

## Some Basic Concepts of Chemistry

### Q 1.

What weight of AgCl will be precipitated when a solution containing 4.77 g of NaCl is added to a solution of 5.77 g of AgNO<sub>3</sub>? (IIT JEE – 1978 – 3 Marks)

### Q 2.

One gram of an alloy of aluminium and magnesium when treated with excess of dil. HCl forms magnesium chloride, aluminium chloride and hydrogen. The evolved hydrogen, collected over mercury at 0°C has a volume of 1.20 litres at 0.92 atm. Pressure. Calculate the composition of the alloy

[H = 1, Mg = 24, Al = 27]

(IIT JEE 1978 – 5 Marks)

### Q 3.

Igniting MnO<sub>2</sub> converts it quantitatively to Mn<sub>3</sub>O<sub>4</sub>. A sample of pyrolusite is of the following composition: MnO<sub>2</sub> 80%, SiO<sub>2</sub> and other inert constituents 15%, rest being water. The sample is ignited in air to constant weight. What is the percentage of Mn in the ignited sample?

[O = 16, Mn = 54.9]

(IIT JEE 1978 – 6 Marks)

### Q 4.

4.215 g of a metallic carbonate was heated in a hard glass tube and the CO<sub>2</sub> evolved was found to measure 1336 ml at 27°C and 700 mm pressure. What is the equivalent weight of the metal?

(IIT JEE 1979 - 5 Marks)

### Q 5.

(a) 5.5 g of a mixture of FeSO<sub>4</sub>, 7H<sub>2</sub>O and Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>·9H<sub>2</sub>O requires 5.4 ml of 0.1 N KMnO<sub>4</sub> solution for complete oxidation. Calculate the number of gram mole of hydrated ferric sulphate in the mixture.

(b) The vapour density (hydrogen = 1) of a mixture consisting of NO<sub>2</sub> and N<sub>2</sub>O<sub>4</sub> is 38.3 at 26.7°C. Calculate the number of moles of NO<sub>2</sub> in 1000 g of the mixture. (IIT JEE 1979 – 4 Marks)

### Q 6.

5 ml of a gas containing only carbon and hydrogen were mixed with an excess of oxygen (30 ml) and the mixture exploded by means of an electric spark. After the explosion, the volume of the mixed gases remaining was 25 ml. on adding a concentrated solution of potassium hydroxide, the volume further diminished to 15 ml of the residual gas being pure oxygen. All volumes have been reduced to N.T.P. Calculate the molecular formula of the hydrocarbon gas.

(IIT JEE 1979 – 4 Marks)

### Q 7.

In the analysis of 0.500 g sample of feldspar, a mixture of chlorides of sodium and potassium is obtained which weighs 0.1180g. Subsequent treatment of mixed chlorides, with silver nitrate

gives 0.2451 g of silver chloride. What is the percentage of sodium oxide and potassium oxide in feldspar. **(IIT JEE 1979 – 5 Marks)**

**Q 8.**

A compound contains 28 percent of nitrogen and 72 percent of metal by weight. 3 atoms of metal combine with 2 atoms of nitrogen. Find the atomic weight of metal. **(IIT JEE 1980 – 2 Marks)**

**Q 9.**

Find the equivalent weight of  $\text{H}_3\text{PO}_4$  in the reaction:



**Q 10.** (i) A sample of  $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$  is strongly heated in air. The residue is  $\text{Mn}_3\text{O}_4$ .

(ii) The residue is dissolved in 100 ml of 0.1 N  $\text{FeSO}_4$  containing dilute  $\text{H}_2\text{SO}_4$

(iii) The solution reacts completely with 50 ml of  $\text{KMnO}_4$  solution.

(iv) 25 ml of  $\text{KMnO}_4$  solution used in step (iii) requires 30 ml of 0.1 N  $\text{FeSO}_4$  solution for complete reaction.

Find the amount of  $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$  present in the sample. **(IIT JEE 1980 - 4 Marks)**

**Q 11.**

(a) One litre of a sample of hard water contains 1 mg of  $\text{CaCl}_2$  and 1 mg of  $\text{MgCl}_2$ . Find the total hardness in terms of parts of  $\text{CaCO}_3$  per  $10^6$  parts of water by weight.

(b) A sample of hard water contains 20 mg of  $\text{Ca}^{++}$  ions per litre. How many milli-equivalents of  $\text{Na}_2\text{CO}_3$  would be required to soften 1 litre of the sample?

(c) 1 gm of Mg is burnt in a closed vessel which contains 0.5 gm of  $\text{O}_2$ .

(i) Which reactant is left in excess?

(ii) Find the weight of the excess reactants.

(iii) How many milliliters of 0.5 N  $\text{H}_2\text{SO}_4$  will dissolve the residue in the vessel. **(IIT JEE 1980)**

**Q 12.**

A hydrocarbon contains 10.5g of carbon per gram of hydrogen. 1 litre of the vapour of the hydrocarbon at  $127^\circ\text{C}$  and 1 atmosphere pressure weighs 2.8g. Find the molecular formula.

**(IIT JEE 1980 – 3 Marks)**

**Q 13.**

Find

(i) The total number of neutrons and

(ii) The total mass of neutrons in 7 mg of  $^{14}\text{C}$ .

(Assume that mass of neutron = mass of hydrogen atom)

**(IIT JEE 1980 – 3 Marks)**

**Q 14.**

A mixture contains NaCl and unknown chloride MCl.

(i) 1 g of this is dissolved in water. Excess of acidified  $\text{AgNO}_3$  solution is added to it. 2.567 g of white ppt. is formed.

(ii) 12 g of original mixture is heated to 300°C. Some vapour come out which are absorbed in acidified AgNO<sub>3</sub> solution, 1.341 g of white precipitate was obtained. Find the molecular weight of unknown chloride. **(IIT JEE 1980)**

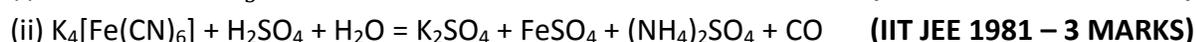
**Q 15.**

A 1.00 gm sample of H<sub>2</sub>O<sub>2</sub> solution containing X per cent H<sub>2</sub>O<sub>2</sub> by weight requires X ml of a KMnO<sub>4</sub> solution for complete oxidation under acidic conditions. Calculate the normality of the KMnO<sub>4</sub> solution.

**(IIT JEE 1981 – 3 Marks)**

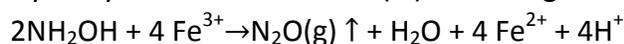
**Q 16.**

Balance the following equations.

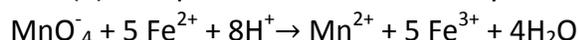


**Q 17.**

Hydroxylamine reduces iron (III) according to the equation:



Iron (II) thus produced is estimated by titration with standard permanganate solution. The is :



A 10 ml. sample of hydroxylamine solution was dilute to 1 litre. 50 ml. of this diluted solution was boiled with an excess of iron (III) solution. The resulting solution required 12 ml. of 0.02 M KMnO<sub>4</sub> solution for complete oxidation of iron (II). Calculate the weight of hydroxylamine in one litre of the original solution. (H = 1, N = 14, O = 16, K = 39, Mn = 55, Fe = 56)

**(IIT JEE 1982 – 4 MARKS)**

**Q 18.**

The density of a 3 M sodium thiosulphate solution (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) is 1.25 g per ml. Calculated (i) the percentage by weight of sodium thiosulphate, (ii) the mole fraction of sodium thiosulphate and (iii) the molalities of Na<sup>+</sup> and S<sub>2</sub>O<sub>3</sub><sup>2-</sup> ions. **(IIT JEE 1983 – 5 MARKS)**

**Q 19.**

4.08 g of a mixture of BaO and an unknown carbonate MCO<sub>3</sub> was heated strongly. The residue weighed 3.64 g. This was dissolved in 100 ml of 1 N HCl. The excess acid required 16 ml of 2.5 N NaOH solution for complete neutralization. Identify the metal M.

**(IIT JEE 1983 – 4 MARKS)**

(At. wt. H = 1, C = 12, O = 16, Cl = 35.5, Ba = 138)

**Q 20.**

Complete and balance the following reaction :





**Q 21.**

2.68 \* 10<sup>-3</sup> moles of a solution containing an ion A<sup>n+</sup> require 1.61 \* 10<sup>-3</sup> moles of MnO<sub>4</sub><sup>-</sup> for the oxidation of A<sup>n+</sup> to AO<sub>3</sub><sup>-</sup> in acid medium. What is the value of n?

(IIT JEE 1984 – 2 Marks)

**Q 22.**

Five ml of 8N nitric acid, 4.8 ml of 5N hydrochloric acid and a certain volume of 17M sulphuric acid are mixed together and made upto 2litre. Thirty ml. of this acid mixture exactly neutralize 42.9 ml of sodium carbonate solution containing one gram of Na<sub>2</sub>CO<sub>3</sub>. 10H<sub>2</sub>O in 100 ml. of water. Calculate the amount in gram of the sulphate ions in solution.

(IIT JEE 1985 – 4 Marks)

**Q 23.**

Arrange the following in increasing oxidation number of iodine.

I<sub>2</sub>, HI, HIO<sub>4</sub>, ICl

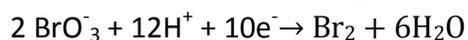
(IIT JEE 1986 – 1 Marks)

**Q 24.**

(i) What is the weight of sodium bromate and molarity of solution necessary to prepare 85.5 ml of 0.672 N solution when the half-cell reaction is



(ii) What would be the weight as well as molarity if the half-cell reaction is :



(IIT JEE 1987 – 5 Marks)

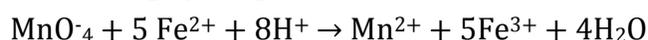
**Q 25.**

A sugar of weight 214.2 g contains 34.2 g of sugar (C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>). Calculate : (i) molal concentration and (ii) mole fraction of sugar in the syrup. (IIT JEE 1988 – 2 Marks)

**Q 26.**

A sample of hydrazine sulphate (N<sub>2</sub>H<sub>6</sub>SO<sub>4</sub>) was dissolved in 100 ml. of water, 10 ml of this solution was reacted with excess of ferric chloride solution and warmed to complete the reaction. Ferrous ion formed was estimated and it required 20 ml. of M/50 potassium permanganate solution. Estimate the amount of hydrazine sulphate in one litre of the solution.

Reaction :



(IIT JEE 1988 – 3 Marks)

**Q 27.**

An equal volume of a reducing agent is titrated separately with 1M  $\text{KMnO}_4$  in acid neutral and alkaline media. The volumes of  $\text{KMnO}_4$  required are 20 ml. in acid, 33.4 ml. neutral and 100 ml. in alkaline media. Find out the oxidation state of manganese in each reduction product. Give the balanced equations for all the three half reactions. Find out the volume of 1M  $\text{K}_2\text{Cr}_2\text{O}_7$  consumed; if the same volume of the reducing agent is titrated in acid medium.

(IIT JEE 1989 – 5 Marks)

**Q 28.**

A mixture of  $\text{H}_2\text{C}_2\text{O}_4$  (oxalic acid) and  $\text{NaHC}_2\text{O}_4$  weighing 2.02 g was dissolved in water and solution made upto one liter. Ten milliliters of the solution required 3.0 ml. of 0.1 N sodium hydroxide solution for complete neutralization. In another experiment, 10.0 ml. of the same solution, in hot dilute sulphuric acid medium. Require 4.0 ml. of 0.1 N potassium permanganate solution for complete reaction. Calculate the amount of  $\text{H}_2\text{C}_2\text{O}_4$  and  $\text{NaHC}_2\text{O}_4$  in the mixture.

(IIT JEE 1990 – 5 Marks)

**Q 29.**

A solid mixture (5.0 g) consisting of lead nitrate and sodium nitrate was heated below  $600^\circ\text{C}$  until the weight of the residue was constant. If the loss in weight is 28.0 per cent, find the amount of lead nitrate and sodium nitrate in the mixture.

(IIT JEE 1990 – 4 Marks)

**Q 30.**

Calculate the molarity of 1 litre solution of 93%  $\text{H}_2\text{SO}_4$  (weight/volume). The density of the solution is 1.84 g/ml.

(IIT JEE 1990 – 1 Marks)

**Q 31.**

A solution of 0.2 g of a compound containing  $\text{Cu}^{2+}$  and  $\text{C}_2\text{O}_4^{2-}$  ions on titration with 0.02 M  $\text{KMnO}_4$  in presence of  $\text{H}_2\text{SO}_4$  consumes 22.6 ml. of the oxidant. The resultant solution is neutralized with  $\text{Na}_2\text{CO}_3$ , acidified with dil. Acetic acid and treated with excess KI. The liberated iodine requires 11.3 ml of 0.05 M  $\text{Na}_2\text{S}_2\text{O}_3$  solution for complete reduction. Find out the molar ratio of  $\text{Cu}^{2+}$  to  $\text{C}_2\text{O}_4^{2-}$  in the compound. Write down the balanced redox reactions involved in the above titration.

(IIT JEE 1991 – 5 Marks)

**Q 32.**

A 1.0 g sample of  $\text{Fe}_2\text{O}_3$  solid of 55.2% purity is dissolved in acid and reduced by heating the solution with zinc dust. The resultant solution is cooled and made upto 100.0 ml. An aliquot of 25.0 ml of this solution requires 17.0 ml of 0.0167 M solution of an oxidant for titration. Calculate the number of electrons taken up by the oxidant in the reaction of the above titration.

(IIT JEE 1991 – 4 Marks)

**Q 33.**

A 2.0 g sample of a mixture containing sodium carbonate, sodium bicarbonate and sodium sulphate is gently heated till the evolution of  $\text{CO}_2$  ceases. The volume of  $\text{CO}_2$  at 750 mm Hg

pressure and at 298 K is measured to be 123.9 ml. A 1.5g of the same sample requires 150 ml. of (M/10) HCl for complete neutralization. Calculate the % composition of the components of the mixture.

(IIT JEE 1992 – 5 Marks)

**Q 34.**

One gram of commercial  $\text{AgNO}_3$  is dissolved in 50 ml. of water. It is treated with 50 ml. of a KI solution. The silver iodide thus precipitated is filtered off. Excess of KI in the filtrate is titrated with (M/10)  $\text{KIO}_3$  solution in presence of 6M HCl till all  $\text{I}^-$  ions are converted into  $\text{ICl}_2$ . It requires 50 ml. of (M/10)  $\text{KIO}_3$  solution. 20 ml. of the same stock solution of KI requires 30 ml. of (M/10)  $\text{KIO}_3$  under similar conditions. Calculate the percentage of  $\text{AgNO}_3$  in the sample.

(Reaction :  $\text{KIO}_3 + 2\text{KI} + 6\text{HCl} \rightarrow 3\text{ICl}_2 + 3\text{KCl} + 3\text{H}_2\text{O}$ )

(IIT JEE 1992 – 4 Marks)

**Q 35.**

Upon mixing 45.0 ml. of 0.25 M lead nitrate solution with 25.0 ml of 0.10 M chromic sulphate solution, precipitation of lead sulphate takes place. How many moles of lead sulphate are formed? Also, calculate the molar concentrations of the species left behind in the final solution. Assume that lead sulphate is completely insoluble.

(IIT JEE 1993 – 3 Marks)

**Q 36.**

The composition of a sample of wustite is  $\text{Fe}_{0.93}\text{O}_{1.00}$ . What percentage of the iron is present in the form of Fe (III)?

(IIT JEE 1994 – 2 Marks)

**Q 37.**

$8.0575 \times 10^{-2}$  kg of Glauber's salt is dissolved in water to obtain  $1 \text{ dm}^3$  of a solution of density  $1077.2 \text{ kg m}^{-3}$ . Calculate the molarity, molality and mole fraction of  $\text{Na}_2\text{SO}_4$  in the solution.

(IIT JEE 1994 – 3 Marks)

**Q 38.**

A 3.00 g sample containing  $\text{Fe}_3\text{O}_4$ ,  $\text{Fe}_2\text{O}_3$  and an inert impure substance, is treated with excess of KI solution in presence of dilute  $\text{H}_2\text{SO}_4$ . The entire iron is converted into  $\text{Fe}^{2+}$  along with the liberation of iodine. The resulting solution is diluted to 100 ml. A 20 ml of the diluted solution requires 11.0 ml of 0.5 M  $\text{Na}_2\text{S}_2\text{O}_3$  solution to reduce the iodine present. A 50 ml of the diluted solution, after complete extraction of the iodine requires 12.80 ml of 0.25 M  $\text{KMnO}_4$  solution in dilute  $\text{H}_2\text{SO}_4$  medium-for the oxidation of  $\text{Fe}^{2+}$ . Calculate the percentages of  $\text{Fe}_2\text{O}_3$  and  $\text{Fe}_3\text{O}_4$  in the original sample.

(IIT JEE 1996 – 5 Marks)

**Q 39.**

An aqueous solution containing 0.10 g  $\text{KIO}_3$  (formula weight = 214.0) was treated with an excess of KI solution. The solution was acidified with HCl. The liberated  $\text{I}_2$  consumed 45.0 mL of thiosulphate solution to decolourise the blue starch-iodine complex. Calculate the molarity of the sodium thiosulphate solution.

(IIT JEE 1998 – 5 Marks)

**Q 40.**

How many millilitres of 0.5 M  $\text{H}_2\text{SO}_4$  are needed to dissolve 0.5 g copper (II) carbonate?  
(IIT JEE 1999 – 3 Marks)

**Q 41.**

A plant virus is found to consist of uniform cylindrical particles of 150 Å in diameter and 5000 Å long. The specific volume of the virus is  $0.75 \text{ cm}^3/\text{g}$ . If the virus is considered to be a single particle, find its molar mass.  
(IIT JEE 1999 – 3 Marks)

**Q 42.**

Hydrogen peroxide solution (20 ml) reacts quantitatively with a solution of  $\text{KMnO}_4$  (20 ml) acidified with dilute  $\text{H}_2\text{SO}_4$ . The same volume of the  $\text{KMnO}_4$  solution is just decolourised by 10 ml of  $\text{MnSO}_4$  in neutral medium simultaneously forming a dark brown precipitate is dissolved in 10, l of 0.2 M sodium oxalate under boiling condition in the presence of dilute  $\text{H}_2\text{SO}_4$ . Write the balanced equations involved in the reactions and calculate the molarity of  $\text{H}_2\text{O}_2$ /  
(IIT JEE 2001 – 5 Marks)

**Q 43.**

Calculate the molarity of water if its density is  $1000 \text{ kg/m}^3$

(IIT JEE 2003 – 2 Marks)