



**PAPER-1(B.E./B. TECH.)**

# **JEE (Main) 2021**

**Questions & solutions**

(Reproduced from memory retention)

**Date : 24 February, 2021 (SHIFT-1) Time ; (9.00 am to 12.00 pm)**

**Duration : 3 Hours | Max. Marks : 300**

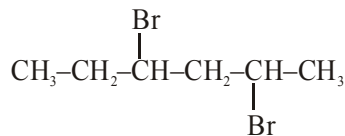
**SUBJECT : CHEMISTRY**

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**CHEMISTRY**

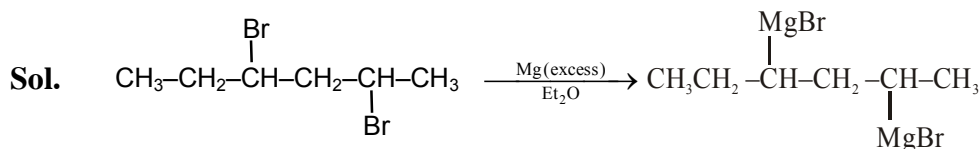
1. The product formed in the first step of the reaction of



with excess Mg/Et<sub>2</sub>O (Et = C<sub>2</sub>H<sub>5</sub>) is :

- (1)  $\text{CH}_3-\text{CH}_2-\overset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\overset{\text{CH}_3}{\text{CH}}-\text{CH}_3$       (2)  $\text{CH}_3-\text{CH}_2-\overset{\text{MgBr}}{\text{CH}}-\text{CH}_2-\overset{\text{MgBr}}{\text{CH}}-\text{CH}_3$
- (3)  $\text{CH}_3-\text{CH} \begin{cases} \text{CH}_2 \\ | \\ \text{CH}-\text{CH}_3 \end{cases}$       (4)  $\text{CH}_3\text{CH}_2-\overset{\text{MgBr}}{\text{CH}}-\text{CH}_2-\overset{\text{MgBr}}{\text{CH}}-\text{CH}_3$

Ans. (4)



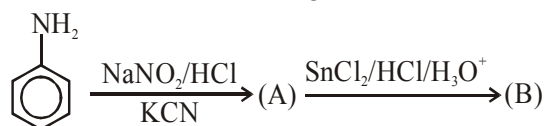
2. Consider the elements Mg, Al, S, P and Si, the correct increasing order of their first ionization enthalpy is :

- (1) Mg < Al < Si < S < P      (2) Al < Mg < Si < S < P  
(3) Mg < Al < Si < P < S      (4) Al < Mg < S < Si < P

Ans. (2)

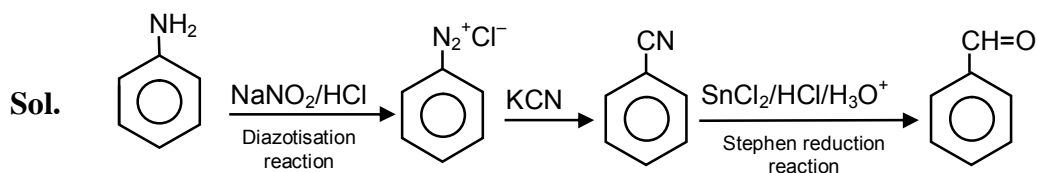
Sol. Al < Mg < Si < S < P

3. 'A' and 'B' in the following reactions are :



- (1) (A) :  $\text{C}_6\text{H}_5\text{N}_2^+\text{Cl}^-$       (B) :  $\text{C}_6\text{H}_5\text{CHO}$       (2) (A) :  $\text{C}_6\text{H}_5\text{N}_2^+\text{Cl}^-$       (B) :  $\text{C}_6\text{H}_5\text{Cl}$
- (3) (A) :  $\text{C}_6\text{H}_5\text{CN}$       (B) :  $\text{C}_6\text{H}_5\text{CHO}$       (4) (A) :  $\text{C}_6\text{H}_5\text{CN}$       (B) :  $\text{C}_6\text{H}_5\text{Cl}$

Ans. (3)



4. Which of the following ore is concentrated using group 1 cyanide salt ?  
 (1) Sphalerite                      (2) Calamine                      (3) Siderite                      (4) Malachite

**Ans. (1)**

**Sol.** Sphalerite

5.  $\text{Al}_2\text{O}_3$  was leached with alkali to get X. The solution of X on passing of gas Y, forms Z. X, Y and Z respectively are :

- (1)  $\text{X} = \text{Na}[\text{Al}(\text{OH})_4]$ ,  $\text{Y} = \text{SO}_2$ ,  $\text{Z} = \text{Al}_2\text{O}_3$                       (2)  $\text{X} = \text{Na}[\text{Al}(\text{OH})_4]$ ,  $\text{Y} = \text{CO}_2$ ,  $\text{Z} = \text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$   
 (3)  $\text{X} = \text{Al}(\text{OH})_3$ ,  $\text{Y} = \text{CO}_2$ ,  $\text{Z} = \text{Al}_2\text{O}_3$                       (4)  $\text{X} = \text{Al}(\text{OH})_3$ ,  $\text{Y} = \text{SO}_2$ ,  $\text{Z} = \text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$

**Ans. (2)**

**Sol.**  $\text{X} = \text{Na}[\text{Al}(\text{OH})_4]$ ,  $\text{Y} = \text{CO}_2$ ,  $\text{Z} = \text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$

6. Which of the following are isostructural pairs ?

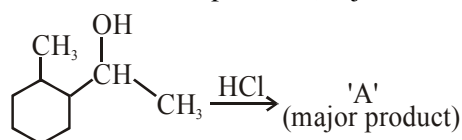
- A.  $\text{SO}_4^{2-}$  and  $\text{CrO}_4^{2-}$   
 B.  $\text{SiCl}_4$  and  $\text{TiCl}_4$   
 C.  $\text{NH}_3$  and  $\text{NO}_3^-$   
 D.  $\text{BCl}_3$  and  $\text{BrCl}_3$

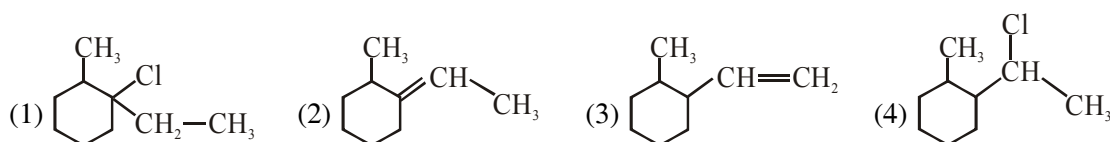
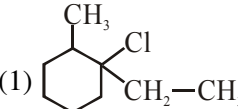
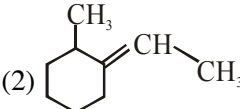
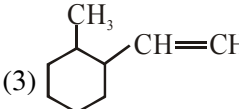
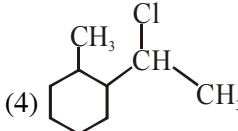
- (1) C and D only                      (2) A and B only                      (3) A and C only                      (4) B and C only

**Ans. (2)**

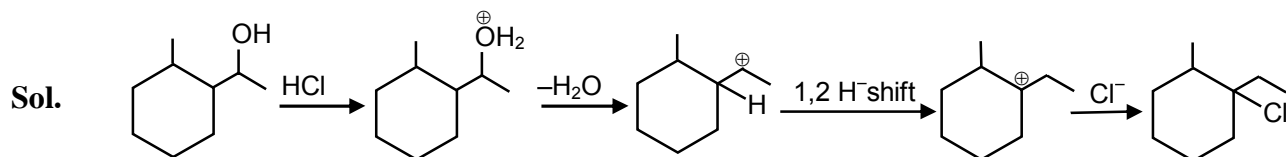
**Sol.**  $\text{SO}_4^{2-}$  and  $\text{CrO}_4^{2-}$  are tetrahedral  
 $\text{SiCl}_4$  and  $\text{TiCl}_4$  are tetrahedral

7. What is the final product (major) 'A' in the given reaction ?

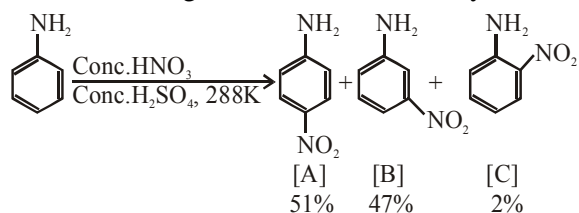


- 
  
 (1)       (2)       (3)       (4) 

**Ans. (1)**



8. In the following reaction the reason why meta-nitro product also formed is :

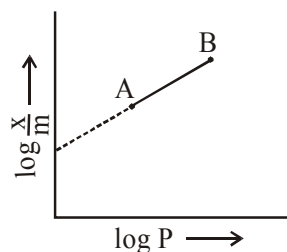


- (1) low temperature
- (2)  $-\text{NH}_2$  group is highly meta-directive
- (3) Formation of anilinium ion
- (4)  $-\text{NO}_2$  substitution always takes place at meta-position

Ans. (3)

Sol. In acidic medium, aniline is converted into anilinium ion which is meta directing.

9. In Freundlich adsorption isotherm, slope of AB line is :



- (1)  $\log n$  with ( $n > 1$ )
- (2)  $n$  with ( $n, 0.1$  to  $0.5$ )
- (3)  $\log \frac{1}{n}$  with ( $n < 1$ )
- (4)  $\frac{1}{n}$  with ( $\frac{1}{n} = 0$  to  $1$ )

Ans. (4)

Sol. Slope =  $\frac{1}{n}$  (0 to 1)

10. (A)  $\text{HOCl} + \text{H}_2\text{O}_2 \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^- + \text{O}_2$

(B)  $\text{I}_2 + \text{H}_2\text{O}_2 + 2\text{OH}^- \rightarrow 2\text{I}^- + 2\text{H}_2\text{O} + \text{O}_2$

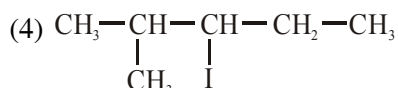
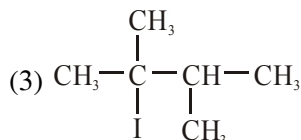
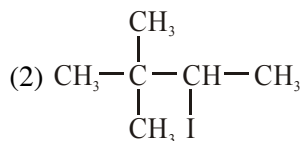
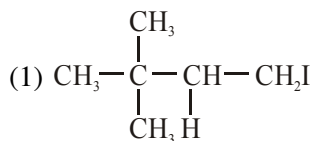
Choose the correct option.

- (1)  $\text{H}_2\text{O}_2$  acts as reducing and oxidising agent respectively in equations (A) and (B)
- (2)  $\text{H}_2\text{O}_2$  acts as oxidising agent in equations (A) and (B)
- (3)  $\text{H}_2\text{O}_2$  acts as reducing agent in equations (A) and (B)
- (4)  $\text{H}_2\text{O}_2$  act as oxidizing and reducing agent respectively in equations (A) and (B)

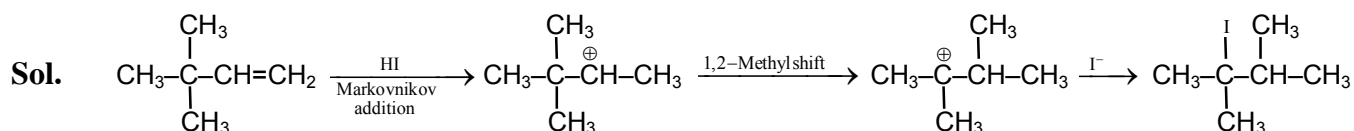
Ans. (3)

Sol.  $\text{H}_2\text{O}_2$  is acting as reducing agent in both the reaction

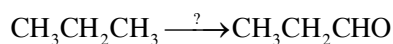
11. What is the major product formed by HI on reaction with  $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}=\text{CH}_2$  ?



Ans. (3)



12. Which of the following reagent is used for the following reaction ?



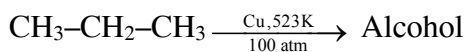
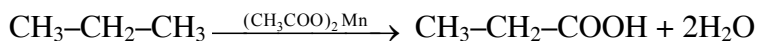
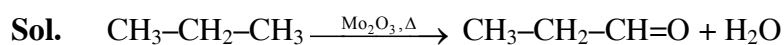
(1) Manganese acetate

(2) Copper at high temperature and pressure

(3) Molybdenum oxide

(4) Potassium permanganate

Ans. (3)



13. Given below are two statements :

**Statement I :** Colourless cupric metaborate is reduced to cuprous metaborate in a luminous flame.

**Statement II :** Cuprous metaborate is obtained by heating boric anhydride and copper sulphate in a non-luminous flame.

In the light of the above statements, choose the most appropriate answer from the options given below.

(1) Statement I is true but Statement II is false

(2) Both Statement I and Statement II are false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are true

Ans. (2)

Sol. Both are false

**14.** Out of the following, which type of interaction is responsible for the stabilisation of  $\alpha$ -helix structure of proteins ?

- |                      |                         |
|----------------------|-------------------------|
| (1) Ionic bonding    | (2) Hydrogen bonding    |
| (3) Covalent bonding | (4) vander Waals forces |

**Ans. (2)**

**Sol.**  $\alpha$ -Helix (secondary structure of proteins) is one of the most common ways in which a peptide chain forms all possible **hydrogen bonds** by twisting into a **right handed screw (helix)** between N-H group and C=O group.

**15.** Match List I with List II.

<b>List I</b> (Monomer Unit)	<b>List II</b> (Polymer)
(a) Caprolactum	(i) Natural rubber
(b) 2-Chloro-1,3-butadiene	(ii) Buna-N
(c) Isoprene	(iii) Nylon 6
(d) Acrylonitrile	(iv) Neoprene

Choose the correct answer from the options given below :

- (1) (a)  $\rightarrow$  (iv), (b)  $\rightarrow$  (iii), (c)  $\rightarrow$  (ii), (d)  $\rightarrow$  (i)  
 (2) (a)  $\rightarrow$  (ii), (b)  $\rightarrow$  (i), (c)  $\rightarrow$  (iv), (d)  $\rightarrow$  (iii)  
 (3) (a)  $\rightarrow$  (iii), (b)  $\rightarrow$  (iv), (c)  $\rightarrow$  (i), (d)  $\rightarrow$  (ii)  
 (4) (a)  $\rightarrow$  (i), (b)  $\rightarrow$  (ii), (c)  $\rightarrow$  (iii), (d)  $\rightarrow$  (iv)

**Ans. (3)**

<b>Sol. Monomers</b>	<b>Polymers</b>
(i) Caprolactum	— Nyolon-6
(ii) 2-Chloro-1,3-butadiene	— Neoprene
(iii) Isoprene	— Natural rubber
(iv) Acrylonitrile + 1,3-butadiene	— Buna N

**16.** The gas released during anaerobic degradation of vegetation may lead to :

- |                         |                               |
|-------------------------|-------------------------------|
| (1) Ozone hole          | (2) Acid rain                 |
| (3) Corrosion of metals | (4) Global warming and cancer |

**Ans. (4)**

**Sol.** The gas  $\text{CH}_4$  evolved due to anaerobic degradation of vegetation which causes global warming and cancer.

**17.** The major components in "Gun Metal" are :

- |                       |                   |
|-----------------------|-------------------|
| (1) Cu, Zn and Ni     | (2) Cu, Sn and Zn |
| (3) Al, Cu, Mg and Mn | (4) Cu, Ni and Fe |

**Ans. (2)**

**Sol.** Components of Gun metal are Cu, Sn and Zn

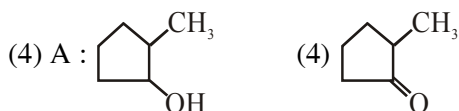
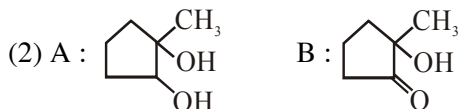
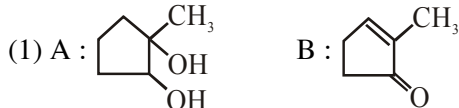
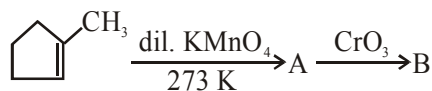
18. The electrode potential of  $M^{2+} / M$  of 3d-series elements shows positive value of :

- (1) Zn                                      (2) Fe                                      (3) Co                                      (4) Cu

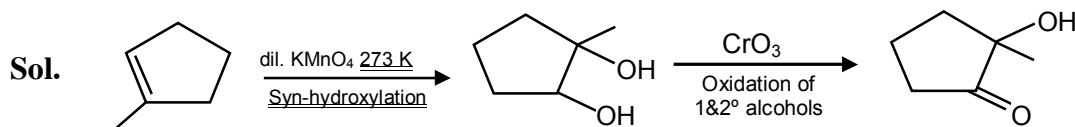
Ans. (4)

Sol. Electrode potential of  $Cu^{2+}/Cu$  is 0.34 Volts

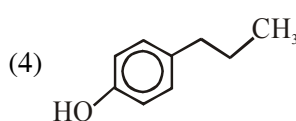
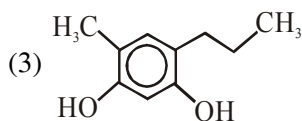
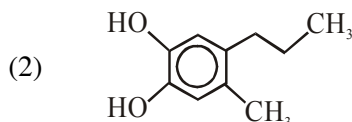
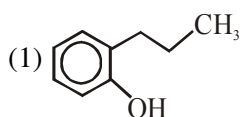
19. Identify products A and B :



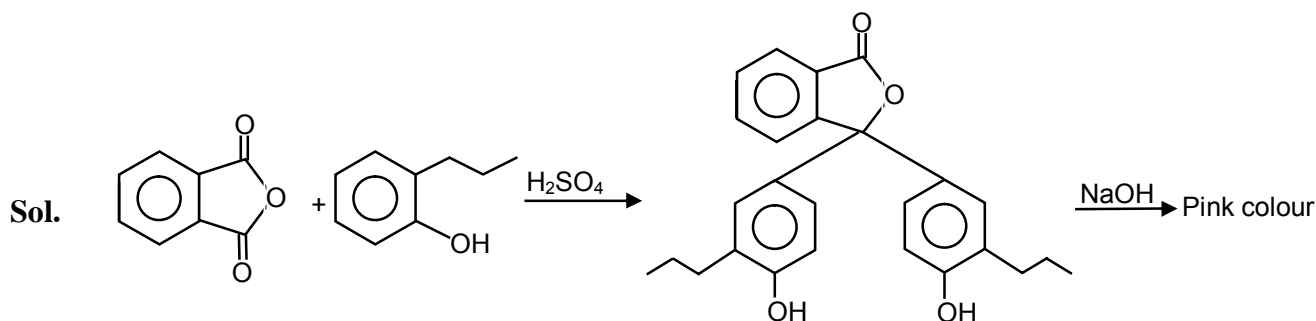
Ans. (2)



20. Which of the following compound gives pink colour on reaction with phthalic anhydride in conc.  $H_2SO_4$  followed by treatment with NaOH ?



Ans. (1)



**Numerical**

1. When 9.45 g of  $\text{ClCH}_2\text{COOH}$  is added to 500 mL of water, its freezing point drops by  $0.5^\circ\text{C}$ . The dissociation constant of  $\text{ClCH}_2\text{COOH}$  is  $x \times 10^{-3}$ .

The value of  $x$  is \_\_\_\_\_. (Rounded off to the nearest integer) [ $K_{f(\text{H}_2\text{O})} = 1.86 \text{ K kg mol}^{-1}$ ]

**Ans. 35**

**Sol.**  $0.5 = (1 + \alpha) \times 1.86 \times \frac{9.45 \times 1000}{94.5 \times 500}$

$\Rightarrow (1 + \alpha) = 1.34$

$\Rightarrow \alpha = 0.34$

$K_a = \frac{C\alpha^2}{1 - \alpha} = \frac{0.2 \times 0.34^2}{1 - 0.34}$

$= 0.035$

$= 35 \times 10^{-3}$

2. 4.5 g of compound A (MW = 90) was used to make 250 mL of its aqueous solution. The molarity of the solution in M is  $x \times 10^{-1}$ . The value of  $x$  is \_\_\_\_\_. (Rounded off to the nearest integer)

**Ans. 2**

**Sol.**  $M = \frac{n}{V} = \frac{4.5/90}{250/1000} = 0.2 = 2 \times 10^{-1}$

3. At 1990 K and 1 atm pressure, there are equal number of  $\text{Cl}_2$  molecules and Cl atoms in the reaction mixture. The value of  $K_p$  for the reaction  $\text{Cl}_{2(g)} \rightleftharpoons 2\text{Cl}_{(g)}$  under the above conditions is  $x \times 10^{-1}$ .

The value of  $x$  is \_\_\_\_\_. (Rounded off to the nearest integer)

**Ans. 5**



Moles  $x$   $x$   
at eq<sup>n</sup>

P.P.  $\frac{1}{2}$   $\frac{1}{2}$

$K_p = \frac{P_{\text{Cl}}^2}{P_{\text{Cl}_2}}$

$= \frac{\left(\frac{1}{2}\right)^2}{\frac{1}{2}} = \frac{1}{2} = 0.5$

$= 5 \times 10^{-1}$

$x = 5$



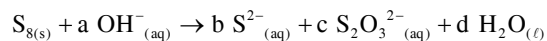
4. Number of amphoteric compounds among the following is \_\_\_\_\_

- (A) BeO                      (B) BaO                      (C) Be(OH)<sub>2</sub>                      (D) Sr(OH)<sub>2</sub>

**Ans. 2**

**Sol.** Be(OH)<sub>2</sub>, BeO

5. The reaction of sulphur in alkaline medium is the below:



The values of 'a' is \_\_\_\_\_. (Integer answer)

**Ans. 12**

**Sol.**  $S_8 + 12OH^- \longrightarrow 4S^{2-} + 2S_2O_3^{2-} + 6H_2O$

6. For the reaction A<sub>(g)</sub> → (B)<sub>(g)</sub>, the value of the equilibrium constant at 300 K and 1 atm is equal to 100.0.

The value of Δ<sub>r</sub>G for the reaction at 300 K and 1 atm in J mol<sup>-1</sup> is -xR, where x is \_\_\_\_\_ (Rounded off to the nearest integer) (R = 8.31 J mol<sup>-1</sup> K<sup>-1</sup> and ln 10 = 2.3)

**Ans. 1380**

**Sol.**  $\Delta_r G^\circ = -RT \ln K_{eq}$   
 $= -R \times 300 \times 2 \times 2.3$   
 $= -1380 R$

7. A proton and a Li<sup>3+</sup> nucleus are accelerated by the same potential. If λ<sub>Li</sub> and λ<sub>p</sub> denote the de Broglie

wavelengths of Li<sup>3+</sup> and proton respectively, then the value of  $\frac{\lambda_{Li}}{\lambda_p}$  is x × 10<sup>-1</sup>.

The value of x is \_\_\_\_\_. (Rounded off to the nearest integer)

(Mass of Li<sup>3+</sup> = 8.3 mass of proton)

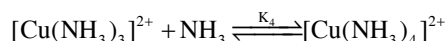
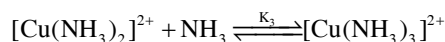
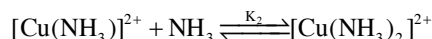
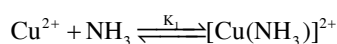
**Ans. 2**

**Sol.**  $\lambda_{DB} \propto \frac{1}{\sqrt{m.K.E.}}$

$$\frac{\lambda_{Li}}{\lambda_p} = \sqrt{\frac{m_p \times e_p V}{8.3m_p \times 3e_p V}}$$

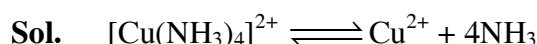
$$\sqrt{\frac{1}{25}} = \frac{1}{5} = 0.2 = 2 \times 10^{-1}$$

8. The stepwise formation of  $[\text{Cu}(\text{NH}_3)_4]^{2+}$  is given below



The value of stability constants  $K_1$ ,  $K_2$ ,  $K_3$  and  $K_4$  are  $10^4$ ,  $1.58 \times 10^3$ ,  $5 \times 10^2$  and  $10^2$  respectively. The overall equilibrium constants for dissociation of  $[\text{Cu}(\text{NH}_3)_4]^{2+}$  is  $x \times 10^{-12}$ . The value of  $x$  is \_\_\_\_\_. (Rounded off to the nearest integer)

**Ans. 1**



$$K = \frac{1}{K_1 K_2 K_3 K_4} = \frac{1}{10^4 \times 1.58 \times 10^3 \times 5 \times 10^2 \times 10^2}$$

$$= 1.26 \times 10^{-12} = 1.26$$

9. The coordination number of an atom in a body-centered cubic structure is \_\_\_\_\_.  
[Assume that the lattice is made up of atoms.]

**Ans. 8**

**Sol.** Theory

10. Gaseous cyclobutene isomerizes to butadiene in a first order process which has a 'k' value of  $3.3 \times 10^{-4} \text{s}^{-1}$  at  $153^\circ\text{C}$ . The time in minutes it takes for the isomerization to proceed 40 % to completion at this temperature is \_\_\_\_\_. (Rounded off to the nearest integer)

**Ans. 26**

**Sol.**  $t = \frac{2.303}{K} \log \frac{100}{100-x}$

$$= \frac{2.303}{3.3 \times 10^{-4}} \log \frac{100}{100-40}$$

$$= \frac{2.303}{3.3 \times 10^{-4}} \times 0.22$$

$$= 1535.33 \text{ sec.}$$

$$= 25.59 \text{ Min.}$$