Q.1 0.27 g of a long chain fatty acid was dissolved in 100 cm³ of hexane, 10 mL of this solution was added dropwise to the surface of water in a round watch glass. Hexane evaporates and a monolayer is formed. The distance from edge to centre of the watch glass is 10 cm. What is the height of the monolayer? [Density of fatty acid = 0.9 g cm⁻³, π = 3]

(1) 10⁻² m  (2) 10⁻⁴ m  (3) 10⁻⁸ m  (4) 10⁻⁶ m

Ans. [4]

Sol. In 100 ml \( \text{gm of fatty acid} = 0.27 \text{ gm} \)

\[ \frac{1 \text{ ml gm}}{100} = \frac{0.27}{100} \]

\[ \frac{10 \text{ ml gm}}{100} = \frac{0.27 \times 10}{100} = 0.027 \]

\[ d = \frac{m}{v} \]

\[ d \times v = m \]

\[ 0.9 \left( \frac{\text{gm}}{\text{cm}^3} \right) \times \text{area} \times \text{height} = 0.027 \text{ gm} \]

\[ 0.9 \times (3) \times (10)^2 \times h = 0.027 \]

\[ h = 10^{-4} \text{ cm} \]

\[ h = 10^{-6} \text{ m} \]

Q.2 5 moles of an ideal gas at 100 K are allowed to undergo reversible compression till its temperature becomes 200 K. If \( C_V = 28 \text{ J K}^{-1} \text{ mol}^{-1} \), calculate \( \Delta U \) and \( \Delta pV \)

(1) \( \Delta U = 14 \text{ J}; \Delta (pV) = 0.8 \text{ J} \)

(2) \( \Delta U = 14 \text{ kJ}; \Delta (pV) = 4 \text{ kJ} \)

(3) \( \Delta U = 14 \text{ kJ}; \Delta (pV) = 18 \text{ J} \)

(4) \( \Delta U = 2.8 \text{ kJ}; \Delta (pV) = 0.8 \text{ kJ} \)

Ans. [2]

Sol. \( \Delta U = nC_V \Delta T \)

\[ = 5(28) (100) \text{ J} = 14000 \text{ J} = 14 \text{ kJ} \]

\( \Delta PV = P_2V_2 - P_1V_1 \)

\[ nRT_2 - nRT_1 = nR(T_2 - T_1) \]

\[ = 5(8)(100) = 4000 \text{ J} = 4 \text{ kJ} \]
Q.3 The calculated spin-only magnetic moments (BM) of the anionic and cationic species of [Fe(H₂O)₆]²⁺ and [Fe(CN)₆]⁻⁴, respectively, are
(1) 2.84 and 5.92  (2) 0 and 5.92  (3) 0 and 4.9  (4) 4.9 and 0
Ans.  [4]
Sol. Compound is [Fe(H₂O)₆]²⁺ [Fe(CN)₆]⁻⁴
Cation is [Fe(H₂O)₆]²⁺
Anion is [Fe(CN)₆]⁻⁴
Configuration of Fe²⁺ = (Ar) 3d⁶
  3d
   
For H₂O W.F. ligand

  +  +  +  +

4 unpaired e⁻, ∴ μ = \sqrt{4(4+2)} = 4.9 = 4.9 B.M.

For CN⁻ & F. ligand

++  +  +  +

No unpaired e⁻
μ = 0

Q.4 The compound that inhibits the growth of tumors is -
(1) cis-[Pd(Cl)₂(NH₃)₂]  (2) trans-[Pd(Cl)₂(NH₃)₂]
(3) cis-[Pt(Cl)₂(NH₃)₂]  (4) trans-[Pt(Cl)₂(NH₃)₂]
Ans.  [3]
Sol. cis platin is used to inhibit growth of tumors

Q.5 Which of the following compounds will show the maximum 'enol' content?
(1) CH₃COCH₃  (2) CH₃COCH₂COOC₂H₅
(3) CH₃COCH₂COCH₃  (4) CH₃COCH₂CONH₂
Ans.  [3]
Sol. β-Dicarbonyl compound
β-Diketone
Extended conjugation and Intramolecular H-bonding in enolic form

Q.6 Which one of the following alkenes when treated with HCl yields majorly an anti Markovnikov product?
(1) CH₃O–CH=CH₂  (2) H₂N–CH=CH₂
(3) F₃C–CH=CH₂  (4) Cl–CH=CH₂
Ans.  [3]
Sol.

\[
\begin{array}{c}
\text{F} \\
\text{F} \\
\text{C} \\
\text{H} \\
\end{array}
\]

– CF₃ → – H effect
Most e⁻ withdrawing group
Q.7  The major product of the following reaction is –

\[ \text{CH}_3\text{Cl} \xrightarrow{\text{H}_2\text{O}, \Delta} \text{CHCl}_2 \text{Cl} \]

(1) \text{CH}_2\text{OH}
(2) \text{CO}_2\text{H}
(3) \text{CHO}
(4) \text{H}_2\text{O}

\text{Ans.} [1]

\text{Sol.}

\[ \text{CH}_3\text{Cl} \xrightarrow{\text{Cl}_2/hv} \text{CHCl}_2 \text{Cl} \]

Q.8  Consider the bcc unit cells of the solids 1 and 2 with the position of atoms as shown below. The radius of atom B is twice that of atom A. The unit cell edge length is 50% more in solid 2 than in 1. What is the approximate packing efficiency in solid 2?

\[ \text{Solid 1} \]

[1] 75%
[2] 90%
[3] 45%
[4] 65%

\text{Ans.} [2]

\text{Sol.}

\[ \text{Solid 1} \]

\[ \text{Solid 2} \]
\[ r_3 = 2r_A \quad \text{and} \quad a_2 = 1.5a_1 \]
\[ 4r_A = \sqrt{3}a_1 \quad \text{and} \quad a_1 = \frac{4r_A}{\sqrt{3}} \]
\[ a_2 = 1.5a_1 \]
\[ \frac{3}{2} \cdot \frac{4r_A}{\sqrt{3}} \]  
\[ a_2 = 2\sqrt{3}r_A \]

\[ \text{PE}_2 = \frac{\left( \frac{4}{3} \pi r_A^3 \times 1 \right) + \left( \frac{4}{3} \pi r_B^3 \times 1 \right)}{a_2^2} \]
\[ = \frac{\frac{4}{3} \pi r_A^3 + \frac{4}{3} \pi (2r_A)^3}{(2\sqrt{3}r_A)^3} \]
\[ = \frac{\frac{4}{3} \pi r_A^3 \times 9}{8 \times 3\sqrt{3} r_A^3} = \frac{\pi}{2\sqrt{3}} = 90.64\% \]
\[ = 90\% \]

**Q.9** If \( p \) is the momentum of the fastest electron ejected from a metal surface after the irradiation of light having wavelength \( \lambda \), then for 1.5 \( p \) momentum of the photoelectron, the wavelength of the light should be (Assume kinetic energy of ejected photoelectron to be very high in comparison to work function)

(1) \( \frac{4}{9}\lambda \)
(2) \( \frac{2}{3}\lambda \)
(3) \( \frac{3}{4}\lambda \)
(4) \( \frac{1}{2}\lambda \)

**Ans.** [1]

**Sol.**

\[ E = \phi + \text{KE} \]
\[ E = \text{KE} \]
\[ \frac{h}{\lambda} = \frac{1}{2}mv^2 \left( \frac{m}{m} \right) = \frac{p^2}{2m} \]
\[ p^2 \propto \frac{1}{\lambda} \]
\[ \left( \frac{P_2}{P_1} \right)^2 = \frac{\lambda_1}{\lambda_2} \]
\[ \left( \frac{1.5P_1}{P_1} \right)^2 = \frac{\lambda_1}{\lambda_2} \]
\[ \left( \frac{3}{2} \right)^2 = \frac{\lambda_1}{\lambda_2} \]
\[ \frac{9}{4} = \frac{\lambda_1}{\lambda_2} \]
\[ \lambda_2 = \frac{4}{9}\lambda_1 \]
Q.10  The major product of the following reaction is –

\[
\begin{align*}
(1) & \text{tBuOK} \\
(2) & \text{Conc. H}_2\text{SO}_4/\Delta \\
(3) & \text{E}_2 \text{ Machanism} \\
(4) & \text{Stanny base}
\end{align*}
\]

Ans. [1]

Sol.

\[
\begin{align*}
\text{tBuOK} & \text{E}_2 \text{ Machanism} \\
\text{Stanny base} & \text{tBuOK}
\end{align*}
\]

Q.11  The Mond process is used for the-

(1) purification of Ni  
(2) extraction of Zn  
(3) extraction of Mo  
(4) purification of Zr and Ti

Ans. [1]

Sol.  Mond process is used for Ni

\[
\begin{align*}
\text{Ni} & + 4\text{CO} \xrightarrow{330-350K} \text{Ni(CO)}_4 \\
\text{impure} & \\
\text{Ni} & + 4\text{CO} \xrightarrow{330-350K} \text{Ni(CO)}_4 \\
\text{impure} & \\
\text{Ni} & + 4\text{CO} \xrightarrow{450-470K} \text{Ni(CO)}_4 \\
\text{Pure} &
\end{align*}
\]
Q.12  For the solution of the gases w, x, y and z in water at 298 K, the Henry law constants \((K_H)\) are 0.5, 2, 35 and 40 kbar, respectively. The correct plot for the given data is -

\[(1)\]
\begin{align*}
\text{Partial pressure} & \\
\text{(0, 0)} & \\
\text{mole fraction of water} & \\
\end{align*}

\[(2)\]
\begin{align*}
\text{Partial pressure} & \\
\text{(0, 0)} & \\
\text{mole fraction of water} & \\
\end{align*}

\[(3)\]
\begin{align*}
\text{Partial pressure} & \\
\text{(0, 0)} & \\
\text{mole fraction of water} & \\
\end{align*}

\[(4)\]
\begin{align*}
\text{Partial pressure} & \\
\text{(0, 0)} & \\
\text{mole fraction of water} & \\
\end{align*}

\[\text{Ans. [2]}\]

\[\text{Sol.}\]

\[k_H = \frac{p_g}{x_g} = \text{bar}\]

\[p_g = k_H x_g = k_H (1 - x_w)\]

\[= k_H - k_H x_w\]

\[= -k_H x_w + k_H\]

\[y = -mx + c\]

\[\text{Higher slope} = \text{higher } K_H\]

\[\text{Lower slope} = \text{Lower } K_H\]

\[k_H \quad \frac{z}{y} > \frac{k_H}{x} > \frac{k_H}{w}\]

Q.13  The IUPAC symbol for the element with atomic number 119 would be -

(1) uue  (2) une  (3) uun  (4) unh

\[\text{Ans. [1]}\]

\[\text{Sol.}\]

\[z = 119\] is ununennium

\[\therefore\] uue

Q.14  The structure of Nylon-6 is ?

\[(1)\]
\[\text{(CH}_2\text{)}_{6-n}^{n} \text{C} – \text{N}\]

\[(2)\]
\[\text{(CH}_2\text{)}_{4-n}^{n} \text{C} – \text{N}\]

\[(3)\]
\[\text{C} – \text{(CH}_2\text{)}_{6-n}^{n} \text{N}\]

\[(4)\]
\[\text{C} – \text{(CH}_2\text{)}_{5-n}^{n} \text{N}\]
Q.15 The ion that has sp$^3$d$^2$ hybridization for the central atom is -

(1) [ICl$\text{4}^-]$  (2) [ICl$\text{2}^-]$  (3) [BrF$\text{2}^-]$  (4) [IF$\text{6}^-$]

Ans. [1]

Sol. Cl$\bigg[$ Cl Cl Cl $\bigg]$ sp$^3$d$^2$

Q.16 For a reaction scheme $A \underset{k_2}{\overset{k_1}{\longrightarrow}} B \underset{k_2}{\longrightarrow} C$, if the rate of formation of B is set to be zero then the concentration of B is given by -

(1) $(k_1 - k_2) [A]$  (2) $k_1k_2[A]$  (3) $(k_1 + k_2) [A]$  (4) $\left(\frac{k_1}{k_2}\right) [A]$

Ans. [4]

Sol. $\frac{dB}{dt} = K_1[A] - K_2[B] = 0$

$K_1[A] = K_2[B]$

$[B] = \frac{K_1}{K_2} [A]$

$\frac{dA}{dt} = K_1[A]$

$\frac{dC}{dt} = K_2[B]$

Q.17 For the following reactions, equilibrium constants are given -

$S(s) + O_2(g) \rightleftharpoons SO_2(g); K_1 = 10^{52}$

$2S(s) + 3O_2(g) \rightleftharpoons 2SO_3(g); K_2 = 10^{129}$

The equilibrium constant for the reaction,

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is

(1) $10^{154}$  (2) $10^{181}$  (3) $10^{25}$  (4) $10^{77}$

Ans. [3]

Sol. $S + O_2 \rightleftharpoons SO_2; K_1 = 10^{52}$

$2S + 3O_2 \rightleftharpoons 2SO_3; K_2 = 10^{129}$

$2SO_2 + O_2 \rightleftharpoons 2SO_3; K_3 = ?$

$K_3 = K_1^{-2} \cdot K_2 = \frac{K_2}{K_1^2} = \frac{10^{129}}{10^{104}} = 1$
Q.18 The statement that is incorrect about the interstitial compounds is -

(1) they are very hard    (2) they have metallic conductivity
(3) they have high melting points    (4) they are chemically reactive

Ans. [4]

Sol. Intersitial compound are –
(i) hard
(ii) chemically inert
(iv) high m.p.
As interstitial compounds are chemically inert

Q.19 The major product obtained in the following reaction is

\[
\text{NaOH} \xrightarrow{\Delta} \begin{array}{c}
\text{CH}_3 \\
\text{OHC} \\
\text{O}
\end{array}
\]

(1) \[ \begin{array}{c}
\text{CH}_3 \\
\text{O} \\
\text{CH}_3
\end{array} \]
(2) \[ \begin{array}{c}
\text{CH}_3 \\
\text{O} \\
\text{H}
\end{array} \]
(3) \[ \begin{array}{c}
\text{CH}_3 \\
\text{O} \\
\text{H}
\end{array} \]
(4) \[ \begin{array}{c}
\text{H}_3\text{C} \\
\text{CH}_2 \\
\text{O}
\end{array} \]

Ans. [2]

Sol.

\[ \begin{array}{c}
\text{O} \\
\text{CH}_3 \\
\text{CH}=\text{O}
\end{array} \]

\[ \text{Inter molecular aldol condensation} \]

\[ \begin{array}{c}
\text{CH}_3 \\
\text{O}
\end{array} \]

\[ \alpha, \beta \text{-unsaturated carbonyl compound} \]

Q.20 The percentage composition of carbon by mole in methane is -

(1) 75%    (2) 80%    (3) 20%    (4) 25%

Ans. [3]

Sol. % composition of C by mole in CH₄
\[
\% \text{ C} = \frac{1}{5} \times 100
\]
= 20%
Q.21 Among the following molecules /ions, $\text{C}_2^2$, $\text{N}_2^2$, $\text{O}_2^2$, $\text{O}_2$ which one is diamagnetic and has the shortest bond length

(1) $\text{N}_2^2$ (2) $\text{O}_2$ (3) $\text{C}_2^2$ (4) $\text{O}_2^2$

Ans. [3]
Sol. $\text{O}_2$, $\text{N}_2^2$ = paramagnetic $\text{C}_2^2$ and $\text{O}_2^2$ = diamagnetic
$\text{C}_2^2$ has B.O. = 3
∴ diamagnetic & shortest B.L.

Q.22 Polysubstitution is a major drawback in -
(1) Reimer Tiemann reaction (2) Friedel Craft's acylation
(3) Friedel Craft's alkylation (4) Acetylation of aniline

Ans. [3]
Sol. Polysubstitution is a major drawback of Friedel–Craft alkylation
$\text{–CH}_3$ gp in highly activating group
due to +H effect of its

Q.23 Calculate the standard cell potential (in V) of the cell in which following reaction takes place –
$\text{Fe}^{2+} (\text{aq}) + \text{Ag}+ (\text{aq}) \rightarrow \text{Fe}^{3+} (\text{aq}) + \text{Ag} (s)$

Given that
$E^\circ_{\text{Ag}+/\text{Ag}} = xV$
$E^\circ_{\text{Fe}^{3+}/\text{Fe}} = yV$
$E^\circ_{\text{Fe}^{2+}/\text{Fe}} = zV$

(1) $x + 2y - 3z$ (2) $x + y - z$ (3) $x - y$ (4) $x - z$

Ans. [1]
Sol.

$E^\circ_{\text{cell}} = E^\circ_{\text{C}} - E^\circ_{\text{A}}$
$\begin{align*}
\text{R.P.} & - \text{R.P.} \\
\text{cell} & = \text{E}_C \text{Ag}^+ / \text{Ag} \\
\text{cell} & = \text{E}_C \text{Fe}^{3+}/\text{Fe}^{2+} = x - (3z - 2y) \\
\text{cell} & = x + 2y - 3z \\
\text{cell} & = \frac{\pm n_1 E_1 \pm n_2 E_2}{n_3} \\
\text{cell} & = \frac{3z - 2y}{1} = 3z - 2y
\end{align*}$

Q.24 The covalent alkaline earth metal halide ($X = \text{Cl, Br, I}$) is

(1) $\text{BeX}_2$ (2) $\text{SrX}_2$ (3) $\text{MgX}_2$ (4) $\text{CaX}_2$

Ans. [1]
Sol. Halides of Be are covalent
Q.25  The correct statement about ICl₅ and ICl₄⁻
(1) both are isostructural
(2) ICl₅ is square pyramidal and ICl₄⁻ is square planer
(3) ICl₅ is trigonal bipyramidal and ICl₄⁻ is tetrahedral
(4) ICl₅ is square pyramidal and ICl₄⁻ is tetrahedral
Ans.  [2]
Sol.  ICl₅ is \[ \text{sp}^3\text{d}^2 \text{ square pyramidal} \]
ICl₄⁻ square planar \[ \text{sp}^3\text{d}^2 \]
Q.26  The major product in the following reaction is ?
\[
\text{base} + \text{N} = \text{H}_2 \text{N} \rightarrow \text{N} = \text{H}_2 \text{N} + \text{CH}_3 \text{I}
\]
\[
\begin{align*}
(1) & \quad \text{N} = \text{H}_2 \text{N} \text{CH}_3 \\
(2) & \quad \text{N} = \text{H}_2 \text{N} \text{CH}_3 \\
(3) & \quad \text{N} = \text{H}_2 \text{N} \\
(4) & \quad \text{N} = \text{H}_2 \text{N} \text{CH}_3
\end{align*}
\]
Ans.  [1] Bonus
Sol.  \[
\text{base} + \text{N} = \text{H}_2 \text{N} \rightarrow \text{N} = \text{H}_2 \text{N} + \text{CH}_3 \text{I}
\]
Official answer according to NTA → 1
Q.27  The maximum prescribed concentration of copper in drinking water is -
(1) 5 ppm  (2) 0.5 ppm  (3) 3 ppm  (4) 0.05 ppm
Ans.  [3]
Sol.  The prescribed conc. of Cu in drinking water is 3 ppm
Q.28  Fructose and glucose can be distinguished by -
(1) Fehling's test  (2) Seliwanoff's test  (3) Barfoed's test  (4) Benedict's test
Ans.  [2]
Sol.  Glucose and fructose can be distinguished by seliwan eff's. It is used to distinguished aldose ketose group.
Q.29 The major product obtained in the following reaction is –

\[
\text{C–CH}_3 \quad \text{CN} \\
\text{H}_2/\text{PCl-C} \\
\text{C–CH}_3 \quad \text{H}_2\text{N} \\
\text{CH–CH}_3 \quad \text{OH} \quad \text{NH–CH}_3 \\
\text{CH}_2–\text{NH}_2
\]

Ans. [2]

Sol.

Q.30 The strength of 11.2 volume solution of H\(_2\)O\(_2\) is : [Given that molar mass of H = 1 g mol\(^{-1}\) and O = 16 g mol\(^{-1}\)]

(1) 1.7% (2) 34% (3) 3.4% (4) 13.6%

Ans. [3]

Sol.

11.2 vol. \(\text{H}_2\text{O}_2\)

\(m = ?\)

Vol. strength = 11.2 M

11.2 = 11.2 \(m\)

\(m = 1\)

1 mole \(\text{H}_2\text{O}_2\) prompt in IL solution

34 gm in 1000 gm solution

\[
\% = \frac{(\text{gm}\text{.}\text{solute})}{(\text{gm}\text{.}\text{solution})} \times 100
\]

\[
= \frac{34}{1000} \times 100 = 3.4\%
\]