Solution

Class 12 - Chemistry

Chemistry Class XII : paper 1

Section A

1. i. A plant cell gets shrink when it is kept in a hypertonic solution.
   ii. Osmotic pressure.
   iii. Osmotic rise of a solution depends upon density & temperature.
   iv. Isotonic solutions have the same molarity.
   v. In an upward direction, osmosis helps in the transportation of water in a plant.

2. i. When E = O; then Kc = Q.
   ii. Straight line.
   iii. ΔG = -nFE

   -827 kJ/mol = - 4 $\times$ 95600 C$\times$ E.

   $\frac{827 \times 100 J/mol}{4 \times 95600 C} = E$

   E = 2.14 V

   iv. The equilibrium constant k related to only E°_{cell} and not E_{cell} because at equilibrium, E_{cell} = O.

   v. EMF of cell = E°(Cu^{2+}/Cu) - E°(Ni^{2+}/Ni)

   = 0.34 - (- 0.25)

   = 0.59 V

3. The units of rate of a reaction are mol L^{-1} s^{-1}. In gaseous reaction the unit of rate of reaction is atm s^{-1}.

4. The required relations are:

   ΔG = -nFE

   W$_{max}$ = nFE^{o}

   where, E = Cell potential, n= no. of electrons

   E^{o} = Standard emf of the cell

   OR

   Second order, because unit is $L\ mol^{-1}\ s^{-1}$.

5. Osmotic pressure is the hydrostatic pressure applied on solution which just prevents the flow of solvent molecules through semipermeable membrane. It may be also defined as the excess pressure which must be applied to a solution to prevent the passage of solvent into it through a semipermeable membrane.

6. Copper is conducting because it has free electrons whereas CuSO$_4$ conducts electricity in molten state because ions becomes free to move in molten state or in aqueous solution but not in solid state.

7. Colligative properties are those properties of dilute solutions which depend only on the number of molecules or solute particles and not on the chemical nature of the solute.

   OR

   Coordination number of each ion in NaCl crystal is 6 as shown in figure.
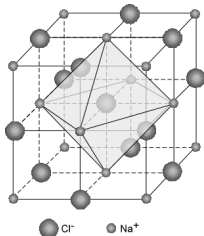
8. We have,

   Molar conductivity = $\Lambda_m = \frac{\kappa}{C}$

   In the above equation, if κ is expressed in Sm^{-1} and the concentration, c in mol m^{-3} then the units of Λ_m are in S m^2 mol^{-1}. It may be noted that:

   1 mol m^{-3} = 1000(L/m^3) x molarity (mol/L), and hence

   $\Lambda_m\left(\ S\ cm^2\ mol^{-1}\right) = \frac{\kappa\ (\ S\ cm^{-1})}{1000\ L\ m^{-3}\ \times\ molariity\ (mol\ L^{-1})}$

If we use S cm^{-1} as the units for κ and mol cm^{-3}, the units of concentration, then the units for Λ_m are S cm^2 mol^{-1}, It can be calculated by using the equation:

$$\Lambda_m\left(\ S\ cm^2\ mol^{-1}\right) = \frac{\kappa\ (\ S\ cm^{-1})\ \times\ 1000\ (cm^3/L)}{molariity\ (mol\ L^{-1})}$$

Both type of units are related to each other by the equations:

1 S m^2 mol^{-1} = 10^4 S cm^{2}mol^{-1} or

1 S cm^2 mol^{-1} = 10^{-4} Sm^2 mol^{-1}

9. Glass is an amorphous solid. It has a tendency to flow very slowly like liquids and make the bottom portion of glass panes in the windows slightly thicker. Therefore, glass is a super cooled liquid.

10. Rate of disappearance of hydrogen $= -\frac{1}{3}\frac{d[H_2]}{dt}$

<div align="center">OR</div>

A single half-cell does not exist independently as reduction and oxidation occur simultaneously therefore single electrode potential cannot be measured.

11.

MOLARITY(M)	MOLALITY(m)
It is the number of moles of solute dissolved per litre of the solution	It is the number of moles of solute dissolved in 1Kg of the solvent
It decreases with increase in temperature	It has no effect on temperature
Unit: mol/L	Unit: mol/Kg

12. Density of crystal like AgCl showing Frenkel defect does not change because no ion is missing from the crystal, infarct they remain occupied interstitial sites.

<div align="center">OR</div>

Standared hydrogen electrode (SHE) is used as reference electrode in determining the standard electrode potential because its reduction and oxidation potential value is 0.0 volt.

13. **(a)** Assertion and reason both are correct statements and reason is the correct explanation for the assertion.
Explanation: When a non-volatile solute is added to water, freezing point lowers due to lowering of vapor pressure.

14. **(b)** Both assertion and reason are correct but reason does not explain assertion.
Explanation: Order of a reaction may be zero or fractional. Order can be determined by rate law expression.

<div align="center">OR</div>

(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
Explanation: Graphite is a good conductor of electricity because three of its four electrons are involved in bonding and 1 electron is free for conduction. But in the case of the diamond, all four electrons are involved in bond formation. So no electron is available for conduction hence diamond is a bad conductor of electricity. Graphite has a layered structure where layers are held by weak van der wall force, that's why it is soft in nature. In the case of diamond, it has a hard & compact 3D structure with strong forces acting gives it hard and brittle structure.
So, Assertion and reason both are correct statements but the reason is not the correct explanation for the assertion.

15. **(c)** Assertion (A) is correct, but Reason (R) is an incorrect statement.
Explanation: The number of ions per unit volume carrying the current decreases on dilution, so conductivity always decreases with a decrease in concentration.
However, molar conductivity increases with dilution. Hence the number of ions per unit volume that carry charge in a solution decreases.

16.

<div align="center">**Section B**</div>

17. Difference between hexagonal and Monoclinic unit cell in terms of their axial lengths and axial angles are given below:

S.No.	property	Hexagonal unit cell	Monoclinic unit cell
1.	Axial distance	$a = b \neq c$	$a \neq b \neq c$
2.	Axial angles	$\alpha = \beta = 90°$, $\gamma = 120°$	$\alpha = \gamma = 90°$, $\beta \neq 90°$
3.	Examples	ZnO	$Na_2SO_4.10H_2O$

18. Given, 5% sugar solution means, w_B = 5g

$w_A = 95g, M_B = 342 g\,mol^{-1}$

Similarly, for 5% glucose solution, $w_B(glu\cos e) = 5g$

$w_A = 95\,g\,and M_B(glu\cos e) = 180\,g\,mol^{-1}$

$\Delta T_f(cane\,sugar) = 273.15K - 271K = 2.15K$

$\Delta T_f = \frac{K_f \times w_B \times 1000}{M_B w_A}$

$2.15 = \frac{K_f \times 5 \times 1000}{342 \times 95}$

$k_f = \frac{2.15 \times 342 \times 95}{5 \times 1000} = 13.9707$

similarly, for glucose

$\Delta T_f(glu\cos e) = \frac{13.9707 \times 5 \times 1000}{180 \times 95}$

$\Delta T_f = 4.085K$

Freezing point of the solution

= 273.15K - 4.085K = 269.065 K

<div align="center">OR</div>

As we know for first order reaction

$t_{1/2} = \frac{0.693}{k}$

$Given, k = 200\,s^{-1}$

$So, t_{1/2} = \frac{0.693}{200} = 3.47 \times 10^{-3}\,s.$

19. The various quantities known to us are as follows:

p_1^0 = 0.850 bar; p = 0.845 bar; M_1 = 78g mol^{-1}; w_2 = 0.5 g; w_1 = 39 g

Substituting these values in equation of relative lowering of vapour pressure, we get

$\frac{0.850\,bar - 0.845\,bar}{0.850\,bar} = \frac{0.5g \times 78 g mol^{-1}}{M_2 \times 39g}$

Therefore, M_2 = 170 g mol^{-1}

20. The given reaction is of the first order with respect to A and of zero order with respect to B.

Therefore, the rate of the reaction is given by,

$Rate = k[A]^1[B]^0$

Rate = k [A]

From experiment I, we obtain

$2.0 \times 10^{-2} mol\,L^{-1} min^{-1} = k(0.1\,mol\,L^{-1})$

$k = 0.2 min^{-1}$

From experiment II, we obtain

$4.0 \times 10^{-2}\,mol\,L^{-1}\,min^{-1} = 0.2 min^{-1}[A]$, so $[A] = 0.2 mol\,L^{-1}$

From experiment III, we obtain

$Rate = 0.2 min^{-1} \times 0.4 mol\,L^{-1} = 0.08\,mol\,L^{-1} min^{-1}$

From experiment IV, we obtain

$2.0 \times 10^{-2} mol\,L^{-1} min^{-1} = 0.2\,min^{-1}[A]$, so $[A] = 0.1 mol\,L^{-1}$

21. We have given: $E^{\Theta}_{(Ag^+/Ag)} = 0.80\,V, E^{\Theta}_{(Cu^{2+}/Cu)} = 0.34\,V, E^{\Theta}_{(Fe^{2+}/Fe)} = 0.44\,V, E^{\Theta}_{(K^+/K)} = -2.93\,V,$

$E^{\Theta}_{(Mg^{2+}/Mg)} = -2.36\,V, E^{\Theta}_{(Cr^{3+}/Cr)} = -0.74\,V$

More negative the value of standard electrode potential (E^{Θ}) of metal, more it has the tendency to oxidise (Reducing agent) itself.

Ag < Cu < Fe < Cr < Mg < K

<div align="center">OR</div>

Let the number of oxide ions in the packing be N.

Then octahedral voids = N.

Therefore, Al^{3+} ions $= \frac{2}{3} \times N = \frac{2N}{3.}$

Ratio of $Al^{3+} : O^{2-} = \frac{2N}{3} : N = 2 : 3$

Hence, formula of corundum is Al_2O_3.

22. A unit cell is characterized by

    a. Its dimensions along the three edges a, b and c. These edges may or may not be mutually perpendicular.

    b. Angles between the edges, α (between b and c), β (between a and b) and γ (between a and b). Thus, a unit cell is characterized by six parameters a, b, c, α , β and γ.
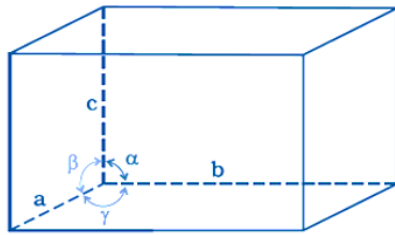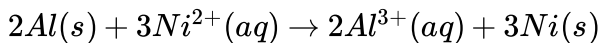

parameters of a unit cell

23. Glass is considered as supercooled liquids because of following reasons:

    i. Like liquids, amorphous solids are isotropic

    ii. Like liquids, they possess fluidity

24. From the equation $2O_3(g) \rightleftarrows 3O_2(g), -\frac{1}{2} \frac{\Delta[O_3]}{\Delta t} = \frac{1}{3} \frac{\Delta[O_2]}{\Delta t}$

$\frac{\Delta(o_2)}{\Delta t} = \frac{-3}{2} \frac{\Delta(0_3)}{\Delta t}$

$= \frac{-3}{2} \times (-5.0 \times 10^{-4} \text{atms}^{-1})$

$= 7.5 \times 10^{-4} \text{atms}^{-1}$

25. We know that

$2Al(s) + 3Ni^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Ni(s)$

for this reaction n=2 moles of electrons.

Standard emf of the cell:

$E^{\ominus}_{cell} = E^{\ominus}_{(Ni^{2+}/Ni)} - E^{\ominus}_{(Al^{3+}/Al)}$

= -0.76 - (-1.66)

= 0.9 V

for free Gibbs energy,

$\Delta G^{\Theta} = -nFE^{\Theta}_{cell}$

$\Delta G^{\Theta} = -2 \times 96500 \, C \, mol^{-1} \times 0.9 \, V$

$\Delta G^{\Theta} = -173700 \, J \, mol^{-1}$

$\Delta G^{\Theta} = -173.700 \, kJ \, mol^{-1}$

Section C

26. We know that, Atomic mass = $M = \frac{d \times a^3 \times N_A}{z}$

Where d = Density of the material = 10.5 g/cm^3

a = Length of the edge of the cell = 4.077 × 10^{-8} cm

N_A = Avagadro number = 6.023 ×10^{23} mol^{-1}

z = No. of atoms = 4

Now, put the values

$M = \frac{10.5 g \, cm^{-3} \times (4.077 \times 10^{-8} cm)^3 \times (6.023 \times 10^{23} mol^{-1})}{4}$

$\therefore$ Atomic mass of silver = 107.08g mol^{-1}

OR

Let Rate = $k[Cl_2]^x[NO]^y$ where k=rate constant, x and y are orders of reaction w.r.t. X and Y respectively

When Rate = $1.2 \times 10^{-4} mol \, L^{-1}S^{-1}$

[Cl$_2$] = 0.10 mol/L: [NO] = 0.010 mol/L

$1.2 \times 10^{-4} mol \, L^{-1}S^{-1}$ =k[0.10 molL^{-1}]x[0.010 mol L^{-1}]^y....(i)

When Rate = $10.8 \times 10^{-4} molL^{-1}s^{-1}$

[Cl$_2$] = 0.10 mol L^{-1}; [NO] = 0.030 mol L^{-1}

$10.8 \times 10^{-4} = k[0.10 molL^{-1}]^x [0.030 molL^{-1}]^y$ ....(ii)

Divide ii by i we get

9=3^y so y=2

When Rate $= 21.6 \times 10^{-4} molL^{-1}S^{-1}$

[Cl$_2$] = 0.20 mol L^{-1}; [NO] = 0.030 mol L-1

$21.6 \times 10^{-4} = k[0.20 molL^{-1}][0.030 molL^{-1}]^2$ ....(iii)

Divide iii by ii we get

2=2^x so x=1

Put these values in i we get

1.2x10^{-4} mol L^{-1}s^{-1}=k(0.01 mol/L)(0.01 mol/L)^2

1.2x10^{-4} mol L^{-1}s^{-1}=k(0.01)^3 (mol/L)^3

k=1.2x10^{-4} mol L^{-1}s^{-1}/10^{-6} mol^{3}L^{-3}=120 mol^{-2}L^{2}s^{-1}

So the rate is given as

Rate=120x[Cl$_2$][NO]^2

27. Consider the order of the reaction with respect to A is x and with respect to B is y.
Therefore, $r_0 = k[A]^x [B]^y$
$5.07 \times 10^{-5} = k[0.20]^x [0.30]^y$ ..... (i)
$5.07 \times 10^{-5} = k[0.20]^x [0.10]^y$ ..... (ii)
$1.43 \times 10^{-4} = k[0.40]^x [0.05]^y$ ..... (iii)
Dividing equation (i) by (ii), we obtain
$\frac{5.07 \times 10^{-5}}{5.07 \times 10^{-5}} = \frac{k[0.20]^x [0.30]^y}{k[0.20]^x [0.10]^y}$
$1 = \frac{[0.30]^y}{[0.10]^y} \left(\frac{0.30}{0.10}\right)^0 = \left(\frac{0.30}{0.10}\right)^y$
y = 0
Dividing equation (iii) by (ii), we obtain
$\frac{1.43 \times 10^{-4}}{5.07 \times 10^{-5}} = \frac{k[0.40]^x [0.05]^y}{k[0.20]^x [0.30]^y}$
$\frac{1.43 \times 10^{-4}}{5.07 \times 10^{-5}} = \frac{[0.40]^y}{[0.20]^y}$ $[Since\ y = 0, [0.05]^y = [0.30]^y = 1]$
$2.821 = 2^x$
$\log 2.821 = x \log 2\ (Taking \log on\ both\ sides) x = \frac{\log 2.821}{\log 2}$
= 1.496
= 1.5 (approximately)
Hence, the order of the reaction with respect to A is 1.5 and with respect to B is 0.

28. The reciprocal of electrical resistance is called conductance. It is usually represented by 'G'.
Thus $G = \frac{1}{R}$
Units: The units of conductance are reciprocal ohms written as

ohm^{-1} or mho
or siemens (S)
$1S = 1\Omega^{-1}$

29. Volume = mass/density
$= 100g/1.10 glcm^3\ = 90.9 cm^3$
M = % × density × 10/molar
mass of solute $= 15 \times 1.1 \times \frac{10}{98} = 1.68M$
Molarity = $\frac{\text{no. of moles of H}_2\text{SO}_4}{\text{volume of solution}} \times 1000$
Molality = $\frac{\text{no. of moles of solute}}{\text{mass of solvent in kg}}$
$\frac{(15/98)}{85g} \times 1000$ = 1.8 M

<div align="center">OR</div>

Zero order reaction:

i. The units of the rate constant are = mol L^{-1} s^{-1}

ii. The half life of a zero order reaction (t$_{1/2}$) is directly proportional to initial concentration of reactant.

First order reaction:

i. The units of the rate constant are time^{-1} such as s^{-1}.

ii. The half life of a first order reaction (t$_{1/2}$) is independent of initial concentration of reactant since t$_{1/2}$ = 0.693/k

30. The series of elements which have been arranged on the basis of their electrode potential is called electrochemical series or activity series.
    Standard EMF of the cell = [standard reduction potential of the right hand side electrode] - [Standard reduction potential of the left hand side electrode]
 $$emf = E^0_{cathode} - E^0_{anode}$$

Section D

31. According to Raoult's law, the partial vapour pressure of each volatile component in any solution is directly proportional to its mole fraction. The solutions which obey Raoult's law over the entire range of concentration are known as ideal solutions. The solutions that do not obey Raoult's law (non-ideal solutions) have vapour pressures either higher or lower than that predicted by Raoult's law. If the vapour pressure is higher,(ie A....B interaction is less than A...A and B...B interaction) then the solution is said to exhibit positive deviation, and if it is lower(A...B interaction is more than A...A and B...B interaction), then the solution is said to exhibit negative deviation from Raoult's law.
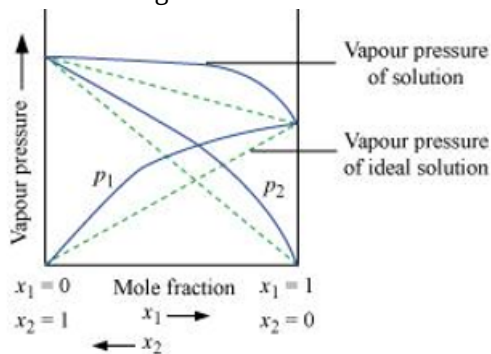
Vapour pressure of a two-component solution showing positive deviation from Raoult's law
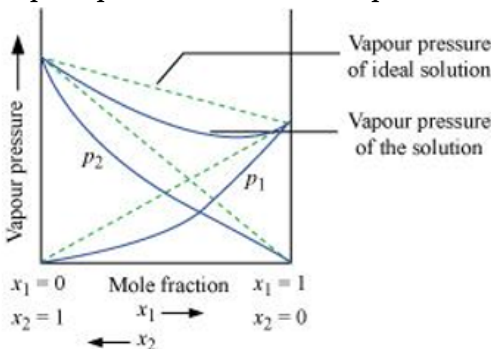
Vapour pressure of a two-component solution showing negative deviation from Raoult's law.

In the case of an ideal solution, the enthalpy of the mixing of the pure components for forming the solution is zero.

ΔSol H = 0

In the case of solutions showing positive deviations, absorption of heat takes place.

Therefore, ΔSol H = Positive

In the case of solutions showing negative deviations, evolution of heat takes place.

Therefore, ΔSol H = Negative

OR

Given, M = 50 g mol^{-1}

Z= 2

d = 5.91 g cm^{-3}

v = a^3

$N_A = 6.022 \times 10^{23}$

By applying the density formula, we have

$d = \frac{Z \times M}{N_A \times a_3}$

$a^3 = \frac{Z \times M}{N_A \times d}$

$= \frac{2 \times 50}{5.91 \times 6.023 \times 10^{23}}$

$= 2.809 \times 10^{-23} cm^3$

32. Both conductivity and molar conductivity change with the concentration of the electrolyte. Conductivity always decreases with decrease in concentration both, for weak and strong electrolytes. This can be explained by the fact that the number of ions per unit volume that carry the current in a solution decreases on dilution. The conductivity of a solution at any given concentration is the conductance of one unit volume of solution kept between two platinum electrodes with unit area of cross section and at a distance of unit length.
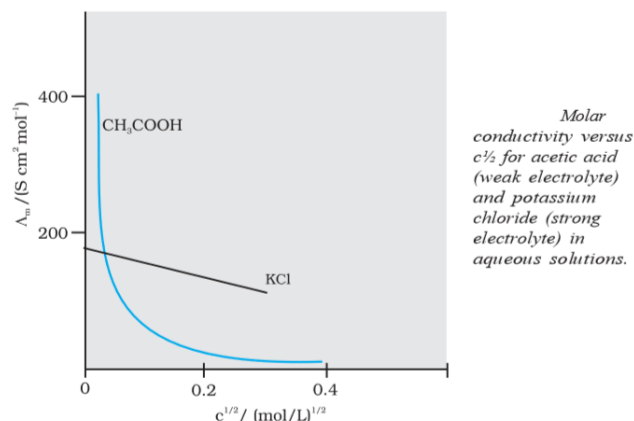
This is clear from the equation:

$G = \frac{\kappa A}{l} = \kappa$ (both A and l are unity in their appropriate units in m or cm)

Molar conductivity of a solution at a given concentration is the conductance of the volume V of solution containing one mole of electrolyte kept between two electrodes with area of cross section A and distance of unit length. Since l = 1 and A = V (Volume containing 1 mole of electrolyte). Therefore,

$\Lambda_m = \frac{\kappa A}{l} = \kappa V$

Molar conductivity increases with decrease in concentration. This is because the total volume, V, of solution containing one mole of electrolyte also increases. It has been found that decrease in κ on dilution of a solution is more than compensated by increase in its volume. Physically, it means that at a given concentration, Λ_m can be defined as the conductance of the electrolytic solution kept between the electrodes of a conductivity cell at unit distance but having area of cross section large enough to accommodate sufficient volume of solution that contains one mole of the electrolyte. When concentration approaches zero, the molar conductivity is known as limiting molar conductivity and is represented by the symbol Λ_m°. The variation in Λ_m with concentration is different for strong and weak electrolytes as shown in the figure.

Molar conductivity versus c½ for acetic acid (weak electrolyte) and potassium chloride (strong electrolyte) in aqueous solutions.

For strong electrolytes, Λ_m increases slowly with dilution and can be represented by the equation:

$\Lambda_m = \Lambda_m^\circ - Ac^{1/2}$

Weak electrolytes like acetic acid have lower degree of dissociation at higher concentrations and hence for such electrolytes, the change in Λ_m with dilution is due to increase in the degree of dissociation and consequently the number of ions in total volume of solution that contains 1 mol of electrolyte. In such cases Λ_m increases steeply on dilution, especially near lower concentrations as shown in the given figure above.

OR

i. Average rate of reaction between the time interval, 30 to 60 seconds, $= \frac{d[Ester]}{dt}$

$= \frac{0.31 - 0.17}{60 - 30} = \frac{0.14}{30}$

$= 4.67 \times 10^{-3} mol \, L^{-1} s^{-1}$

ii. For a pseudo first order reaction,

$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$

For t= 30 s, $k_1 = \frac{2.303}{30}\log\frac{0.55}{0.31}$

$= 1.911 \times 10^{-2} s^{-1}$

For t= 60 s, $k_2 = \frac{2.303}{60}\log\frac{0.55}{0.17}$

$= 1.957 \times 10^{-2} s^{-1}$

For t= 90 s,

$k_3 = \frac{2.303}{90}\log\frac{0.55}{0.085} = 2.075 \times 10^{-2} s^{-1}$
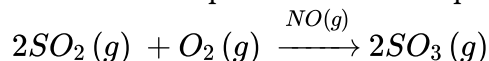
Then, average rate constant, $k = \frac{k_1+k_2+k_3}{3}$

$= \frac{(1.911\times10^{-2})+(1.957\times10^{-2})+(2.075\times10^{-2})}{3} = 1.98 \times 10^{-2} s^{-1}$

33. Homogeneous catalysis:

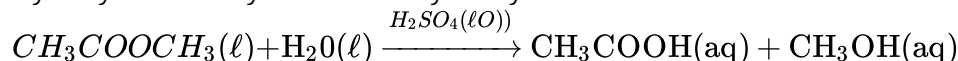When reactant and catalyst are in the same phase, the process is said to be homogeneous catalysis.

Examples:

   i. Oxidation of sulphur dioxide in the presence of oxygen gas and nitric oxide gas as catalyst.

$2SO_2(g) + O_2(g) \xrightarrow{NO(g)} 2SO_3(g)$

  ii. Hydrolysis of methyl acetate catalysed by H^+ ions.

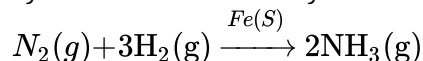$CH_3COOCH_3(\ell) + H_20(\ell) \xrightarrow{H_2SO_4(\ell O))} CH_3COOH(aq) + CH_3OH(aq)$

Heterogeneous catalysis: The catalytic process in which the reactant and catalyst are in different phases is known as heterogeneous catalysis.
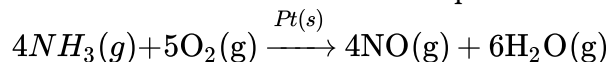
Examples:-

   i. Oxidation of sulphur dioxide in presence of platinum.

$O_2(g) + 2SO_2(g) \xrightarrow{pt(s)} 2SO_3(g)$
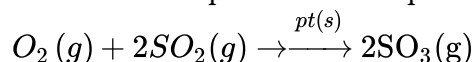
  ii. Synthesis of ammonia by Haber's process

$N_2(g) + 3H_2(g) \xrightarrow{Fe(S)} 2NH_3(g)$

 iii. Oxidation of ammonia in Ostwald's process.

$4NH_3(g) + 5O_2(g) \xrightarrow{Pt(s)} 4NO(g) + 6H_2O(g)$

OR

a. $A_m = \frac{\kappa}{c} = \frac{4.95\times10^{-5}\text{Scm}^{-1}}{0.001} \times \frac{1000\text{cm}^3}{\text{L}} = 49.5\text{Scm}^2\text{mol}^{-1}$

$\alpha = \frac{A_m}{\Lambda_m^\circ} = \frac{49.5\text{Scm}^2\text{mol}^{-1}}{390.5\text{Scm}^2\text{mol}^{-1}} = 0.126$

$K = \frac{c\alpha^2}{(1-\alpha)} = \frac{0.001\text{molL}^{-1}\times(0.126)^2}{1-0.126} = 1.8 \times 10^5 \text{molL}^{-1}$

((If K= $c\alpha^2$, then K= 1.6×10^{-5} mol L^{-1}

b. $E_{(\text{cell})} = E_{(\text{cell})}^\ominus \quad - \frac{0.059}{6}\log\frac{\lfloor\text{Al}^{3+}\text{J}^2}{[\text{cu}^{2+}]^3}$

c. Batteries which are rechargeable

   Example- Lead storage, Ni-Cd batteries