Code No. : SY 17

HIGHER SECONDARY FIRST TERMINAL SECOND YEAR EXAMINATION 2018-2019

CHEMISTRY – ANSWER KEY

Question 1 to 5 carry 1 score each.

1. Glass
2. Molality
3. 3
4. As_2S_3 sol/$Fe(OH)_3$ sol/gold sol (any metal sol or metal hydroxide sol or metal sulphide sol)
5. ZSM-5

Questions 6 to 19 carry 2 scores each. Answer any 11 questions.

6. Henry's law states that at a constant temperature, the solubility of a gas in a liquid is directly proportional to the pressure of the gas. Or, the partial pressure of the gas in vapour phase (p) is directly proportional to the mole fraction of the gas (x) in the solution.
   Applications: Preparation of soda water, a medical condition known as bends in scuba divers, a medical condition known as anoxia in people living at high altitudes and mountaineers. (Any 2)
7. Sea water is a solution. For solutions, the freezing point is lower than that of the pure solvent and the boiling point is higher. So Sea water freezes at lower temperature than distilled water but boils at higher temperature.
8. We know that $M_1V_1 = M_2V_2$
   Here $M_1 = 0.5$ M, $V_1 = 30$ mL, $V_2 = 500$ mL and $M_2 = ?$
   So, $M_2 = M_1V_1/V_2$
   $= 0.5 \times 30/500 = 0.03$ M
9. $\lambda^0m(NaCl) = 126.4$ $Scm^2\ mol^{-1}$, $\lambda^0m(HCl) = 425.9$ $Scm^2\ mol^{-1}$, $\lambda^0m(CH_3COONa) = 91.0$ $Scm^2\ mol^{-1}$
   $\lambda^0m(CH_3COOH) = \lambda^0m(CH_3COONa) + \lambda^0m(HCl) - \lambda^0m(NaCl)$
   $= 91.0 + 425.9 – 126.4 = 390.5$ $Scm^2\ mol^{-1}$
10. **Faraday's first law** states that the amount of substance deposited or liberated at the electrodes (m) is directly proportional to the quantity of electricity (Q) flowing through the electrolyte.
    i.e. $m \propto Q$.
    Faraday's second law states that when same quantity of electricity is passed through solutions of different substances, the amount of substance deposited or liberated is directly proportional to their chemical equivalence.
11. Electrode reactions:
    Anode reaction: $Al \rightarrow Al^{3+} + 3e^-$
    Cathode reaction: $Cu^{2+} + 2e^- \rightarrow Cu$
    Cell reaction is: $2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$
12. Differences between order and molecularity are:

	Order	Molecularity
1.	It is the sum of the powers of the concentration terms in the rate law expression	It is the total number of reactant species collide simultaneously in a chemical reaction
2.	It is an experimental quantity	It is a theoretical quantity
3.	It can be zero or fractional	It cannot be zero or fractional
4.	It is applicable to both elementary and complex reactions	It is applicable only to elementary reactions

13. In this reaction, the concentration of one of the reactants (water) is large excess and so its change in concentration does not affect the rate of the reaction. Hence it is a pseudo first order reaction.
14. For a zero order reaction, the integrated rate law is: $k = \frac{[R]_0 - [R]}{t}$

    When t = $t_{1/2}$, $[R] = \frac{1}{2}[R]_0$
    On substituting these values in the above equation,

    $$k = \frac{[R]_0 - \frac{1}{2}[R]_0}{t_{1/2}}$$

    or, $$\mathbf{t_{1/2} = \frac{[R]_0}{2k}}$$
15. First order at low pressure and zero order at high pressure. Another example is decomposition of HI on the surface of gold.

    $$2HI \xrightarrow{Pt} H_2 + I_2$$
16. In adsorption, the substance is concentrated only at the surface while in absorption, the substance is uniformly distributed throughout the bulk of the solid. Or, adsorption is a surface phenomenon while absorption is a bulk phenomenon. For e.g. $CaCl_2$ absorbs moisture while silica gel adsorbs it.
17. Selectivity is the ability of a catalyst to direct a chemical reaction to a particular product.
    e.g.: CO reacts with H_2 to form different products based on the nature of the catalyst.
    i) $CO + 3H_2 \xrightarrow{Ni} CH_4 + H_2O$
    ii) $CO + 2H_2 \xrightarrow{Cu/ZnO\text{-}Cr_2O_3} CH_3OH$
    iii) $CO + H_2 \xrightarrow{Cu} HCHO$
18. a) $Cl^- < SO_4^{2-} < PO_4^{3-}$ (Score: 1)
    b) Hardy-Schulze rule (Score: 1)
19. If there are more than one sulphide ores, we can selectively prevent one of the ores from coming to the froth by adding depressant. For example, the depressant NaCN selectively prevents ZnS from coming to the froth in a mixture containing ZnS and PbS.

    Questions 20 to 28 carry 3 scores each. Answer any 7 questions.
20. a) This is because on heating, the crystal loses oxygen as follows:

    $$Zn \longrightarrow Zn^{2+} + \frac{1}{2} O_2 + 2e^-$$

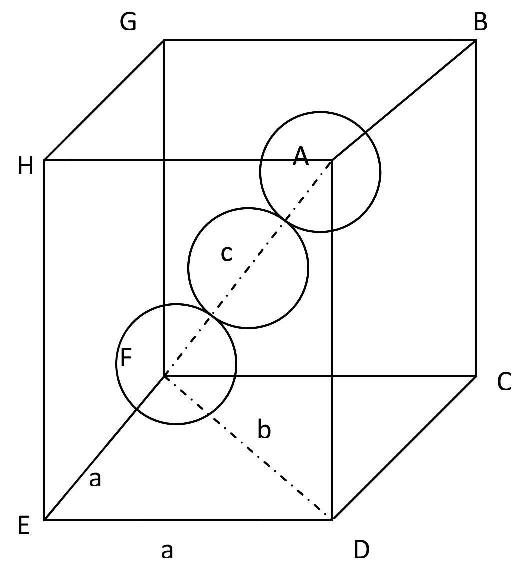
    The Zn^{2+} ions move to the interstitial sites and the electrons to neighbouring interstitial sites. These interstitial electrons make ZnO yellow. (Score: 2)

    b) This is due to metal deficiency defect due to cation vacancies. In crystals of FeO, some Fe^{2+} cations are missing from the lattice site. To maintain electrical neutrality some Fe^{2+} ions become Fe^{3+}. (Score: 1)
21. We know that density of a unit cell, $d = \frac{z.M}{N_A.a^3}$

    To find the nature of the unit cell, calculate the value of z.
    Here d = 2.7×10^3 kg/m^3, M = 2.7×10^{-2} kg/mol, a = 405pm = 405×10^{-12}m, z = ?
    $Z = d.N_A.a^3/M$
    $= 2.7 \times 10^3 \times 6.022 \times 10^{23} \times (405 \times 10^{-12})^3/2.7 \times 10^{-2} = 4$
    Since z= 4, the cubic unit cell is fcc.

22. Consider a body-centred cube with edge length 'a', face diagonal 'b' and body diagonal 'c'.

From the figure it is clear that the atom at the centre is in contact with the other two atoms diagonally placed.



In ΔEFD,

$FD^2 = EF^2 + ED^2$

i.e. $b^2 = a^2 + a^2 = 2a^2$

or, $b = \sqrt{2}a$

In ΔAFD,

$AF^2 = AD^2 + FD^2$

i.e. $c^2 = a^2 + b^2$

$= a^2 + 2a^2 = 3a^2$

Or, $c = \sqrt{3}a$

But, c = 4r (where r is the radius of the particle)

$\therefore$ $4r = \sqrt{3}a$

Or, $a = 4r/\sqrt{3}$

23. a) Molarity (M): It is defined as the number of moles of solute dissolved per litre of solution.
    b) Molality (m): It is defined as the number of moles of the solute present per kilogram (kg) of the solvent.
    c) Mole fraction (x): It is defined as the ratio of the number of moles of a particular component to the total number of moles of solution.
24. a) Raoult's law states that for a solution of volatile liquids, the partial vapour pressure of each component in the solution is directly proportional to its mole fraction. (Score: 1)
    b) In aqueous solution, KCl ionizes completely and hence the number of particles doubled. So i is nearly equal to 2.
    But ethanoic acid dimerises in benzene. So the no. of particles become halved and hence i is nearly equal to 0.5. (Score: 2)
25. Lead storage cell consists of lead as anode and a grid of lead packed with lead dioxide (PbO_2) as the cathode. The electrolyte is 38% H_2SO_4 solution.
    The cell reactions are:
    Anode: $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$
    Cathode: $PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$
    The overall cell reaction is: $Pb(s)+PbO_2(s)+2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$.

26. The scattering of light beam by colloidal particles is known as Tyndall effect. It is observed only when the following conditions are satisfied:

(i) The size of the dispersed particles is much larger than the wavelength of the light used.
(ii) The refractive indices of the dispersed phase and the dispersion medium differ greatly in magnitude.

27. a) Effect of pressure: In the case of both physisorption and chemisorption, the extent of adsorption increases with increase in pressure, reaches a maximum value and then become constant. The pressure at which extent of adsorption becomes maximum (constant) is called saturation pressure.
Effect of temperature: Physisorption occurs at low temperature and the extent of adsorption decreases with increase in temperature. But chemisorption increases with increase in temperature. (Score: 2)
b) Freundlich adsorption isotherm is: $x/m = k.P^{1/n}$ (where n > 1)
or, $\log x/m = \log k + 1/n \log P$. (Score: 1)

28. Bauxite, the ore of aluminium, usually contains silica (SiO_2), iron oxides and titanium oxide (TiO_2) as impurities. Here the powdered ore is treated with a concentrated solution of NaOH at 473 – 523 K and 35 – 36 bar pressure. Alumina (Al_2O_3) dissolves in NaOH to form sodium aluminate [Silica (SiO_2) also dissolves in NaOH to form sodium silicate] leaving behind the impurities.

$Al_2O_3 (s) + 2NaOH(aq) + 3H_2O(l) \rightarrow 2Na[Al(OH)_4](aq)$

The aluminate in solution is neutralised by passing CO_2 gas and hydrated Al_2O_3 is precipitated. The solution is seeded with freshly prepared hydrated Al_2O_3 which induces the precipitation.

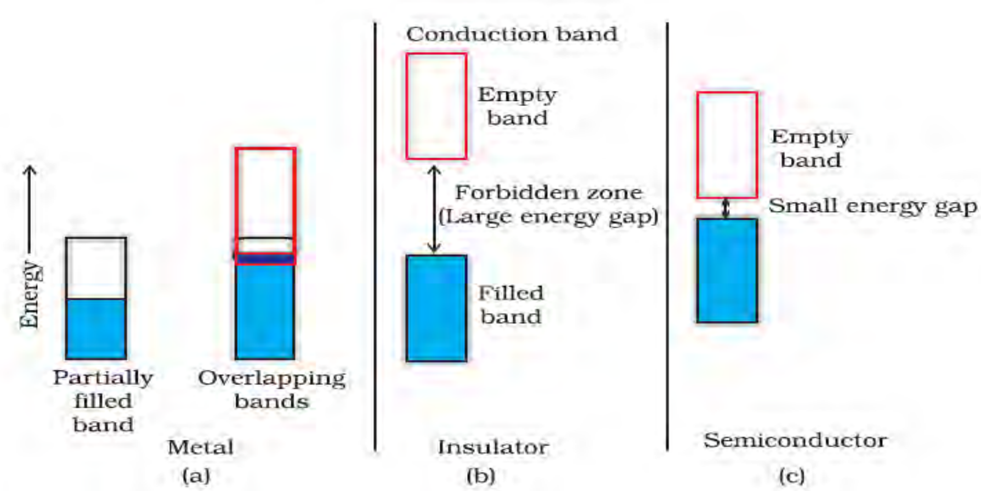
$2Na[Al(OH)_4](aq) + CO_2(g) \rightarrow Al_2O_3.xH_2O(s) + 2NaHCO_3 (aq)$

The sodium silicate remains in the solution and hydrated alumina is filtered, dried and heated to give back pure alumina (Al_2O_3).

$Al_2O_3.xH_2O(s) \xrightarrow{1470 K} Al_2O_3 (s) + xH_2O(g)$.

Question 29 to 32 carry 4 score each. Answer any 3 questions.

29. a) In metals, the valence band is either partially filled or overlapped with the conduction band. So the electrons can easily flow under an applied electric field and the metal shows conductivity.
In insulators, the gap between valence band and the conduction band is large and hence the electrons cannot jump from valence band to conduction band. So they do not conduct electricity.
In semiconductors, the gap between the valence band and the conduction band is small. So some electrons may jump from valence band to conduction band and hence they show some conductivity.
Or,



(Score: 3)

b) A semiconductor formed by doping a 14th group element with an electron rich impurity (like 15th group element) is called n-type semiconductor. (Score: 1)

30. Corrosion is the process of formation of oxide or other compounds of a metal on its surface by the action of air, water-vapour, CO_2 etc.

Rusting of iron occurs in presence of water and air. It is a redox reaction. At a particular spot of the metal, oxidation takes place and that spot behaves as anode. Here Fe is oxidized to Fe^{2+}.

$2Fe (s) \rightarrow 2 Fe^{2+} + 4 e^-$

Electrons released at anodic spot move through the metal and go to another spot on the metal and reduce oxygen in presence of H^+. This spot behaves as cathode. The reaction taking place at this spot is: $O_2(g) + 4 H^+(aq) + 4 e^- \rightarrow 2 H_2O (l)$

The overall reaction is: $2Fe(s)+O_2(g) + 4H^+(aq) \rightarrow 2Fe^{2+}(aq)+ 2 H_2O (l)$

The ferrous ions (Fe^{2+}) are further oxidised to ferric ions (Fe^{3+}) and finally to hydrated ferric oxide ($Fe_2O_3 . x H_2O$), which is called rust.

31. a) The probability that more than three molecules can collide and react simultaneously is very small. So reactions of molecularity greater than three are rare. (Score: 1)

b) We know that,

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

$$\log \frac{0.07}{0.02} = \left(\frac{E_a}{2.303 \times 8.314\, JK^{-1}mol^{-1}}\right)\left[\frac{700 - 500}{700 \times 500}\right]$$

$$0.544 = E_a \times 5.714 \times 10^{-4}/19.15$$

$$E_a = 0.544 \times 19.15/5.714 \times 10^{-4} = 18230.8 \text{ J}$$

Since $k = Ae^{-Ea/RT}$

$$0.02 = Ae^{-18230.8/8.314 \times 500}$$

$$A = 0.02/0.012 = 1.61$$

(Score: 3)

32. **a) Calcination**: Here the ore is heated in the absence of air or in limited supply of air. It is used for the conversion of hydroxide and carbonate ores to oxide ore. Here O_2 is not used up.

E.g. $ZnCO_3 (s) \xrightarrow{\Delta} ZnO(s) + CO_2(g)$

Roasting: Here the ore is heated in a regular supply of air below the melting point of the metal. This method is used for the conversion of sulphide ores to oxide ore. Here O_2 is used up.

E.g. $2 ZnS + 3 O_2 \rightarrow 2 ZnO + 2 SO_2$ (Score: 2)

b) **Hall-Heroult process**: Here the purified Al_2O_3 is mixed with Na_3AlF_6 (cryolite) or CaF_2 and is eletrolysed. The electrolysis is carried out in a carbon lined steel vessel, which acts as cathode. Graphite rods are used as anode. During electrolysis Al_2O_3 is reduced to Al by carbon.

The electrolytic reactions are:

Cathode: Al^{3+} (melt) + $3e^- \rightarrow$ Al (l)

Anode: C(s) + O^{2-} (melt) $\rightarrow$ CO(g) + $2e^-$

C(s) + $2O^{2-}$ (melt) $\rightarrow CO_2$ (g) + $4e^-$ (Score: 2)

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