FINAL JEE–MAIN EXAMINATION – JANUARY, 2020

(Held On Tuesday 07th JANUARY, 2020) TIME : 2 : 30 PM to 5 : 30 PM

CHEMISTRY — TEST PAPER WITH ANSWER

1. Within each pair of elements of F & Cl , S & Se, and Li & Na, respectively, the elements that release more energy upon an electron gain are-

(1) F, Se and Na

(2) F, S and Li

(3) Cl, S and Li

(4) Cl, Se and Na

NTA Ans. (3)

Sol. (i) Electron affinity of second period p-block element is less than third period p-block element due to small size of second period p-block element.

E.A. order : F < Cl

(ii) Down the group electron affinity decreases due to size increases.

EA. order : S > Se

Li > Na

2. The redox reaction among the following is :

(1) Combination of dinitrogen with dioxygen at 2000 K

(2) Formation of ozone from atmosphereic oxygen in the presence of sunlight

(3) Reaction of H_2SO_4 with NaOH

(4) Reaction of $[Co(H_2O)_6]Cl_3$ with $AgNO_3$

NTA Ans. (1)

Sol. (i) $N_2 + O_2 \xrightarrow{2000\ K} 2NO$ (Redox reaction)

during the reaction, oxidation of nitrogen take place from 0 to 2 and reduction of oxygen take place from 0 to –2. It means this reaction is redox reaction.

(ii) $3O_2 \xrightarrow{h\nu} 2O_3$ (Non – redox reaction)

(iii) $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$ (neutralization reaction)

(iv) $[Co(H_2O)_6]Cl_3 + 3AgNO_3$

$\rightarrow 3AgCl\downarrow + [Co(H\ O)\ ](NO\ )$

3. Among the statements(a)-(d), the incorrect ones are-

(a) Octahedral Co(III) complexes with strong field ligands have very high magnetic moments

(b) When $\Delta_0 < P$, the d-electron configuration of Co(III) in an octahedral complex is $t_{eg}^4\ e_g^2$

(c) Wavelength of light absorbed by $[Co(en)_3]^{3+}$ is lower than that of $[CoF_6]^{3-}$

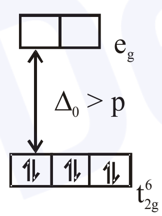
(d) If the Δ_0 for an octahedral complex of Co(III) is 18,000 cm^{-1}, the Δ_t for its tetrahedral complex with the same ligand will be 16,000 cm^{-1}

(1) (a) and (b) only (2) (c) and (d) only

(3) (b) and (c) only (4) (a) and (d) only

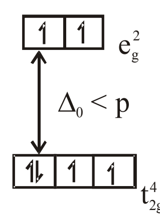
NTA Ans. (4)

Sol. (a) Co^{+3} (with strong field ligands)



diamagnetic

(b) If $\Delta_0 < p$;



(c) Splitting power of ethylenediamine (en) is greater than fluoride (F^-) ligand therefore more energy absorbed by $[Co(en)_3]^{3+}$ as compared to $[CoF_6]^{3-}$.

So wave length of light absorbed by $[Co(en)_3]^{3+}$ is lower than that of $[CoF_6]^{3-}$

(d) $\Delta_t = \frac{4}{9}\Delta_0$

so if Δ_0 = 18,000 cm^{-1}

$\Delta = \frac{4}{-} \times 18000 = 8000\ cm^{-1}$

4. The number of possible optical isomers for the complexes MA_2B_2 with sp^3 and dsp^2 hybridised metal atom, respectively, is :

Note : A and B are unidentate neutral and unidentate monoanionic ligands, respectively

(1) 0 and 0

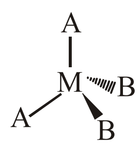
(2) 0 and 2

(3) 0 and 1

(4) 2 and 2

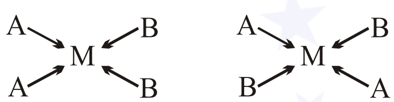
NTA Ans. (1)

Sol. (a) If the complex MA_2B_2 is sp^3 hybridised then the shape of this complex is tetrahedral this structure is opticaly inactive due to the presence of plane of symmetry.



Optical isomes = 0

(b) If the complex MA_2B_2 is dsp^2 hybridised then the shape of this complex is square planar.



(Cis-isomer) (Trans-isomer)

Both isomers are optically inactive due to the presence of plane of symmetry.

Optical isomers = 0

5. In the following reactions products(A) and (B), respectively , are :

$NaOH + Cl_2 \rightarrow (A)$ + side products

(hot and conc.)

$Ca(OH)_2 + Cl_2 \rightarrow (B)$ + side products

(dry)

(1) $NaClO_3$ and $Ca(OCl)_2$

(2) $NaOCl$ and $Ca(ClO_3)_2$

(3) $NaClO_3$ and $Ca(ClO_3)_2$

(4) $NaOCl$ and $Ca(OCl)_2$

NTA Ans. (1)

Sol. $6NaOH + 3Cl_2 \longrightarrow NaClO_3 + 5NaCl + 3H_2O$

(hot and conc.) (A) side product

$2Ca(OH)\ + 2Cl \longrightarrow Ca(OCl)\ + CaCl\ + 2H\ O$

6. Which of the following statements is correct-

(1) Gluconic acid can form cyclic (acetal/hemiacetal) structure

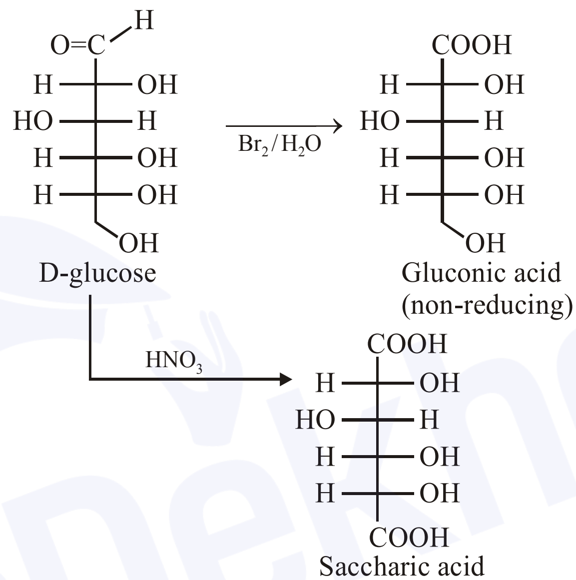
(2) Gluconic acid is a partial oxidation product of glucose

(3) Gluconic acid is obtained by oxidation of glucose with HNO_3

(4) Gluconic acid is a dicarboxylic acid

NTA Ans. (2)

Sol.



7. The bond order and the magnetic characteristics of CN^- are :

(1) 3, diamagnetic

(2) $2\frac{1}{2}$, paramagnetic

(3) 3, paramagnetic

(4) $2\frac{1}{2}$, diamagnetic

NTA Ans. (1)

Sol. According to MOT (If z is internuclear axis) The configuration of

$$CN^- : \sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \pi_{2p_x}^2 = \pi_{2p_y}^2, \sigma_{2p_z}^2$$

$$\text{Bond order} = \frac{1}{2}(10-4)$$

$$= 3$$

CN^- is diamagnetic due to absence of unpaired

8. The equation that is incorrect is -

(1) $(\Lambda_m^0)_{NaBr} - (\Lambda_m^0)_{NaI} = (\Lambda_m^0)_{KBr} - (\Lambda_m^0)_{NaBr}$

(2) $(\Lambda_m^0)_{H_2O} = (\Lambda_m^0)_{HCl} + (\Lambda_m^0)_{NaOH} - (\Lambda_m^0)_{NaCl}$

(3) $(\Lambda_m^0)_{KCl} - (\Lambda_m^0)_{NaCl} = (\Lambda_m^0)_{KBr} - (\Lambda_m^0)_{NaBr}$

(4) $(\Lambda_m^0)_{NaBr} - (\Lambda_m^0)_{NaCl} = (\Lambda_m^0)_{KBr} - (\Lambda_m^0)_{KCl}$

NTA Ans. (1)

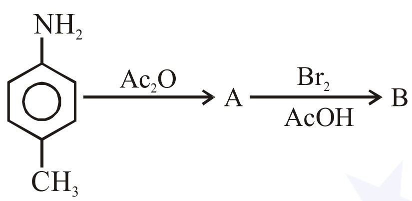
Sol. Option (1) is incorrect.

According to Kohlrausch's law correct expression is

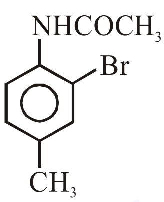
$$(\Lambda_m^0)_{NaBr} - (\Lambda_m^0)_{NaI} = (\Lambda_m^0)_{KBr} - (\Lambda_m^0)_{KI}$$

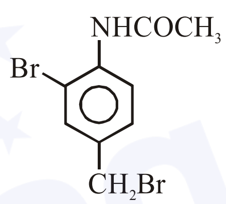
The other statements are correct.

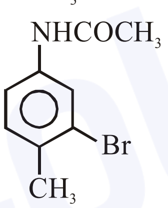
9. In the following reaction sequence

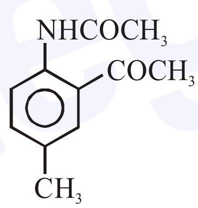


the major products B is -

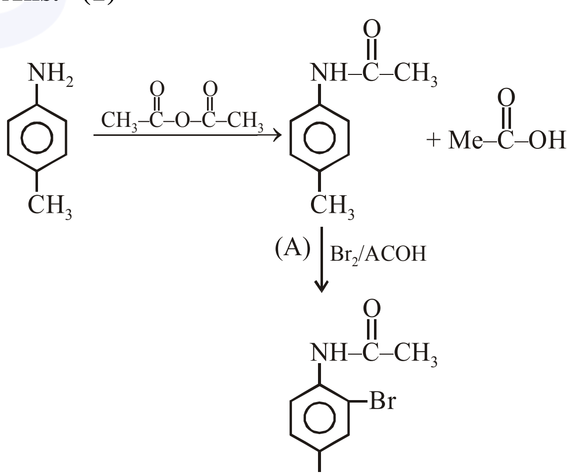
(1) 

(2) 

(3) 

(4) 

NTA Ans. (1)

Sol. 

10. Two open beakers one containing a solvent and the other containing a mixture of that solvent with a non volatile solute are together sealed in a container. Over time -

(1) The volume of the solution does not change and the volume of the solvent decreases

(2) The volume of the solution decrease and the volume of the solvent increases

(3) The volume of the solution increase and the volume of the solvent decreases

(4) The volume of the solution and the solvent does not change

NTA Ans. (3)

Sol. The pure solvent solution will try to maintain higher vapour pressure in the sealed container and in return the solvent vapour molecules will condense in the solution of non-volatile solute as it maintains an equilibrium with lower vapour pressure. (Lowering of vapour pressure is observed when a non volatile solute is mixed in a volatile solvent)

This will eventually lead to increase in the volume of solution and decrease in the volume of solvent.

11. A chromatography column, packed with silica gel as stationary phase, was used to separate a mixture of compounds consisting of (A) benzanilide (B) aniline and (C) acetophenone. When the column is eluted with a mixture of solvents, hexane : ethyl acetate (20 : 80), the sequence of obtained compounds :

(1) (B), (C) and (A) (2) (C), (A) and (B)

(3) (A), (B) and (C) (4) (B), (A) and (C)

NTA Ans. (2)

Sol. (A) Benzanilide → Ph–NH–C(=O)–Ph (μ = 2.71 D)

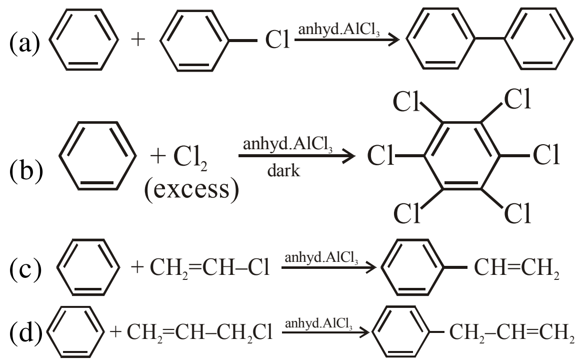
(B) Aniline → $Ph–NH_2$ (μ = 1.59 D)

(C) Acetophenone → $Ph–C(=O)–CH_3$ (μ = 3.05 D)

Dipole moment : C > A > B

Hence the sequence of obtained compounds is

12. Consider the following reactions :



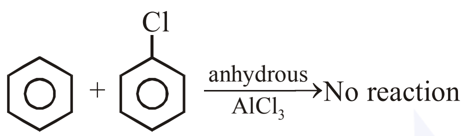
Which of these reactions are possible ?

(1) (a) and (d) (2) (b) and (d)

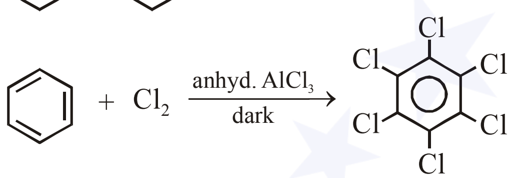
(3) (a) and (b) (4) (b) , (c) and (d)

NTA Ans. (2)

Sol. (a)

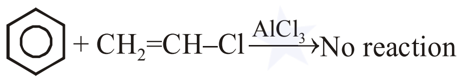


(b)

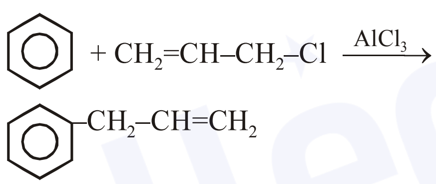


(electrophilic substitution)

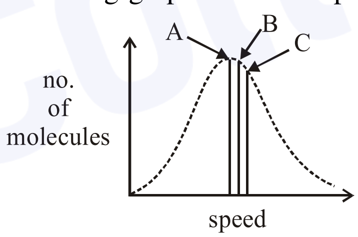
(c)



(d)



13. Identify the correct labels of A, B and C in the following graph from the options given below:



Root mean square speed (V_{rms}) ; most probable speed (V_{mp}) ; Average speed ($V_{av.}$)

(1) A – V_{rms} ; B –V_{mp} ; C – V_{av}

(2) A – V_{av} ; B –V_{rms} ; C – V_{mp}

(3) A – V_{mp} ; B –V_{rms} ; C – V_{av}

(4) A – V_{mp} ; B –V_{av} ; C – V_{rms}

NTA Ans. (4)

$\left(\sqrt{2RT}\right)$ $\left(\sqrt{8RT}\right)$ $\left(\sqrt{3RT}\right)$

14. Among the statements (a) - (d), the correct ones are -

(a) Decomposition of hydrogen peroxide gives dioxygen

(b) Like hydrogen peroxide, compounds , such as $KClO_3$, $Pb(NO_3)_2$ and $NaNO_3$when heated liberated dioxygen

(c) 2-Ethylanthraquinone is useful for the industrial preparation of hydrogen peroxide.

(d) Hydrogen peroxide is used for the manufacture of sodium perborate

(1) (a), (b) and (c) only

(2) (a) and (c) only

(3) (a), (b) , (c) and (d)

(4) (a), (c) and (d) only

NTA Ans. (3)

Sol. (a) $H_2O_2 \rightarrow 2H_2O + O_2$

(b) $KClO_3 \xrightarrow[MnO_2]{\Delta} KCl + \frac{3}{2}O_2$

$Pb(NO_3)_2 \xrightarrow{\Delta} PbO + 2NO_2 + \frac{1}{2}O_2$

$NaNO_3 \xrightarrow{\Delta} NaNO_2 + \frac{1}{2}O_2$

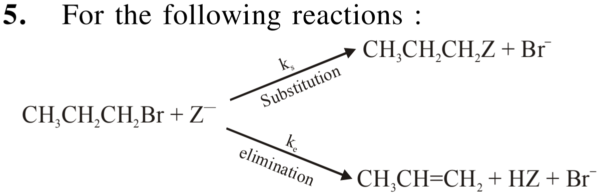
(c) 2-ethylanthraquinol $\underset{H_2/Pd}{\overset{O_2(air)}{\rightleftharpoons}}$ 2-ethylanthraquinone + H_2O_2

(d) $2H_3BO_3 + 2NaOH + 2H_2O_2$

$\longrightarrow Na_2[B_2(O_2)(OH)_4] + 4H_2O$

All statements are correct

15. For the following reactions :



where

$Z^- = CH_3CH_2O^-$ (A) or $H_3C-C(CH_3)_2-O^-$ (B),

k_s and k_e , are , respectively, the rate constants for the substitution and elimination, and $\mu = \frac{k_s}{k_e}$, the correct options is -

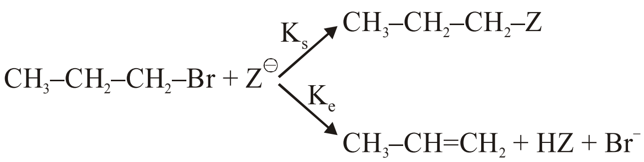
(1) $\mu_B > \mu_A$ and $k_e(B) > k_e(A)$

(2) $\mu_B > \mu_A$ and $k_e(A) > k_e(B)$

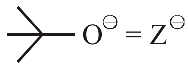
(3) $\mu_A > \mu_B$ and $k_e(B) > k_e(A)$

μ μ

Sol.



(A) $CH_3–CH_2–O^- = Z^{\ominus} \longrightarrow$

(B) 

(B) with more steric crowding forms elimination product compared to substitution.

$K_e(B) > K_e(A)$

$$\mu_B = \frac{K_s(B)}{K_e(A)} < \mu_A = \frac{K_s(A)}{K_e(A)}$$

16. The refining method used when the metal and the impurities have low and high melting temperatures, respectively, is -

(1) zone refining

(2) liquation

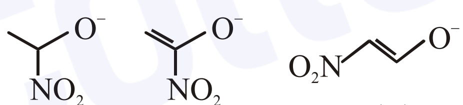
(3) vapour phase refining

(4) distillation

NTA Ans. (2)

Sol. Liquation method is used when the melting point of metal is less compare to the melting point of the associated impurity.

17. The correct order of stability for the following alkoxides is :



(A) (B) (C)

(1) (C) > (B) > (A)

(2) (C) > (A) > (B)

(3) (B) > (C) > (A)

(4) (B) > (A) > (C)

NTA Ans. (1)

Sol. (C) > (B) > (A)

18. The ammonia (NH_3) released on quantitative reaction of 0.6 g urea (NH_2CONH_2) with sodium hydroxide (NaOH) can be neutralized by :

(1) 100 ml of 0.1 N HCl

(2) 200 ml of 0.4 N HCl

(3) 100 ml of 0.2 N HCl

(4) 200 ml of 0.2 N HCl

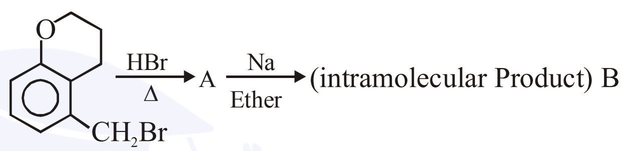
NTA Ans. (3)

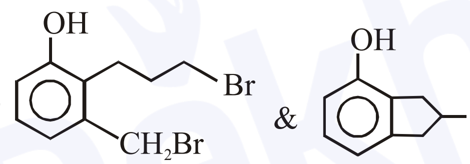
Sol. $NH_2CONH_2 + 2NaOH \rightarrow Na_2CO_3 + 2NH_3$

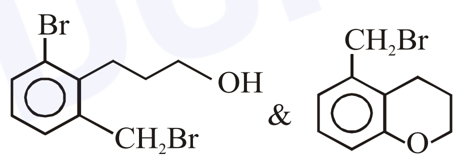
10 mmoles 20mmoles

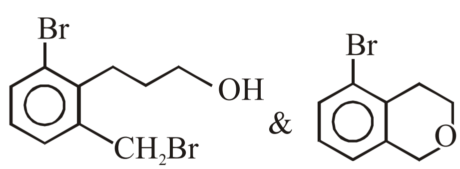
Hence, NH_3 will require 20 meq.

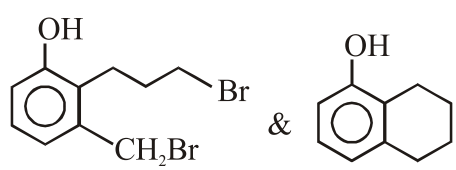
19. In the following reaction squence, structures of A and B, respectively will be :



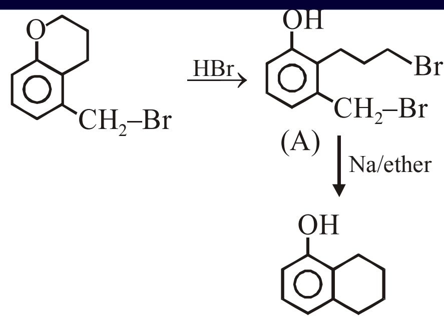
(1) 

(2) 

(3) 

(4) 

NTA Ans. (4)

Sol. 

20. For the reaction

$2H_2(g) + 2NO(g) \rightarrow N_2(g) + 2H_2O(g)$

the observed rate expression is, rate = $k_f[NO]^2[H_2]$. The rate expression of the reverse reaction is :

(1) $k_b[N_2][H_2O]^2/[NO]$ (2) $k_b[N_2][H_2O]$

(3) $k_b[N_2][H_2O]^2$ (4) $k_b[N_2][H_2O]^2/[H_2]$

NTA Ans. (4)

Sol. $$K_{eq} = \frac{k_f}{k_b} = \frac{[N_2][H_2O]^2}{[H_2]^2[NO]^2}$$

At equilibrium $r_f = r_b$

$$k_f \underset{[\text{Given}]}{[H_2][NO]^2} = k_b \frac{[N_2][H_2O]^2}{[H_2]}$$

Hence, rate expression for reverse reaction.

$$= k_b \frac{[N_2][H_2O]^2}{[H_2]}$$

21. Conside the following reactions :

$NaCl + K_2Cr_2O_7 + H_2SO_4(\text{Conc.}) \rightarrow (A) +$ Side products

$(A) + NaOH \rightarrow (B) +$ Side product

$(B) + H_2SO_4(\text{dilute}) + H_2O_2 \rightarrow (C) +$ Side product

The sum of the total number of atoms in one molecule each of (A), (B) and (C) is

NTA Ans. (18.00)

Sol. $4NaCl + K_2Cr_2O_7 + 6H_2SO_4$

$\downarrow$

$2CrO_2Cl_2 + 4NaHSO_4 + 2KHSO_4 + 3H_2O$
(A)

$CrO_2Cl_2 + 4\,NaOH \longrightarrow Na_2CrO_4 + 2NaCl + 2H_2O$
(B)

$Na_2CrO_4 + 2H_2SO_4 + 2H_2O_2$

$\downarrow$

$CrO_5 + 2NaHSO_4 + 3H_2O$
(C)

A = CrO_2Cl_2

B = Na_2CrO_4

C = CrO_5

Total number of atom in A + B + C = 18

22. 3g of acetic acid is added to 250 mL of 0.1 M HCl and the solution made up to 500 mL.

To 20 mL of this solution $\frac{1}{2}$ mL of 5 M NaOH is added. The pH of the solution is _____.

[Given : pK_a of acetic acid = 4.75, molar mass of acetic acid = 60 g/mol, log3 = 0.4771]

Neglect any changes in volume

NTA Ans. (5.22 to 5.24)

Sol. 3gm Acetic Acid + 250 ml 0.1 M HCl + Water

$\longrightarrow$ made to 500 ml solution.

$\Rightarrow$ 500 ml solution has 25 meq of HCl
50 meq of CH_3COOH

$\therefore$ 20ml solution has 1 meq of HCl
2 meq of CH_3COOH

We have added 2.5 meq. of NaOH $\left(5M, \frac{1}{2}\text{ ml}\right)$

Finally, NaOH & HCl are completely consumed and we are left with 0.5 meq of CH_3COOH
and 1.5 meq of CH_3COONa

$$pH = pKa + \log \frac{1.5}{0.5}$$

$$= 4.75 + \log 3 = 4.75 + 0.4771$$

$$= 5.2271$$

23. The standard heat of formation $\left(\Delta_f H^0_{298}\right)$ of ethane in (kJ/mol), if the heat of combustion of ethane, hydrogen and graphite are –1560, –393.5 and –286 kJ/mol, respectively is _______

NTA Ans. (–192.50 or –85.00)

Sol. $2C(\text{graphite}) + 3H_2(g) \longrightarrow C_2H_6(g)$

$$\Delta_f H\,(C_2H_6) = 2\Delta H_{comb}\,(C_{graphite}) + 3\,\Delta H_{comb}(H_2) - \Delta H_{comb}\,(C_2H_6)$$

$$= -\left(286\times 2\right) - \left(393.5\times 3\right) - \left(-1560\right)$$

$$= -572 - 1180.5 + 1560 = -192.5 \text{ kJ/mole}$$

24. The flucculation value of HCl for arsenic sulphide sol. is 30 m mole L^{-1}. If H_2SO_4 is used for the flocculation of arsenic sulphide, the amount, in grams, of H_2SO_4 in 250 ml required for the above purpose is ______.
(molecular mass of H_2SO_4 = 98 g/mol)

NTA Ans. (0.36 to 0.38)

Sol. 1 L solution requires 30 m.mol HCl
250 ml sol. will require 7.5 m.mol HCl
or 3.75 m.mol H_2SO_4

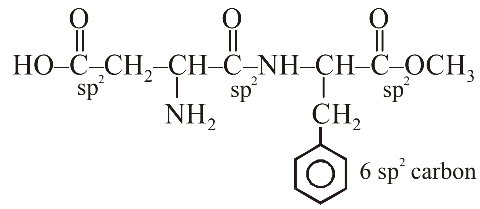
$$\Rightarrow \frac{3.75\times 98}{1000} \text{ gm } H_2SO_4$$

$$= 0.3675 \text{ gm } H_2SO_4$$

25. The number of sp^2 hybridised carbons present in "Aspartame" is ________.

NTA Ans. (9.00)

Sol.



no. of sp^2–carbon → 9