

B.Tech.
First Semester Examination, Dec.-2009
Engineering Chemistry (CH-101-F)

Note : Question one is compulsory. All questions carry equal marks. Answer five questions in total. Attempt at least one-questions from Sections : I, II, III & IV.

Q. 1. (a) Define triple point of water system.

Ans. The point in phase diagram of water system at which all three phases exist called the triple point of water system.

The temperature and pressure of water at this point are 0.0075°C & 4.58 mm respectively.

Q. 1. (b) What is a promotor? Can it alone act as a catalyst?

Ans. Promotor : Action of promotors is explained by assuming that a loose compound is formed between the catalyst and the promotor which possesses an increased absorption capacity than the pure catalyst only.

Q. 1. (c) What are the salts responsible for temporary and permanent hardness of water?

Ans. Salt responsible for temporary hardness are bicarbonates of Ca & Mg and other heavy metals.

Salt responsible for permanent hardness are chloride & sulphate of Ca & Mg.

Q. 1. (d) Define co-ogulation.

Ans. The phenomenon of changing colliodal state to a suspended state is known as co-ogulation.

Q. 1. (e) What is the effect of CO_2 on electrochemical corrosion?

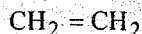
Ans. Corrosion by CO_2 the extent of corrosive effect depends mainly on the chemical affinity between the metal and gas involved.

Q. 1. (f) Explain flash & fire point of lubricants.

Ans. Flash and fire points is the lowest temperature at which the oil lubricant gives off enough vapors that ignite for a movement, when a tiny flame is brought near it while fire point is lowest temperature at which vapor burns.

Q. 1. (g) Define functionality.

Ans. The number of bonding sites presents in a monomer is known as its functionality.



When double bond break to active sites form hence it is bifunctional monomer.

Q. 1. (h) Define thermoplastic polymer and give two examples.

Ans. Thermoplastic are the polymers which gets soften on heating and harden on cooling without or with very little change in their properties.

E.g., Nylon6, 6, PVC.

Q. 1. (i) What is the difference between atomic & molecular spectra?

Ans. Atomic Spectra : A line spectrum is obtained when the substance in atomic form.

Molecular Spectra : A band spectrum that is separated by dark spaces.

Q. 1. (j) What finger print region in IR spectroscopy?

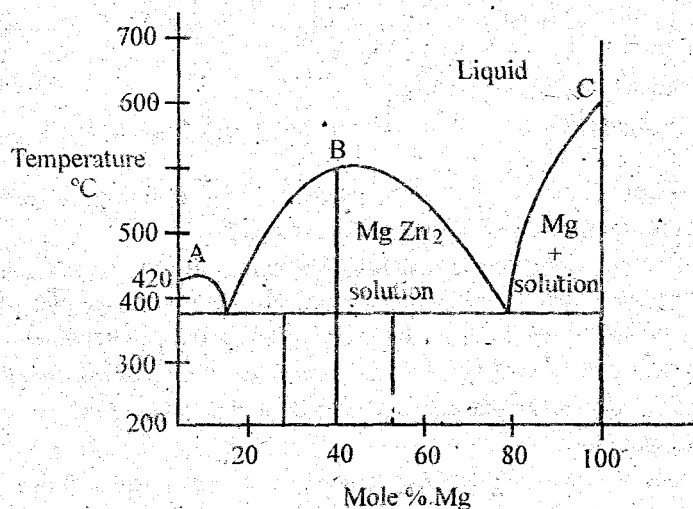
Ans. The region below 1500 cm^{-1} in IR spectroscopy is called finger print region.

Section-I

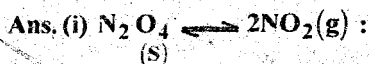
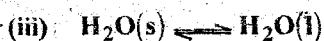
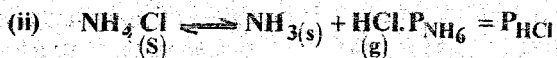
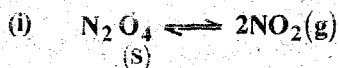
Q. 2. (a) What do you mean by congruent melting point? Discuss Zn-Mg system in detail.

Ans. Congruent Melting Point : Compounds which melts sharply at a constant temperature into a liquid of same composition as the solid is said to possess a congruent melting point.

If it melts sharply at a constant temperature into a liquid, having the same composition as that solid.



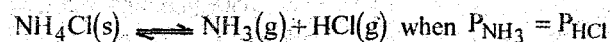
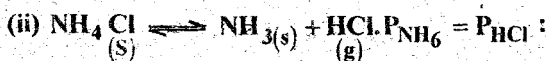
Q. 2. (b) Determine the number of component, number of phases and degree of freedom in following equilibrium :



Number component = 1 Degree of freedom = 2

Number of Phase = 1

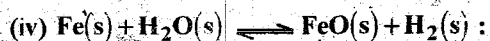
$$C = 1, P = 1, F = 2$$



$$C = 1, P = 2, F = 1$$



$$C = 1, P = 2, F = 1$$



Q. 3. (a) What is meant by catalysis? Discuss the general characteristic of a catalyst.

Ans. Catalysis : The phenomenon of increase the rate of reaction with the help of catalyst is known as catalysis.

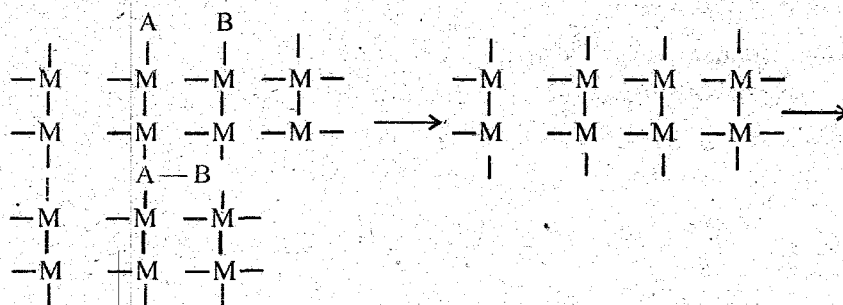
General Characteristic of Catalyst :

- (i) Catalyst remains unchanged in amount and chemical composition at the end of reaction.
- (ii) Only a small quantity of catalyst is needed.
- (iii) The catalyst does not alter the position of equilibrium in a reverse reaction.
- (iv) Catalyst does not initiate the reaction.
- (v) Catalyst is specific in its nature.
- (vi) Catalyst cannot alter the nature of the products of the reaction.
- (vii) A catalyst is poisoned by certain substances.

Q. 3. (b) Describe the adsorption theory of heterogeneous catalysis with suitable example.

Ans. Adsorption or contact theory was postulated by Faraday (1883) and received by many others. It explains the actions of heterogeneous catalysis. According to it,

- (i) The surface of the solid catalyst possesses some isolated active spots.
- (ii) Due to these free unsatisfied valency forces on catalyst surface, the molecules of the gaseous reactants get adsorbed.
- (iii) Adsorbed molecules react due to their close proximity, forming products.
- (iv) The chemical action is accelerated on account of increased concentration of reacting substances on the surface of the solid catalyst and no definite intermediate compound formation takes place.



- (v) The forces which keep the molecules of the reactants intact with catalyst also attract the reacting molecules. The distorted molecules of the catalyst being under more strain and more reactive.

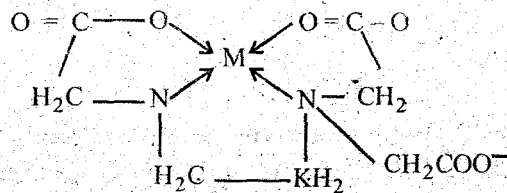
Section-II

Q. 4. (a) Discuss principle and procedure of EDTA method for determination of hardness.

Ans. Principle : EDTA is a hexadentate ligand and binds the hardness causing metal ions Ca^{2+} or

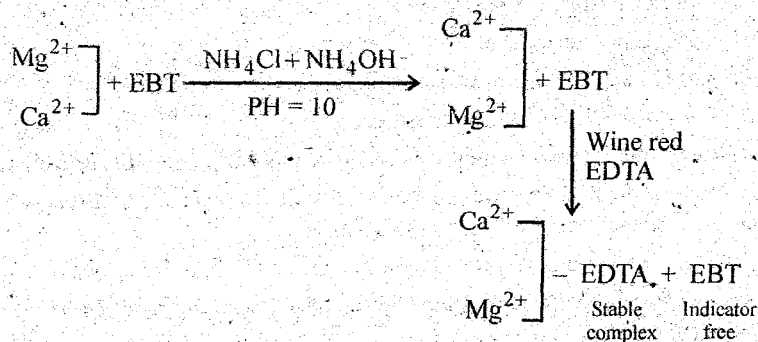
Mg^{2+} to give very stable chelate colour complex.

Therefore, the determination of hardness by this method is known as complexometric titration.



When EBT indicator is added to a sample of hard water at $PH = 10$, it gives wine red colour complex, which is titrated with standard EDTA solution, which combine with Ca^{2+} and Mg^{2+} to form a stable complex and erchrome black T is liberated which has blue colour.

Therefore, at end point wine red colour is changed into blue colour.



Procedure : Various steps are involved in procedure.

Step I : Standardisation of EDTA Solution : 50 ml standard hard water (SHW) in conical then 10 ml buffer solution & 2, -3 drop of EBT, wine red colour then titrate with EDTA upto wine red to blue colour appear.

Let V_1 ml of EDTA solution used.

Step II : Determination of total Hardness :

50 ml hard water sample + 10 ml buffer + 2 drop EBT

Wine red \rightarrow Titrate with EDTA \rightarrow Upto blue colour.

Let V_2 ISNL of EDTA solution used.

Step III : Determination of permanent hardness. Let V_3 ml of EDT solution used in case of boiled water.

Calculation : Total hardness $= \frac{V_2}{V_1} \times 1000 \text{ ppm}$

Permanent hardness $= \frac{V_3}{V_1} \times 1000 \text{ ppm}$

Temporary hardness $= \left(\frac{V_2 - V_3}{V_1} \right) \times 1000 \text{ ppm}$

Q. 4. (b) 100 ml of water sample requires 20 ml of N/50 H_2SO_4 for neutralization to phenolphthalein end point and another 25 ml is required for complete neutralisation. Calculate the type and amount of alkalinity.

Ans. At phenolphthalein end point

Volume of water sample = 100 ml

Volume of acid used = 20 ml (A ml)

Water Vs acid.

$$N_1 V_1 = N_2 V_2$$

$$N_1 \times 100 = \frac{1}{50} \times 20$$

$$N_1 = \frac{20}{50 \times 100}$$

$$\text{Strength (in terms of } \text{CaCO}_3) = \frac{20}{50 \times 100} \times 50 \text{ gm/l}$$

$$\begin{aligned} \text{Phenolphthalein alkalinity} &= \frac{20}{100} \text{ gm/l} = \frac{20}{100} \times 1000 \text{ mg/l} \\ &= 200 \text{ ppm} \end{aligned}$$

At methyl orange end point (Volume of Acid in methyl orange case is B ml)

Volume of Acid used = (A + B)

$$N_1 V_1 = N_2 V_2$$

$$N_1 \times 100 = \frac{1}{50} \times (A + B)$$

$$N_1 \times 100 = \frac{1}{50} \times (20 + 25)$$

$$N_1 = \frac{45}{100 \times 50}$$

$$S = N_1 \times E_{\text{CaCO}_3} = \frac{45}{100 \times 50} \times 50 \text{ g/p}$$

$$= \frac{45}{100 \times 50} \times 50 \times 1000 \text{ ppm}$$

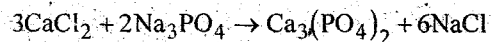
$$= 450 \text{ ppm.}$$

Q. 4. (c) Write short note on :

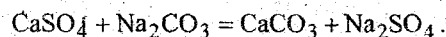
(i) Phosphate conditioning,

(ii) Carbonate conditioning.

Ans. (i) Phosphate Conditioning : In high pressure boilers, scale formation can be avoided by adding phosphate, which reacts with hardness of water forming non-adherent and easily removable, soft sludge of calcium and magnesium phosphates, which can be removed by blow-down operation, e.g. :

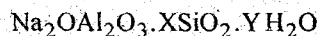


(ii) **Carbonate Conditioning** : In low pressure boiler's scale-formation can be avoided by adding sodium carbonate to boiler water, when CaSO_4 is converted into calcium carbonate in equilibrium.



Q. 5. (a) What are natural and synthetic zeolites? Explain the zeolite process for softening of hard water.

Ans. Zeolite are hydrated sodium aluminosilicates capable of exchanging its sodium with the hardness producing cation in water. The formula of zeolite is



$$x = 2 - 10$$

$$y = 2 - 6$$

Natural Zeolites : These are amorphous and non-porous in nature, they are derived from green sands by washing, heating and treating with NaOH.

e.g., Natrolite $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2 \cdot 2\text{H}_2\text{O}$

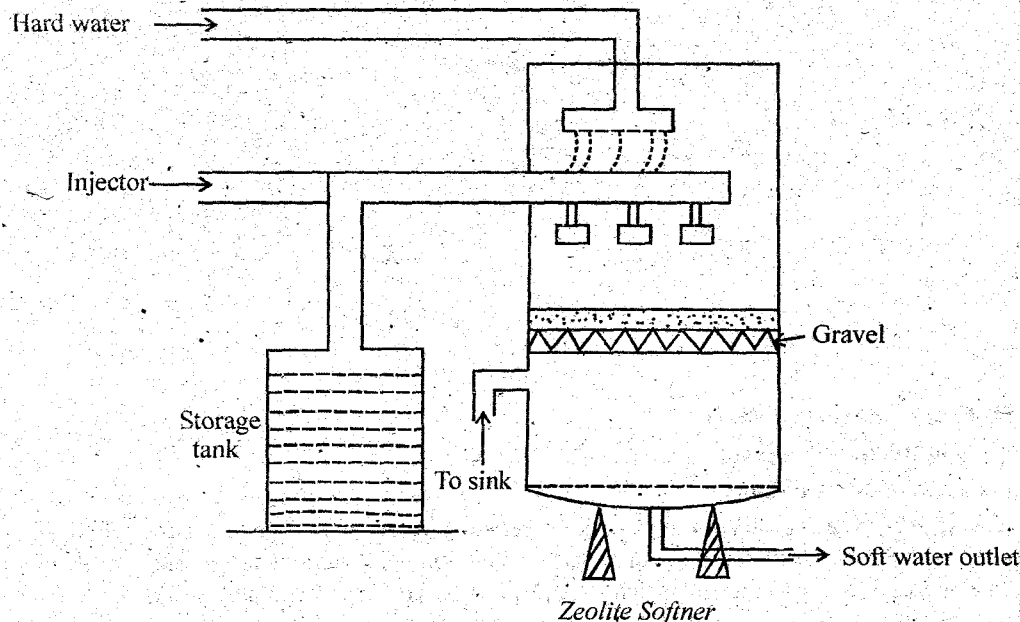
Synthetic Zeolites : These are porous and gel structured synthetic zeolites are prepared by heating together solutions of :

- (a) Sodium silicate, aluminium sulphate & sodium aluminate.
- (b) China clay, feldspar and soda ash.

Process hard water is percolated at a definite rate through the bed of zeolites housed in a cylindrical unit.

The hardness causing Ca^{2+} & Mg^{2+} ions are retained by zeolites as CaZ & MgZ respectively until water contains sodium salts after sometime bed get exhausted.

At this stage the supply of hard water is stopped and regeneration is carried out.



Thus, softening by zeolites involved alternate cycles of softening run and regeneration. The regeneration step comprises.

1. Back washing
2. Brining
3. Rinsing before reuse.

The soft water thus obtained has hardness less than 30 ppm.

Q. 5. (b) Write short note on :

(i) Mixed Bed demineralization

(ii) Reverse osmosis.

Ans. (i) Mixed Bed Demineralization : It consists of an intimate mixture of strongly acidic cation exchanger and strongly basic anion exchanger with a cylindrical net. When hard water is passed through this bed it encounters a number of times cation and anion exchangers alternatively. Consequently the net effect is equivalent to passing hardwater through a series of several cation and anion exchangers. The out going water has the residual hardness 0–1 ppm, therefore this method is very effective.

(ii) Reverse Osmosis : The flow of solvent but not the solute from a region of low concentration to high concentration when the two solutions of different concentrations are separated by a semipermeable membrane is known as osmosis.

The hydrostatic pressure (P) which must be applied to the solution of higher concentration in order to just prevent the phenomenon of osmosis.

If a hydrostatic pressure in excess of osmotic pressure is applied to the higher concentration. Side the flow of solvent gets reversed and this process is known as reverse osmosis.

Section-III

Q. 6. (a) Define the term corrosion and discuss the factor that effect corrosion.

Ans. Corrosion : Any process of deterioration and consequent loss of a solid metallic material through an unwanted chemical or electrochemical attack by its environment starting at its surface is called corrosion.

Factors that Effect Corrosion :

(a) Nature of the Metal :

- (i) Position on galvanic series
- (ii) Over voltage
- (iii) Relative areas of the anodic and cathodic parts
- (iv) Purity of metal
- (v) Physical state of metal
- (vi) Nature of surface film
- (vii) Passive character metal.

(b) Nature of the Corroding Environment :

- (i) Temperature
- (ii) Humidity of air
- (iii) Presence of impurities

- (iv) Influence of pH
- (v) Presence of suspended particle.

Q. 6. (b) Discuss the following :

- (i) Soil corrosion,
- (ii) Sacrificial anodic protection.

Ans. (i) Soil Corrosion : The corrosiveness of a soil depends upon :

- (i) Its acidity
- (ii) Degree of acceleration
- (iii) Electrical conductivity
- (iv) Its moisture and salts
- (v) Soil texture.

According to particle size, soils are classified as :

- (a) Gravelly or sandy soils
- (b) Water-logged soils
- (c) Intermediate character soils.

(ii) Sacrificial Anodic Protection : In this method, the metallic structure is connected by a wire to a more anodic metal so that all the corrosion is concentrated at this more active metal. The more active metal itself gets corroded slowly. While the parent's structure is protected. The more active metal so-employed is called sacrificial anode.

Q. 7. (a) What are greases? Mention their uses.

Ans. Lubricating grease is a semi-solid, consisting of a soap dispersed throughout a liquid lubricating oil. The liquid lubricant may be petroleum oil or even a synthetic oil.

Greases are prepared by saponification of fat followed by adding hot lubricating oil while under agitation.

Greases are used :

- (i) In situation where oil cannot be remained.
- (ii) Bearing and gear works on high temperature.
- (iii) Bearing needs to be sealed against dust.

Q. 7. (b) Define and explain the term emulsion. Why graphite and MOS_2 are preferred as solid lubricant?

Ans. Emulsion : An emulsion is two-phase system, consisting of a fairly coarse dispersion of two immiscible liquids, the one being dispersed as fine droplets in the other.

(a) Graphite : It is the most widely used of all solid lubricants. It is very soapy to touch non-inflammable and not oxidized in air below 375°C . In the absence of air can use upto very much higher temperature.

(b) Molybdenum Disulphide : It Possesses very low coefficient of friction and is stable in air upto 400°C . Its fine powder may be sprinkled on surfaces sliding at high velocity. It is used along solvents and greases.

Q. 7. (c) Define the term lubrication and lubricants? What are different type of lubricants? Discuss the basic principle of lubricants.

Ans. Lubrication and Lubricants : Any substance introduced between two moving/sliding surfaces with a view to reduce the frictional resistance between them is known as a lubricant.

The main purpose of a lubricant is to keep the sliding/moving surfaces apart. So that frictional resistance and consequent destruction of material is minimised by introduction of lubricants in between them called lubrication.

1. Lubricating oils
2. Semi-solid lubricant
3. Solid lubricants
4. Synthetic lubricants.

Principles of Lubricants : Friction caused to lot of wear and tear. Large amount of heat dissipated loss of efficiency of machine. Moreover of moving parts get hot up, damaged even sometimes results in seizure.

Section-IV

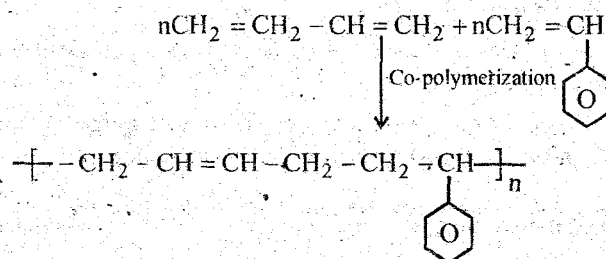
Q. 8. (a) What are elastomer? Give preparation, properties and application of:

(i) GR-S

(ii) GR-N Rubber.

Ans. The group of polymers exhibiting high degree of elasticity, stretching at least twice of their original length under the action of tensile force and recover their dimensions after the removal of the applied force just like rubber, are known as elastomer.

(i) GR-S is the styrene-butadiene rubber preparation.



Properties :

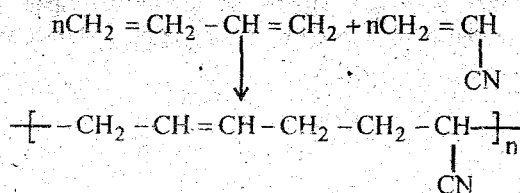
1. High load bearing capacity.
2. High abrasion resistance.
3. Low oxygen and ozone resistance.
4. Swell in oils and solvents.

Applications :

1. Shoe soles & foot wear components.
2. Floor tiles.
3. Wire & cable insulations.
4. Motor type.

(ii) GR-N : This is also known as Buna-N-Rubber.

Preparation : It is prepared by the copolymerization of butadiene and acrylonitrile.



Properties :

1. It is resistant to heat.
2. It has good abrasion resistance.
3. It is less resistance than natural rubber.

Applications :

1. Automobile parts.
2. Conveyer belts.
3. High altitude aircraft.
4. Printing rollers.

Q. 8. (b) Write detailed note on biodegradation of polymer.

Ans. A process in which the degradation of polymer results from the action of naturally occurring microorganism such as bacteria, fungi and algae.

It is reversible process characterized by a loss of properties, this is because of the change in the structure of polymer by the action of microorganism.

Polymers having molecular weight less than 9000 are generally degradate by bacteria. Such polymers convert into dust by micro organism. A good biodegradable polymer should-not produce harmful or toxic products.

Parameters	Natural Biodegradable polymers	Synthetic biodegradable polymers
(i) Source	Derivatives of plants	Petrochemicals or agriculture based products
(ii) Example	(a) Polysaccharides polysaccharides e.g., Starch, cellulose	(a) Polyvinyl Alcohols
	(b) Polyester e.g., polyhydroxy alkanoates	(b) Polyvinyl esters
	(c) Proteins, e.g., wool silk, gelatin	(c) Polyamide esters

These polymers are in general expensive, emit green house gases/toxic gases and may have adverse effect on environment, therefore future biodegradable polymer must overcome all such physical problems.

Q. 9. (a) Discuss the principle and working of a flame photometer.

Ans. Principle of Flame Photometer : Flame photometer is an absorption meter which employs a much narrower band and wavelength as produced by a mono-chromator such an instrument can be made to operate in the ultraviolet, visible and infrared regions, using suitable source of radiant energy.

All forms of absorption instruments have the following features are common :

- (i) Source of electromagnetic radiation.
- (ii) Intensity control by variant slit.
- (iii) Wavelength control by using color filter.
- (iv) Sample holder such as test tube cuvette, cell, etc.
- (v) Sample form such as gas.
- (vi) Receptor.
- (vii) Signal indicator.

Q. 9. (b) Explain the principle of U.V. Spectroscopy.

Ans. Principle of U.V. Spectroscopy : U.V. spectroscopy is also known as electronic spectroscopy because it involves the transition of electron(s) within a molecule or ion from a lower to higher electronic energy level.

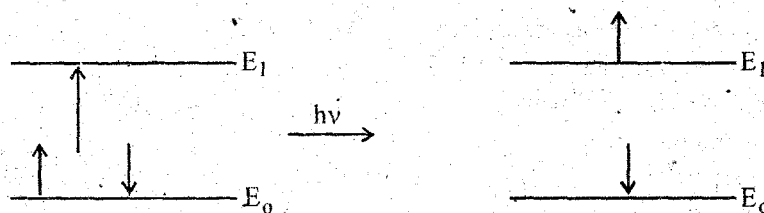
The energy required for this transition depends upon the energy difference between two energy levels. Let after absorbing U.V. radiation of frequency ν electron excited from ground state to excited state.

$$E_1 - E_0 = h\nu$$

Exc. state Gr. state

$$E_1 - E_0 = \frac{hc}{\lambda}$$

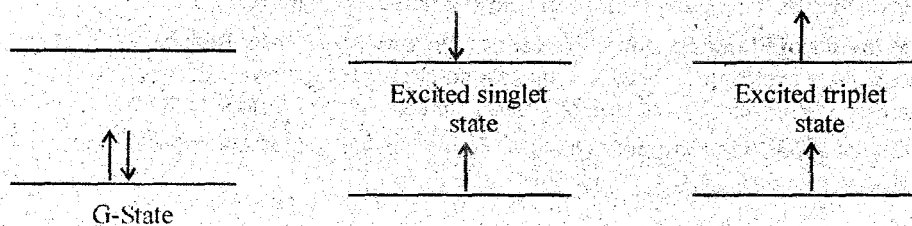
Electron from lower energy level $E_0 \xrightarrow[\text{Transition}]{h\nu}$ Electron in higher energy level E_1



Absorption Spectra

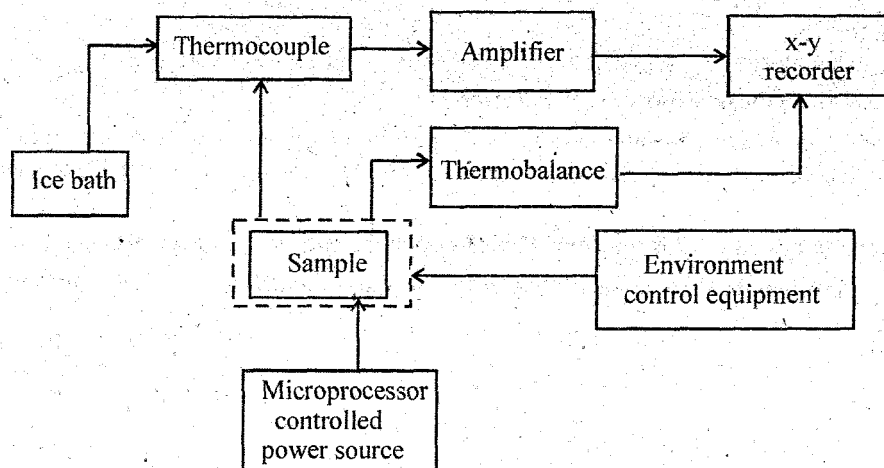
In ground state electrons are essentially paired.

If the transition of electron from ground state to excited state is such a way that the spin of electron are paired it is known as excited singlet state or on other hand if the electron have parallel spin it is known as excited triplet state.



Q. 9. (c) Write short note on TGA.

Ans. TGA :



Involving in recording continuously the mass of the sample as its temperature is increased linearly from ambient to a high 1200°C.

The following are the physical and chemical changes :

- (i) Vaporization of moisture
- (ii) Dehydration of the substance
- (iii) Decomposition
- (iv) Dissociation
- (v) Combination
- (vi) Oxidation of the substance
- (vii) Reduction of the substance.