

# CHEMISTRY



This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

- 36.** At 80°C, the vapour pressure of pure liquid 'A' is 520 mm Hg and that of pure liquid 'B' is 1000 mm Hg. If a mixture solution of 'A' and 'B' boils at 80°C and 1 atm pressure, the amount of 'A' in the mixture is (1 atm = 760 mm Hg)
- |                    |                    |
|--------------------|--------------------|
| (1) 50 mol percent | (2) 52 mol percent |
| (3) 34 mol percent | (4) 48 mol percent |

**Sol. (1)**

$$P_A^0 = 520 \text{ mm Hg}$$

$$P_B^0 = 1000 \text{ mm Hg}$$

$$P_T = P_A^0 X_A + P_B^0 X_B$$

$$P_T = P_A^0 X_A + P_B^0 (1 - X_A)$$

$$760 = 520X_A + 1000(1 - X_A)$$

$$760 = 520X_A + 1000 - 1000X_A$$

$$480X_A = 240$$

$$X_A = \frac{240}{480} = 0.5 = 50\text{molpercent}$$

- 37.** For a reaction  $\frac{1}{2}A \rightarrow 2B$ , rate of disappearance of 'A' is related to the rate of appearance of 'B' by the expression

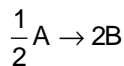
(1)  $-\frac{d[A]}{dt} = 4 \frac{d[B]}{dt}$

(2)  $-\frac{d[A]}{dt} = \frac{1}{2} \frac{d[B]}{dt}$

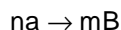
(3)  $-\frac{d[A]}{dt} = \frac{1}{4} \frac{d[B]}{dt}$

(4)  $-\frac{d[A]}{dt} = \frac{d[B]}{dt}$

**Sol.(3)**



for any general reaction



$$\frac{1}{n} \frac{-dA}{dt} = \frac{1}{m} \frac{dB}{dt}$$

$$\therefore \frac{1}{2} \frac{-dA}{dt} = \frac{1}{2} \frac{dB}{dt}$$

$$2 \cdot \frac{-dA}{dt} = \frac{1}{2} \frac{dB}{dt}$$

$$\text{or } \frac{-dA}{dt} = \frac{1}{4} \frac{dB}{dt}$$

38. The equilibrium constants  $K_{P_1}$  and  $K_{P_2}$  for the reactions  $X \rightleftharpoons 2Y$  and  $Z \rightleftharpoons P + Q$ , respectively are in the ratio of 1 : 9. If the degree of dissociation of X and Z be equal then the ratio of total pressures at these equilibria is

(1) 1 : 9                      (2) 1 : 36                      (3) 1 : 1                      (4) 1 : 3

Sol. (2)



$$1 - \alpha \quad 2\alpha$$

$$K_{P_1} = \frac{(\text{mol fraction of } y \cdot P_{T_1})^2}{\text{mol fraction of } x \cdot P_{T_1}}$$

$$= \frac{\left(\frac{2\alpha}{1+\alpha}\right)^2 \cdot \frac{P_{T_1}^2}{P_{T_1}}}{\frac{1-\alpha}{1+\alpha}} = \frac{4\alpha^2}{(1+\alpha)(1-\alpha)} \cdot P_{T_1}$$



$$1 - \beta \quad \beta \quad \beta$$

$$K_{P_2} = \frac{\left(\frac{\beta}{1+\beta}\right)^2 \cdot P_{T_2}^2}{\frac{1-\beta}{1+\beta} \cdot P_{T_2}}$$

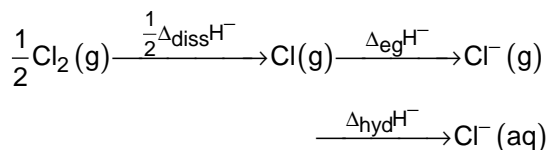
$$= \frac{\beta^2}{(1-\beta)(1+\beta)} \cdot P_{T_2}$$

$$\text{given } \frac{K_{P_1}}{K_{P_2}} = \frac{1}{9} \text{ and } \alpha = \beta$$

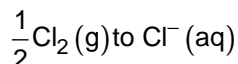
$$\therefore \frac{1}{9} = \frac{4\alpha^2 \cdot P_{T_1}}{(1+\alpha)(1-\alpha)} \times \frac{(1+\alpha)(1-\alpha)}{\alpha^2 P_{T_2}}$$

$$\frac{1}{36} = \frac{P_{T_1}}{P_{T_2}}$$

39. Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below:



The energy involved in the conversion of



using the data,

$$\Delta_{\text{diss}} \text{H}_{\text{Cl}_2}^- = 240 \text{ kJ mol}^{-1},$$

$$\Delta_{\text{eg}} \text{H}_{\text{Cl}}^- = -349 \text{ kJ mol}^{-1},$$

$$\Delta_{\text{hyd}} \text{H}_{\text{Cl}}^- = -381 \text{ kJ mol}^{-1}) \text{ will be}$$

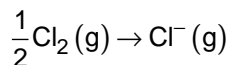
$$(1) +120 \text{ kJ mol}^{-1}$$

$$(2) +152 \text{ kJ mol}^{-1}$$

$$(3) -610 \text{ kJ mol}^{-1}$$

$$(4) -850 \text{ kJ mol}^{-1}$$

**Sol.(3)** The energy involved in the reaction



$$= \frac{1}{2} \times \Delta_{\text{H}_{\text{diss}}} \text{Cl}_2 + \Delta_{\text{H}_{\text{eg}}} \text{Cl} + \Delta_{\text{H}_{\text{hyd}}} \text{Cl}^-$$

$$= \frac{1}{2} \times 240 + (-349) + (-381)$$

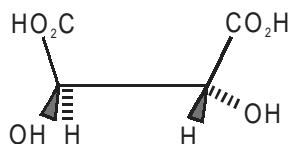
$$= -610 \text{ kJ / mol}$$

40.  $\alpha$ -D-(+)-glucose and  $\beta$ -D-(+)-glucose are  
 (1) enantiomers (2) conformers (3) epimers (4) anomers

Sol. (4)

$\alpha$ -D-(+)-glucose and  $\beta$ -D-(+)-glucose are anomers.

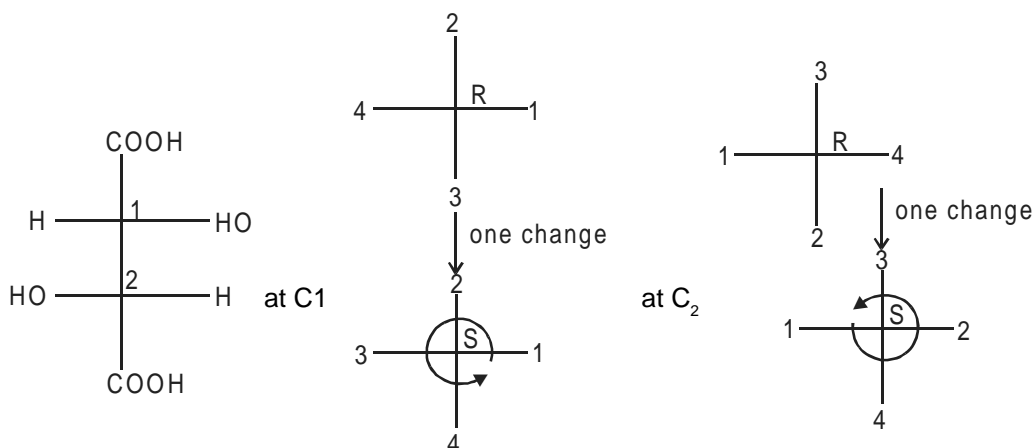
41. The absolute configuration of



is

- (1) S, R (2) S, S (3) R, R (4) R, S

Sol. (3)

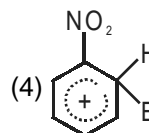
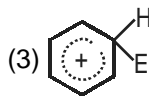
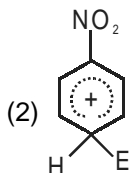
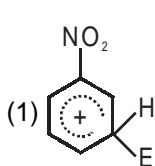


$\therefore$  R, R

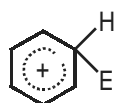
42. Which of the following factors is of **no significance** for roasting sulphide ores to the oxides and not subjecting the sulphide ores to carbon reduction directly?
- (1)  $\text{CO}_2$  is more volatile than  $\text{CS}_2$   
 (2) Metal sulphides are thermodynamically more stable than  $\text{CS}_2$   
 (3)  $\text{CO}_2$  is thermodynamically more stable than  $\text{CS}_2$   
 (4) Metal sulphides are less stable than the corresponding oxides

Sol. (3)

43. The electrophile,  $E^+$  attacks the benzene ring to generate the intermediate  $\sigma$  – complex. Of the following, which  $\sigma$  – complex is of lowest energy?



**Sol. (3)**



is the most stable as  $-\text{NO}_2$  is an electron withdrawing group and destabilizes the sigma complex.

44. Bakelite is obtained from phenol by reaction with  
 (1)  $\text{HCHO}$  (2)  $(\text{CH}_2\text{OH})_2$  (3)  $\text{CH}_3\text{CHO}$  (4)  $\text{CH}_3\text{COCH}_3$

**Sol. (1)**

Bakelite is obtained by condensation of phenol with formaldehyde  $\text{HCHO}$ .

45. The organic chloro compound, which show complete stereochemical inversion during a  $\text{S}_\text{N}2$  reaction, is  
 (1)  $\text{CH}_3\text{Cl}$  (2)  $(\text{C}_2\text{H}_5)_2\text{CHCl}$  (3)  $(\text{CH}_3)_3\text{CCl}$  (4)  $(\text{CH}_3)_2\text{CHCl}$

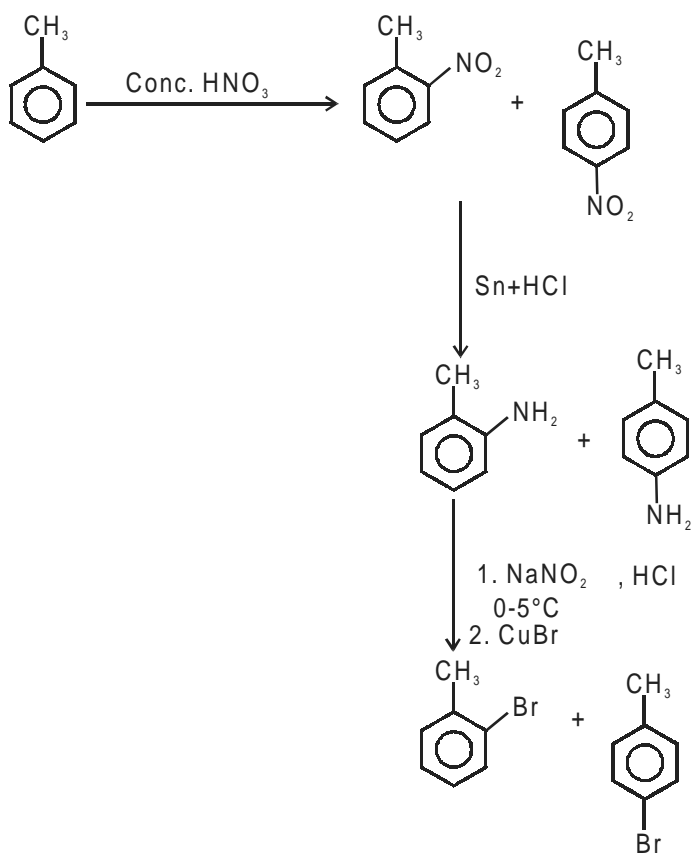
**Sol. (1)**

Inversion is a characteristic property of  $\text{S}_\text{N}2$  reaction and primary alkyl halides react via  $\text{S}_\text{N}2$   
 $\therefore \text{CH}_3\text{Cl}$ .

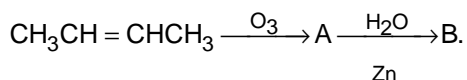
**46.** Toluene is nitrated and the resulting product reduced with Tin and hydrochloric acid. The product so obtained is diazotised and the heated with cuprous bromide. The reaction mixture so formed contains

- (1) mixture of o- and m-bromotoluenes
- (2) mixture of o- and p-bromotoluenes
- (3) mixture of o- and p-dibromobenzenes
- (4) mixture of o- and p-bromoanilines

**Sol. (2)**



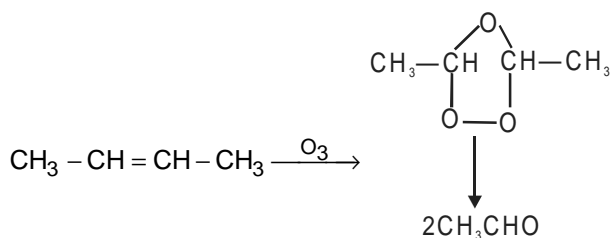
47. In the following sequence of reactions, the alkene affords the compound 'B'



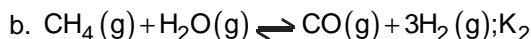
The compound B is

- (1)  $\text{CH}_3\text{CHO}$                       (2)  $\text{CH}_3\text{CH}_2\text{CHO}$                       (3)  $\text{CH}_3\text{COCH}_3$                       (4)  $\text{CH}_3\text{CH}_2\text{COCH}_3$

Sol. (1)



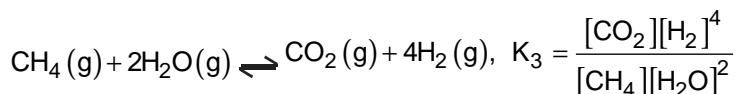
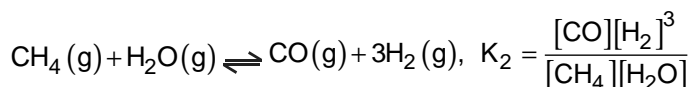
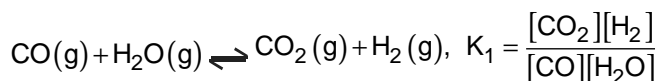
48. For the following three reactions a, b and c, equilibrium constants are given:



which of the following relations is correct?

- (1)  $K_3 \cdot K_2^3 = K_1^2$                       (2)  $K_1 \sqrt{K_2} = K_3$                       (3)  $K_2 K_3 = K_1$                       (4)  $K_3 = K_1 K_2$

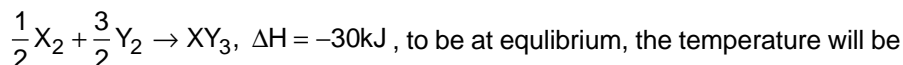
Sol. (4)



$$\text{So, } K_1 = \frac{K_3}{K_2}$$

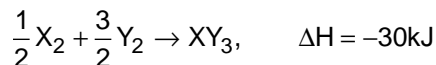
$$\therefore K_3 = K_1 K_2$$

49. Standard entropy of  $X_2$ ,  $Y_2$  and  $XY_3$  are 60, 40 and  $50 \text{ J K}^{-1} \text{ mol}^{-1}$ , respectively. For the reaction,



- (1) 1000 K                      (2) 1250 K                      (3) 500 K                      (4) 750 K

**Sol. (4)**



$$\Delta S = 50 - \frac{1}{2} \times 60 - \frac{3}{2} \times 40$$

$$\Delta S = 40 \text{ J/K} = -0.04 \text{ kJ/K}$$

$$\Delta G = \Delta H - T \Delta S$$

$$\text{at equilibrium } \Delta G = 0$$

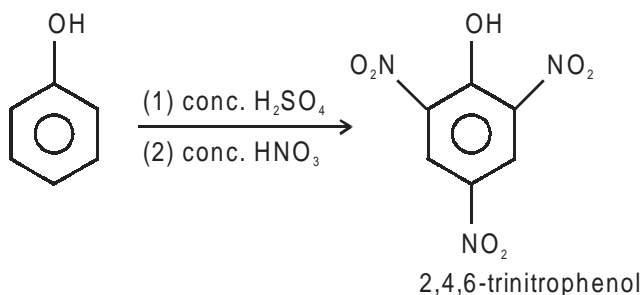
$$T = \frac{\Delta H}{\Delta S} = \frac{-30}{-0.04}$$

$$T = 750 \text{ K}$$

50. Phenol, when it first reacts with concentrated sulphuric acid and then with concentrated nitric acid, gives

- (1) nitrobenzene                      (2) 2,4,6-trinitrobenzene  
(3) o-nitrophenol                      (4) p-nitrophenol

**Sol. (2)**



51. The hydrocarbon which can react with sodium in liquid ammonia is

- (1)  $\text{CH}_3\text{CH}_2\text{C} \equiv \text{CCH}_2\text{CH}_3$                       (2)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{C} \equiv \text{CCH}_2\text{CH}_2\text{CH}_3$   
(3)  $\text{CH}_3\text{CH}_2\text{C} \equiv \text{CH}$                       (4)  $\text{CH}_3\text{CH} \equiv \text{CHCH}_3$

**Sol. (3)**

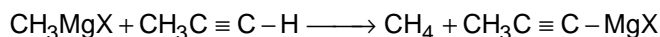
Only terminal alkyne react with  $\text{NaNH}_2$ .



52. The treatment of  $\text{CH}_3\text{MgX}$  with  $\text{CH}_3\text{C} \equiv \text{CH} - \text{H}$  produces

- (1)  $\text{CH}_4$  (2)  $\text{CH}_3 - \text{CH} = \text{CH}_2$
- (3)  $\text{CH}_3\text{C} \equiv \text{C} - \text{CH}_3$  (4)  $\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{CH}_3 - \text{C} = \text{C} - \text{CH}_3 \end{array}$

**Sol. (1)**



53. The correct decreasing order of priority for the functional groups of organic compounds in the IUPAC system of nomenclature is

- (1)  $-\text{CONH}_2$ ,  $-\text{CHO}$ ,  $-\text{SO}_3\text{H}$ ,  $-\text{COOH}$  (2)  $-\text{COOH}$ ,  $-\text{SO}_3\text{H}$ ,  $-\text{CONH}_2$ ,  $-\text{CHO}$
- (3)  $-\text{SO}_3\text{H}$ ,  $-\text{COOH}$ ,  $-\text{CONH}_2$ ,  $-\text{CHO}$  (4)  $-\text{CHO}$ ,  $-\text{COOH}$ ,  $-\text{SO}_3\text{H}$ ,  $-\text{CONH}_2$

**Sol. (2)**

54. The  $\text{pK}_a$  of a weak acid, HA, is 4.80. The  $\text{pK}_b$  of a weak base, BOH, is 4.78. The pH of an aqueous solution of the corresponding salt, BA, will be

- (1) 9.22 (2) 9.58 (3) 4.79 (4) 7.01

**Sol. (4)**

$$\begin{aligned} \text{pH} &= 7 - \frac{1}{2} \log \frac{k_a}{k_b} = 7 + \frac{1}{2} (-\log k_a + \log k_b) \\ &= 7 + \frac{1}{2} (4.8 - 4.78) = 7.01 \end{aligned}$$

55. In context with the industrial preparation of hydrogen from water gas ( $\text{CO} + \text{H}_2$ ), which of the following is the correct statement?

- (1) CO is oxidised to  $\text{CO}_2$  with steam in the presence of a catalyst followed by absorption of  $\text{CO}_2$  in alkali
- (2) CO and  $\text{H}_2$  are fractionally separated using differences in their densities
- (3) CO is removed by absorption in aqueous  $\text{Cu}_2\text{Cl}_2$  solution
- (4)  $\text{H}_2$  is removed through occlusion with Pd

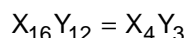
**Sol. (1)**

56. In a compound, atoms of element Y form ccp lattice and those of element X occupy  $\left(\frac{2}{3}\right)^{\text{rd}}$  of tetrahedral voids. The formula of the compound will be  
 (1)  $X_3Y_4$  (2)  $X_4Y_3$  (3)  $X_2Y_3$  (4)  $X_2Y$

**Sol. (2)**

Effective number of atoms of Y = 4 = 12

Effective number of atoms of X =  $8 \times \frac{2}{3} = \frac{16}{3} = 16$

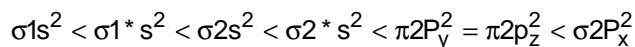


57. Which one of the following pairs of species have the same bond order?

(1)  $\text{NO}^+$  and  $\text{CN}^+$  (2)  $\text{CN}^-$  and  $\text{NO}^+$  (3)  $\text{CN}^-$  and  $\text{CN}^+$  (4)  $\text{O}_2^-$  and  $\text{CN}^-$

**Sol. (2)**

Total number of electrons in  $\text{CN}^-$  and  $\text{NO}^+$  are 14



$$\text{B.O.} = \frac{1}{2}(10 - 4) = 3$$

58. The vapour pressure of water at 20 °C is 17.5 mm Hg. If 18 g of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) is added to 178.2 g of water at 20 °C, the vapour pressure of the resulting solution will be  
 (1) 17.325 mm Hg (2) 17.675 Hg (3) 15.750 mm Hg (4) 16.500 mm Hg

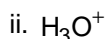
**Sol. (1)**

$$P_s = P_o \frac{N}{n + N}$$

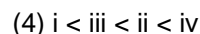
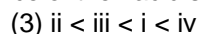
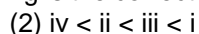
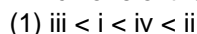
$$= 17.5 \times \frac{\frac{178.2}{18}}{\frac{178.2}{18} + \frac{18}{180}} = 17.5 \times \frac{9.9}{9.9 + 0.1}$$

$$= 17.5 \times \frac{9.9}{10} = 17.325 \text{ mm Hg}$$

59. Four species are listed below



Which one of the following is the correct sequence of their acid strength?



Sol. (4)

60. The ionisation enthalpy of hydrogen atom is  $1.312 \times 10^6 \text{ J mol}^{-1}$ . The energy required to excite the electron in the atom from  $n = 1$  to  $n = 2$  is

(1)  $9.84 \times 10^5 \text{ J mol}^{-1}$

(2)  $8.51 \times 10^5 \text{ J mol}^{-1}$

(3)  $6.56 \times 10^5 \text{ J mol}^{-1}$

(4)  $7.56 \times 10^5 \text{ J mol}^{-1}$

Sol. (1)

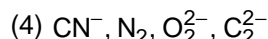
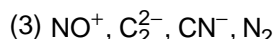
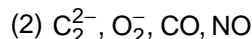
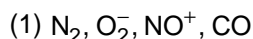
$$E_n = -1.312 \times 10^6 \left[ \frac{1}{1^2} - \frac{1}{2^2} \right] \text{ J/mol}$$

$$= -1.312 \times 10^6 \left[ 1 - \frac{1}{4} \right] \text{ J/mol}$$

$$= -\frac{3}{4} \times 1.312 \times 10^6 \text{ J/mol}$$

$$= 9.84 \times 10^5 \text{ J/mol}$$

61. Which one of the following constitutes a group of the isoelectronic species?



Sol. (3)

Number of electrons

$$\text{NO}^+ = 7 + 8 - 1 = 14$$

$$\text{C}_2^{2-} = 6 \times 2 + 2 = 14$$

$$\text{CN}^- = 6 + 7 + 1 = 14$$

$$\text{N}_2 = 2 \times 7 = 14$$

62. Gold numbers of protective colloids A, B, C and D are 0.50, 0.01, 0.10 and 0.005, respectively. The correct order of their protective powers is

- (1)  $B < D < A < C$       (2)  $D < A < C < B$       (3)  $C < B < D < A$       (4)  $A < C < B < D$

**Sol. (4)**

$$\text{Gold number} \propto \frac{1}{\text{Protective power}}$$

So,  $A < C < B < D$

63. Larger number of oxidation states are exhibited by the actinoids than those by the lanthanoids, the main reason being

- (1) more reactive nature of the actinoids than the lanthanoids  
(2) 4f orbitals more diffused than the 5f orbitals  
(3) lesser energy difference between 5f and 6d than between 4f and 5d orbitals  
(4) more energy differences between 5f and 6d than between 4f and 5d orbitals

**Sol. (3)**

5f and 6d has less energy difference while 4f and 5d orbitals have large.

64. Given  $E_{\text{Cr}^{3+}/\text{Cr}}^{\circ} = -0.72 \text{ V}$ ,  $E_{\text{Fe}^{2+}/\text{Fe}}^{\circ} = -0.42 \text{ V}$ .

The potential for the cell  $\text{Cr} | \text{Cr}^{3+} (0.1 \text{ M}) || \text{Fe}^{2+} (0.01 \text{ M}) | \text{Fe}$  is

- (1)  $-0.26 \text{ V}$       (2)  $0.26 \text{ V}$       (3)  $0.339 \text{ V}$       (4)  $-0.339 \text{ V}$

**Sol. (2)**

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{.0591}{n} \log K_C$$

$$= .30 - \frac{.0591}{6} \log \frac{[\text{Cr}^{3+}]^2}{[\text{Fe}^{2+}]^3}$$

$$= .30 - \frac{.0591}{6} \log \frac{(.1)^2}{(.01)^3}$$

$$= .30 - \frac{.0591}{6} \times 4$$

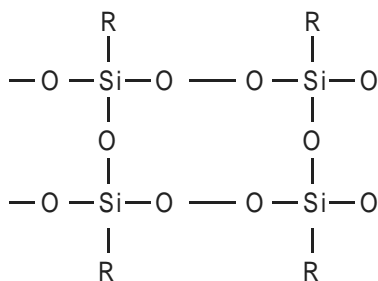
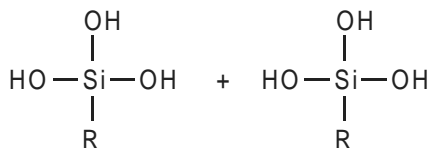
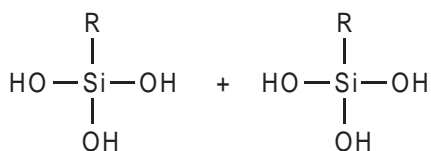
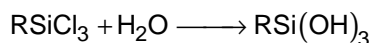
$$= .30 - .0394 = .2606$$

65. Amount of oxalic acid present in a solution can be determined by its titration with  $\text{KMnO}_4$  solution in the presence of  $\text{H}_2\text{SO}_4$ . The titration gives unsatisfactory result when carried out in the presence of  $\text{HCl}$ , because  $\text{HCl}$
- (1) oxidises oxalic acid to carbon dioxide and water
  - (2) gets oxidised by oxalic acid to chlorine
  - (3) furnishes  $\text{H}^+$  ions in addition to those from oxalic acid
  - (4) reduces permanganate to  $\text{Mn}^{2+}$

**Sol. (4)**

66. Among the following substituted silanes the one which will give rise to cross linked silicone polymer on hydrolysis is
- (1)  $\text{R}_3\text{SiCl}$                       (2)  $\text{R}_4\text{Si}$                       (3)  $\text{RSiCl}_3$                       (4)  $\text{R}_2\text{SiCl}_2$

**Sol. (3)**



67. In which of the following octahedral complexes of Co (at. no. 27), will the magnitude of  $\Delta_o$  be the highest?

- (1)  $[\text{Co}(\text{NH}_3)_6]^{3+}$       (2)  $[\text{Co}(\text{CN})_6]^{3-}$       (3)  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$       (4)  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$

**Sol. (2)**

The strong ligand will produce large  $\Delta_o$ .

As pairing tendency of  $\text{CN}^-$  is larger than  $\text{C}_2\text{O}_4^{2-}$

So,  $[\text{Co}(\text{CN})_6]^{3-}$  will have highest  $\Delta_o$ .

68. The coordination number and the oxidation state of the element 'E' in the complex

$[\text{E}(\text{en})_2(\text{C}_2\text{O}_4)]\text{NO}_2$  (where en is ethylene diamine) are, respectively

- (1) 6 and 3      (2) 6 and 2      (3) 4 and 2      (4) 4 and 3

**Sol. (1)**

$[\text{E}(\text{en})_2\text{C}_2\text{O}_4]\text{NO}_2$

Oxidation number of E =  $a - 2 - 1 = 0 \therefore a = +3$

Coordination number =  $2 \times 2 + 2 = 6$  (as en and  $\text{C}_2\text{O}_4$  both are bidentate)

69. Identify the wrong statement in the following.

- (1) Acid rain is mostly because of the oxides of nitrogen and sulphur  
(2) Chlorofluorocarbons are responsible for ozone layer depletion  
(3) Greenhouse effect is responsible for global warming  
(4) Ozone layer does not permit infrared radiation from the sun to reach the earth

**Sol. (4)**

70. Which one of the following is the correct statement?

- (1)  $\text{B}_2\text{H}_6 \cdot 2\text{NH}_3$  is known as 'inorganic benzene'  
(2) Boric acid is a protonic acid  
(3) Beryllium exhibits coordination number of six  
(4) Chlorides of both beryllium and aluminium have bridged chloride structures in solid phase

**Sol. (4)**