$, a straight line with a slope of –4250 K is obtained. Calculate 'E_a' for the reaction.

(R = 8.314 JK^{-1} mol^{-1})

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1. Number of atoms present in one face-centred cubic crystal:

Number of atoms present at corners per unit cell =

8 corner atoms × $\frac{1}{8}$ atom per unit cell = 1 atom

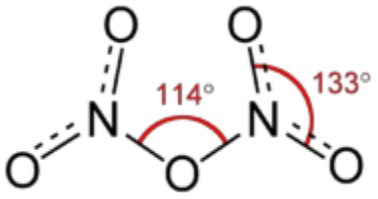
Number of atoms present at faces per unit cell = 6 face-centred atoms × $\frac{1}{2}$ atom per unit cell = 3 atoms

∴Total number of atoms per unit cell = 4 atoms.

2. Mond's process is the method used for refining of nickel metal. In this process, nickel is heated in a steam of carbon monoxide to form volatile nickel carbonyl $Ni(CO)_4$. Nickel carbonyl vapour on further heating decomposes to give pure nickel.

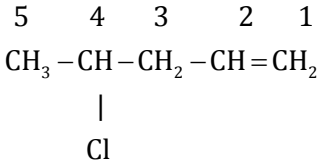
$$\underset{\text{Impure}}{Ni} + 4CO \xrightarrow{330-350K} Ni(CO)_4 \xrightarrow{450-470K} \underset{\text{Pure}}{Ni} + 4CO$$

3.



Covalence of nitrogen in nitrogen pentoxide is 4.

4.



IUPAC name: 4-chloropent-1-ene

5. CH_3Br reacts with KCN to form CH_3CN. It is a nucleophilic substitution reaction.

$$CH_3Br + KCN \rightarrow \underset{\text{Methyl nitrite}}{CH_3CN} + KBr$$

6. Structure of 3-methyl butanal

$$H_3C-\underset{\displaystyle |}{\underset{\displaystyle CH_3}{CH}}-CH_2-CHO$$

7.

$$\underset{3^o}{(CH_3)_3N} < \underset{1^o}{CH_3NH_2} < \underset{2^o}{(CH_3)_2NH}$$

As a consequence of combined effects of inductive effects and solvation, the secondary amines are the strongest bases.

8. There are three types of RNA molecules: Messenger RNA (mRNA), transfer RNA (tRNA) and ribosomal RNA (rRNA).

9. w_1 = weight of solvent (H_2O) = 1 kg = 1000 gm w_2 = weight of solute ($C_6H_{12}O_6$) =18 gm

M_2 = Molar mass of solute ($C_6H_{12}O_6$) =180 g mol^{-1}

K_b = 0.52 K kg mol^{-1}

$$T_b^o = -373.15K$$

$$\therefore \Delta T_b = \frac{K_b \times 1000 \times w_2}{M_2 \times W_1}$$

$$= \frac{0.52 \times 1000 \times 18}{180 \times 1000}$$

$$= 0.052K$$

$$\Delta T_b = T_b - T^o{}_b$$

$$0.052 = T_b - 373.15$$

$$\therefore T_b = 373.202K$$

10.

$$\text{Molar conductivity}(\Lambda_m) = \frac{k \times 1000}{C}$$

Given:

$k = 0.025 Scm^{-1}$

$C = 0.02$ M

$$(\Lambda_m) = \frac{0.025 \times 1000}{0.20}$$

$$= 125 Scm^2\ mol^{-1}$$

Molar conductivity is 125 Scm^2 mol^{-1}.

11.

(i) Smoke
Dispersed phase: Solid
Dispersion medium: Gas
(i) Milk
Dispersed phase: Liquid
Dispersion medium: Liquid

OR

Lyophilic colloids:

Colloidal solutions in which the particles of the dispersed phase have a great affinity for the dispersion medium are called lypophilic colloids. These are reversible in nature. These are stable and cannot be easily coagulated by small amounts of electrolytes.

Lyophobic colloids:

Colloidal solutions in which there is no affinity between particles of the dispersed phase and the dispersion medium are called lyophobic colloids. These are irreversible in nature. These are unstable and can be easily coagulated on addition of a small amount of electrolyte due to the lack of protecting layer around the charged colloidal particles.

12.

S. No.	Point of difference	Physiosorption	Chemisorption
(i)	Specificity	It is not specific in nature.	It is highly specific in nature.
(ii)	Temperature Dependence	Usually occurs at low temperature and decreases with an increase in temperature.	Occurs at high temperature and increases with the increase in temperature.
(iii)	Reversibility	It is reversible in nature.	It is irreversible in nature.
(iv)	Enthalpy change	Enthalpy of adsorption is low; it is of the order of 20–40 $KJmol^{-1}$.	Enthalpy of adsorption is high; it is of the order of 80–240 $KJmol^{-1}$.

13.

(a) Dilute solution (0.5%) of NaCN or KCN is used for leaching of silver metal in the presence of air in the metallurgy of silver.

(b) Out of C and CO, CO is a better reducing agent at the lower temperature range because the CO, CO_2 line lies below the Fe, FeO line, i.e. $\Delta G_{(CO, CO_2)} < \Delta G_{(Fe, FeO)}$. So, CO will reduce FeO and will itself be oxidised to CO_2.

14.

(i) PCl_5 on heating decomposes to give PCl_3 and Cl_2

$$PCl_5 \rightarrow PCl_3 + Cl_2$$

(ii) H_3PO_3 on heating gives orthophosphoric acid and phosphine

$$4H_3PO_3 \rightarrow 3H_3PO_4 + PH_3$$

15.

(a) Cu metal in the first transition series (3d series) shows the +1 oxidation state most frequently. This is because the electronic configuration of Cu is $3d^{10}\ 4s^1$ and after losing one electron, it acquires the stable $3d^{10}$ fully filled electronic configuration.

(b) The colour of cations is dependent on the number of unpaired electrons present in the d-orbital. The electronic configuration of the following cations is

(c)

Sc (Z = 21) = $3d^1\ 4s^2$ and $Sc^{3+} = 3d^0\ 4s^0$
As the d-orbital is empty, it is colourless.

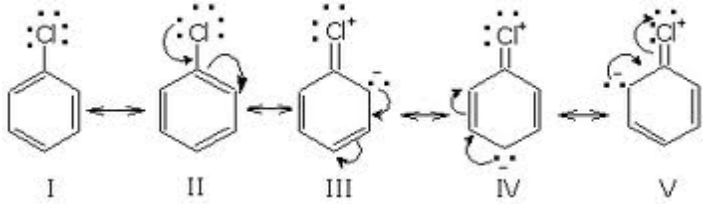
V (Z = 23) = $3d^3\ 4s^2$ and $V^{3+} = 3d^2\ 4s^0$
As the d-orbital has 2 unpaired electrons, it undergoes d–d transition and is green.

Ti (Z = 22) = $3d^2\ 4s^2$ and $Ti^{4+} = 3d^0\ 4s^0$.
As the d-orbital is empty, it is colourless.

Mn (Z =25) = $3d^5 4s^2$ and $Mn^{2+} = 3d^5\ 4s^0$.
As the d-orbital has 5 unpaired electrons, it is pink.

16. Chlorobenzene is less reactive towards a nucleophilic substitution reaction because of the following reasons:

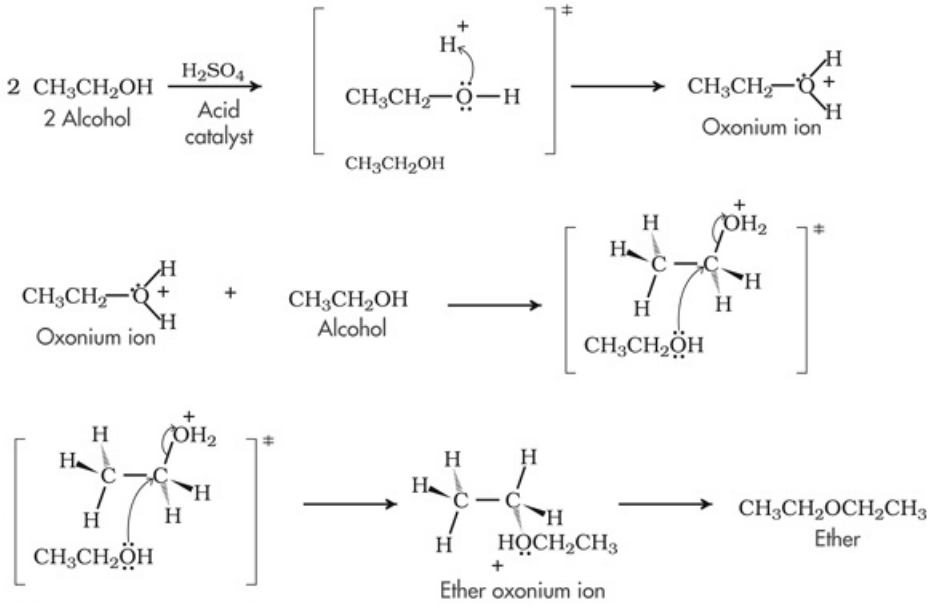
- Resonance effect: The electron pair on the chlorine atom is in conjugation with the π electrons of the benzene ring which results in the following resonance structures:



It results in delocalisation of the electrons of C–Cl bond and a partial double bond character develops in the bond, which makes it difficult for the nucleophile to cleave the C–Cl bond.

- Polarity of the C–Cl bond: The sp^2 hybridised carbon atom involved in C–Cl bond in chlorobenzene is more electronegative than the sp^3 hybrid carbon atom in alkyl halide. Therefore, this sp^2 hybridised carbon atom has less tendency to release electrons to the Cl atom. Thus, lower the polarity of C–Cl, lesser is the reactivity.

17. Mechanism for the reaction:

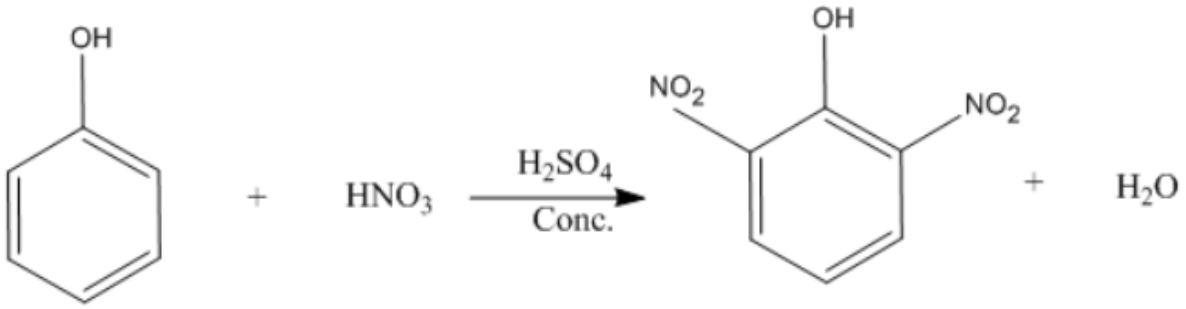


18.

(i) Hydration of propene, i.e. addition of water in the presence of H_2SO_4 in accordance with Markovnikov's rule, gives propan-2-ol.

$$\underset{\text{propene}}{CH_3-CH=CH_2} + H_2SO_4 \xrightarrow[\text{Boil}]{H_2O} \underset{\text{propen}-2-\text{ol}}{CH_3-\underset{\displaystyle OH}{\underset{|}{CH_2}}-CH_3}$$

(ii) When concentrated nitric acid is added to phenol in the presence of sulphuric acid, it gives 2,4,6-trinitrophenol.



19.

(a) Values showed by Sonali: Knowledge and awareness of the ill effects of junk food and care and concern for her school mates.
Values showed by the principal: Responsible and understanding behaviour in listening to a student's views and taking prompt action in replacing junk food with healthy food.

(b) The water-soluble vitamins are Vitamin B complex and Vitamin C.

20.

(i) The variable oxidation states of transition elements are due to the participation of ns and (n−1) d-electrons in bonding. When ns-electrons take part in bonding, the element will show a lower oxidation state, and when (n − 1) d-electrons take part in bonding, the element will show a higher oxidation state.

(ii) This is because the atomic radii of 4d and 5d transition elements are nearly the same. This similarity in size is due to lanthanide contraction. So, Zr and Hf have almost identical radii.

(iii) Transition elements act as good catalysts in a chemical reaction because of their partly filled d-orbitals and various oxidation states.
Their rough surface area provides active sites for the absorption of reactant molecules.

OR

(i) $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

(ii) $2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$

(iii) $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

21.

(i) Sodium benzoate is used as a food preservative, whereas equanil is a tranquilliser and morphine is an analgesic.
(ii) Bithional is an antiseptic added to soaps to reduce odours produced by bacterial decomposition of organic matter on the skin.
(iii) Tranquillisers relieve stress and fatigue by inducing a sense of well-being, so they are used in making sleeping pills.

22.

(a) When silicon is doped with boron, a p-type semiconductor is obtained.
(b) The magnetism shown in the alignment of magnetic moments is ferromagnetism.
(c) Impurity defect is produced when AgCl is doped with $CdCl_2$.

23.

(i)

$$CH_3CH_2Br \xrightarrow{KCN} \underset{A}{CH_3CH_2CN} \xrightarrow{LiAlH_4} \underset{B}{CH_3CH_2CH_2NH_2} \xrightarrow[0^\circ C]{HNO_2} \underset{C}{CH_3CH_2CH_2OH}$$

(ii)

$$CH_3COOH \xrightarrow[\Delta]{NH_3} \underset{A}{CH_3CONH_2} \xrightarrow{NaOH+Br_2} \underset{B}{CH_3NH_2} \xrightarrow{CHCl_3+Alco.KOH} \underset{C}{CH_3NC}$$

24.

IUPAC Nomenclature:
(i) Triamminetrichlorochromium (III)
(ii) Potassium hexacyanoferrate (III)
(iii) Dibromidobis (ethane-1, 2-diammine) cobalt (III) ion

25.

Mass of $K_2SO^4w_2 = 2.5 \times 10^{-2}$ g

Molar mass of K_2SO_4, $M_2 = 174$ g mol^{-1}

V = 2L

R = 0.0821 L atm K^{-1} mol^{-1}

T= 25°C = 298 K

$$\text{Osmotic pressure, } \pi = \frac{w_2 RT}{M_2 V}$$

$$\pi = \frac{2.5\times10^{-2}\times0.0821\times298}{174\times2}$$

$$= \frac{61.1645\times10^{-2}}{348}$$

$$= 1.76\times10^{-3}\text{atm}$$

$$\text{Osmotic pressure is } 1.76\times10^{-3}\text{atm}$$

26.

At the anode: $Fe \rightarrow Fe^{2+} + 2e^-$

At the cathode: $2H^+ + 2e^- \rightarrow H_2$

n = 2

$$E_{cell} = E^o_{cell} - \left(\frac{0.059}{n}\right)\log\frac{C_{oxid}}{C_{red}}$$

$$E_{cell} = 0.44 - \frac{0.059}{2}\log\frac{0.001}{1}$$

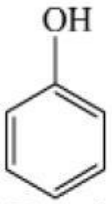
$$E_{cell} = 0.44 - 0.02955 \text{ x } (-3)$$

$$= 0.44 + 0.08865 = 0.53 \text{ V}$$

EMF of the cell is 0.53 V.

27.

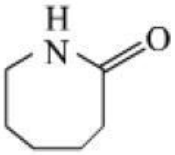
(i)



Phenol

HCHO
formaldehyde

(ii)



Caprolactam

(iii)

$CH_2 = CH_2$
Ethylene

28.

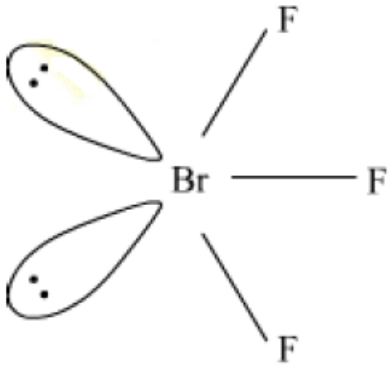
(a)

(i) F atom is small in size. Due to this, the electron–electron repulsion between the lone pairs of F–F is large. Thus, the bond dissociation energy of F_2 is lower than that of Cl_2.

(ii) PH_3 has a lower boiling point than NH_3 because the NH_3 molecule possesses intermolecular hydrogen bonding which binds its molecules strongly, whereas PH_3 has weaker Van der Waal's forces. Thus, PH_3 has a lower boiling point than NH_3.

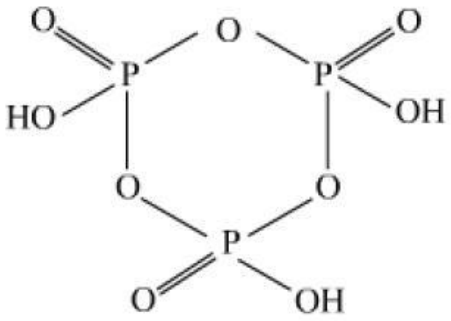
(b) Structures of the following molecules:

(i) BrF_3, bent T-shape



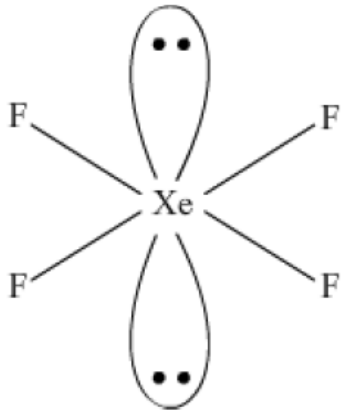
BrF_3

(ii) $(HPO_3)_3$, cyclic structure



$(HPO_3)_3$

(iii) XeF_4, square planar



OR

(a)

(i) Helium mixed with oxygen under pressure is given to sea divers for respiration. Air is not given to sea divers because nitrogen present in the air is soluble in the blood and will give a painful sensation called bends by bubbling out blood on moving from the high pressure in the deep sea to the low atmospheric pressure.

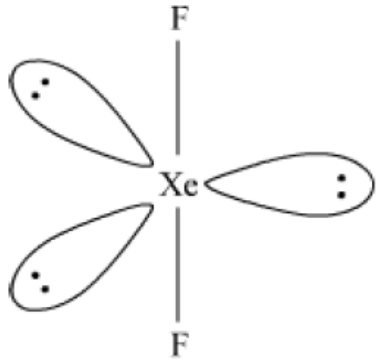
(ii) Fluorine being the most electronegative atom does not exhibit a positive oxidation state because its electrons are strongly attracted by the nuclear charge because of its small atomic size, and therefore, removal of an electron is not possible.

(iii) Sulphur shows catenation behaviour more than that of oxygen because the sulphur atom is larger than the oxygen atom.

The O–O bond in oxygen experiences repulsion due to the lone pairs present on the oxygen atom, and therefore, the bond is weaker than the S–S bond.

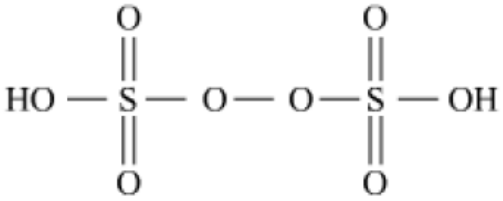
(b) Structure of the following molecules:

(i) XeF2, linear



XeF_2

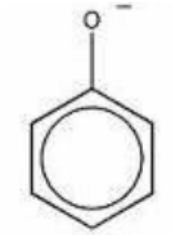
(ii)



$H_2S_2O_8$

29.

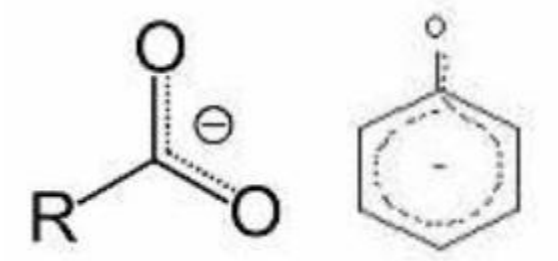
(a) On losing a proton, carboxylic acid forms carboxylate ion and phenol forms phenoxide ion.



$RCOO^-$

Carboxylate ion Phenoxide ion

Now, the negative charge is delocalised in both molecules as follows:



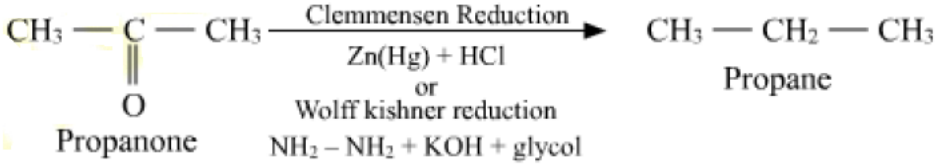
The conjugate base of carboxylic acid has two resonance structures in which the negative charge is delocalised over two oxygen atoms (since O is more electronegative than C) which stabilises the carboxylate ion. On the other hand, in the phenoxide ion, the charge is delocalised over entire molecule on the less electronegative atom (Carbon).

Thus, resonance of phenoxide is not important in comparison to resonance in carboxylate ion. Further, in carboxylate ion, the negative charge is effectively delocalised over two oxygen atoms, whereas it is less effectively delocalised over one oxygen atom and less electronegative carbon atom.

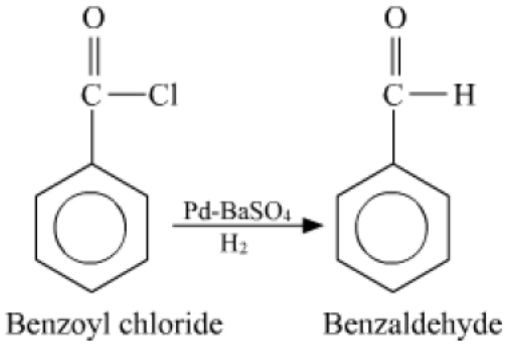
Thus, phenol is less acidic than carboxylic acid. In other words, carboxylic acids are stronger acids than phenols.

(b)

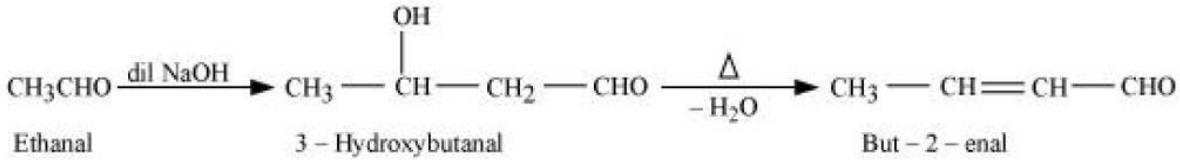
(i) Conversion of propanone to propane:



(ii) Conversion of benzoyl chloride to benzaldehyde:



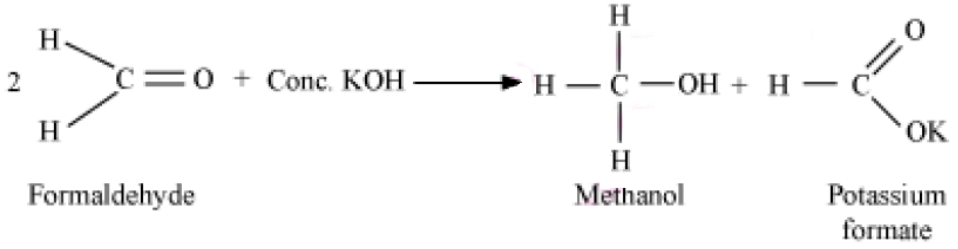
(iii) On treatment with dilute alkali, ethanol produces 3-hydroxybutanal and gives but-2-enal on heating.



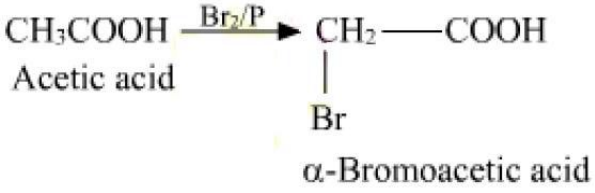
OR

(a)

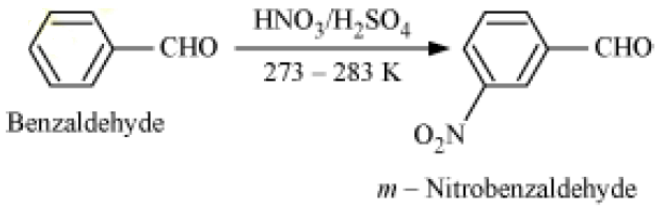
(i)



(ii)



(iii)



(b)

(i) Test to distinguish between ethanal and propanal:
Iodoform test: Ethanal gives iodoform test.
$CH_3CHO + 4NaOH + 3I_2 \rightarrow CHI3$ (Yellow ppt.) $+ HCOONa + 3NaI + 3H_2O$
Propanal does not give this test.
$CH_3CH_2CHO + 4NaOH + 3I_2 \rightarrow$ No reaction

(ii) Test to distinguish between benzoic acid and phenol:
$NaHCO_3$ test: When benzoic acid reacts with $NaHCO_3$, brisk effervescence of CO_2 gas is evolved.
$C_6H_5COOH + NaHCO_3 \rightarrow C_6H_5COONa + H_2O + CO_2\uparrow$
Phenols do not give any effervescence with $NaHCO_3$.

30.

(a)

(i) Differential rate equation: Rate $= \frac{-d[R]}{dt} = K[A]^2[B]$

(ii) On increasing the concentration of A three times as 3A:

$$\text{Rate}' = K[3A]^2[B]$$
$$= 9K[A]^2[B] \text{ i.e. New rate is 9 times the initial rate.}$$
$$= 9K[A]^2[B]$$
$$= 9(\text{Rate})$$

(iii) On increasing the concentration of A and B as 2A and 2B:

$$\text{Rate } “= K[2A]^2[2B]$$
$$= K(4 \text{ x } 2)\ [A]^2[B]$$
$$= 8K[A]^2[B]$$
$$= 8(\text{Rate})$$

8 times the initial rate.

$$\begin{array}{lccc} & A & \rightarrow & P \\ t=0 & a & & 0 \\ t=t & (a-x) & & x \end{array}$$

(b) For 30% decomposition, it takes 40 min, i.e. 70% of reactant is left after 40 min.

$$K=\frac{2.303}{t}\log\frac{a}{a-x}$$

$$K=\frac{2.303}{t}\log\frac{a}{(70/100)a}$$

$$=\frac{2.303}{40}\log 1.428$$

$$\therefore K=0.00891\,\text{min}^{-1}$$

$$\therefore t_{1/2}=\frac{0.693}{K}$$

$$=\frac{0.693}{0.008913}$$

$$t_{1/2}=77.78\,\text{min}$$

OR

(a) For a first-order reaction,

$$\begin{array}{lccc} & A & \rightarrow & P \\ t=0 & a & & 0 \\ t=t & (a-x) & & x \end{array}$$

Case 1: If 't' is the time required for 99% completion, then x = 99% of a

$$(a-x)=\frac{1}{100}a$$

$$=\frac{a}{100}$$

$$t=\frac{2.303}{K}\log\frac{a}{a-x}$$

$$=\frac{2.303}{K}\log\frac{a\times 100}{a}$$

$$t=\frac{2.303}{K}\log 10^2$$

$$\therefore t=2\left[\frac{2.303}{K}\right]$$

Case 2: If 't' is the time required for 90% of completion, then x = 90% of a

$$a - x = \frac{10}{100}a = \frac{a}{10}$$

$$t = \frac{2.303}{K}\log\frac{a}{a-x}$$

$$= \frac{2.303}{K}\log\frac{a \times 10}{a}$$

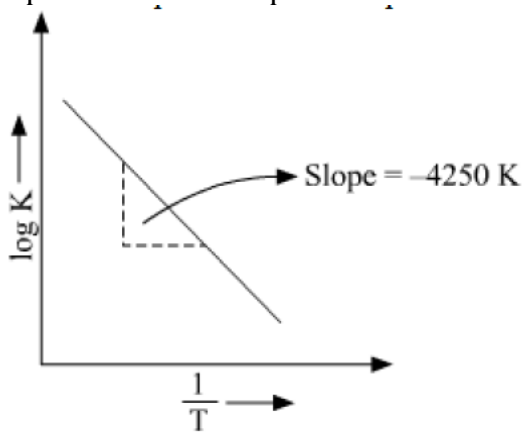
$$\therefore t = \frac{2.303}{K}$$

Therefore, the time required for 99% completion of the first-order reaction is twice the time required for 90% completion.

(b) $\log k = \log A \frac{E_a}{2.303R}\left(\frac{1}{T}\right)$

E_a is activation energy.

The above equation is like y = mx + c, where if we plot yv/s x, we get a straight line with slope 'm' and intercept 'c'.



Slope = $\frac{-E_a}{2.303R}$

$$\frac{-E_a}{2.303R} = -4250\,K$$

$$E_a = 4250 \times 2.303 \times 8.314$$

$$E_a = 81{,}375.3535\ J\ mol^{-1}$$