

IIT-JEE 2006 Solutions by MOMENTUM

(questions based on memory of students)

CHEMISTRY

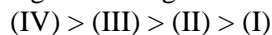
INSTRUCTIONS:

- (i) Question no. 1 to 12 has only one correct option. You will be awarded 3 marks for right answer and -1 mark for wrong answer.
- (ii) Question no. 13 to 20 has one or more than one correct option(s). You will be awarded 5 marks if you answer all correct options and only correct option(s) and -1 mark will be awarded for wrong answer.
- (iii) Question no. 21 to 32 are based on small write up first go through it then answer these questions. You will be awarded 5 marks for right answer and -2 marks for wrong answer.
- (iv) Question no. 33 to 36 are subjective problems. Circle their correct answers. There is no negative marking for it. Each question carries 6 marks.
- (v) Question no. 37 to 40 carry 6 marks each. These may have more than one correct options. There is no negative marking for these.

1. Arrange the following compounds in the order of increasing boiling point

- | | |
|-------------------------------|-------------------------------|
| (I) Hydroxy benzene | (II) ortho dihydroxy benzene |
| (III) meta dihydroxy benzene | (IV) para dihydroxy benzene |
| (a) (IV) > (III) > (II) > (I) | (b) (III) > (IV) > (II) > (I) |
| (c) (II) > (III) > (I) > (IV) | (d) (I) > (II) > (III) > (IV) |

Sol. Normally compound having large molar mass boils at higher temperature. So compound (I) will have the least boiling point. In remaining isomeric dihydroxy benzenes compound (II) will involve extensive intramolecular hydrogen bonding. While compound (IV) will not exhibit intramolecular hydrogen bonding rather form intermolecular hydrogen bonding.

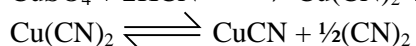


∴ (a)

2. If excess of KCN be added to copper sulphate solution it losses its blue colour due to the formation of

- (a) $[\text{Cu}(\text{CN})_4]^{3-}$ (b) $[\text{Cu}(\text{CN})_4]^{2-}$ (c) $[\text{Cu}(\text{OH})_2]$ (d) CuCN

Sol. $\text{CuSO}_4 + 2\text{KCN} \longrightarrow \text{Cu}(\text{CN})_2 + \text{K}_2\text{SO}_4$



unstable pseudo halogen



∴ (a)

3. $\text{B}(\text{OH})_3 + \text{NaOH} \rightleftharpoons \text{Na}[\text{B}(\text{OH})_4]_{(\text{aq})}$

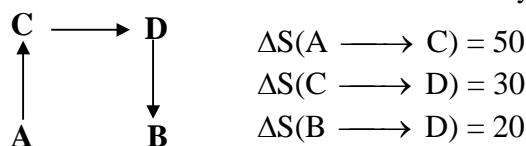
Which of the following is the best catalyst to take this reaction in forward direction

- (a) cis-1,2 diol (b) trans-1,2 diol (c) borax (d) Na_2HBO_4

Sol. Boric acid is a very weak acid. It does not react with alkali explicitly. However, the weak orthoboric acid may be converted into comparatively strong monobasic acid by addition of any cis-1,2 diol to pull the reaction in forward direction significantly.

∴ (a)

4. A process $A \longrightarrow B$ is difficult to occur directly instead it takes place in three successive steps.



The entropy change for the process $A \longrightarrow B$ is

- (a) 100 (b) -60 (c) -100 (d) +60

Sol. $A \longrightarrow C$; $\Delta S = 50$

$C \longrightarrow D$; $\Delta S = 30$

$D \longrightarrow B$; $\Delta S = -20$

For $A \longrightarrow B$: $\Delta S = 50 + 30 - 20 = 60$

\therefore (d)

5. The bond length in CO is 1.128 Å. What will be the bond length of CO in $\text{Fe}(\text{CO})_5$

- (a) 1.158 Å (b) 1.128 Å (c) 1.178 Å (d) 1.118 Å

Sol. The metal (Fe) makes the back bonding to CO. The metal to ligand bonding creates a synergic effect which strengthens the bond between CO and the metal (Fe). Which results in the contraction of CO bond length.

\therefore (d)

6. The correct IUPAC name of $\text{C}_6\text{H}_5\text{COCl}$ is

- (a) Benzene carbonyl chloride (b) Benzoyl chloride
(c) Chlorophenyl ketone (d) Phenylchloride ketone

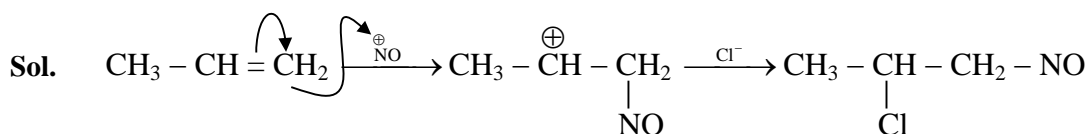
Sol. It's trivial name benzoyl chloride is itself accepted name in IUPAC system.

\therefore (b)

7. $\text{CH}_3 - \text{CH} = \text{CH}_2 \xrightarrow{\text{NOCl}} ?$

The product of the following reaction is

- (a) $\text{CH}_3 - \underset{\text{NO}}{\text{CH}} - \text{CH}_2\text{Cl}$ (b) $\text{CH}_3 - \underset{\text{Cl}}{\text{CH}} - \text{CH}_2 - \text{NO}$
(c) $\text{CH}_3 - \text{CH}_2 - \underset{\text{Cl}}{\text{CH}} - \text{NO}$ (d) $\text{ON} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2\text{Cl}$

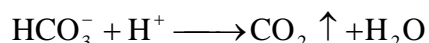


\therefore (b)

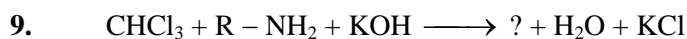
8. When benzene sulphonic acid and para nitrophenol are heated separately with NaHCO_3 , the gases evolved are respectively

- (a) SO_2, NO_2 (b) SO_2, NO (c) SO_2, CO_2 (d) CO_2, CO_2

Sol. Both benzene sulphonic acid and para nitrophenol are stronger acid than carbonic acid so the actual reaction in both cases would be



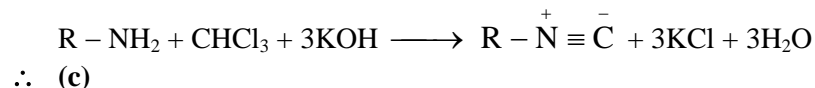
\therefore (d)



What is the product?

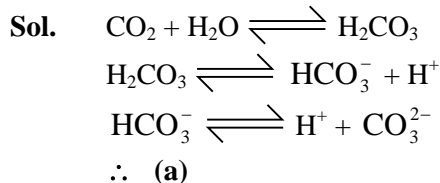
- (a) $\text{R}-\text{CN}$ (b) $\text{R}-\overset{-}{\text{N}} \equiv \overset{+}{\text{C}}$ (c) $\text{R}-\overset{+}{\text{N}} \equiv \overset{-}{\text{C}}$ (d) RCH_2NH_2

Sol. This is carbylamine reaction which goes as



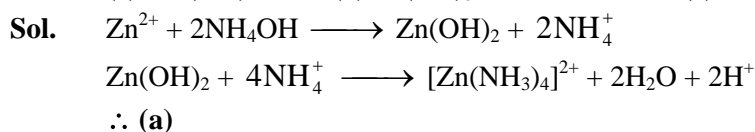
10. If CO_2 be passed into water, what will remain present in solution

- (a) $\text{CO}_2, \text{H}_2\text{CO}_3, \text{CO}_3^{2-}, \text{HCO}_3^-$ (b) $\text{H}_2\text{CO}_3, \text{CO}_2$
 (c) $\text{HCO}_3^-, \text{CO}_3^{2-}$ (d) $\text{CO}_2, \text{HCO}_3^-$



11. An aqueous solution of metal salt is given. NH_4Cl and NH_4OH are added to it and white precipitate is formed. Some part of precipitate remains in dissolved state as well. The above solution that dissolves in NH_4OH is of

- (a) $\text{Zn}(\text{OH})_2$ (b) $\text{Al}(\text{OH})_3$ (c) $\text{Mg}(\text{OH})_2$ (d) $\text{Ca}(\text{OH})_2$



12. The molar heat capacity of a monoatomic gas for which the ratio of pressure and volume is one.

- (a) $4/2 R$ (b) $3/2 R$ (c) $5/2 R$ (d) zero

Sol. In general the molar heat capacity for any process is given by

$$C = C_v + \frac{R}{1-n} \text{ when } PV^n = \text{constant}$$

Here $\frac{P}{V} = 1$ i.e. $PV^{-1} = \text{constant}$

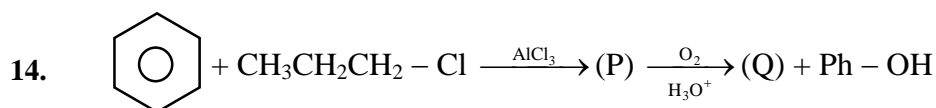
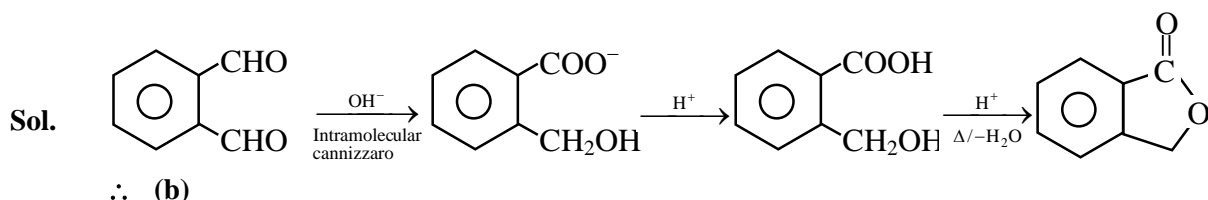
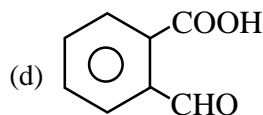
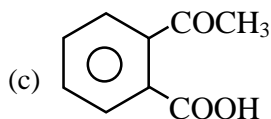
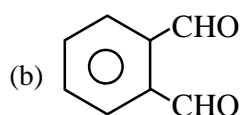
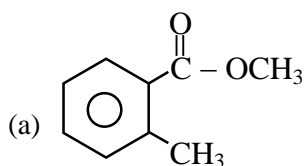
$$C = \frac{3}{2}R + \frac{R}{2}$$

$$C = 2R$$

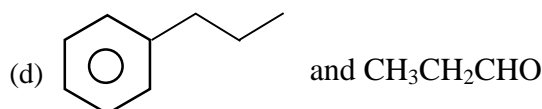
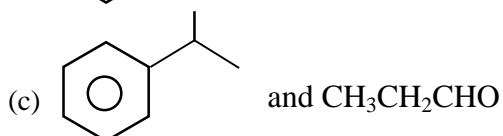
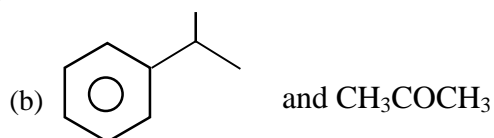
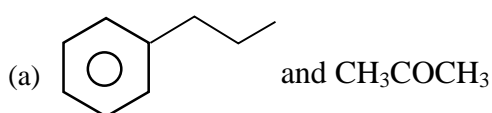
∴ (a)

13. Compound (I) can be obtained from which of the following compound by heating with alkali followed by acid hydrolysis

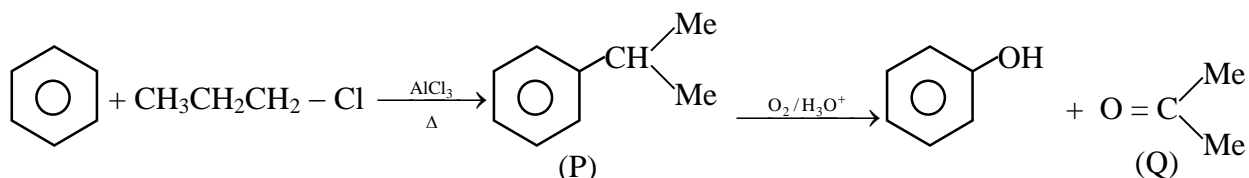




Find major products (P) and (Q) are respectively

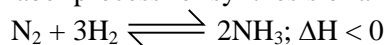


Sol.



\therefore (b)

15. In Haber process for synthesis of ammonia



Pick the correct statement

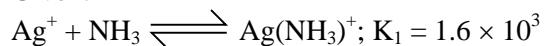
- (a) Addition of catalyst does not change K_p but changes ΔH .
 (b) At equilibrium, $2G_{\text{NH}_3} = G_{\text{N}_2} + 3G_{\text{H}_2}$ (where G is Gibbs' free energy)
 (c) At higher temperature it increases the rate of forward and backward reaction by a factor of 2.
 (d) At 400 K addition of catalyst will increase forward reaction by 2 times while reverse reaction rate will be changed by 1.7 times.

Sol. At equilibrium state $\Delta G = 0$ for any reaction.

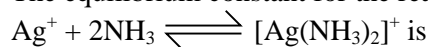
Therefore,

$$\begin{aligned} \Delta G &= G_p - G_R \\ &= (G_{\text{N}_2} + 3G_{\text{H}_2}) - 2G_{\text{NH}_3} \end{aligned} \quad \therefore \text{(b)}$$

16. Given:



The equilibrium constant for the reaction



(a) 6.8×10^3 (b) 1.088×10^7 (c) 1.088×10^6 (d) 1.6×10^3

Sol. Equilibrium constant

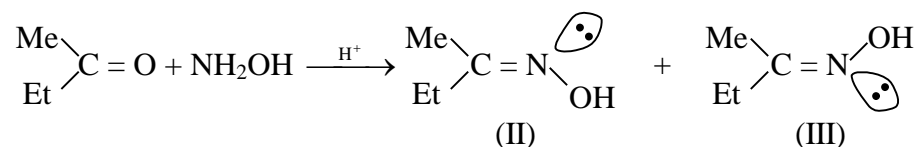
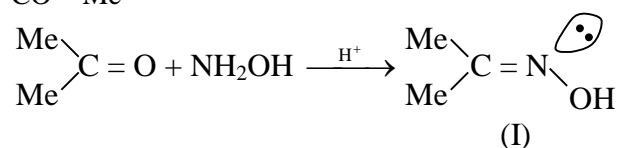
$$K = K_1 \times K_2 = 1.6 \times 6.8 \times 10^6 = 1.088 \times 10^7$$

∴ (b)

17. There is a mixture of lowest molecular weight ketone and its next homologue. It is treated with hydroxyl amine when a mixture of oximes is obtained.

(a) 2 oximes are obtained (b) 3 oximes are obtained
(c) one of the oximes is optically active (d) All oximes are optically active

Sol. The lowest molecular weight ketone is Me – CO – Me and its next higher homologue is MeCH₂ – CO – Me



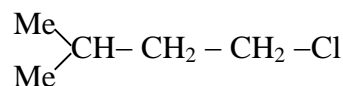
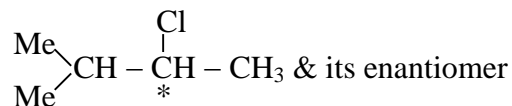
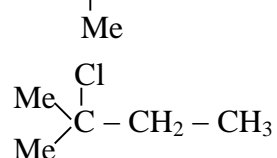
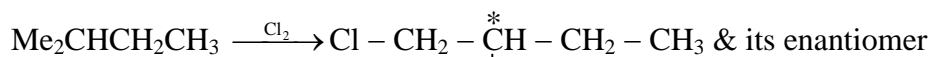
∴ (b)

18. $(\text{CH}_3)_2\text{CH}-\text{CH}_2-\text{CH}_3 \xrightarrow{\text{Cl}_2} \text{(N) mixture of isomeric products } \text{C}_5\text{H}_{11}\text{Cl} \xrightarrow[\text{Distillation}]{\text{Fraction}} \text{(F)}$

The number of compounds formed respectively for (N) and (F) are

(a) 6,6 (b) 6,4 (c) 4,4 (d) 3,3

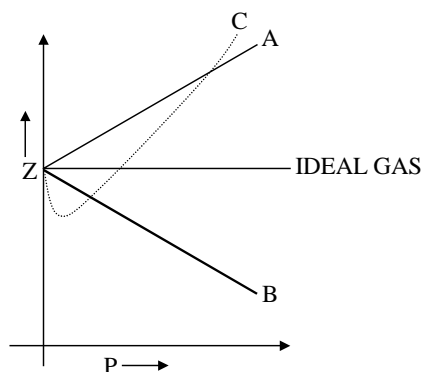
Sol.



Since, enantiomer have nearly same physical properties therefore on fractional distillation we will get just four distinct compounds without resolution.

∴ (b)

19.



$$\text{where } Z = \frac{PV}{nRT},$$

a = Van der Waal's constant for pressure correction

b = Van der Waal's constant for volume correction

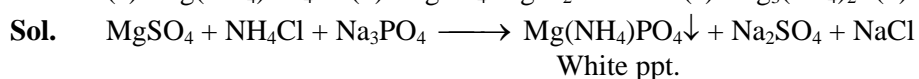
Pick the only incorrect statement

- (a) for gas A, if $a = 0$, the compressibility factor is directly proportional to pressure
 (b) for gas B, if $b = 0$, the compressibility factor is directly proportional to pressure.
 (c) for gas C, $a \neq 0$, $b \neq 0$, it can be used to calculate a and b by giving lowest P value and its intercept with $Z = 1$
 (d) slope for all three gases at high pressure is positive.

Sol. (c)

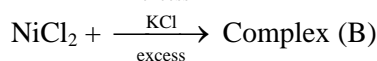
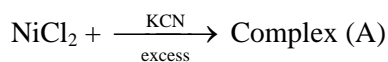
20. When MgSO_4 and NH_4Cl is added along with Na_3PO_4 a white precipitate is formed. What is it?

- (a) $\text{Mg}(\text{NH}_4)\text{PO}_4$ (b) $\text{MgSO}_4 \cdot \text{MgCl}_2$ (c) $\text{Mg}_3(\text{PO}_4)_2$ (d) $\text{MgSO}_4 \cdot \text{Mg}(\text{PO}_4)_2$



\therefore (a)

Passage - I



The coordination number of nickel in both complexes (A) and (B) is 4.

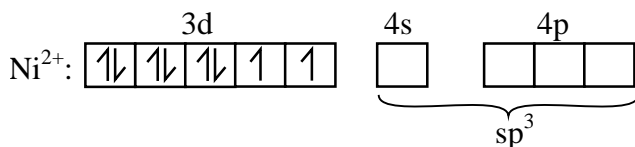
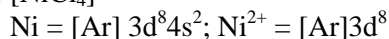
21. The IUPAC name of complex (A) and (B) are
 (a) Potassium tetracyanonicklate(II) and Potassium tetrachloronicklate(II)
 (b) Potassium tetracyanonickel(II) and Potassium tetrachloronickel(II)
 (c) Potassium cyanonicklate(II) and Potassium chloronicklate(II)
 (d) Potassium cyanonickel(II) and Potassium chloronickel(II)

Sol. (a)

22. Which of the following is correct?

- (a) Complex (A) is diamagnetic and complex (B) is paramagnetic
 (b) Complex (A) is paramagnetic and complex (B) is diamagnetic
 (c) Complex (A) with cyano is paramagnetic with two unpaired electrons and (B) is diamagnetic.
 (d) Complex (A) with cyano is diamagnetic and complex (B) with chloro is paramagnetic with two unpaired electrons.

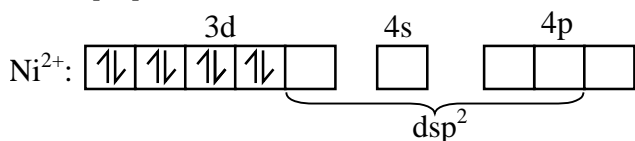
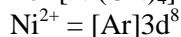
Sol. For $[\text{NiCl}_4]^{2-}$



Cl^- being weak field ligand is unable to pair up the electrons and Ni^{2+} needs four empty orbitals to accommodate four Cl^- ligand. Thus, $[\text{NiCl}_4]^{2-}$ shows sp^3 hybridization and tetrahedral shape.

$$\text{Magnetic moment} = \sqrt{2(2+2)} = 2.82 \text{ BM}$$

For $[\text{Ni}(\text{CN})_4]^{2-}$:



CN^- is a strong field ligand so forces the 3d electrons to pair up to give one 3d orbital vacant. Thus, $[\text{Ni}(\text{CN})_4]^{2-}$ shows dsp^2 hybridization and square planar shape.

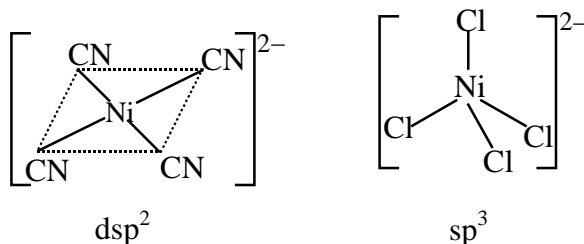
Magnetic moment = 0 (as unpaired electrons are zero).

\therefore (a)

23. The hybridization state of the central atom of complex (A) and (B) are

(a) both are dsp^2 (b) both are sp^3 (c) sp^3, dsp^2 (d) dsp^2, sp^3

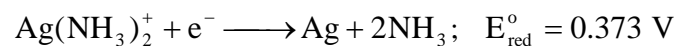
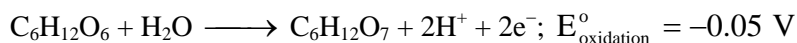
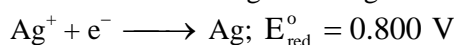
Sol.



\therefore (d)

Passage -II

Reaction of Tollen's reagent with glucose

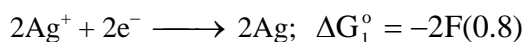
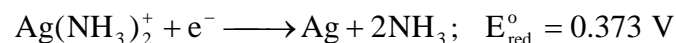
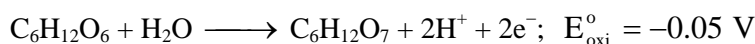


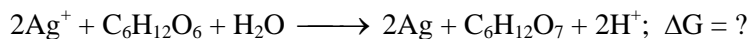
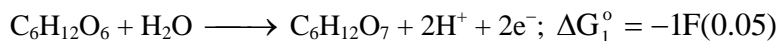
$$\text{Given: } \frac{2.303 RT}{F} = 0.0591 \text{ \& } \frac{F}{RT} = 38.35$$

24. The value of $\ln K$ for $2\text{Ag}^+ + \text{C}_6\text{H}_{12}\text{O}_6 + \text{H}_2\text{O} \rightleftharpoons 2\text{Ag} + \text{C}_6\text{H}_{12}\text{O}_7 + 2\text{H}^+$ is

(a) 59.44 (b) 29.19 (c) 66.2 (d) 116.4

Sol. $\text{Ag}^+ + e^- \longrightarrow \text{Ag}; E_{\text{red}}^\circ = 0.800 \text{ V}$





$$\Delta G^\circ = -1.6 F + 0.05 F$$

$$\Delta G^\circ = -1.55 F$$

$$\Delta G^\circ = -RT \ln K$$

$$-RT \ln K = -1.55 F$$

$$\ln K = \frac{1.55 F}{RT}$$

$$\ln K = 1.55 \times 38.35 = 59.44$$

∴ (a)

25. If on addition of NH_3 , pH of solution rises to 11. Then which of the electrode is affected by change in pH.

(a) $E_{\text{oxidation}}$ increases over E° by 0.65 V

(b) $E_{\text{reduction}}$ increases over E° by 0.65 V

(c) $E_{\text{oxidation}}$ decreases over E° by 0.65 V

(d) $E_{\text{reduction}}$ decreases over E° by 0.65 V

Sol. The anode is affected by change in pH

$$E = E^\circ - \frac{0.0591}{2} \log \frac{[C_6H_{12}O_6]}{[C_6H_{12}O_7]} [H^+]^2$$

$$\begin{aligned} E &= E^\circ - 0.0591 \log [H^+] \\ &= E^\circ - 0.0591 \log [10^{-11}] \\ &= E^\circ + 0.0591 \times 11 \\ &= E^\circ + 0.65 \end{aligned}$$

∴ (a)

26. For this reaction we prefer to add NH_3 , what is the reason ?

(a) $Ag(NH_3)_2^+$ is weaker oxidizing agent than Ag^+

(b) If we do not add NH_3 then silver salt of gluconic acid is formed.

(c) gluconic acid is soluble in NH_3

(d) to increase oxidation potential of glucose.

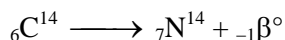
Sol. (b)

Passage-III

C^{14} radio carbon dating technique is used to determine the age of fossil fuel from archaeological excavations. This technique is based on simple principle of chemical kinetics.

Earth's atmosphere is constantly bombarded by cosmic rays (consisting of electrons, neutrons and atomic nuclei) of extremely high penetrating power. Atmospheric nitrogen (N^{14}) captures these neutrons (cosmic rays) to produce radioactive C^{14} isotope and hydrogen (${}_1H^1$). ${}_7N^{14} + {}_0n^1 \longrightarrow {}_6C^{14} + {}_1H^1$

The unstable carbon eventually forms ${}^{14}CO_2$, which mixes with the ordinary carbon dioxide (${}^{12}CO_2$) in the air. As the carbon-14 isotope decays, it emits β -particles.



The C^{14} isotope enters the biosphere when carbon dioxide is taken up in plant photosynthesis. Plants are eaten by animals, which exhale C^{14} as CO_2 . Eventually, C^{14} participates in many aspects of the carbon cycle. The C^{14} lost by radioactive decay is constantly replenished by the production of new isotopes in the atmosphere. In this decay-replenishment process, a dynamic equilibrium is established whereby the ratio of C^{14} to C^{12} remains constant in living matter. But when an individual plant or an animal dies, the C^{14} isotope in it is no longer replenished, so the ratio

decreases as C^{14} decays. So, the number of C^{14} nuclei after time t (after the death of living matter) would be less than in a living matter. Now, using first order integrated rate law,

$$t_{1/2} = \frac{0.693}{\lambda}$$

For 30,000 year the cosmic rays have same intensity and organism are also have the same. But from some years the changes in this are observed due to excessive burning of fossil fuel and nuclear tests.

27. Why we use the carbon dating to calculate the age of the fossil?
 (a) Rate of exchange of carbon between atmosphere and living is slower than decay of C^{14} .
 (b) It is not appropriate to use C^{14} dating to determine age.
 (c) Rate of exchange of C^{14} between atmosphere and leaving organism is so fast that an equilibrium is set up between the intake of C^{14} by organism and its exponential decay.
 (d) none of the above

Sol. (c)

28. For how many old fossil can be process of C-dating be used.

- (a) 6 years (b) 6000 year
 (c) 60,000 year (d) any age it does depend on the age of the fossil.

Sol. (b)

29. If C_1 is the conc. of C^{14} in the sample taken near nuclear site and C_2 is the concentration of the sample taken away from nuclear site

(a) $t_1 - t_2 = \frac{1}{\lambda} \ln \frac{C_1}{C_2}$ (there is a decrease in age of sample taken at nuclear site)

(b) $t_1 - t_2 = \frac{1}{\lambda} \ln \frac{C_1}{C_2}$ (there is a increase in age of sample taken at nuclear site)

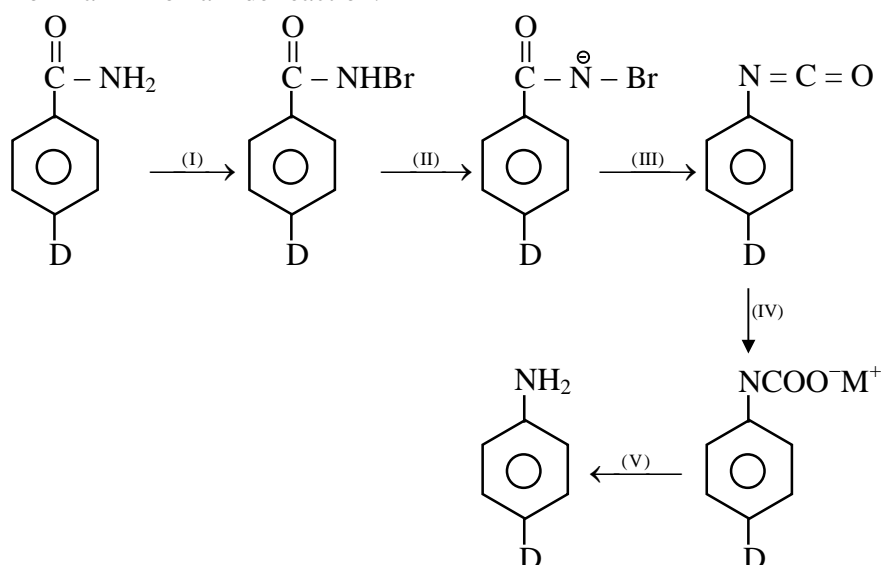
- (c) There is no change irrespective of value of C_1 and C_2

(d) $\frac{t_1}{t_2} = \frac{C_1}{C_2}$

Sol. (b)

Passage -IV

Hoffmann Bromamide reaction:

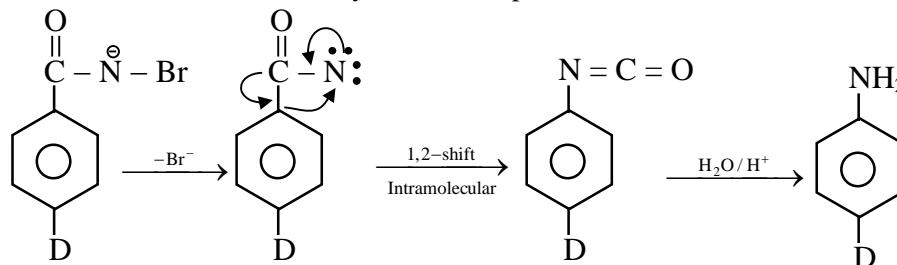


30. Reagent used in reaction (I) is
 (a) $\text{Br}_2 + \text{NaOH}$ (b) $\text{KBr} + \text{NaOH}$ (c) NBS (d) $\text{KBr} + \text{NaHCO}_3$

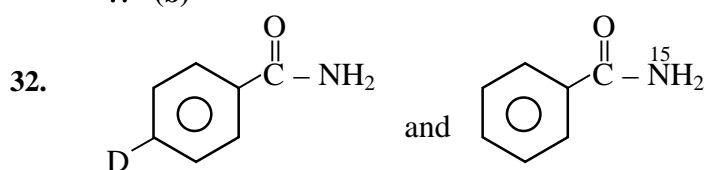
Sol. (a)

31. Which step is r.d.s. for Hoffmann Bromamide reaction ?
 (a) (II) (b) (III) (c) (IV) (d) (V)

Sol. The r.d.s. is formation of isocyanate i.e. step (III).



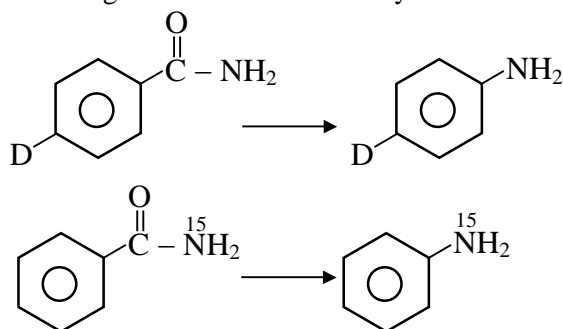
\therefore (b)



The above mixture is treated in above process, then products obtained are

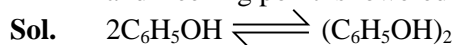
- (a) +
- (b) +
- (c) +
- (d) + + +

Sol. Rearrangement of nitrene to isocyanate is intramolecular 1,2-shift.



\therefore (a)

33. 72.5 g of phenol is dissolved in 1 kg of a solvent ($k_f = 14$) which leads to dimerization of phenol and freezing point is lowered by 7 kelvin. What percent of total phenol is present in dimeric form?



$$\begin{array}{ccc} 1 & & 0 \\ 1-\alpha & & \alpha/2 \end{array}$$

$$\Delta T_f = i \times k_f \times m$$

$$\frac{7}{14 \times m} = i \quad m = \frac{72.5}{1 \times 94}$$

$$i = \frac{7 \times 94}{14 \times 72.5}$$

$$i = 1 - \alpha + \frac{\alpha}{2} = 1 - \frac{\alpha}{2}$$

$$1 - i = \frac{\alpha}{2}$$

$$\frac{\alpha}{2} = (1 - i) = (1 - 0.65)$$

$$\frac{\alpha}{2} = 0.35$$

\therefore 70% phenol is present in dimeric form.

34. A metal of atomic mass = 75 forms a cubic lattice of edge length 5 \AA and density 2 g cm^{-3} . Calculate the radius of the atom given Avogadro's number, $N_A = 6 \times 10^{23}$.

Sol. $d = \frac{Zm}{N_A \times a^3}$

$$Z = \frac{d \times N_A \times a^3}{m} = \frac{2 \times 6 \times 10^{23} \times 5 \times 5 \times 5 \times 10^{-24}}{75} = 20 \times 10^{-1} = 2$$

Therefore the cubic lattice will be body centered.

For BCC lattice:

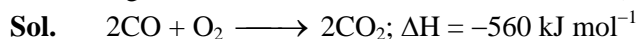
$$\sqrt{3}a = 4r$$

$$\therefore r = \frac{\sqrt{3}}{4}a = \frac{1.732 \times 5 \times 10^2}{4} = 2.165 \times 10^2 = 216.5 \approx \mathbf{217 \text{ pm}}$$

35. For the reaction,



In one litre vessel at 500 K the initial pressure is 70 atm and after the reaction it becomes 40 atm at constant volume of one litre. Calculate change in internal energy. All the above gases show significant deviation from ideal behaviour. (1 L atm = 0.1 kJ)



$$\Delta H = \Delta U + \Delta n_g RT, \quad \Delta H = \Delta U + \Delta(PV), \quad \Delta H = \Delta U + V(P_2 - P_1)$$

$$-560 = \Delta U + 1(40 - 70)$$

$$-560 = \Delta U - 30$$

$$\Delta U = -530 \text{ litre atm}, \quad \Delta U = \mathbf{-53 \text{ kJ mol}^{-1}}$$

36. Question not available.

List-1

List-2

37. (a) $\text{Bi}^{3+} \longrightarrow [\text{BiO}]^+$ (P) Hydrolysis
 (b) $\text{AlO}_2^- \longrightarrow \text{Al}(\text{OH})_3$ (Q) Acidification
 (c) $\text{SiO}_4^{2-} \longrightarrow \text{Si}_2\text{O}_7^{3-}$ (R) Dilution with water
 (d) $\text{B}_4\text{O}_7^{2-} \longrightarrow \text{B}(\text{OH})_3$ (S) heating

Sol.

- (a) (P) (Q) (R) (S) (b) (P) (Q) (R) (S)
 (c) (P) (Q) (R) (S) (d) (P) (Q) (R) (S)

38. List-1	List-2
(a) PhCHCH_3 show fast elimination and $\begin{array}{c} \\ \text{Br} \end{array}$ PhCD-CH_3 show slow elimination under the same $\begin{array}{c} \\ \text{Br} \end{array}$ condition.	(P) E_1
(b) In $\text{PhCH}_2\text{CH}_2\text{Br}$ and $\text{PhCD}_2\text{CH}_2\text{Br}$ the later does not undergoes elimination readily.	(Q) $\text{E}_{1\text{CB}}$
(c) $\text{PhCHDCH}_2\text{Br}$ on elimination in the presence of $\text{C}_2\text{H}_5\text{OD}$ and $\text{C}_2\text{H}_5\text{O}^-$ gives $\text{PhCD}=\text{CH}_2$	(R) First order reaction
(d) Elimination in $\text{CH}_3\text{CHBrCH}_3$ is easily as compared to $\text{CH}_3\text{CHBrCD}_3$	(S) E_2

Sol.

- (a) (P) (Q) (R) (S) (b) (P) (Q) (R) (S)
 (c) (P) (Q) (R) (S) (d) (P) (Q) (R) (S)

39. List-1 List-2
 (a) Self reduction (P) Pb extraction
 (b) Carbon reduction (Q) Cu extraction
 (c) Complex formation then precipitation with another metal (R) Ag extraction
 (d) decomposition of iodide (S) B extraction

Sol.

- (a) (P) (Q) (R) (S) (b) (P) (Q) (R) (S)
 (c) (P) (Q) (R) (S) (d) (P) (Q) (R) (S)

40. Given in hydrogenic atom r_n , V_n , E , K_n stand for radius, potential energy, total energy and kinetic energy in n^{th} orbit. Find the value of U,v,x,y

- (a) $U = \frac{V_n}{K_n}$ (P) 1
 (b) $\frac{1}{r_n} \propto E^x$ (Q) -2
 (c) $r_n \propto Z^y$ (R) -1
 (Z = Atomic number)
 (d) $v =$ (Angular momentum of electron in its lowest energy level) (S) 0

Sol. (a) $U = \frac{V_n}{K_n} = \frac{-kze^2/r}{kze^2/2r} = -2$

(b) $E_n = \frac{kz^2}{n^2}$, $r_n = \frac{k'n^2}{z}$, $\frac{1}{r_n} \propto \frac{E_n}{z}$ $\therefore x = 1$

(c) $r_n = k \frac{n^2}{z}$, $r_n \propto n^2 z^{-1}$ $\therefore y = -1$

(d) Angular momentum of electron in 1s orbital $= \sqrt{l(l+1)} \frac{h}{2\pi} = \sqrt{0(0+1)} \frac{h}{2\pi} = 0$

(a) P Q R S

(b) P Q R S

(c) P Q R S

(d) P Q R S