# IIT - JEE ADVENCED - 2012

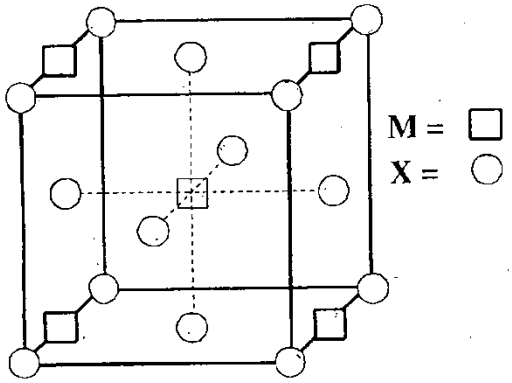
## PAPER-1 [Code – 8]

## PART - II: CHEMISTRY

### SECTION – I: Single Correct Answer Type

This section contains **10 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

21. A compound $M_pX_q$ has cubic close packing (ccp) arrangement of X. Its unit cell structure is shown below. The empirical formula of the compound is




(A) MX (B) $MX_2$
(C) $M_2X$ (D) $M_5X_{14}$

***Sol.*** **(B)**

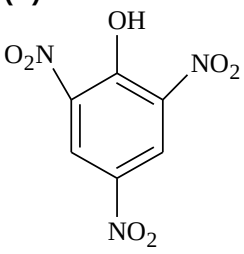
$$X = 8\times\frac{1}{8}+6\times\frac{1}{2}=4$$

$$M = 4\times\frac{1}{4}+1=2$$

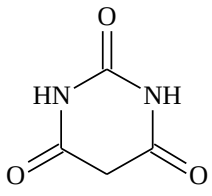
So, unit cell formula of the compound is $M_2X_4$ and the empirical formula of the compound is $MX_2$.

22. The carboxyl functional group (–COOH) is present in
(A) picric acid (B) barbituric acid
(C) ascorbic acid (D) aspirin

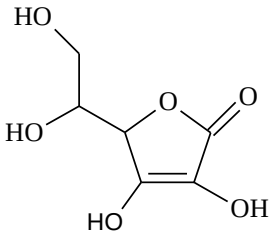
***Sol.*** **(D)**



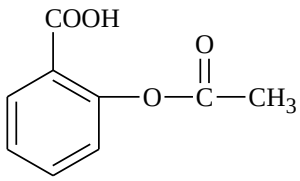
(Picric Acid)



(Barbituric Acid)



(Ascorbic Acid)



(Asprin)

23. As per IUPAC nomenclature, the name of the complex $[Co(H_2O)_4(NH_3)_2]Cl_3$ is
(A) Tetraaquadiaminecobalt (III) chloride (B) Tetraaquadiamminecobalt (III) chloride
(C) Diaminetetraaquacobalt (III) chloride (D) Diamminetetraaquacobalt (III) chloride

***Sol.*** **(D)**

$[Co(H_2O)_4(NH_3)_2]Cl_3$

Dia**mm**inetetraaquacobalt (III) chloride

24. In allene ($C_3H_4$), the type(s) of hybridization of the carbon atoms is (are)

(A) *sp* and $sp^3$ (B) *sp* and $sp^2$

(C) only $sp^2$ (D) $sp^2$ and $sp^3$

***Sol.*** **(B)**

$$\overset{sp^2}{H_2}C=\overset{sp}{C}=\overset{sp^2}{C}H_2$$

25. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is [$a_0$ is Bohr radius]

(A) $\dfrac{h^2}{4\pi^2 m a_0^2}$ (B) $\dfrac{h^2}{16\pi^2 m a_0^2}$

(C) $\dfrac{h^2}{32\pi^2 m a_0^2}$ (D) $\dfrac{h^2}{64\pi^2 m a_0^2}$

***Sol.*** **(C)**

As per Bohr's postulate,

$$mvr=\frac{nh}{2\pi}$$

So, $v=\dfrac{nh}{2\pi mr}$

$$KE=\frac{1}{2}mv^2$$

**So,** $KE=\dfrac{1}{2}m\left(\dfrac{nh}{2\pi mr}\right)^2$

Since, $r=\dfrac{a_o\times n^2}{z}$

So, for 2nd Bohr orbit

$$r=\frac{a_o\times 2^2}{1}=4a_o$$

$$KE=\frac{1}{2}m\left(\frac{2^2h^2}{4\pi^2m^2\times(4a_0)^2}\right)$$

$$KE=\frac{h^2}{32\pi^2 m a_0^2}$$

26. Which ordering of compounds is according to the decreasing order of the oxidation state of nitrogen?

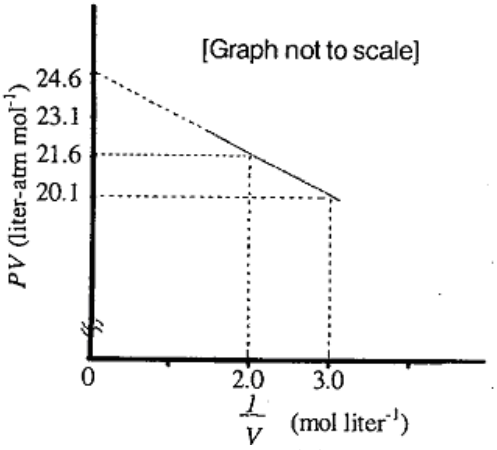
(A) $HNO_3$, NO, $NH_4Cl$, $N_2$ (B) $HNO_3$, NO, $N_2$, $NH_4Cl$

(C) $HNO_3$, $NH_4Cl$, NO, $N_2$ (D) NO, $HNO_3$, $NH_4Cl$, $N_2$

***Sol.*** **(B)**

$\overset{+5}{H}\overset{}{N}O_3, \overset{+2}{N}O, \overset{0}{N_2}, \overset{-3}{N}H_4Cl$

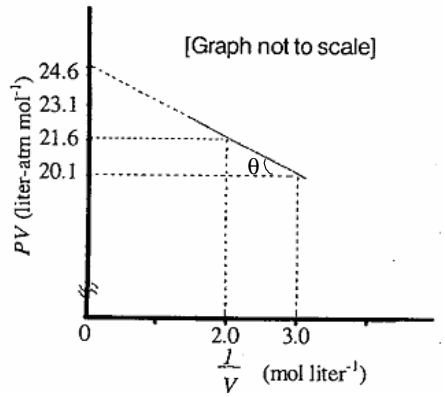
27. For one mole of a van der Waals gas when $b = 0$ and $T = 300$ K, the $PV$ vs. $1/V$ plot is shown below. The value of the van der Waals constant $a$ (atm.litre$^2$mol$^{-2}$) is




(A) 1.0 (B) 4.5

(C) 1.5 (D) 3.0

***Sol.*** **(C)**




van der Waals equation for 1 mole of real gas is,

$$\left(P+\frac{a}{V^2}\right)(V-b)=RT$$

but, b = 0 (given)

$$\Rightarrow\left(P+\frac{a}{V^2}\right)(V)=RT$$

$$\therefore \quad PV=-a\times\frac{1}{V}+RT \qquad \text{.....(i)}$$

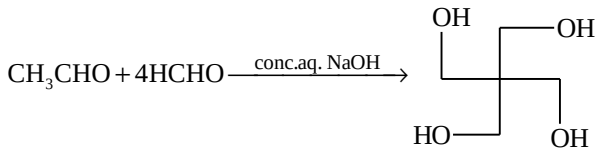
$y = mx + c$

Slope = $\tan(\pi-\theta) = -a$

So, $\tan\theta = a = \frac{21.6-20.1}{3-2} = 1.5$

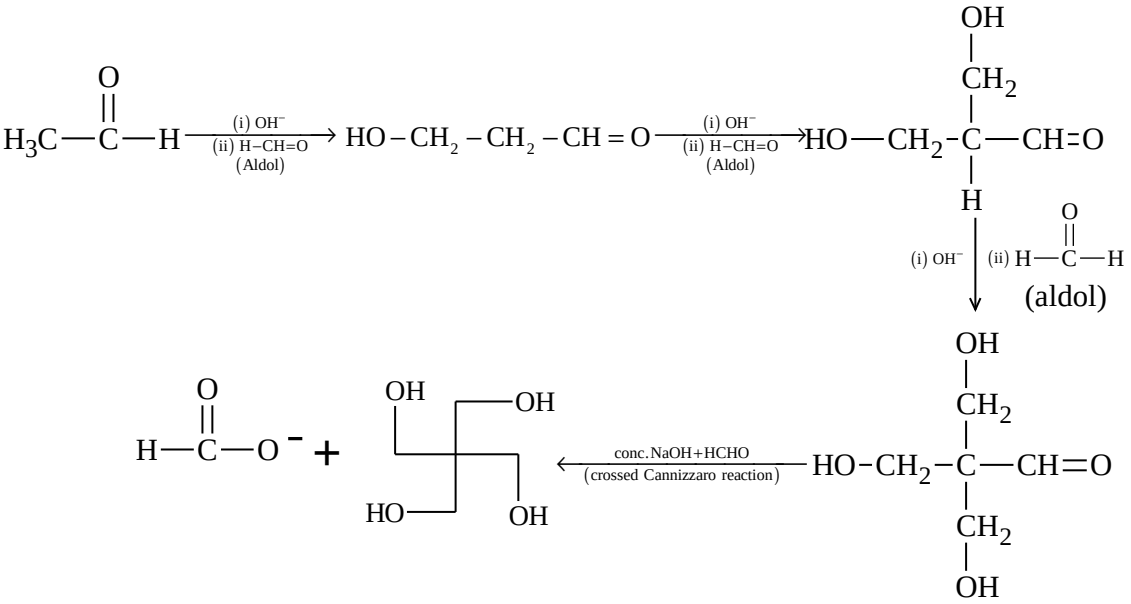
or, $\tan\theta = \frac{24.6-20.1}{3-0} = 1.5$

28. The number of aldol reaction(s) that occurs in the given transformation is



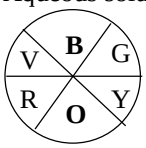
(A) 1 (B) 2
(C) 3 (D) 4

***Sol.*** **(C)**

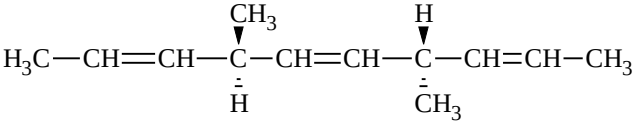


29. The colour of light absorbed by an aqueous solution of $CuSO_4$ is
(A) orange- red (B) blue-green
(C) yellow (D) violet

***Sol.*** **(A)**
Aqueous solution of copper sulphate absorbs orange red light and appears blue (complementary colour).

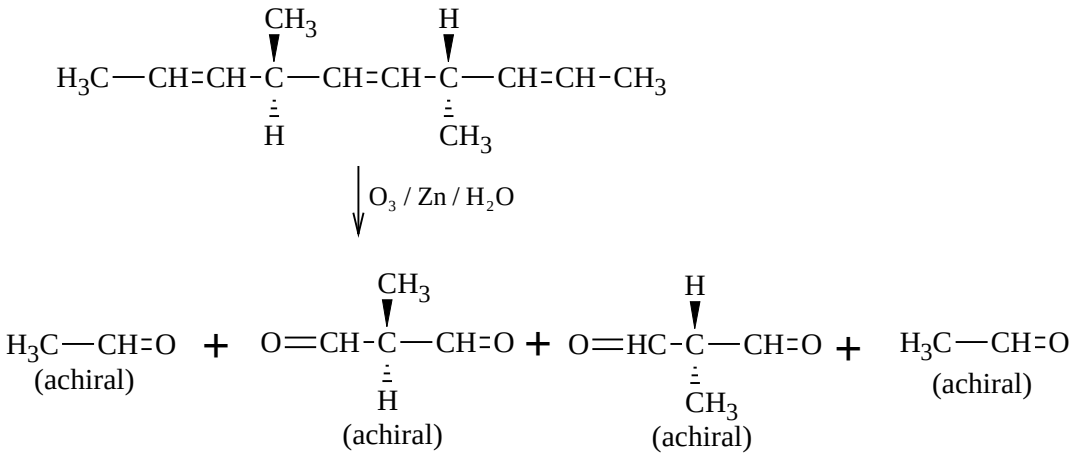



30. The number of optically active products obtained from the **complete** ozonolysis of the given compound is



(A) 0 (B) 1
(C) 2 (D) 4

***Sol.*** **(A)**




**SECTION II : Multiple Correct Answer (s) Type**

This section contains **5 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct.**

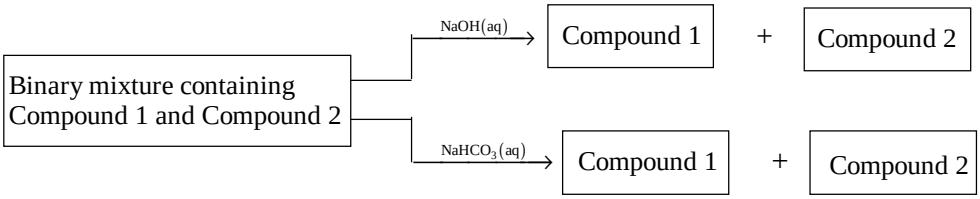
31. Which of the following hydrogen halides react(s) with $AgNO_3$(aq) to give a precipitate that dissolves in $Na_2S_2O_3$(aq)?
(A) HCl (B) HF
(C) HBr (D) HI

***Sol.*** **(A, C, D)**

$$HX + AgNO_3 \rightarrow AgX\downarrow + HNO_3 \ (X = Cl,\ Br,\ I)$$

$$AgX + 2Na_2S_2O_3 \rightarrow Na_3\left[Ag\left(S_2O_3\right)_2\right] + NaX$$

32. Identify the binary mixture(s) that can be separated into individual compounds, by differential extraction, as shown in the given scheme.

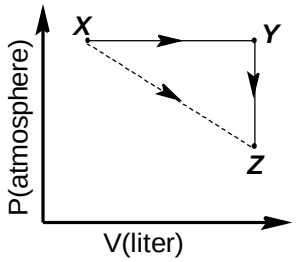



(A) $C_6H_5OH$ and $C_6H_5COOH$ (B) $C_6H_5COOH$ and $C_6H_5CH_2OH$
(C) $C_6H_5CH_2OH$ and $C_6H_5OH$ (D) $C_6H_5CH_2OH$ and $C_6H_5CH_2COOH$

***Sol.*** **(B, D)**

(A) Both are soluble in NaOH, hence **inseparable**.
(B) Only benzoic acid ($C_6H_5COOH$) is soluble in NaOH and $NaHCO_3$, while benzyl alcohol ($C_6H_5CH_2OH$) is not. Hence, **separable.**
(C) Although NaOH can enable separation between benzyl alcohol ($C_6H_5CH_2OH$) and phenol ($C_6H_5OH$) as only the later is soluble in NaOH. However, in $NaHCO_3$, both are insoluble. Hence, **inseparable.**
(D) α-phenyl acetic acid ($C_6H_5CH_2COOH$) is soluble in NaOH and $NaHCO_3$. While benzyl alcohol ($C_6H_5CH_2OH$) is not. Hence, **separable.**

33. For an ideal gas, consider only *P-V* work in going from an initial state ***X*** to the final state ***Z.*** The final state ***Z*** can be reached by either of the two paths shown in the figure. Which of the following choice(s) is(are) correct? [Take ΔS as change in entropy and *w* as work done]




(A) $\Delta S_{x\to z} = \Delta S_{x\to y} + \Delta S_{y\to z}$ (B) $w_{x\to z} = w_{x\to y} + w_{y\to z}$

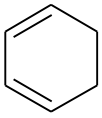
(C) $w_{x\to y\to z} = w_{x\to y}$ (D) $\Delta S_{x\to y\to z} = \Delta S_{x\to y}$

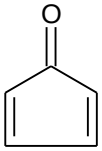
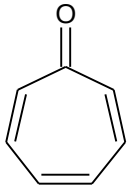
***Sol.*** **(A, C)**

$\Delta S_{X\to Z} = \Delta S_{X\to Y} + \Delta S_{Y\to Z}$ [entropy (S) is a state function, hence additive]

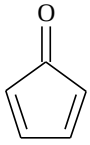
$w_{X\to Y\to Z} = w_{X\to Y}$ (work done in Y $\to$ Z is zero as it is an isochoric process)

34. Which of the following molecules, in pure form, is (are) **unstable** at room temperature?

(A)  (B) 

(C)  (D) 

***Sol.*** **(B, C)**

Compound  and  being antiaromatic are unstable at room temperature.

35. Choose the correct reason(s) for the stability of the **lyophobic** colloidal particles.
(A) Preferential adsorption of ions on their surface from the solution
(B) Preferential adsorption of solvent on their surface from the solution
(C) Attraction between different particles having opposite charges on their surface
(D) Potential difference between the fixed layer and the diffused layer of opposite charges around the colloidal particles

***Sol.*** **(A, D)**

Lyophobic colloids are stable due to preferential adsorption of ions on their surface from solution and potential difference between the fixed layer and the diffused layer of opposite charges around the colloidal particles that makes lyophobic sol stable.

## SECTION III: Integer Answer Type

This section contains **5 questions.** The answer to each question is a **single digit integer,** ranging from 0 to 9 (both inclusive).

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36. 29.2 % (w/w) HCl stock solution has density of 1.25 g $mL^{-1}$. The molecular weight of HCl is 36.5 g $mol^{-1}$. The volume (mL) of stock solution required to prepare a 200 mL solution of 0.4 M HCl is

***Sol.*** **(8)**

Stock solution of HCl = 29.2% (w/w)

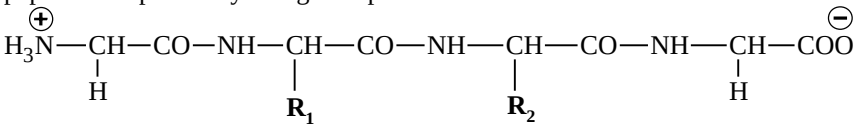
Molarity of stock solution of HCl $= \frac{29.2\times1000\times1.25}{36.5\times100}$

If volume of stock solution required = V ml

$V\times\frac{29.2}{36.5}\times\frac{1000}{80} = 200\times0.4$

$\Rightarrow$ V = 8 ml

37. The substituents $\mathbf{R_1}$ and $\mathbf{R_2}$ for nine peptides are listed in the table given below. How many of these peptides are positively charged at pH = 7.0?



| Peptide | $\mathbf{R_1}$ | $\mathbf{R_2}$ |
|---|---|---|
| I | H | H |
| II | H | $CH_3$ |
| III | $CH_2COOH$ | H |
| IV | $CH_2CONH_2$ | $(CH_2)_4NH_2$ |
| V | $CH_2CONH_2$` | $CH_2CONH_2$ |
| VI | $(CH_2)_4NH_2$ | $(CH_2)_4NH_2$ |
| VII | $CH_2COOH$ | $CH_2CONH_2$ |
| VIII | $CH_2OH$ | $(CH_2)_4NH_2$ |
| IX | $(CH_2)_4NH_2$` | $CH_3$ |

***Sol.*** **(4)**

Peptides with isoelectric point (pI) > 7, would exist as cation in neutral solution (pH = 7).

IV, VI, VIII and IX

38. An organic compound undergoes first-order decomposition. The time taken for its decomposition to 1/8 and 1/10 of its initial concentration are $t_{1/8}$ and $t_{1/10}$ respectively. What is the value of $\frac{[t_{1/8}]}{[t_{1/10}]}\times10$? (take $\log_{10}2$ = 0.3)

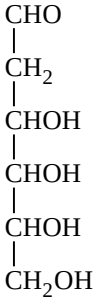
***Sol.*** **(9)**

$$t_{1/8} = \frac{2.303\log8}{k} = \frac{2.303\times3\log2}{k}$$

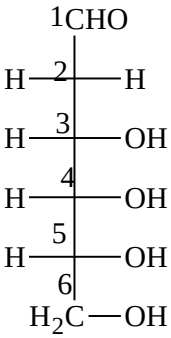
$$t_{1/10} = \frac{2.303}{k}\log10 = \frac{2.303}{k}$$

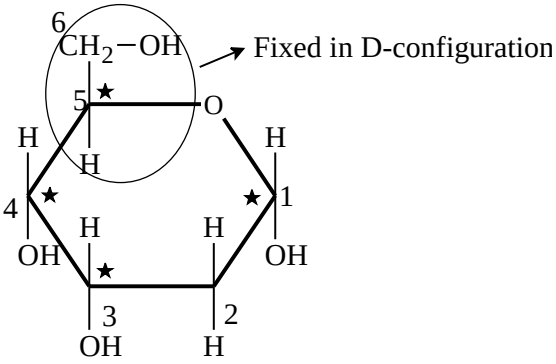
$$\left[\frac{t_{1/8}}{t_{1/10}}\right]\times10 = \frac{\left(\frac{2.303\times3\log2}{k}\right)}{\left(\frac{2.303}{k}\right)}\times10 = 9$$

39. When the following aldohexose exists in its **D**-configuration, the total number of stereoisomers in its pyranose form is



***Sol.*** **(8)**




Hence total number of stereoisomers in pyranose form of D-configuration = $2^3 = 8$

40. The periodic table consists of 18 groups. An isotope of copper, on bombardment with protons, undergoes a nuclear reaction yielding element **X** as shown below. To which group, element **X** belongs in the periodic table?

$^{63}_{29}Cu + ^{1}_{1}H \rightarrow 6^{1}_{0}n + \alpha + 2^{1}_{1}H + X$

***Sol.*** **(8)**

$^{63}_{29}Cu + {}_1H^1 \rightarrow 6\,{}_0n^1 + {}^{4}_{2}He + 2\,{}_1H^1 + {}^{A}_{Z}X$

Mass number: $63 + 1 = 1 \times 6 + 4 + 1 \times 2 + A$

$A = 64 - 12 = 52$

Atomic number: $29 + 1 = 6 \times 0 + 2 + 2 \times 1 + Z$

$Z = 30 - 4 = 26$

$^{A}_{Z}X = {}^{52}_{26}Fe$

Hence X is in group ‘8’ in the periodic table.