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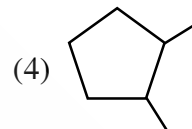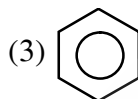## PAPER-1(B.E./B. TECH.)

JEE (Main) 2021
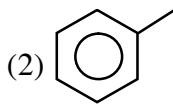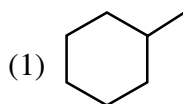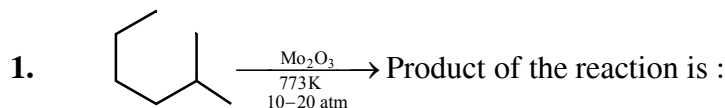
Questions & Solutions
(Reproduced from memory retention)

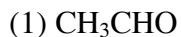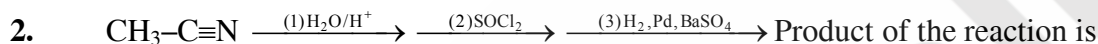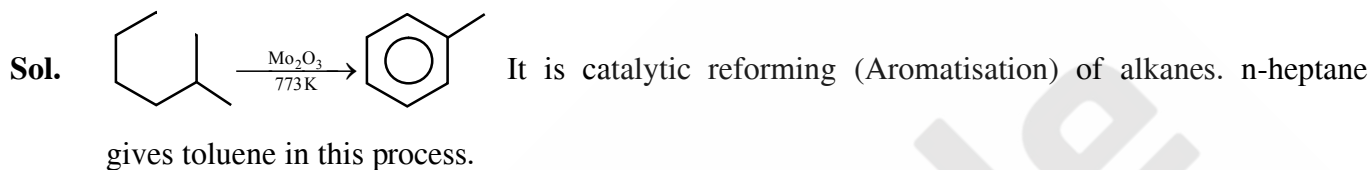**Date : 25 February, 2021 (SHIFT-1) Time ; (9.00 am to 12.00 pm)**
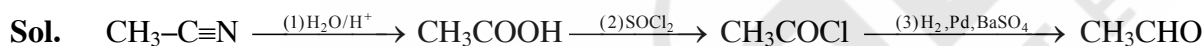
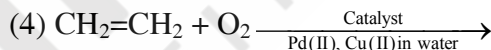**Duration : 3 Hours | Max. Marks : 300**
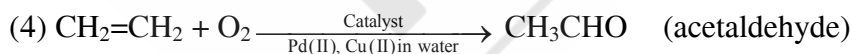
SUBJECT : CHEMISTRY

CHEMISTRY

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

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

Ans. (2)

Sol. $\xrightarrow[773K]{Mo_2O_3}$ 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.
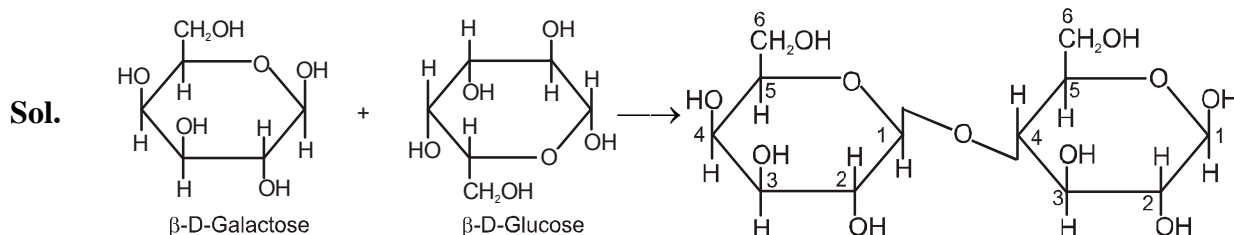
The linkage is between C-1 of Galactose and C-4 of Glucose.

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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
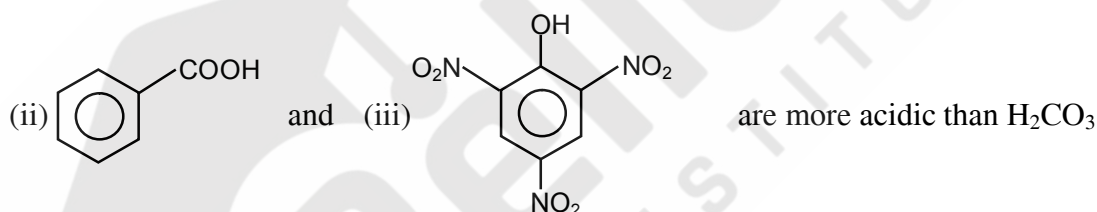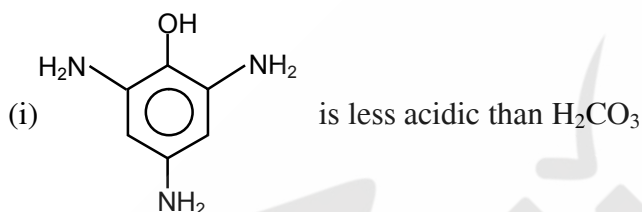   (4) Statement I , II both are false

Ans. **(4)**

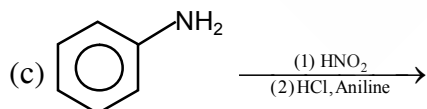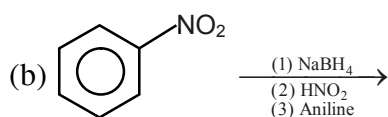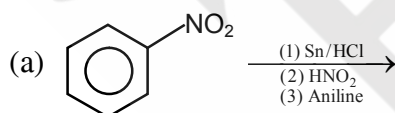6. Which of the following set of compounds give $NaHCO_3$ test ?
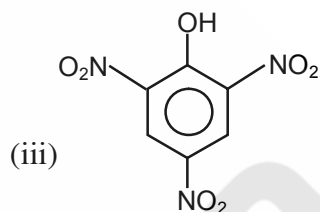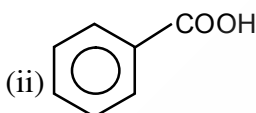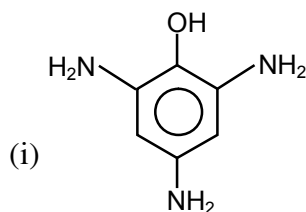
   (1) i, ii   (2) i, iii   (3) ii, iii   (4) i, ii, iii

Ans. **(3)**

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

 is less acidic than H_2CO_3

 and (iii) are more acidic than H_2CO_3

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

   (a) $\xrightarrow[\substack{(2)\ HNO_2 \\ (3)\ Aniline}]{(1)\ Sn/HCl}$

   (b) $\xrightarrow[\substack{(2)\ HNO_2 \\ (3)\ Aniline}]{(1)\ NaBH_4}$

   (c) $\xrightarrow[\substack{(2)\ HCl,\ Aniline}]{(1)\ HNO_2}$

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

Ans. **(2)**

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Sol.

8.
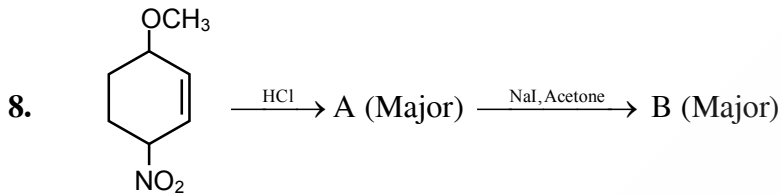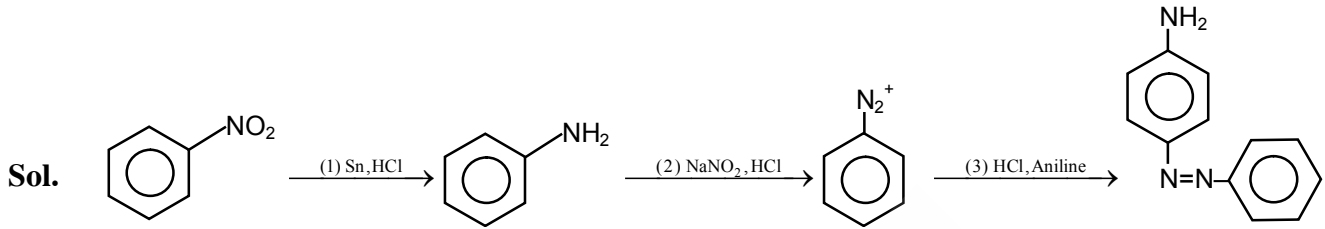
Products A and B are :

(1)

(2)

(3)

(4)
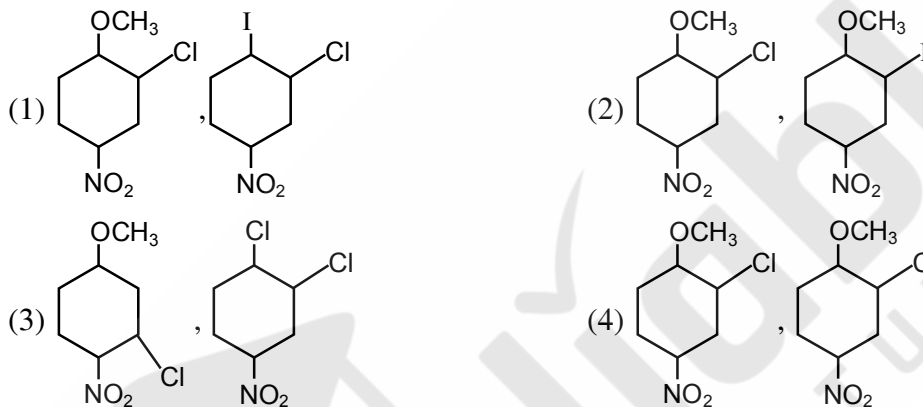
Ans. **(2)**

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

(3) ΔH v/s T (4) ΔS v/s T

Ans. **(1)**

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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) 1.9×10^{-5} (2) 0.625×10^{-6}

(3) 2.2×10^{-16} (4) 1.25×10^{-6}

Ans. **(1)**

Sol. Lets solubility is x

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

$H^+ + CN^- \rightleftharpoons HCN \quad K = \dfrac{1}{k_a} = \dfrac{1}{6.6 \times 10^{-10}}$
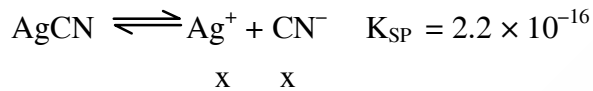
$K_{SP} \times \dfrac{1}{k_a} = [Ag^{+1}][CN^-] \times \dfrac{[HCN]}{[H^+][CN^-]}$

$2.2 \times 10^{-16} \times \dfrac{1}{6.6 \times 10^{-10}} = \dfrac{[S] \times [S]}{10^{-3}}$
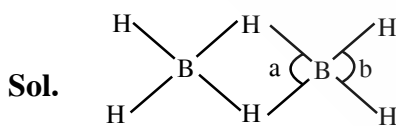
$S^2 = \dfrac{2.2}{6.6} \times 10^{-9}$

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

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

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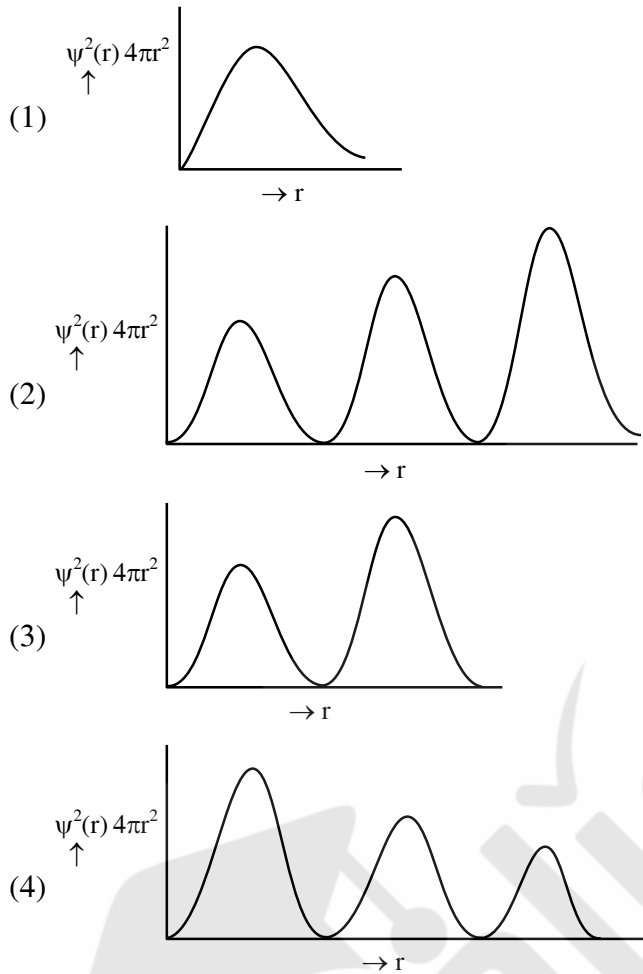
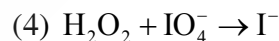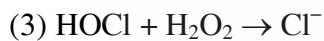**Ans.** **(2)**

Sol.

Bond angle b > a

% S-character ∝ B.A.

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

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13. Which of the following probability $4\pi r^2$. Distribution cause is correct for 3s orbital?
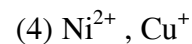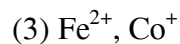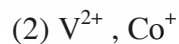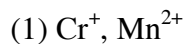
(1)

(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) $H_2O_2 + IO_4^- \rightarrow I^-$
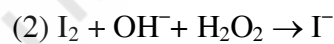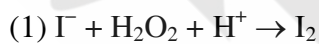
Ans. **(1)**

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

   $Mn^{2+} \Rightarrow [Ar]3d^5$
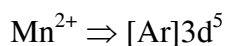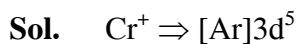
16. Which of the following is not possible according to MOT

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

Ans. **(1)**

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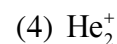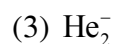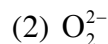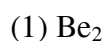
Sol. Species $\rightarrow$ Bond order

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

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

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

He_2^+ $\rightarrow$ $\dfrac{1}{2}$ (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. $\left[Mn(CN)_6\right]^{4-}_{(i)}$ $\left[Fe(CN)_6\right]^{3-}_{(ii)}$

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

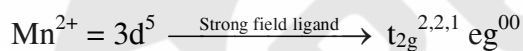(1) sp^3d^2 diamagnetic
(2) d^2sp^3 diamagnetic

(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 $\dfrac{x}{m}$ is proportional to p^x, x is

(1) $\dfrac{1}{n}$
(2) 1
(3) 0
(4) ∞

Ans. **(1)**

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

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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. $n_{CO_2} = \dfrac{2.64}{44} = 0.06$ $n_c = 0.06$

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

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

$n_H = 0.06 \times 2 = 0.12$

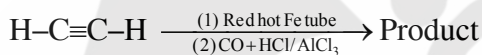Weight of $H_2 = 0.12$ gram

∴ Weight of oxygen in $C_xH_yO_z$
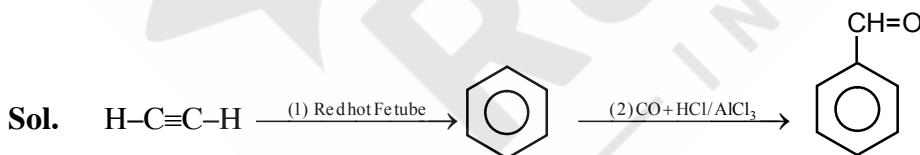
$= 1.8 \times 0.72 - 0.12$

$= 0.96$ gram

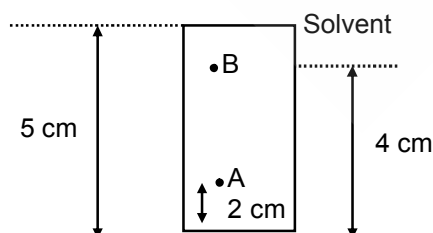% weight of oxygen $= \dfrac{0.96}{1.8} \times 100$

$= 53.3$ %

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

$H{-}C{\equiv}C{-}H \xrightarrow[\text{(2) CO+HCl/AlCl}_3]{\text{(1) Red hot Fe tube}} \text{Product}$
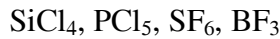
Ans. 7

Sol.

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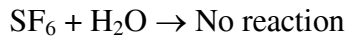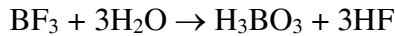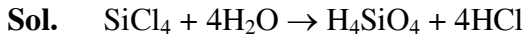

Ans. 0.4

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

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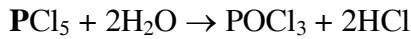
24. A_2B_3 is 60% ionised in its 1m aqueous solution. Determine Boiling point of solution K_b of $H_2O = 0.52°C$ m^{-1}

Ans. **101.768°C**

Sol. $A_2B_3 \longrightarrow 2A^{+3} + 3B^{-2}$
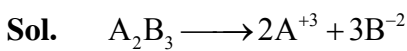
No. of Ions = 2 + 3 = 5

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

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

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

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

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

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

$(T_b)_{Solution} = 101.768°C$

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. $\dfrac{P_1}{T_1} = \dfrac{P_2}{T_2}$

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

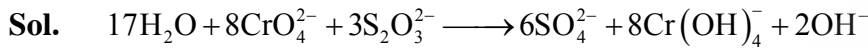$T_2 = \dfrac{40 \times 300}{35}$

= 342.86 K

= 69.85°C

$\simeq 70°C$

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26. $CrO_4^{2-} + S_2O_3^{2-} \longrightarrow SO_4^{2-} + Cr(OH)_4^-$
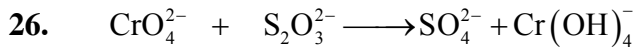
0.154M   40ml

V = ?   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

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

27. $NH_2CN(S) + \dfrac{3}{2}O_2(g) \longrightarrow N_2(g) + CO_2(g) + H_2O(\ell)$ $\Delta U = -744.24 KJ/mole$
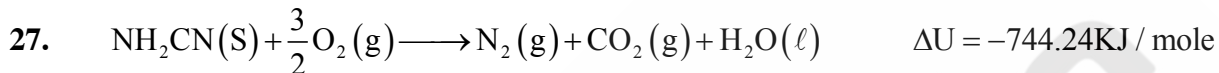
Find out $|\Delta H|$ at 298 K in kJ/mole

Ans. **743**

Sol. $NH_2CN(S) + \dfrac{3}{2}O_2(g) \longrightarrow N_2(g) + CO_2(g) + H_2O(\ell)$ $\Delta n_g = (1+1) - \dfrac{3}{2} = \dfrac{1}{2}$
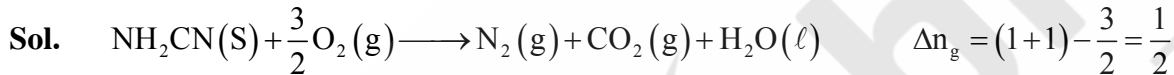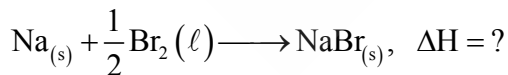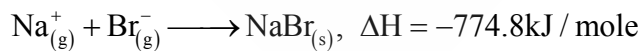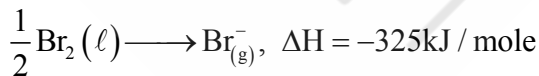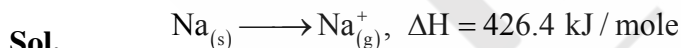
$\Delta H = \Delta U + \Delta n_g RT$

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

$= -744.24 + 1.24$

$\simeq -743$ 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 ΔH_f (in kJ/mole) of NaBr(s) is –x. Calculate the value of x.

Ans. **673.4 kJ/mole**

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

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

$\dfrac{Na_{(g)}^+ + Br_{(g)}^- \longrightarrow NaBr_{(s)},\ \Delta H = -774.8 \text{kJ/mole}}{Na_{(s)} + \dfrac{1}{2}Br_2(\ell) \longrightarrow NaBr_{(s)},\ \Delta H = ?}$

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

$= -673.4$ kJ/mole

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29. For a general reaction $aA + bB \rightarrow cC + dD$
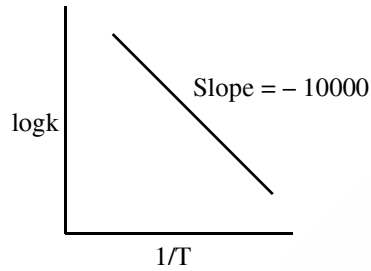
If rate constant (k) at T = 500 K is 10^{-5}, temperature at which k is 10^{-4}

Ans. 526.3K

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

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

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

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

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

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

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

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

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

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