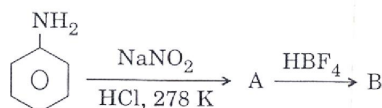


## AIEEE 2010

## Chemistry Solution

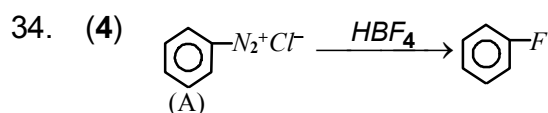
### PART B - Chemistry

31. In aqueous solution the ionization constants for carbonic acid are  $K_1 = 4.2 \times 10^{-7}$  and  $K_2 = 4.8 \times 10^{-11}$ . Select the correct statement for a saturated 0.034 M solution of the carbonic acid.
- (1) The concentration of  $H^+$  is double that of  $CO_3^{2-}$   
(2) The concentration of  $CO_3^{2-}$  is 0.034 M  
(3) The concentration of  $CO_3^{2-}$  is greater than that of  $HCO_3^-$   
(4) The concentrations of  $H^+$  and  $HCO_3^-$  are approximately equal
31. (4) Since second dissociation is less therefore  $[H^+] \approx [HCO_3^-]$
32. Solubility product of silver bromide is  $5.0 \times 10^{-13}$ . The quantity of potassium bromide (molar mass taken as  $120 \text{ g mol}^{-1}$ ) to be added to 1 litre of 0.05 M solution of silver nitrate to start the precipitation of  $AgBr$  is
- (1)  $5.0 \times 10^{-8} \text{ g}$       (2)  $1.2 \times 10^{-10} \text{ g}$       (3)  $1.2 \times 10^{-9} \text{ g}$       (4)  $6.2 \times 10^{-5} \text{ g}$
32. (3)  $[Br^-] = (5 \times 10^{-13}) / (0.05) = 10^{-11} \text{ M} = [KBr]$   
amount =  $1.2 \times 10^{-9} \text{ g}$
33. The correct sequence which shows decreasing order of the ionic radii of the elements is
- (1)  $O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$       (2)  $Al^{3+} > Mg^{2+} > Na^+ > F^- > O^{2-}$   
(3)  $Na^+ > Mg^{2+} > Al^{3+} > O^{2-} > F^-$       (4)  $Na^+ > F^- > Mg^{2+} > O^{2-} > Al^{3+}$
33. (1) For isoelectronic ions, greater is the positive charge smaller is the size and greater is the negative charge larger is the size.
34. In the chemical reactions,



the compounds 'A' and 'B' respectively are

- (1) Nitrobenzene and Chlorobenzene  
(2) Nitrobenzene and fluorobenzene  
(3) Phenol and benzene  
(4) Benzene diazonium chloride and fluorobenzene



35. If  $10^{-4} \text{ dm}^3$  of water is introduced into a  $1.0 \text{ dm}^3$  flask at 300 K, how many moles of water are in the vapour phase when equilibrium is established ?  
 (Given : Vapour pressure of  $\text{H}_2\text{O}$  at 300 K is 3170 Pa ;  $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ )  
 (1)  $1.27 \times 10^{-3} \text{ mol}$  (2)  $5.56 \times 10^{-3} \text{ mol}$   
 (C)  $1.53 \times 10^{-2} \text{ mol}$  (4)  $4.46 \times 10^{-2} \text{ mol}$
35. (1) Amount of  $\text{H}_2\text{O} = 10^{-4} \times 10^3 = 0.1 \text{ ml} = 0.1 \text{ gm}$ .  
 $V = 1000 \text{ ml}$ .  $T = 300\text{K}$ ,  $P = 0.03170 \text{ atm}$   
 $n = (PV/RT) = (0.03170 \times 1) / (0.082 \times 300) = 1.27 \times 10^{-3} \text{ mol}$
36. From amongst the following alcohols the one that would react fastest with conc.  $\text{HCl}$  and anhydrous  $\text{ZnCl}_2$ , is  
 (1) 1-Butanol (2) 2-Butanol (3) 2-Methylpropan-2-ol (4) 2-Methylpropanol
36. (3) Greater the stability of carbocation, greater is the rate of reaction. (3) gives  $3^\circ$  carbocation.
37. If sodium sulphate is considered to be completely dissociated into cations and anions in aqueous solution, the change in freezing point of water ( $\Delta T_f$ ), when 0.01 mol of sodium sulphate is dissolved in 1 kg of water, is ( $K_f = 1.86 \text{ K kg mol}^{-1}$ )  
 (1) 0.0186 K (2) 0.0372 K (3) 0.0558 K (4) 0.0744 K
37. (3)  $\Delta T_f = 1.86 \times (0.01 / 1) \times 3 = 0.0558 \text{ (K)}$
38. Three reactions involving  $\text{H}_2\text{PO}_4^-$  are given below :  
 (i)  $\text{H}_3\text{PO}_4 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{H}_2\text{PO}_4^-$   
 (ii)  $\text{H}_2\text{PO}_4^- + \text{H}_2\text{O} \rightarrow \text{HPO}_4^{2-} + \text{H}_3\text{O}^+$   
 (iii)  $\text{H}_2\text{PO}_4^- + \text{OH}^- \rightarrow \text{H}_3\text{PO}_4 + \text{O}^{2-}$   
 In which of the above does  $\text{H}_2\text{PO}_4^-$  act as an acid ?  
 (1) (i) only (2) (ii) only (3) (i) and (ii) (4) (iii) only
38. (2) In (ii)  $\text{H}_2\text{PO}_4^-$  acts as acid.
39. The main product of the following reaction is  
 $\text{C}_6\text{H}_5\text{CH}_2\text{CH}(\text{OH})\text{CH}(\text{CH}_3)_2 \xrightarrow{\text{conc. H}_2\text{SO}_4}$
- (1)
- (2)
- (3)
- (4)
39. (2)  $\text{Ph} - \text{CH}_2 - \text{CH}(\text{OH}) - \text{CH}(\text{CH}_3)_2 \xrightarrow{\text{conc. H}_2\text{SO}_4} \text{PhCH}=\text{CH}(\text{CH}_3)_2$   
 Benzyl carbocation is more stable and trans alkene is the most stable product. Also there is conjugation in the product.

40. The energy required to break one mole of  $Cl - Cl$  bonds in  $Cl_2$  is  $242 \text{ kJ mol}^{-1}$ . The longest wavelength of light capable of breaking a single  $Cl - Cl$  bond is  
 ( $c = 3 \times 10^8 \text{ ms}^{-1}$  and  $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$ )  
 (1) 494 nm (B) 594 nm (C) 640 nm (D) 700 nm

40. (1) B.E. per molecule =  $(242 \times 1000) / (6.02 \times 10^{23}) = (6.6 \times 10^{-34} \times 3 \times 10^8) / \lambda$   
 $\therefore \lambda = 494 \text{ nm}$

41. 29.5 mg of an organic compound containing nitrogen was digested according to Kjeldahl's method and the evolved ammonia was absorbed in 20 mL of 0.1 M  $HCl$  solution. The excess of the acid required 15 mL of 0.1 M  $NaOH$  solution for complete neutralization. The percentage of nitrogen in the compound is  
 (1) 29.5 (2) 59.0 (3) 47.4 (D) 23.7

41. (4) meq. of  $NH_3 = 20 \times 0.1 \times 1 - 15 \times 0.1 \times 1 = 0.5 \text{ meq.}$   
 $\therefore \% \text{ of } N = (0.5 \times 14 \times 100 \times 1000) / (1000 \times 29.5) = 23.7 \%$

42. Ionisation energy of  $He^+$  is  $19.6 \times 10^{-18} \text{ J atom}^{-1}$ . The energy of the first stationary state ( $n = 1$ ) of  $Li^{2+}$  is  
 (1)  $8.82 \times 10^{-17} \text{ J atom}^{-1}$  (2)  $4.41 \times 10^{-16} \text{ J atom}^{-1}$   
 (3)  $-4.41 \times 10^{-17} \text{ J atom}^{-1}$  (4)  $-2.2 \times 10^{-15} \text{ J atom}^{-1}$

42. (3)  $E_1 / E_2 = (Z_1^2 \times n_2^2) / (n_1^2 \times Z_2^2)$  or  $19.6 \times 10^{-18} / x = 4 / 9$  or  $x = 4.41 \times 10^{-17}$

43. On mixing, heptane and octane form an ideal solution. At 373 K, the vapour pressures of the two liquid components (heptane and octane) are 105 kPa and 45 kPa respectively. Vapour pressure of the solution obtained by mixing 25.0 g of heptane and 35 g of octane will be (molar mass of heptane =  $100 \text{ g mol}^{-1}$  and of octane =  $114 \text{ g mol}^{-1}$ )  
 (1) 144.5 kPa (2) 72.0 kPa (3) 36.1 kPa (4) 96.2 kPa

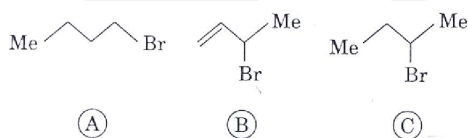
43. (2)  $n_H = (25 / 100) = 0.25$ ;  $n_O = 35 / 114 = 0.3$ ;  $X_H = 5 / 11$  and  $X_O = 6 / 11$   
 $\therefore P_T = (5 / 11) \times 105 + (6 / 11) \times 45 = 72$

44. Which one of the following has an optical isomer ?

- (A)  $[Zn(en)_2]^{2+}$  (2)  $[Zn(en)(NH_3)_2]^{2+}$   
 (3)  $[Co(en)_3]^{3+}$  (4)  $[Co(H_2O)_4(en)]^{3+}$   
 (en = ethylenediamine)

44. (3)  $[Co(en)_3]^{3+}$  is optically active.

45. Consider the following bromides :



The correct order of  $S_N1$  reactivity is

- (1)  $A > B > C$  (2)  $B > C > A$  (3)  $B > A > C$  (4)  $C > B > A$

45. (2) Rate of  $S_N1$  reaction depends on stability of carbocation intermediate. B gives allyl, C gives  $2^\circ$  and A gives  $1^\circ$  carbocation.

46. One mole of a symmetrical alkene on ozonolysis gives two moles of an aldehyde having a molecular mass of 44 u. The alkene is  
 (1) Ethene (2) Propene (3) 1-butene (4) 2-butene
46. (4)  $CH_3 - CH = CH - CH_3 \xrightarrow{\text{Ozonolysis}} 2CH_3 - CHO$
47. Consider the reaction :  
 $Cl_2(aq) + H_2S(aq) \rightarrow S(s) + 2H^+(aq) + 2Cl^-(aq)$   
 The rate equation for this reaction is  
 $\text{rate} = k [Cl_2] [H_2S]$   
 Which of these mechanisms is/are consistent with this rate equation ?  
 A.  $Cl_2 + H_2S \rightarrow H^+ + Cl^- + Cl^{\cdot} + HS^-$  (slow)  
 $Cl^{\cdot} + HS^- \rightarrow H^+ + Cl^- + S$  (fast)  
 B.  $H_2S \rightleftharpoons H^+ + HS^-$  (fast equilibrium)  
 $Cl_2 + HS^- \rightarrow 2Cl^- + H^+ + S$  (slow)  
 (1) A only (2) B only  
 (3) Both A and B (4) Neither A nor B
47. (1)  $\text{Rate} = K [Cl_2][HS^-]$  ;  $K_{eq} = [H^+][HS^-] / [H_2S]$   $\therefore [HS^-] = K_{eq} [H_2S] / [H^+]$   
 $\therefore \text{Rate} = K [Cl_2] \times K_{eq} [H_2S] / [H^+]$   
 So, B is not the correct mechanism.
48. The Gibbs energy for the decomposition of  $Al_2O_3$  at 500 °C is as follows :  
 $(2/3) Al_2O_3 \rightarrow (4/3) Al + O_2, \Delta_r G = + 966 \text{ kJ mol}^{-1}$   
 The potential difference needed for electrolytic reduction of  $Al_2O_3$  at 500 °C is at least  
 (1) 5.0 V (2) 4.5 V (3) 3.0 V (4) 2.5 V
48. (4)  $\Delta G = -nFE$  or  $966000 = 4 \times 96500 \times E$   
 $\therefore E = 2.5 \text{ V}$
49. The correct order of increasing basicity of the given conjugate bases ( $R = CH_3$ ) is  
 (1)  $RCO\bar{O} < HC \equiv \bar{C} < \bar{N}H_2 < \bar{R}$  (2)  $RCO\bar{O} < HC \equiv \bar{C} < \bar{R} < \bar{N}H_2$   
 (3)  $\bar{R} < HC \equiv \bar{C} < RCO\bar{O} < \bar{N}H_2$  (4)  $RCO\bar{O} < \bar{N}H_2 < HC \equiv \bar{C} < \bar{R}$
49. (1) order of acidic strength is  $RCOOH > HC \equiv CH > NH_3 > R-H$   
 So, basicity of their conjugate base will have opposite order.
50. The edge length of a face centered cubic cell of an ionic substance is 508 pm. If the radius of the cation is 110 pm, the radius of the anion is  
 (1) 144 pm (2) 288 pm (3) 398 pm (4) 618 pm
50. (1)  $a = 2r_+ + 2r_- \Rightarrow 508 = 2 \times 110 + 2x \therefore x = 144$
51. Out of the following, the alkene that exhibits optical isomerism is  
 (1) 2-methyl-2-pentene (2) 3-methyl-2-pentene  
 (3) 4-methyl-1-pentene (4) 3-methyl-1-pentene
51. (4)  $CH_3-CH_2-CH(CH_3)-CH=CH_2$  is optically active.

52. For a particular reversible reaction at temperature  $T$ ,  $\Delta H$  and  $\Delta S$  were found to be both +ve. If  $T_e$  is the temperature at equilibrium, the reaction would be spontaneous when
- (1)  $T = T_e$                       (2)  $T_e > T$                       (3)  $T > T_e$                       (4)  $T_e$  is 5 times  $T$
52. (3)  $\Delta G = \Delta H - T\Delta S$   $\therefore T > T_e$  as  $\Delta G$  is negative for spontaneous reaction.
53. Percentages of free space in cubic close packed structure and in body centered packed structure are respectively
- (1) 48% and 26%                      (2) 30% and 26%                      (3) 26% and 32%                      (4) 32% and 48%
53. (3) P.F. of CCP is 74% and that of BCC is 68%
54. The polymer containing strong intermolecular forces e.g. hydrogen bonding, is
- (1) natural rubber                      (2) teflon                      (3) nylon 6,6                      (4) polystyrene
54. (3) Nylon 6,6 is a fibre which has H-bonding.
55. At 25°C, the solubility product of  $Mg(OH)_2$  is  $1.0 \times 10^{-11}$ . At which  $pH$ , will  $Mg^{2+}$  ions start precipitating in the form of  $Mg(OH)_2$  from a solution of 0.001 M  $Mg^{2+}$  ions ?
- (1) 8                      (2) 9                      (3) 10                      (4) 11
55. (3)  $[OH^-]^2 = 10^{-11} / 10^{-3} = 10^{-8}$   $\therefore [OH^-] = 10^{-4}$   $p^{OH} = 4$  ;  $p^H = 10$
56. The correct order of  $E_{M^{2+}/M}^\circ$  values with negative sign for the four successive elements  $Cr$ ,  $Mn$ ,  $Fe$  and  $Co$  is
- (1)  $Cr > Mn > Fe > Co$                       (2)  $Mn > Cr > Fe > Co$   
 (3)  $Cr > Fe > Mn > Co$                       (4)  $Fe > Mn > Cr > Co$
56. (2) Based on fact.
57. Biuret test is **not** given by
- (1) proteins                      (2) carbohydrates                      (3) polypeptides                      (4) urea
57. (2) Biurate test is not given by carbohydrate as it does not contain  $N$ .
58. The time for half life period of a certain reaction  $A \rightarrow$  Products is 1 hour. When the initial concentration of the reactant 'A', is  $2.0 \text{ mol L}^{-1}$ , how much time does it take for its concentration to come from  $0.50$  to  $0.25 \text{ mol L}^{-1}$  if it is a zero order reaction ?
- (1) 1 h                      (2) 4 h                      (3) 0.5 h                      (4) 0.25 h
58. (4)  $t_{1/2} = (2-1) / K$                       or  $K = 1$                        $\therefore t_{1/2} = (0.5 - 0.25) / 1 = 0.25 \text{ hr}$ .
59. A solution containing 2.675 g of  $CoCl_3 \cdot 6NH_3$  ( molar mass =  $267.5 \text{ g mol}^{-1}$  ) is passed through a cation exchanger. The chloride ions obtained in solution were treated with excess of  $AgNO_3$  to give 4.78 g of  $AgCl$  ( molar mass =  $143.5 \text{ g mol}^{-1}$  ). The formula of the complex is ( At. mass of  $Ag = 108 \text{ u}$  )
- (1)  $[CoCl(NH_3)_5]Cl_2$                       (2)  $[Co(NH_3)_6]Cl_3$                       (3)  $[CoCl_2(NH_3)_4]Cl$                       (4)  $[CoCl_3(NH_3)_3]$
59. (2)  $n_{AgCl} = 4.78 / 143.5 = 0.03$  and  $n_{\text{complex}} = 0.01$ .  
 Therefore 3 moles of  $AgCl$  are produced per mole of complex.  
 Therefore formula is  $[Co(NH_3)_6]Cl_3$

60. The standard enthalpy of formation of  $NH_3$  is  $-46.0 \text{ kJ mol}^{-1}$ . If the enthalpy of formation of  $H_2$  from its atoms is  $-436 \text{ kJ mol}^{-1}$  and that of  $N_2$  is  $-712 \text{ kJ mol}^{-1}$ , the average bond enthalpy of  $N-H$  bond in  $NH_3$  is

- (1)  $-1102 \text{ kJ mol}^{-1}$       (2)  $-964 \text{ kJ mol}^{-1}$       (3)  $+352 \text{ kJ mol}^{-1}$       (4)  $+1056 \text{ kJ mol}^{-1}$

60. (3)  $N_2 + 3H_2 \rightarrow 2NH_3$   
 $-46 \times 2 = -6x + (3 \times 436 + 712)$   
or  $-92 = -6x + 2020$        $\therefore x = 352$