CBSE Board
Class XII Chemistry

Time: 3 Hrs Total Marks: 70

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1. All questions are compulsory.
2. Question nos. **1 to 8** are very short answer questions and carry 1 mark each
3. Question nos. **9 to 18** are short answer questions and carry 2 marks each. Use of calculator is not permitted.
4. Question nos. **19 to 27** are also short answer questions and carry 3 marks each
5. Question nos**. 28 to 30** are long answer questions and carry 5 marks each
6. Use log tables if necessary, use of calculators is not allowed.

Q1: Solid A is a very hard electrical insulator in solid as well as in molten state and melts at extremely high temperature. Name the type of solid.

Q2: Define ferromagnetic substances. Give any one example of a ferromagnetic substance.

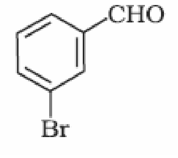
Q3: Can activation energy for a chemical reaction be zero? Explain why?

Q4: It has been found that for a reaction a large number of colliding molecules have energy more than threshold values, yet the reaction is slow. Why?

Q5: Why does NO_2 dimerise?

Q6: The para isomer of dichlorobenzene has higher melting point than ortho and meta isomer. Why?

Q7: Give the IUPAC name of the compound given below:



Q 8: Name the base which is not present in RNA?

Q 9: An element with molar mass 2.7×10^{-2} kg mol^{-1} forms a cubic unit cell with edge length 405 pm. If the density is 2.7×10^{3} kg m^{-3}, what is the nature of the cubic unit cell? (Given $N_A = 6.022 \times 10^{23}$ mol^{-1})

Q10: Predict the products of electrolysis of silver electrodes in an aqueous solution of $AgNO_3$.

OR

Q10: Write the reactions taking place at anode and cathode in a dry cell.

Q11: Explain what is observed when:

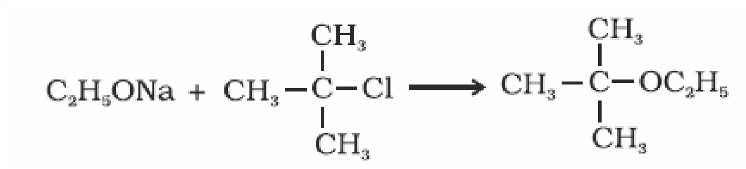
(a) An electrolyte, NaCl is added to hydrated ferric oxide sol.
(b) An electric current is passed through a colloidal sol.

Q12: State any two points of difference between physisorption and chemisorption.

Q13: Draw the structure of N_2O_5.What is the oxidation state of nitrogen in N_2O_5?

Q14: Explain why is dioxygen a gas but sulphur a solid?

Q 15: Following is not an appropriate reaction for preparation of t-butyl ethyl ether.



$$C_2H_5ONa + CH_3-\underset{CH_3}{\overset{CH_3}{C}}-Cl \longrightarrow CH_3-\underset{CH_3}{\overset{CH_3}{C}}-OC_2H_5$$

(i) What would be the major product of this reaction? Give reason.
(ii) Write a suitable reaction for the preparation of t-butyl ethyl ether.

Q16: Name the test that you will use you to distinguish between 2-methylbutan–2–ol and butanol. Name the chemical test and write the chemical reactions involved.

Q17: Complete the following reactions:

(a) $C_6H_5NH_2 + Br_2(aq) \longrightarrow$
(b) $C_6H_5NH_2 + (CH_3CO)_2O \xrightarrow{\text{pyridine}}$

Q18: Give a plausible explanation for each of the following:

(a) Why are amines less acidic than alcohols of comparable molecular masses?
(b) Why do primary amines have higher boiling points than tertiary amines?

Q19: Represent the cell in which following reaction takes place:

$$Mg(s) + 2Ag^{+}(0.0001M) \rightarrow Mg^{2+}(0.130M) + 2Ag(s)$$

Write the individual reactions taking place at anode and cathode.

Q20: In a pseudo first order hydrolysis of ester in water, the following results were obtained:

t (s)	0	30	60	90
[Ester] (mol L^{-1})	0.55	0.31	0.17	0.085

(i) Calculate the average rate of reaction between the time intervals 30 to 60 seconds.
(ii) Calculate the pseudo first order rate constant for the hydrolysis of ester.

OR

Q20: Show that time required for 99% completion of a chemical reaction is twice the time required for the completion of 90% reaction.

Q 21:

(a) Give one point of difference between mineral and ore.
(b) Give an example of ore that can be concentrated by magnetic separation method.
(c) How does sodium cyanide act as depressant in preventing ZnS from forming the forth?

Q 22:

(a) Ammonia is a good complexing agent. Explain with an example.
(b) SO_3 has zero dipole moment. Explain?
(c) Noble gases have low boiling points. Explain.

Q 23: On the basis of valence bond theory, explain the formation of square planar $[Pt(CN)_4]^{2-}$ ion. Calculate the number of unpaired electrons present in the square planar $[Pt(CN)_4]^{2-}$ ion. (Atomic number of Pt =78)

Q24: How will you bring the following conversions?

(a) Ethanol to ethyl fluoride
(b) Benzene to biphenyl
(c) Bromomethane to propanone

Q.25 Define the following terms related to proteins:

(a) Peptide linkage
(b) Primary structure of proteins
(c) Denaturation of proteins

Q26: Write the names and structures of the monomers of the following polymers:

(a) Buna-S
(b) Neoprene

Q27: Sushil and swetha are arguing about the effect of soaps and detergents on environment. Sushil says soaps are better and swetha says that detergents are better for environment.

(a) State the major difference between soaps and detergents.
(b) Which one is better for environment: soaps or detergents?
(c) What values do you get from this?

Q 28: Vapour pressure of chloroform ($CHCl_3$) and dichloromethane (CH_2Cl_2) at 298 K are 200 mm Hg and 415 mm Hg respectively.

(a) Calculate the vapour pressure of the solution prepared by mixing 25.5 g of $CHCl_3$ and 40 g of CH_2Cl_2 at 298 K
(b) Calculate the mole fractions of each component in vapour phase.

OR

Q 28: Calculate the depression in the freezing point of water when 10 g of $CH_3CH_2CHClCOOH$ is added to 250 g of water. $K_a = 1.4x10^{-3}$, $K_f = 1.86$ K kg mol^{-1}. (Atomic mass of C=12, H=1, Cl=35.5, O=16)

Q 29:

(a) Why do transition elements exhibit higher enthalpies of atomization?
(b) Copper is regarded as transition metal though it has completely filled d-orbitals (d^{10}). Explain.
(c) Use Hund's rule to derive the electronic configuration of Ce^{3+} ion and calculate its magnetic moment on the basis of 'spin-only' formula.
(d) Why do Zr and Hf exhibit similar properties?
(e) How would you account for increasing oxidizing power in the series?

$$VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$$

OR

Q 29:

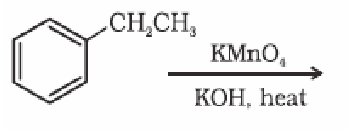
(a) (Which out of $Lu(OH)_3$ and $La(OH)_3$ is more basic and why?
(b) Explain how the colour of $K_2Cr_2O_7$ solution depends on pH of the solution?
(c) Though both Cr^{2+} and Mn^{3+} have d^4 configuration, yet Cr^{2+} is reducing agent while Mn^{3+} is good oxidising agent. Explain why?
(d) Calculate the magnetic moment of a divalent and a trivalent ion in aqueous solution of an element if its atomic number is 25.

Q30: An organic compound (A) (molecular formula $C_8H_{16}O_2$) was hydrolysed with dilute sulphuric acid to give a carboxylic acid (B) and an alcohol (C). Oxidation of (C) with chromic acid produced (B). (C) on dehydration gives but–1–ene. Deduce the structures of A, B, C and D. Write equations for the reactions involved.

OR

Q30: Complete each synthesis by giving missing starting material, reagents or products

(a)



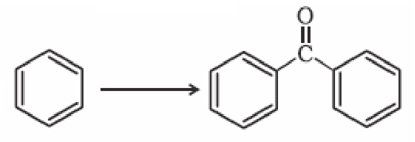
(b)

$C_6H_5CHO \xrightarrow{H_2NCONHNH_2}$

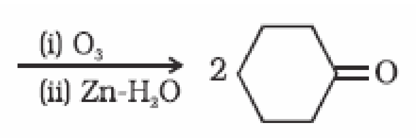
(c)

$C_6H_5CHO + CH_3CH_2CHO \xrightarrow{\text{dil. NaOH}}$

(d)



(e)



CBSE Board Class
XII Chemistry
Solution

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Solution

Ans1:

Covalent or network solid (1)

Ans 2:

The substances which are strongly attracted by the magnetic field and show permanent magnetism even when the magnetic field is removed are known as ferromagnetic substances. $\left(\frac{1}{2}\right)$

Example: Iron or any other example. $\left(\frac{1}{2}\right)$

Ans 3:

Activation energy for a chemical reaction cannot be zero. $\left(\frac{1}{2}\right)$

In the Arrhenius equation,

$$k = Ae^{-\frac{E_a}{RT}}$$

If E_a, is zero then k = A

This means that every collision between molecules lead to the chemical reaction. This is not true. Thus, E_a cannot be zero. $\left(\frac{1}{2}\right)$

Ans 4:

This is because the colliding molecules may not have proper orientation at the time of collision, which is also a necessary condition for an effective collision. (1)

Ans 5:

NO_2 contains odd number of valence electrons. It behaves as a typical odd electron molecule and therefore undergoes dimerisation to form stable N_2O_4 molecule with even number of electrons. (1)

Ans 6:

The melting point of para isomer of dichlorobenzene is quite higher than that of ortho or meta isomers. This is due to the fact that para dichlorobenzene has a symmetrical structure and therefore, its molecules can easily pack closely in crystal lattice. As a result, intermolecular forces of attraction are stronger and therefore, greater energy is required to break its lattice and, it melts at higher temperature. (1)

Ans 7:

3-Bromobenzaldehyde (1)

Ans 8:

Thymine (1)

Ans 9:

Edge length = a = 405 pm = 405 x 10^{-12} m

Density of the cell = d = 2.7 x 10^3 kg m^{-3}

Molar mass = M = 2.7 x 10^{-2} kg mol^{-1}

$$\text{Density, d} = \frac{z \times M}{a^3 \times N_A} \qquad \left(\frac{1}{2}\right)$$

$$\therefore 2.7 \times 10^3 \text{ kg m}^{-3} = \frac{z \times 2.7 \times 10^{-2} \text{kg mol}^{-1}}{(405 \times 10^{-12} \text{m})^3 \times (6.022 \times 10^{23} \text{mol}^{-1})} \qquad \left(\frac{1}{2}\right)$$

$$\therefore z = \frac{(2.7 \times 10^3 \text{kg m}^{-3}) \times (405 \times 10^{-12} \text{m})^3 \times (6.022 \times 10^{23} \text{mol}^{-1})}{2.7 \times 10^{-2} \text{kg mol}^{-1}}$$

$$= 4 \qquad \left(\frac{1}{2}\right)$$

Since the unit cell contains 4 atoms, it is cubic close packed structure, ccp. $\left(\frac{1}{2}\right)$

Ans 10:

Electrolysis of aqueous solution of $AgNO_3$ using silver electrodes:

$$AgNO_3(s) + nH_2O \longrightarrow Ag^+(aq) + NO_3^-(aq)$$

$$H_2O \rightleftharpoons H^+ + OH^-$$

At cathode: Ag^+ ions have lower discharge potential than H^+ ions. Hence Ag^+ ions will be deposited as silver (in preference to H^+ ions). $\left(\frac{1}{2}\right)$

$$Ag^+(aq) + e^- \longrightarrow Ag\ (s) \qquad \left(\frac{1}{2}\right)$$

At anode: Since silver electrode is attacked by NO_3^- ions, Ag anode will dissolve to form Ag^+ ions in the solution. $\left(\frac{1}{2}\right)$

$$Ag(s) \longrightarrow Ag^+(aq) + e^- \qquad \left(\frac{1}{2}\right)$$

OR

Ans 10:

At anode: $Zn(s) \rightarrow Zn^{2+} + 2e^-$ (1)

At cathode: $MnO_2 + NH_4^+ + e^- \rightarrow MnO(OH) + NH_3$ (1)

Ans 11:

(i) When NaCl is added to hydrated ferric oxide sol, positively charged colloidal particles of $Fe(OH)_3$ get coagulated by oppositely charged Cl^- ions provided by NaCl. (1)

(ii) On passing electric current, colloidal particles move towards the oppositely charged electrode where they lose their charge and get coagulated. This is electrophoresis process. (1)

Ans12:

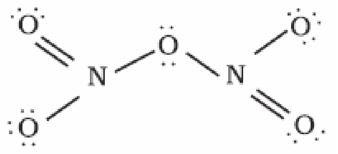
Difference between Physisorption & Chemisorption

Physisorption	Chemisorption
The forces between the adsorbate molecules and the adsorbent are weak van der Waals' forces. $\left(\frac{1}{2}\right)$	The forces between the adsorbate molecules and the adsorbent are strong chemical bonds. $\left(\frac{1}{2}\right)$
It results into multimolecular layers on adsorbent surface under pressure. $\left(\frac{1}{2}\right)$	It results into unimolecular layer. $\left(\frac{1}{2}\right)$

(Or any other differences can also be mentioned)

Ans 13:

N_2O_5 has the structure shown below:



(1)

The oxidation state of nitrogen in N_2O_5 is +5. (1)

Ans 14:

Due to small size and high electronegativity, oxygen atom forms pπ-pπ double bond, O = O. The intermolecular forces in dioxygen are weak van der Waals' forces and therefore, dioxygen exists as a gas. (1)

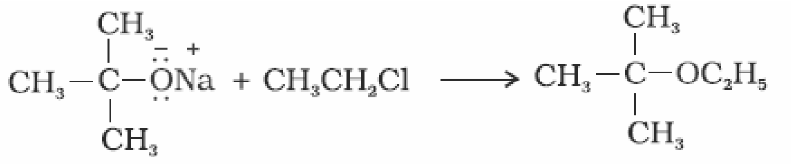
On the other hand, sulphur does not form stable pπ-pπ bond and does not exists as S_2. In sulphur molecule, 8 S atoms are linked by single bonds to form polyatomic molecule and hence have stronger van der Waals forces as compared to that present in oxygen. Therefore sulphur exists as a solid. (1)

Ans 15:

(a) Major product of the reaction is 2-methylprop-1-ene. $\left(\frac{1}{2}\right)$

This is because sodium ethoxide is strong nucleophile as well as a strong base. Thus, elimination predominates over substitution. $\left(\frac{1}{2}\right)$

(b)



$$CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-\ddot{\underset{\cdot\cdot}{O}}\overset{-\ +}{N}a + CH_3CH_2Cl \longrightarrow CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-OC_2H_5$$

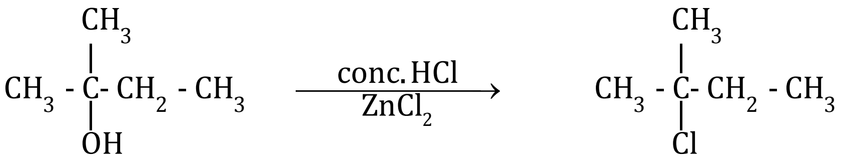
(1)

Ans 16:

(a) Lucas reagent test $\left(\frac{1}{2}\right)$

Lucas reagent is conc. HCl—$ZnCl_2$

2-methylbutan-2-ol is a tertiary alcohol and therefore it reacts with Lucas reagent at room temperature giving turbidity immediately. $\left(\frac{1}{2}\right)$



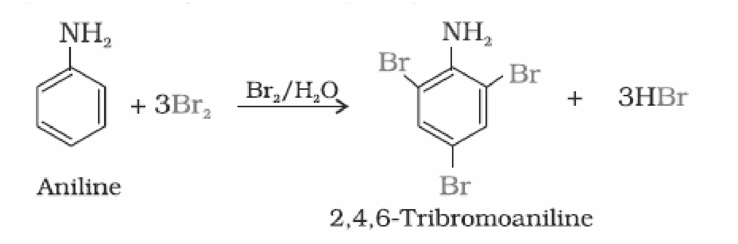
$$CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle OH}{\overset{|}{\underset{|}{C}}}}-CH_2-CH_3 \xrightarrow[ZnCl_2]{conc.\,HCl} CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle Cl}{\overset{|}{\underset{|}{C}}}}-CH_2-CH_3$$

2 - Chloro - 2 - methyl butane $\left(\frac{1}{2}\right)$

Butanol CH_3-CH_2-CH_2CH_2OH is a primary alcohol and does not produce turbidity with Lucas reagent at room temperature. $\left(\frac{1}{2}\right)$

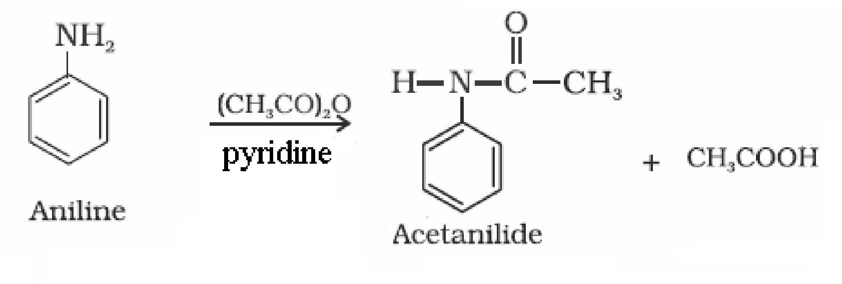
Ans17:

(a)



(1)

(b)



(1)

Ans 18:

(i) Loss of proton from amines gives amide ion whereas loss of a proton from alcohol gives an alkoxide ion.

$$\underset{\text{Amine}}{RNH_2} \longrightarrow \underset{\text{Amide ion}}{RNH^-} + H^+$$

$$\underset{\text{Alcohol}}{ROH} \longrightarrow \underset{\text{Alkoxide ion}}{RO^-} + H^+$$

Since O is more electronegative than N, therefore RO^- can accommodate the negative charge more easily than RNH^-. Consequently, RO^- is more stable than RNH^-.Thus alcohols are more acidic than amines. (1 mark)

(ii) Primary amines have two hydrogen atoms on N atom and therefore form intermolecular hydrogen bonding.

Tertiary amines do not have hydrogen atoms on N atom and therefore tertiary amine does not form hydrogen bonds. Due to the presence of hydrogen bonding in primary amines, they have higher boiling point than tertiary amines. (1)

Ans 19:

Cell representation:

$$Mg(s)\,|\,Mg^{2+}(0.130\,M)\,||\,Ag^{+}(0.0001M)\,|\,Ag(s) \qquad (1)$$

At anode: Oxidation reaction takes place:

$$Mg(s) \longrightarrow Mg^{2+}(aq) + 2e^{-} \qquad (1)$$

At cathode: Reduction reaction takes place:

$$Ag^{+}(aq) + e^{-} \longrightarrow Ag(s) \qquad (1)$$

Ans 20:

(a)

$$r_{av} = -\left(\frac{c_2 - c_1}{t_2 - t_1}\right) \qquad \left(\frac{1}{2}\right)$$

$$= -\left(\frac{0.17 - 0.31}{60 - 30}\right)$$

$$= 4.67 \times 10^{-3} \ \ mol\,L^{-1}s^{-1} \qquad \left(\frac{1}{2}\right)$$

(b)

$$k = \frac{2.303}{t}\ \log\frac{[A]_0}{[A]} \qquad \left(\frac{1}{2}\right)$$

$$\text{At } t = 30\,s$$

$$k = \frac{2.303}{t}\ \log\frac{0.55}{0.31}$$

$$= \frac{2.303}{30} \times 0.249$$

$$= 1.91 \times 10^{-2} s^{-1}$$

At t = 60 s

$$k = \frac{2.303}{60} \times \log\frac{0.55}{0.17}$$

$$= \frac{2.303}{60} \times 0.5099$$

$$= 1.96 \times 10^{2} s^{-1} \qquad \left(\frac{1}{2}\right)$$

At t = 90 s

$$k = \frac{2.303}{90} \log\frac{0.55}{0.085}$$

$$= \frac{2.303}{90} \times 0.8109$$

$$= 2.07 \times 10^{-2}\ s^{-1} \qquad \left(\frac{1}{2}\right)$$

Average value of $k = 1.98 \times 10^{-2} s^{-1}$ $\left(\frac{1}{2}\right)$

OR

Ans 20:

For a first order reaction

$$t = \frac{2.303}{k} \log \frac{[A]_0}{[A]} \qquad \left(\frac{1}{2}\right)$$

Let initial concentration = a

For 99% completion of reaction,

$$t_{(99\%)} = \frac{2.303}{k} \log \frac{a}{0.01\,a} \qquad \left(\frac{1}{2}\right)$$

$$= \frac{2.303}{k} \log 100$$

$$= \frac{2.303 \times 2}{k} \qquad \ldots(i) \qquad \left(\frac{1}{2}\right)$$

For 90% completion of reaction,

$$t_{(90\%)} = \frac{2.303}{k} \log \frac{a}{0.1\,a} \qquad \left(\frac{1}{2}\right)$$

$$= \frac{2.303}{k} \times 1 \qquad \ldots(ii) \qquad \left(\frac{1}{2}\right)$$

Dividing equation (i) by (ii)

$$t_{\frac{(99\%)}{(90\%)}} = 2 \qquad \left(\frac{1}{2}\right)$$

or $t_{(99\%)} = 2 \times t_{(90\%)}$

Ans 21:

(a) Difference between mineral' and ore

Mineral	Ore
Minerals are naturally occurring chemical substances in the earth's crust obtained by mining. $\left(\frac{1}{2}\right)$	The minerals from which a metal can be economically and conveniently extracted is ore. $\left(\frac{1}{2}\right)$

Or any other point of difference

(b) Magnetite (Fe_3O_4) or any other example (1)

(c) Sodium cyanide combines with ZnS to form a complex $Na_2[Zn(CN)_4]$ on the surface of ZnS and hence prevents it from forming the froth.

$$\mathrm{ZnS} + 4\,\mathrm{NaCN} \rightarrow \mathrm{Na_2[Zn(CN)_4]} + \mathrm{Na_2S}$$

Ans 22:

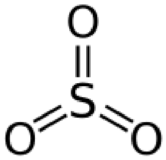
(a) Ammonia is a good complexing agent because of the presence of lone pair of electrons on nitrogen. This lone pair can be easily donated to electron deficient compounds forming complexes. $\left(\frac{1}{2}\right)$

For example, it reacts with Cu^{2+} ion to form a deep blue complex.

$$\mathrm{Cu^{2+}(aq)} + 4\mathrm{NH_3(aq)} \longrightarrow \underset{\text{Complex (deep blue)}}{[\mathrm{Cu(NH_3)_4}]^{2+}} \qquad \left(\frac{1}{2}\right)$$

(b)

In the gaseous state, SO_3 has planar triangular structure with oxygen sulphur oxygen bond angles of 120° each. Therefore, individual S=O dipole moments cancel each other and resultant dipole moment is zero. (1)



(c)

Noble gases are mono-atomic gases and are held together by weak van der Waals' forces (or dispersion forces). Therefore, they are liquefied at very low temperature. Hence they have low boiling points. (1)

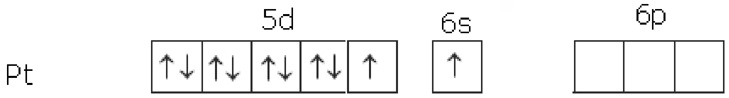
Ans 23:

Atomic number of platinum is 78.

Electronic configuration of platinum atom in ground state:

$[Xe]4f^{14}\,5d^{9}\,6s^{1}$ $\left(\frac{1}{2}\right)$

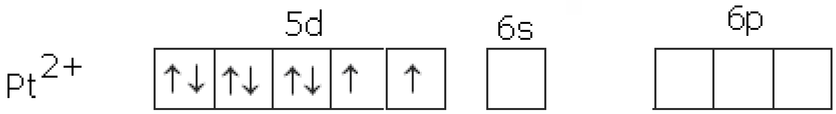
Outer electronic configuration of Pt: $5d^{9}\,6s^{1}$



$\left(\frac{1}{2}\right)$

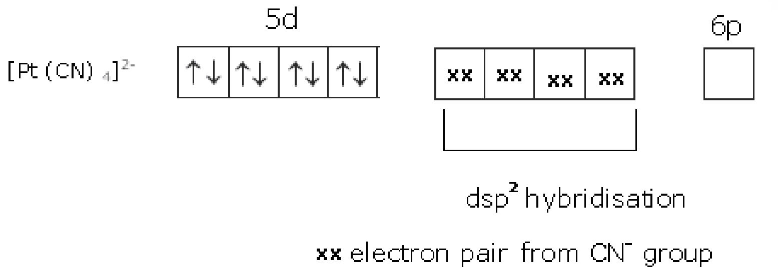
In the complex, Pt is in +2 oxidation state.

Outer electronic configuration of Pt^{2+} : $5d^{8}$ $\left(\frac{1}{2}\right)$



$\left(\frac{1}{2}\right)$

To have square planar geometry, Pt^{2+} undergoes dsp^{2} hybridization.



$\left(\frac{1}{2}\right)$

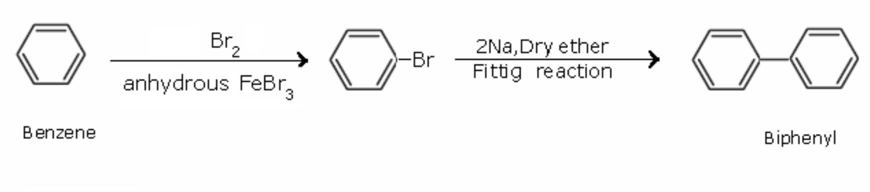
Hence, there are no unpaired electrons in $[Pt(CN)_4]^{2-}$. $\left(\frac{1}{2}\right)$

Ans 24:

(a) Ethanol to ethyl fluoride

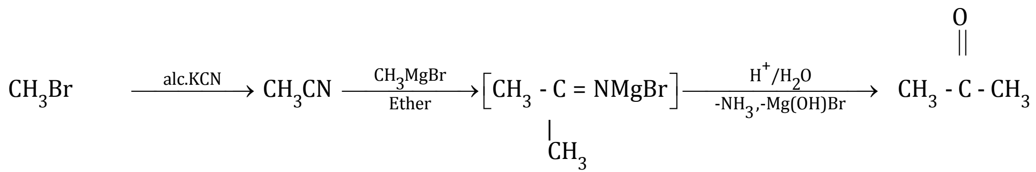
$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[-SO_2,-HCl]{SOCl_2} CH_3CH_2Cl \xrightarrow{AgF} \underset{\text{Ethyl fluoride}}{CH_3CH_2F} \quad (1)$$

(b) Benzene to biphenyl



(1mark)

(c) Bromomethane to propanone

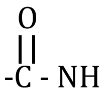


$$\underset{\text{Bromomethane}}{CH_3Br} \xrightarrow{alc.KCN} CH_3CN \xrightarrow[Ether]{CH_3MgBr} \left[CH_3 - \underset{\underset{CH_3}{|}}{C} = NMgBr\right] \xrightarrow[-NH_3,-Mg(OH)Br]{H^+/H_2O} \underset{\text{Propanone}}{CH_3 - \overset{\overset{O}{||}}{C} - CH_3}$$

(1)

Ans 25:

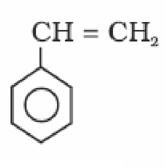
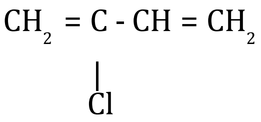
(a) Peptide linkage: Linkage formed due to condensation reaction between carboxyl group of one amino acid and amino group of another amino acid with elimination of water molecule is called peptide linkage.

The resulting  $\overset{\displaystyle O}{\overset{||}{-C}}-NH$ linkage is called peptide linkage. (1)

(b) Primary structure of proteins: The primary structure of proteins gives the sequence in which the amino acids are linked to each other in polypeptide chains of proteins. (1)

(c) Denaturation of proteins: A process that changes the physical and biological properties of proteins without affecting the chemical composition of a protein is called denaturation of proteins. (1)

Ans 26:

Name of polymer	Structure & Name of monomers
Buna-S	$CH_2=CH-CH=CH_2$ $\left(\frac{1}{2}\right)$ 1, 3-Butadiene $\left(\frac{1}{2}\right)$ &  $\left(\frac{1}{2}\text{ mark}\right)$ Styrene $\left(\frac{1}{2}\right)$
Neoprene	 $CH_2=\underset{\displaystyle Cl}{\underset{\vert}{C}}-CH=CH_2$ $\left(\frac{1}{2}\right)$ 2-Chloro-1,3-butadiene/Chloroprene $\left(\frac{1}{2}\right)$

Ans 27:

(a) Difference between soaps and detergents:

Soaps	Detergents
Soaps are the sodium salts of long chain fatty acids. $\left(\frac{1}{2}\right)$	Detergents are sodium salts of long chain alkyl sulphates or long chain alkyl benzene sulphonates. $\left(\frac{1}{2}\right)$

(b) Soaps are biodegradable. Therefore they do no cause any pollution problem are safe for environment. $\left(\frac{1}{2}\right)$

Some of the detergents are not biodegradable. Therefore they cause pollution. $\left(\frac{1}{2}\right)$

(c) Values associated: environment conservation and knowledge of chemistry. (1)

Ans 28:

(a)

Molar mass of $CH_2Cl_2 = 12 \text{ x } 1 + 1 \text{ x } 2 + 35.5 \text{ x } 2 = 85 \text{ g mol}^{-1}$

Molar Mass of $CHCl_3 = 12 \text{ x } 1 + 1 \text{ x } 1 + 35.5 \text{ x } 3 = 119.5 \text{ g mol}^{-1}$

$$\text{Moles of } CH_2Cl_2 = \frac{40}{85 \text{ g mol}^{-1}} = 0.47 \text{ mol} \qquad \left(\frac{1}{2}\right)$$

$$\text{Moles of } CHCl_3 = \frac{25.5 \text{ g}}{119.5 \text{ g mol}^{-1}} = 0.213 \text{ mol} \qquad \left(\frac{1}{2}\right)$$

Total number of moles $= 0.47 + 0.213 = 0.683 \text{ mol}$

$$\chi_{CH_2Cl_2} = \frac{0.47 \text{ mol}}{0.683 \text{ mol}} = 0.688 \qquad \left(\frac{1}{2}\right)$$

$$\chi_{CHCl_3} = 1.00 - 0.688 = 0.312 \qquad \left(\frac{1}{2}\right)$$

$$\begin{aligned} p_{total} &= \chi_{CHCl_3} p^o_{CHCl_3} + \chi_{CH_2Cl_2} p^o_{CH_2Cl_2} \\ &= (1 - \chi_{CH_2Cl_2}) p^o_{CHCl_3} + \chi_{CH_2Cl_2} p^o_{CH_2Cl_2} \\ &= p^o_{CHCl_3} + (p^o_{CH_2Cl_2} - p^o_{CHCl_3}) \chi_{CH_2Cl_2} \qquad \text{(Eq - 1)} \end{aligned}$$

Using Eq - 1 we get

$$P_{total} = p^o_{CHCl_3} + (p^o_{CH_2Cl_2} - p^o_{CHCl_3}) \chi_{CH_2Cl_2} \qquad \left(\frac{1}{2}\right)$$

$$\begin{aligned} &= 200 + (415 - 200) \text{ x } 0.688 \\ &= 200 + 147.9 \\ &= 347.9 \text{ mm Hg} \qquad \left(\frac{1}{2}\right) \end{aligned}$$

(b) Mole fraction of a component in vapour phase can be obtained by using the relation $y_i = p_i / p_{total}$

$p_{CH_2Cl_2} = 0.688 \text{ x } 415 \text{ mm Hg} = 285.5 \text{ mm Hg}$ $\left(\frac{1}{2}\right)$

$p_{CHCl_3} = 0.312 \text{ x } 200 \text{ mm Hg} = 62.4 \text{ mm Hg}$ $\left(\frac{1}{2}\right)$

$y_{CH_2Cl_2} = 285.5 \text{ mm Hg}/347.9 \text{ mm Hg} = 0.82$ $\left(\frac{1}{2}\right)$

$y_{CHCl_3} = 62.4 \text{ mm Hg}/347.9 \text{ mm Hg} = 0.18$ $\left(\frac{1}{2}\right)$

OR

Ans 28:

Molar mass of $CH_3CH_2CHClCOOH$
$= 4 \text{ x } 12 + 7 \text{ x } 1 + 35.5 + 2 \text{ x } 16$
$= 122.5 \text{ g mol}^{-1}$

Moles of $CH_3CH_2CHClCOOH = \frac{10}{122.5}$

$= 8.16 \times 10^{-2}$ mol $\left(\frac{1}{2}\right)$

$$\text{Molality of solution} = \frac{\text{number of moles of solute} \times 1000}{\text{mass of solvent in grams}} \quad \left(\frac{1}{2}\right)$$

$$= \frac{8.16 \times 10^{-2} \times 1000}{250}$$

$$= 0.3265 \text{ m} \quad \left(\frac{1}{2}\right)$$

Calculation of degree of dissociation (α) of $CH_3CH_2CHClCOOH$

	$CH_3CH_2CHClCOOH \rightleftharpoons$	$CH_3CH_2CHClCOO^-$	$+ \quad H^+$	
At equilibrium	$1 - \alpha$	α	α	$\left(\frac{1}{2}\right)$
Conc. after dissociation	$c(1 - \alpha)$	$c\alpha$	$c\alpha$	$\left(\frac{1}{2}\right)$

Now

$$K_a = \frac{c\alpha \, . \, c\alpha}{c\,(1 - \alpha)}$$

Since, $\alpha <<< 1$

$K_a = c\alpha^2$ $\left(\frac{1}{2}\right)$

$$\text{or } \alpha = \sqrt{K_a / c}$$

$$= \sqrt{\frac{1.4 \times 10^{-3}}{0.3265}}$$

$$= 0.065$$

Calculatation of van't Hoff factor (i)

$$CH_3CH_2CHClCOOH \rightleftharpoons CH_3CH_2CHClCOO^- \quad + \quad H^+$$

At equilibrium	$1 - \alpha$	α	α

$i = \dfrac{1 - \alpha + \alpha + \alpha}{1}$ $\left(\frac{1}{2}\right)$

$$= \frac{1 + \alpha}{1}$$

$$= 1 + 0.065$$

$= 1.065$ $\left(\frac{1}{2}\right)$

$\Delta T_f = iK_f m$ $\left(\frac{1}{2}\right)$

$$= 1.065 \times 1.86 \times 0.3265$$

$= 0.647 \text{ K}$ $\left(\frac{1}{2}\right)$

Ans 29:

(a) The high enthalpies of atomization of transition elements are due to large number of unpaired electrons in their atoms. Therefore they have stronger inter-atomic interactions and hence, stronger bonding between atoms. Thus, they have high enthalpies of atomization. (1)

(b) Transition elements are defined as the elements which have incompletely filled d orbitals in its ground state or any one of its oxidation states. Cu^{2+} has partially filled d–orbitals (d^9) and thus copper is regarded as transition metal. (1)

(c) Ce(Z = 58): $[Xe]^{54}\ 4f^1\ 5d^1\ 6s^2$

$Ce^{3+}: 4f^1$ $\left(\frac{1}{2}\right)$

No. of unpaired electrons is 1

Magnetic moment,

$$\mu = \sqrt{n(n+2)}$$
$$= \sqrt{1(1+2)}$$
$$= \sqrt{3}$$
$$= 1.73\ \text{BM}$$ $\left(\frac{1}{2}\right)$

(d) Due to lanthanoid contraction, Hf and Zr have almost similar atomic size and therefore, their properties are similar. (1)

(e) Increasing oxidizing power in the series is due to increasing stability of lower species to which they are reduced. (1)

OR

Ans 29:

(a) $La(OH)_3$ is more basic than $Lu(OH)_3$. Due to lanthanoid contraction the size of lanthanoid ions decreases regularly with increase in atomic number. As a result of decrease in size, the covalent character between lanthanoid ion and OH^- ions increase from La^{3+} to Lu^{3+}. Therefore, the basic character of hydroxides decreases from $La(OH)_3$ to $Lu(OH)_3$. (1)

(b) In the solution, the following equilibrium exists dichromate and chromate ion:

$$Cr_2O_7^{2-} + 2OH^- \rightleftharpoons 2CrO_4^{2-} + H_2O \qquad \left(\frac{1}{2}\right)$$

In acidic medium, (pH < 7), it exists as $Cr_2O_7^{2-}$ ions and hence has orange colour. In basic medium (pH > 7), it exists as CrO_4^{2-} ions and therefore has yellow colour. $\left(\frac{1}{2}\right)$

(c) Electronic configuration of Cr is [Ar] $3d^5\,4s^1$ .Cr^{2+} is a reducing agent because its electronic configuration changes from $3d^4$ to $3d^3$ when Cr^{2+} changes to Cr^{3+}. The $3d^3$ configuration is stable because it has stable half filled t_{2g} subshell ($t_{2g}^{\,3}$). $\left(\frac{1}{2}\right)$

Electronic configuration of Mn is [Ar] $3d^5 4s^2$.

Mn^{3+} on changing to Mn^{2+} becomes stable because of half filled d^5 configuration which has extra stability. Thus, Mn^{3+} is a good oxidising agent. $\left(\frac{1}{2}\right)$

(d)

Electronic configuration of element having atomic number 25: $3d^5\,4s^2$

Outer electronic configuration of divalent ion: $3d^5$

No. of unpaired electrons = 5

$$\begin{aligned}\mu &= \sqrt{n(n+2)} \\ &= \sqrt{5(5+2)} \\ &= 5.92\ \text{BM}\end{aligned} \qquad (1)$$

Outer electronic configuration of trivalent ion: $3d^4$

No. of unpaired electrons = 4

$$\mu = \sqrt{4(4+2)}$$

$= 4.90$ BM (1 mark)

Ans30:

Since the given compound on hydrolysis with dil. H_2SO_4 gives carboxylic acid (B) and an alcohol (C), it must be an ester. $\left(\frac{1}{2}\right)$

Also, the oxidation of alcohol C with chromic acid gives carboxylic acid B. So both the carboxylic acid and alcohol contains the same number of carbon atoms. $\left(\frac{1}{2}\right)$

Alcohol C on dehydration gives but-1-ene. So, the carboxylic acid B and alcohol C both contain 4 carbon atoms. $\left(\frac{1}{2}\right)$

Alcohol C on dehydration gives but-1-ene and therefore, C must be a straight chain alcohol, i.e., butan-1-ol. $\left(\frac{1}{2}\right)$

This also suggests that the ester A must be butyl butanoate.

The reactions are:

$$\underset{\substack{\text{A}\\ \text{Butyl butanoate}\\ (\text{M.F.} = C_8H_{16}O_2)}}{CH_3CH_2CH_2COOCH_2CH_2CH_2CH_3} \xrightarrow[\text{Hydrolysis}]{\text{dil. } H_2SO_4} \underset{\substack{\text{B}\\ \text{Butanoic acid}}}{CH_3CH_2CH_2COOH} + \underset{\substack{\text{C}\\ \text{Butan - 1 - ol}}}{CH_3CH_2CH_2CH_2OH} \quad (1)$$

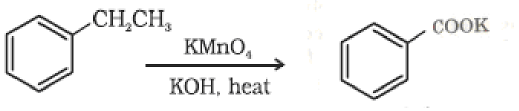
$$\underset{\text{B}}{CH_3CH_2CH_2CH_2OH} \xrightarrow[\text{Oxidation}]{CrO_3/H_2SO_4} \underset{\text{C}}{CH_3CH_2CH_2COOH} \quad (1)$$

$$\underset{\text{B}}{CH_3CH_2CH_2CH_2OH} \xrightarrow{\text{Dehydration}} \underset{\text{But - 1 - ene}}{CH_3CH_2CH = CH_2} \quad (1)$$

OR

Ans 30:

(a)



Potassium benzoate

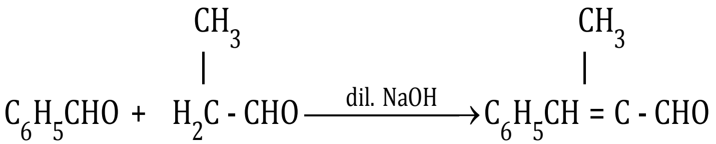
(1)

(b)

$$C_6H_5CHO \xrightarrow{H_2NCONHNH_2} C_6H_5CH = NNHCONH_2$$

Benzaldehyde semicarbazone (1)

(c)

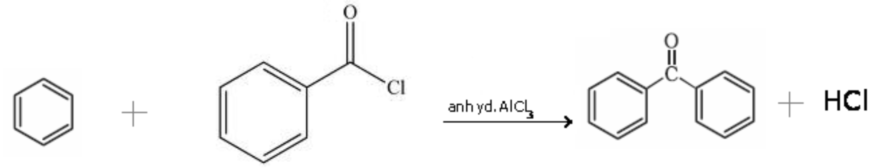


$$C_6H_5CHO + \overset{\overset{\displaystyle CH_3}{|}}{H_2C} - CHO \xrightarrow{\text{dil. NaOH}} C_6H_5CH = \overset{\overset{\displaystyle CH_3}{|}}{C} - CHO$$

2 - Methyl - 3 - phenylprop - 2 - enal

(1)

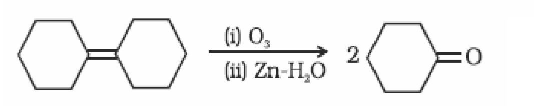
(d)



Benzophenone

(1)

(e)



Cyclohexanone

(1)