VIDYAPEETH ACADEMY
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## PAPER-1(B.E./B. TECH.)

# JEE (Main) 2021

## Questions & Solutions

(Reproduced from memory retention)

**Date : 25 February, 2021 (SHIFT-1) Time ; (9.00 am to 12.00 pm)**

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

## SUBJECT : CHEMISTRY

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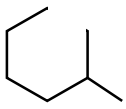
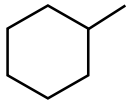
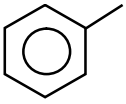
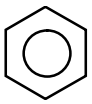
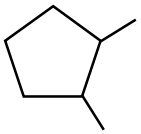
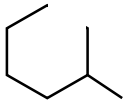
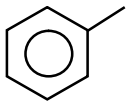
# CHEMISTRY

**1.**  $\xrightarrow[773\,K\\10-20\ atm]{Mo_2O_3}$ Product of the reaction is :

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

**Ans.** **(2)**

**Sol.**  $\xrightarrow[773\,K]{Mo_2O_3}$  It is catalytic reforming (Aromatisation) of alkanes. n-heptane gives toluene in this process.

**2.** $CH_3–C\equiv N \xrightarrow{(1)H_2O/H^+} \xrightarrow{(2)SOCl_2} \xrightarrow{(3)H_2,Pd,BaSO_4}$ Product of the reaction is

(1) $CH_3CHO$ (2) $CH_3COOH$ (3) $CH_3CH_2OH$ (4) $CH_3CH_3$

**Ans.** **(1)**

**Sol.** $CH_3–C\equiv N \xrightarrow{(1)H_2O/H^+} CH_3COOH \xrightarrow{(2)SOCl_2} CH_3COCl \xrightarrow{(3)H_2,Pd,BaSO_4} CH_3CHO$

**3.** Which of the following will not yield acetaldehyde ?

(1) $CH_3CN$ + DiBAL-H (2) $CH_3CH_2OH$ + Cu, heat

(3) $CH_3CH_2OH + CrO_3, H_2SO_4$ (4) $CH_2=CH_2 + O_2 \xrightarrow[Pd(II),\,Cu(II)\,in\,water]{Catalyst}$

**Ans.** **(3)**

**Sol.** (1) $CH_3CN$ + DiBAL-H $\longrightarrow$ $CH_3CHO$ (acetaldehyde)

(2) $CH_3CH_2OH$ + Cu, heat $\longrightarrow$ $CH_3CHO$ (acetaldehyde)

(3) $CH_3CH_2OH + CrO_3, H_2SO_4 \longrightarrow CH_3COOH$ (acetic acid)

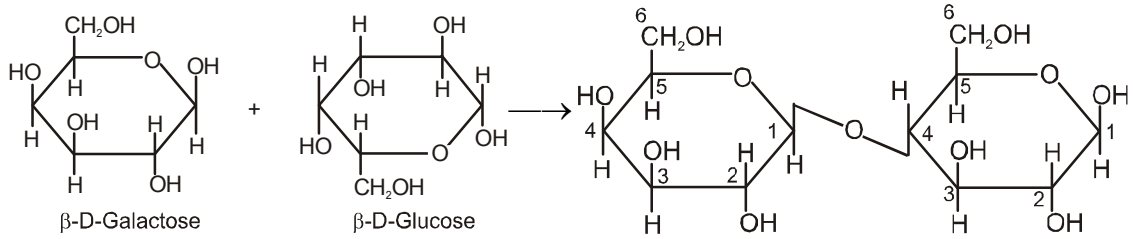
(4) $CH_2=CH_2 + O_2 \xrightarrow[Pd(II),\,Cu(II)\,in\,water]{Catalyst} CH_3CHO$ (acetaldehyde)

**4.** Lactose contains which carbon Link between galactose and glucose-

(1) 1–Galactose, 4–glucose (2) 1–Galactose, 6–glucose

(3) 4–Galactose, 1–glucose (4) 1–Galactose, 2–glucose

**Ans.** **(1)**

**Sol.** 


The linkage is between C-1 of Galactose and C-4 of Glucose.

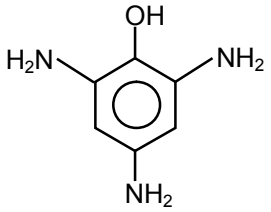
**5.** **Statement -1 :** An allotrope of oxygen is responsible for reducing smog.

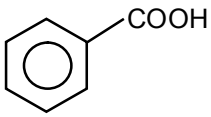
**Statement -2 :** Oxides of nitrogen and sulphur are responsible for photo chemical smog.

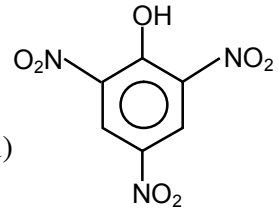
(1) Statement I is true ,Statement II is false
(2) Statement I is false ,Statement II is true
(3) Statement I , II both are true
(4) Statement I , II both are false

**Ans.** **(4)**

**6.** Which of the following set of compounds give $NaHCO_3$ test ?

(i) 

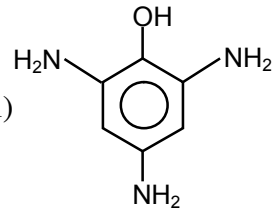

(ii) 


(iii) 

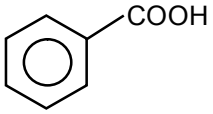

(1) i, ii (2) i, iii (3) ii, iii (4) i, ii, iii

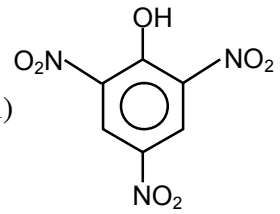
**Ans.** **(3)**

**Sol.** Compounds which are more acidic than $H_2CO_3$ give test with $NaHCO_3$.

(i) 

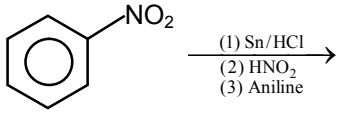
is less acidic than $H_2CO_3$

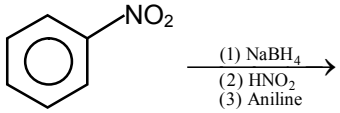
(ii) 

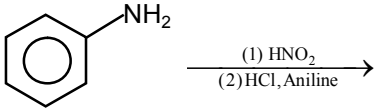
and (iii) 

are more acidic than $H_2CO_3$

**7.** In which of the following reaction p-aminoazobenzene is not formed ?

(a) 

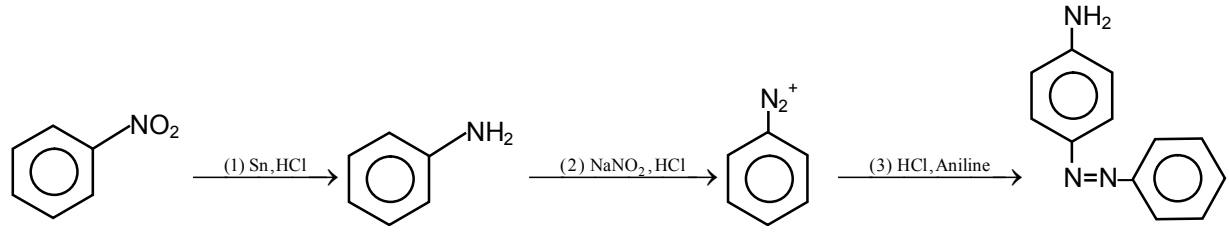

(b) 


(c) 

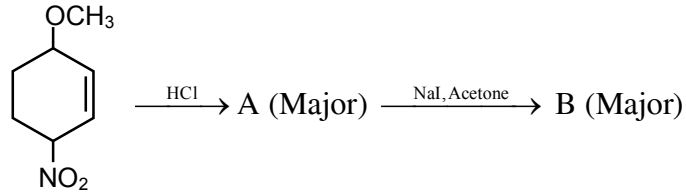

(1) Only a (2) Only b (3) Only c (4) a and b

**Ans.** **(2)**

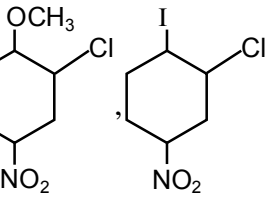
**Sol.**

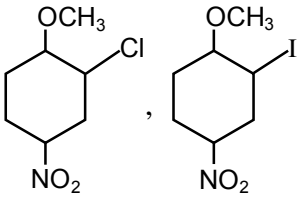


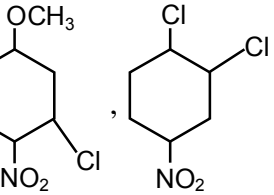

**8.**

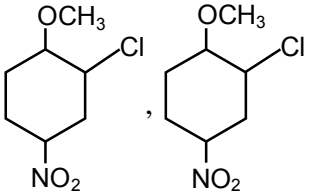



Products A and B are :

(1) 


(2) 


(3) 


(4) 


**Ans.** **(2)**

**9.** Which among the following is true ?

(1) Buna-N is a natural polymer

(2) Buna-N's manufacture requires nascent oxygen

(3) Neoprene is addition co-polymer and used in bucket formation

(4) Buna-S is straight linear polymer and is thermosetting plastic

**Ans.** **(2)**

**Sol.** Theory

**10.** Quantities plotted on y & x-axis on Ellingham diagram are

(1) $\Delta G$ v/s T

(2) $\Delta G - T\Delta S$ v/s T

(3) $\Delta H$ v/s T

(4) $\Delta S$ v/s T

**Ans.** **(1)**

**11.** Solubility of AgCN in buffer of pH = 3 is x

$K_{SP_{AgCN}} = 2.2 \times 10^{-16}$

$K_{a_{HCN}} = 6.6 \times 10^{-10}$

(1) $1.9 \times 10^{-5}$ (2) $0.625 \times 10^{-6}$

(3) $2.2 \times 10^{-16}$ (4) $1.25 \times 10^{-6}$

**Ans.** **(1)**

**Sol.** Lets solubility is x

$$AgCN \rightleftharpoons \underset{x}{Ag^+} + \underset{x}{CN^-} \quad K_{SP} = 2.2 \times 10^{-16}$$

$$H^+ + CN^- \rightleftharpoons HCN \quad K = \frac{1}{k_a} = \frac{1}{6.6 \times 10^{-10}}$$

$$K_{SP} \times \frac{1}{k_a} = [Ag^{+1}]\,[CN^-] \times \frac{[HCN]}{[H^+][CN^-]}$$

$$2.2 \times 10^{-16} \times \frac{1}{6.6 \times 10^{-10}} = \frac{[S] \times [S]}{10^{-3}}$$

$$S^2 = \frac{2.2}{6.6} \times 10^{-9}$$

$$S^2 = \frac{1}{30} \times 10^{-8}$$

$$S = \sqrt{\frac{1}{30}} \times 10^{-4} = 1.9 \times 10^{-5}$$

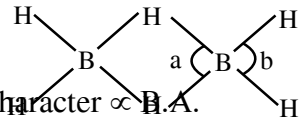
**12.** In $B_2H_6$

(1) $BH_3$ is a lewis base (2) External B-H bonds have less p-character

(3) All bond angles are 120° (4) B-H-B bonds are not identical

**Ans.** **(2)**

**Sol.**

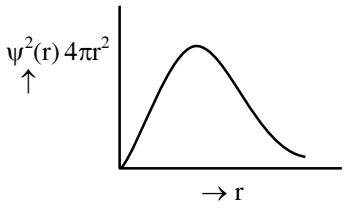


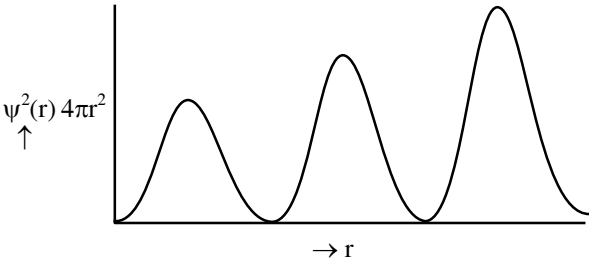

% S-character ∝ B.A.

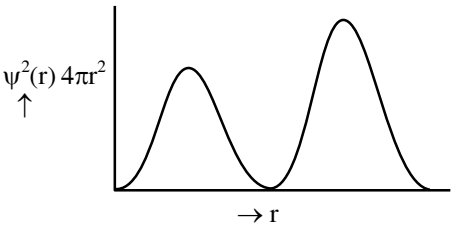
Bond angle a > b

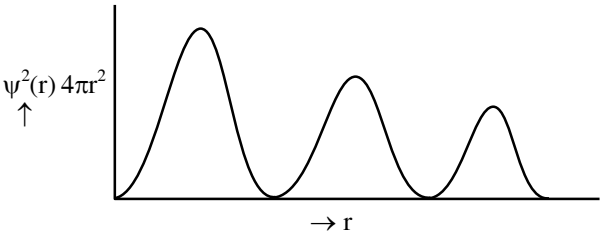
Therefore external bond has more % s-character or less % p-character.

**13.** Which of the following probability $4\pi r^2$. Distribution cause is correct for 3s orbital?

(1) 


(2) 


(3) 


(4) 


**Ans.** **(2)**

**14.** In which of the following reaction $H_2O_2$ is acting as an oxidising agent.

(1) $I^- + H_2O_2 + H^+ \rightarrow I_2$ (2) $I_2 + OH^- + H_2O_2 \rightarrow I^-$

(3) $HOCl + H_2O_2 \rightarrow Cl^-$ (4) $H_2O_2 + IO_4^- \rightarrow I^-$

**Ans.** **(1)**

**15.** Which of the following ion pairs have same outermost configuration ?

(1) $Cr^+$, $Mn^{2+}$ (2) $V^{2+}$ , $Co^+$ (3) $Fe^{2+}$, $Co^+$ (4) $Ni^{2+}$ , $Cu^+$

**Ans.** **(1)**

**Sol.** $Cr^+ \Rightarrow [Ar]3d^5$

$Mn^{2+} \Rightarrow [Ar]3d^5$

**16.** Which of the following is not possible according to MOT

(1) $Be_2$ (2) $O_2^{2-}$ (3) $He_2^-$ (4) $He_2^+$

**Ans.** **(1)**

**Sol.** Species $\rightarrow$ Bond order

$Be_2$ $\rightarrow$ 0 (zero) (not possible)

$O_2^{2-}$ $\rightarrow$ 1 (one)

$He_2^-$ $\rightarrow$ $\frac{1}{2}$ (Half)

$He_2^+$ $\rightarrow$ $\frac{1}{2}$ (Half)

**17.** $S_1$ : $CeO_2$ is used in oxidation of aldehyde & ketone

$S_2$ : $EuSO_4$ is strong reducing agent

(1) Only $S_1$ is correct (2) Only $S_2$ is correct

(3) Both are incorrect (4) Both are correct

**Ans** **(4)**

**18.** $\underset{(i)}{[Mn(CN)_6]^{4-}}$ $\underset{(ii)}{[Fe(CN)_6]^{3-}}$

Hybridisation & magnetic nature of (i) & (ii) respectively are-

(1) $sp^3d^2$ diamagnetic (2) $d^2sp^3$ diamagnetic

(3) $sp^3d^2$ paramagnetic (4) $d^2sp^4$ paramagnetic

**Ans.** **(4)**

**Sol.** $[Mn(CN)_6]^{4-}$

$Mn^{2+} = 3d^5 \xrightarrow{\text{Strong field ligand}} t_{2g}^{2,2,1}\, eg^{00}$

Hybridisation = $d^2sp^3$

$[Fe(CN)_6]^{3-}$

$Fe^{3+} = 3d^5 \xrightarrow{\text{Strong field ligand}} t_{2g}^{2,2,1}\, eg^{00}$

Magnetic nature $\rightarrow$ paramagnetic

**19.** According to Freundlich isotherm at moderate pressure $\frac{x}{m}$ is proportional to $p^x$, x is

(1) $\frac{1}{n}$ (2) 1 (3) 0 (4) $\infty$

**Ans.** **(1)**

**Sol.** $\frac{x}{m} = kp^{1/n}$

**20.** 1.8 gram $C_xH_yO_z$ compound on combustion gives 2.64 gram $CO_2(g)$ and 1.08 gram of $H_2O$. Find out mass % of oxygen in compound.

(1) 63.3 % (2) 53.3% (3) 51.3% (4) 55.33%

**Ans.** (2)

**Sol.** $n_{CO_2} = \frac{2.64}{44} = 0.06$ $n_c = 0.06$

Weight of carbon = $0.06 \times 12 = 0.72$ gram

$n_{H_2O} = \frac{1.08}{18} = 0.06$

$n_H = 0.06 \times 2 = 0.12$

Weight of $H_2 = 0.12$ gram

$\therefore$ Weight of oxygen in $C_xH_yO_z$

$= 1.8 \times 0.72 - 0.12$

$= 0.96$ gram

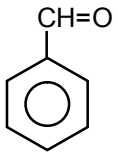
% weight of oxygen $= \frac{0.96}{1.8} \times 100$

$= 53.3$ %

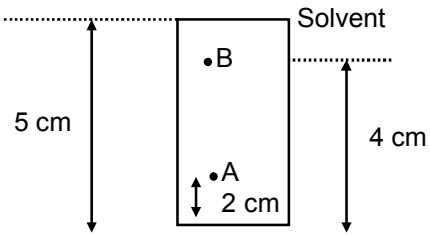
**21.** How many $sp^2$ hybridised carbon atoms in the final product ?

$H-C\equiv C-H \xrightarrow[(2)CO+HCl/AlCl_3]{(1)\text{ Red hot Fe tube}}$ Product

**Ans.** **7**

**Sol.** $H-C\equiv C-H \xrightarrow{(1)\text{ Red hot Fe tube}}$  $\xrightarrow{(2)CO+HCl/AlCl_3}$ 


**22.** The separation of A and B using chromatography is done. Calculate the retarding factor of A ?




**Ans.** **0.4**

**Sol.** retarding factor $= \frac{2}{5} = 0.4$

**23.** How many of the following do not hydrolyse ?

$SiCl_4$, $PCl_5$, $SF_6$, $BF_3$

**Ans.** **1 ($SF_6$)**

**Sol.** $SiCl_4 + 4H_2O \rightarrow H_4SiO_4 + 4HCl$

$PCl_5 + 2H_2O \rightarrow POCl_3 + 2HCl$

$BF_3 + 3H_2O \rightarrow H_3BO_3 + 3HF$

$SF_6 + H_2O \rightarrow$ No reaction

**24.** $A_2B_3$ is 60% ionised in its 1m aqueous solution. Determine Boiling point of solution $K_b$ of $H_2O = 0.52°C\ m^{-1}$

**Ans.** **101.768°C**

**Sol.** $A_2B_3 \longrightarrow 2A^{+3} + 3B^{-2}$

No. of Ions = 2 + 3 = 5

$i = 1 + (n-1)\alpha = 1 + (5-1) \times .6$

$= 1 + 4 \times .6 = 1 + 2.4 = 3.4$

$\Delta T_b = K_b \times m \times i$

$= 0.52 \times 1 \times 3.4 = 1.768°C$

$\Delta T_b = (T_b)_{Solution} - \left[(T_b)_{H_2O}\right]_{Solvent}$

$1.768 = (T_b)_{Solution} - 100$

$(T_b)_{Solution} = 101.768°C$

**25.** A tyre containing $N_2$ has 35 psi at 27°C. At what temperature (in°C) pressure will be 40psi?

**Ans.** **70°C**

**Sol.** $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$\frac{35}{300} = \frac{40}{T_2}$

$T_2 = \frac{40 \times 300}{35}$

$= 342.86\ K$

$= 69.85°C$

$\simeq 70°C$

**26.** $CrO_4^{2-} + S_2O_3^{2-} \longrightarrow SO_4^{2-} + Cr(OH)_4^-$

$0.154M \quad 40ml$

$V = ? \quad 0.25M$

**Ans.** $\simeq$ **173ml**

**Sol.** $17H_2O + 8CrO_4^{2-} + 3S_2O_3^{2-} \longrightarrow 6SO_4^{2-} + 8Cr(OH)_4^- + 2OH^-$

Applying mole – mole analysis

$$\frac{0.154 \times V}{8} = \frac{40 \times 0.25}{3} \qquad \therefore \ V \simeq 173ml$$

**27.** $NH_2CN(S) + \frac{3}{2}O_2(g) \longrightarrow N_2(g) + CO_2(g) + H_2O(\ell)$ $\qquad \Delta U = -744.24 KJ/mole$

Find out $|\Delta H|$ at 298 K in kJ/mole

**Ans.** **743**

**Sol.** $NH_2CN(S) + \frac{3}{2}O_2(g) \longrightarrow N_2(g) + CO_2(g) + H_2O(\ell)$ $\qquad \Delta n_g = (1+1) - \frac{3}{2} = \frac{1}{2}$

$\Delta H = \Delta U + \Delta n_g RT$

$$= -744.24 + \frac{1}{2} \times \frac{8.314 \times 298}{1000}$$

$= -744.24 + 1.24$

$\simeq -743$ kJ/mole

**28.** Enthalpy of formation from Na to $Na^+(g)$ is 426.4 kJ/mole and that of $Br^-(g)$ from $Br_2(\ell)$ is –325 KJ/mole. Lattice energy of NaBr(s) is –774.8 kJ/mole. Determine $\Delta H_f(\text{in kJ/mole})$ of NaBr(s) is –x . Calculate the value of x.

**Ans.** **673.4 kJ/mole**

**Sol.**

$$Na_{(s)} \longrightarrow Na^+_{(g)}, \ \Delta H = 426.4 \text{ kJ/mole}$$

$$\frac{1}{2}Br_2(\ell) \longrightarrow Br^-_{(g)}, \ \Delta H = -325 kJ/mole$$

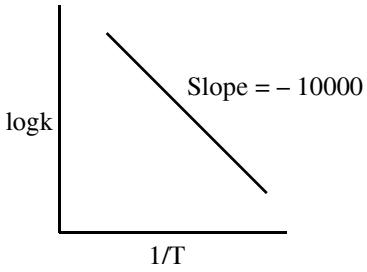
$$Na^+_{(g)} + Br^-_{(g)} \longrightarrow NaBr_{(s)}, \ \Delta H = -774.8 kJ/mole$$

$$Na_{(s)} + \frac{1}{2}Br_2(\ell) \longrightarrow NaBr_{(s)}, \ \Delta H = ?$$

$\Rightarrow \Delta H = 426.4 - 325 - 774.8$

$= -673.4$ kJ/mole

**29.** For a general reaction $aA + bB \rightarrow cC + dD$




If rate constant (k) at T = 500 K is $10^{-5}$, temperature at which k is $10^{-4}$

**Ans.** **526.3K**

**Sol.** $\log_{10}k = \log_{10}A - \dfrac{E_a}{2.303RT}$

$\text{Slope} = \dfrac{-E_a}{2.303R} = -10000$

$\log_{10}\dfrac{k_2}{k_1} = \dfrac{E_a}{2.303R} \times \left[\dfrac{1}{T_1} - \dfrac{1}{T_2}\right]$

$\log_{10}\dfrac{10^{-4}}{10^{-5}} = 10000 \times \left[\dfrac{1}{500} - \dfrac{1}{T}\right]$

$1 = 10000 \times \left[\dfrac{1}{500} - \dfrac{1}{T}\right]$

$\dfrac{1}{10000} = \dfrac{1}{500} - \dfrac{1}{T}$

$\dfrac{1}{T} = \dfrac{1}{500} - \dfrac{1}{10000}$

$= \dfrac{20-1}{10,000} = \dfrac{19}{10000}$

$T = \dfrac{10,000}{19} = 526.3K$