APPLIED CHEMISTRY- II (MAY-2018 SOLUTION)

Q.1. Attempt any 5 of the following: [3 M x 5 Q= 15 M]

Q.1. (a) Define Power Alcohol. Give any two advantages of power alcohol.

Ans:

Power Alcohol:

When ethyl alcohol is used as fuel in internal combustion engine, it is called as power alcohol.

Generally, ethyl alcohol is used as its 5-25% mixture with petrol.

Advantages:-

1) Addition of ethyl alcohol to petrol increases its octane number.
2) Power alcohol is cheaper than petrol.

Q.1. (b) Explain why cathodic coating is preferred over anodic coating for manufacturing of containers to store food stuffs.

Ans:

1) Cathodic Coating is used for storing any foodstuff as it is nontoxic.
2) It protects the metal from corrosion and avoids any food poisoning.
3) E.g.:- Tinning.

Q.1. (c) A sample of coal has the following composition:-

C= 70% O=23% H=5% S=1.5% N=0.4% Ash=0.1%

Calculate GCV of this fuel.

Ans:

Given: - C= 70% **O**=23% **H**=5% **S**=1.5% **N**=0.4% **Ash**=0.1%

Required: - GCV=?

Formula: GCV$= \frac{1}{100}[8080C + 34500\left(H - \frac{O}{8}\right) + 2240S]$

Calculations:

GCV$=\frac{1}{100}[8080 \times 70 + 34500\left(5 - \frac{23}{8}\right) + 2240 \times 1.5]$

GCV= 6422.725 kcal/kg

Q.1. (d) Give the composition, properties and uses of high phosphorous bronze.

Ans:

High Phosphorous bronze

Composition:

Sn = 10-13% **P** = 0.4-1% **Cu** = Rest%

Properties:

1) Good Strength and resistance to corrosion under sea water.
2) It can be rolled or drawn into wires.
3) Abrasion resistant
4) Hard
5) Brittle
6) Low coefficient of friction.

Uses:

1) For springs, turbine blades, pumps, boiler fitting, bearing plates, spindle, for valves.

2) For gear wheels, side, valves, bearing, taps, bushes springs, turbine blades etc.

Q.1. (e) Why is it essential to design safer chemicals and products wrt green chemistry principle? Explain with an example.

Ans:

1) The synthetic method should be designed wherever possible to use and generate substances having little or no toxicity to human health and the environment.
2) The starting material selected should be least toxic.
3) The reactions in which intermediates or reagents or products are toxic should not be followed. Instead alternative pathways should be used for synthesis.
4) Bhopal Gas Tragedy led to lots of deaths.
5) Thus, green chemistry recommends the design of synthesis to use and generate substances with little or no toxicity to humans and the environment.

Q.1. (f) What is matrix phase and particle phase in concrete? Give any two properties of concrete.

Ans:

Concrete

Matrix Phase = Cement

Particulate Phase= Sand and Gravels

Properties:

1) It is harder than ordinary cement.
2) Sets well on surface thereby holding structures.

Q.1. (g) Porous Film is also called as 'Non protective Film'. Explain with an example.

Ans:

In porous film, the volume of metal oxide formed is less than the volume of the metal from which it is formed. Hence this film possesses pores or cracks in the structure. Through these pores, atmospheric oxygen can enter and attack the metal. Hence it is non protective oxide film. Examples: Such type of oxide film is formed in alkali metals like Li, K, Na and alkaline metals like Ca, Sr, and Mg.

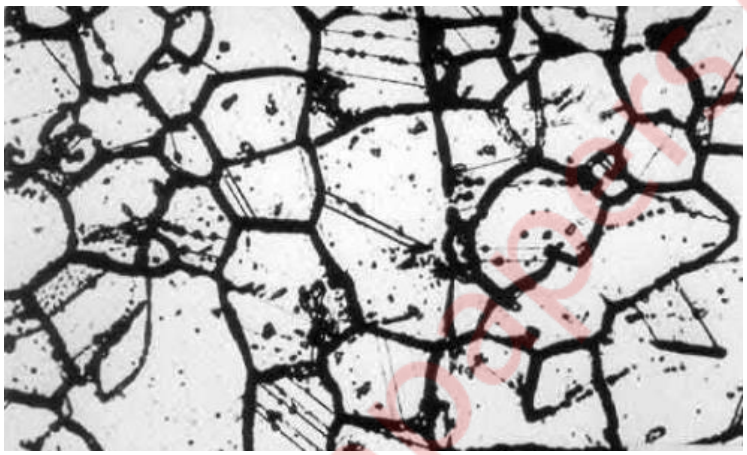
Q.2. (a) Define Electrochemical Corrosion. Explain Intergranular Corrosion with a neat diagram. [6 M]

Ans:

The corrosion which is brought about through ionic reactions in the presence of moisture or solution as a conducting medium when two dissimilar metals are in contact with each other is called electro chemical corrosion. It also occurs when the metal surface is in immediate contact with aqueous acidic/alkaline/neutral/electrolytic solutions forming the short circuited galvanic cells.

- Intergranular corrosion (IGC), also known as intergranular attack (IGA), is a form of corrosionwhere the boundaries of crystallites of the material are more susceptible to corrosion than their insides. (Cf. transgranular corrosion.)
- This situation can happen in otherwise corrosion-resistant alloys, when the grain boundaries are depleted, known as grain boundary depletion, of the corrosion-inhibiting elements such as chromium by some mechanism.
- In nickel alloys and austeniticstainless steels, where chromium is added for corrosion resistance, the mechanism involved is precipitation of chromium carbide at the grain boundaries, resulting in the formation of chromium-depleted zones adjacent to the grain boundaries (this process is called sensitization).

- Around 12% chromium is minimally required to ensure passivation, a mechanism by which an ultra thin invisible film, known as passive film, forms on the surface of stainless steels. This passive film protects the metal from corrosive environments.
- The self-healing property of the passive film make the steel stainless. Selective leaching often involves grain boundary depletion mechanisms.



Q.2. (b) i) 1.95 gm of coal sample was taken for nitrogen estimation by Kjeldahis's method. The ammonia liberated required 9.5 ml of 0.4 N H_2SO_4 for neutralization. Calculate the percentage of nitrogen in coal sample. [3 M]

Ans.

Given:

Weight Of Coal= 1.95 gm **Normality of H_2SO_4=** 0.4 N

Volume of H_2SO_4= 9.5 ml

Required: % N=?

Formula: %N=$\frac{vol\ of\ H2SO4 \times Normality \times 1.4}{wt\ of\ coal}$

Calculations:

%N=$\frac{9.5 \times 0.4 \times 1.4}{1.95}$

%N= 2.72%

Q.2.(b) (ii) Write a note on Green Solvents. [2 M]

Ans.

The green solvent is newer concept involves technology which has been popularly preferred over conventional solvent extraction process because of environmental concerns, such as the need to eliminate organic solvents and to find appropriate technologies for their disposal e.g. Ionic liquids CO2,Propylene Glycol etc. Super critical fluid possesses properties of gases and liquids in an intriguing manner, which could offer range of applications/possibilities in both synthetic and analytical chemistry. Supercritical ionic liquid carbon dioxide has found to be an energy conserving, selective and waste reducing alternatives to organic solvents and therefore is viewed as promising environmentally benign solvents. In addition supercritical fluids can lead to reaction, which are difficult or even impossible to achieve conventional solvents Supercritical ionic extraction is relatively new technology with a large potential for application in industry.

Q.2. (c) Explain structural Composition of plywood. [4 M]

Ans.

Adjacent wood sheets in plywood are aligned with the grain direction at right angles to each other. Laminar composites are constructed using the same materials such as cotton, paper or woven glass fibers.

It possesses high strength in a number of direction in the 2-D planes.

Q.3. (a) Define Fuel Cell. Explain Hydrogen Oxygen Fuel Cell with a neat diagram. [6 M]

Ans.

A cell capable of generating an electric current by converting the chemical energy of a fuel directly into electrical energy is known as fuel cell.

Q.3. (b) i) Define Shape Memory Alloys. Give its properties and uses. [3 M]

Ans.

The shape memory alloys are metal alloys undergo deformed at one temperature but on rising or falling temperature, they return to their original shape.

Properties:

1) Excellent corrosion resistance.
2) High fatigue strength.

Uses:

1) Microsurgery
2) Reinforce weak blood vessels.

Q.3. (b) ii) Define bio-diesel and give its advantages. [2 M]

Ans.

Biodiesel is a liquid biofuel obtained by chemical processes from vegetable oils or animal fats and an alcohol that can be used in diesel engines, alone or blended with diesel oil.
Chemically biodiesel is the methyl ester of long of long chain carboxylic acids. It is also called as 'Green Fuel'.

Advantages of Biodiesel:

1. Cheaper
2. High cetane numbers 45 to 54 & high CV of @ 40KJ/gm.
3. Regenerative & environmental friendly. It causes less pollution.
4. It has certain extent of lubricity.
5. Clean to use in diesel engine.

Q.3. (c) Calculate the % atom economy for the following reaction with respect to acetophenone. [4 M]

C6H6+CH3COCL = C6H5COCH3+HCL

Ans.

Given:

Molecular weight of Products= 12x6+1x5+12+16+12+1x3= 120

Molecular Weight of Reactants= 12x6+1x6+12+1x3+12+16+35.5= 156.5

Required: %Atom economy= ?

Formula: %Atom economy= $\frac{molecular\ weight\ of\ the\ product}{total\ molecular\ weight\ of\ the\ reactants} \times 100$

%Atom economy=$\frac{120}{156.5} \times 100$

%Atom economy= 76.677

Q.4. (a) What is cathodic protection? Explain impressed current cathodic protection with the applications. [6 M]

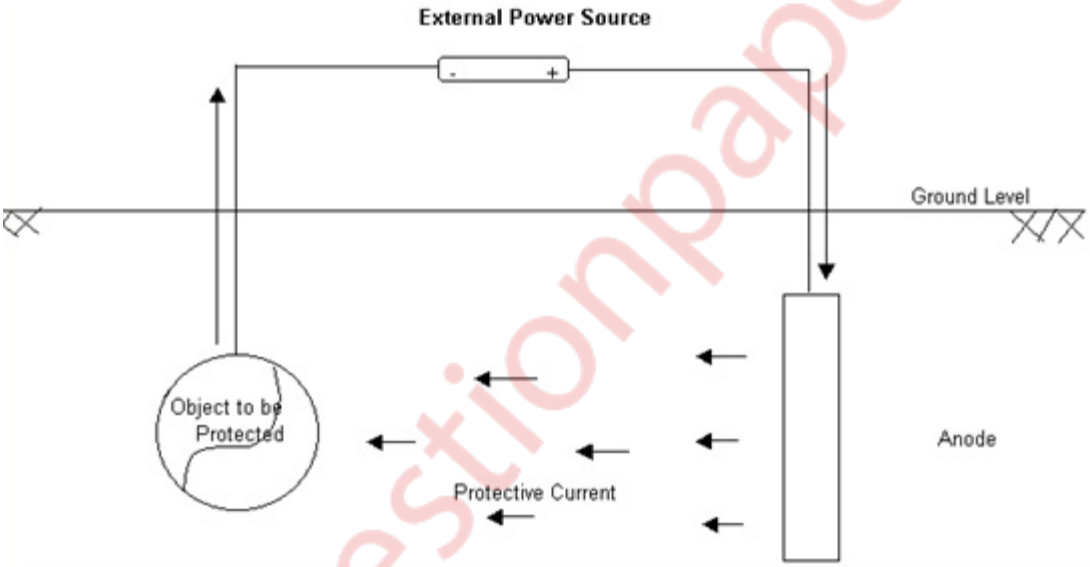
Ans.

Cathodic protection:

In this process base metal is forced to behave like a cathode either by connecting it with some more active metal or by using impressed current in order to protect it from corrosion. It can be explained by considering the corrosion of metal M in acid environment.

Impressed Current Cathodic Protection

In this method, a current is applied in the opposite direction to that of the corrosion current there by nullifying its effect on the base metal i.e. converting the base metal to cathode from anode. The impressed current is obtained by using a D.C. source such as a wet battery or a dry cell along with an insoluble anode such as platinum, stainless steel, graphite etc. which is embedded underground and to this, impressed current is applied. The whole assembly is connected to the metallic structure to be protected. The anode can be single fora small structure like water tank or there can be many series connected such anodes if the structure to be protected is big like long pipeline, oil-rig platforms on the sea etc. The insoluble anode is kept inside back-fill made up of mostly gypsum which increases the electrical contact with the soil.



Advantages:

This method can protect very large and long structures. Further its maintenance is easy.

Disadvantage:

The anode needs frequent replacement.

Applications:

Protection from soil corrosion of underground pipelines, cables, protection from seawater corrosion of cables ship bulls, piers.

Q.4. (b) (i) What is green chemistry? Give its significance. [3 M]

Ans.

Green Chemistry

Environment friendly chemical synthesis which reduces the use and generation of hazardous substance/pollutants is known as Green chemistry.

Significance of Green chemistry:

1) A novel approach that blends the application of chemistry with economic growth and environmental preservation.
2) To develop strategy for sustainable chemical process industries.
3) Achieve conservation of limited resources through cost effectiveness and pollution prevention.
4) Therefore basic axiom of Green chemistry is to design product and processes that reduce or eliminate the generation of all wastes.

Q.4. (b) (ii) Define Composite. Give any two applications of composite materials. [2 M]

Ans.

Composite materials can be defined as 'A multiphase product made using two or more existing materials which exhibits properties of its constituents as well as shows certain unique properties of its own'. Thus, composites are engineered materials, comprising of metals, ceramics, glasses and polymers.

Applications:

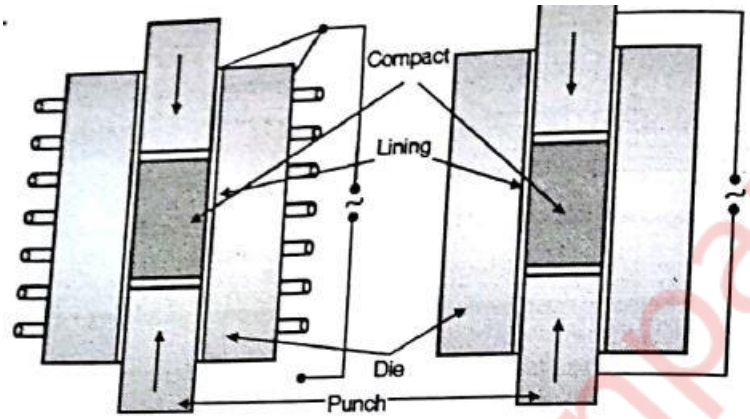
1) Construction
2) Transportation
3) Electrical and electronics and telecommunication
4) Agriculture

Q.4. (c) What is powder metallurgy? Explain hot compaction method with a neat labelled diagram. [4 M]

Powder metallurgy is a process which deals with product of useful components from fine metal powders, from individual, mixed or alloyed with or without inclusion of non-metallic constituents.

Hot Compaction Method:

The equipment used is similar to that used in cold compaction.



(A) By induction heating (B) by direct current heating

Fig. 2.9.5 : Tooling for axial hot

But the process is operated at higher temperature, and pressure. The ceramic powder with the binder are fed into die and pressed at high temperature and pressure into article, followed by sintering and finishing. The temperature can be raised by direct current of induction current.

Uses:

Process is used for making tools such as metal bonded diamond tools, or carbide compacts.

Q.5. (a) A gaseous fuel contains H_2=50% CH_4=30% N_2=2% CO=7% C_2H_4=3% C_2H_6=5% and water vapours=3%. Calculate weight and volume of air for 2m^3 of the gas. [6 M]

Ans.

Given:

H2=50% **CH4=**30% **N2=**2% **CO=**7% **C2H4=**3% **C2H6=**5% **water vapors=**3%

Required: Vol. and weight for complete combustion of 2 m3 of fuel.

	Constituents	Volume		Reaction	Vol. of oxygen required
		%	m3		
(i)	H_2	50	0.5	$H_2+\frac{1}{2}O_2=H_20$	0.5X0.5=0.25
(ii)	CH_4	30	0.3	$CH_4+2O_2=CO_2+H_2O$	0.3X2=0.6
(iii)	CO	7	0.07	$CO+\frac{1}{2}O_2=CO_2$	0.07X0.5=0.035
(iv)	C_2H_4	3	0.03	$C_2H_4+3O_2=2CO_2+2H_2O$	0.03X3=0.15
(v)	C_2H_6	5	0.05	$C_2H_6+3.5O_2=2CO_2+3H_2O$	0.05X3.5=0.175

Total Volume of O2 Required= 0.25+0.6+0.035+0.15+0.175= **1.21**

Vol. of air required=1.21x2 m^3=**2.420m3**

22.4 m^3 of air weighs 28.949 kg

2.420 m^3 of air will weigh =$\frac{2.420}{22.4} \times 28.949 = \mathbf{3.12}\boldsymbol{kg}$

Wt. of air required=3.12kg.

Q.5.(b) (i) List the three main constituents of paint and give functions of each. [3 M]

Ans.

Paints are formed by using various ingredients which are listed below. Each ingredients is mixed for a particular function.

1) Drying oils /medium/ vehicle.
2) Pigments
3) Thinners
4) Driers

Constituent - Drying oils or vehicle

Examples - Linseed oil, soya bean oil, dehydrated castor oil, neem oil, fish oil, etc.

Functions - They help pigments to be held on surface. They provide dried film by oxidation or polymerization. They provide durable water resistant film of paint.

Constituent - Pigments

Examples - White pigments: White lead, ZnO, Titanium oxide, Coloured pigments Red lead, Fe_2O_3, chrome red, etc.

Functions - Provide opacity, colour strength, and protection. Provide resistance against abrasion. Minimize shrinkage and cracking caused on drying.

Constituent - Thinners

Examples - Turpentine, spirits, benzene, naphtha, xylol, kerosene, methylated naphthalene etc.

Functions - Adjust viscosity of formulation. Help in drying of the paint. Suspend the pigments and dissolve film forming material.

Constituent - Driers

Examples - Oxygen carrying catalyst, Linoleates of Co, Mn, Zn, etc

Functions - Improve drying process. Act as catalyst in drying process.

Q.5. (b) (ii) Explain the effect of the following alloying elements on steel. [2 M]

Ans.

Chromium

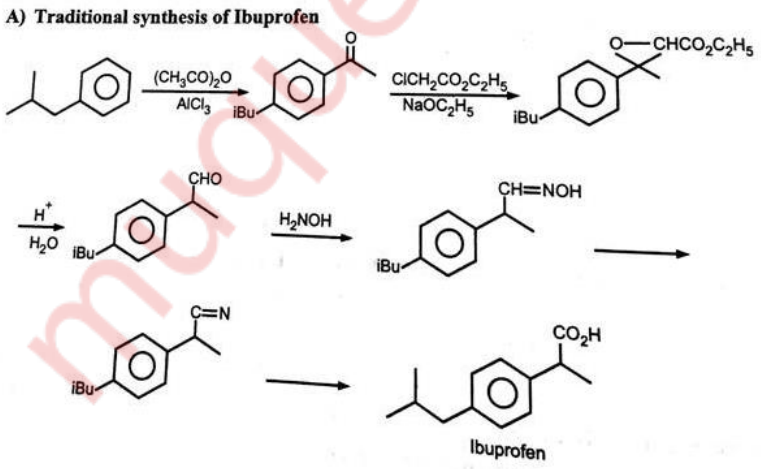
Improves tensile strength , hardness, wear resistance, and toughness. Imparts high corrosion resistance.

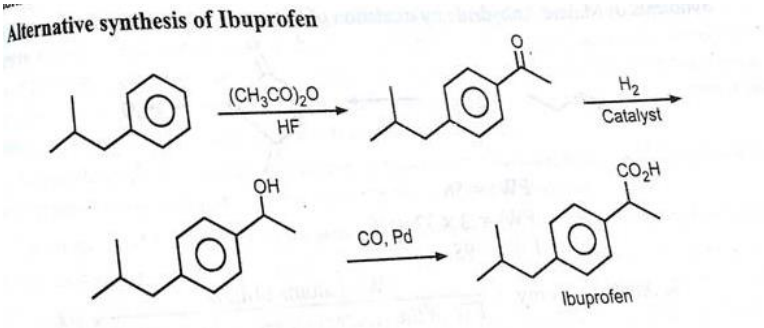
Tungsten

Improves red hardness, toughness, abrasion resistance and shock resistance.

Q.5. (c) Explain conventional and green chemistry route for production of Ibuprofen. Highlight the green chemistry principle involved. [4 M]

Ans.





Q.6. (a) Write short notes on:-

a) Computing b) Sintering [6 M]

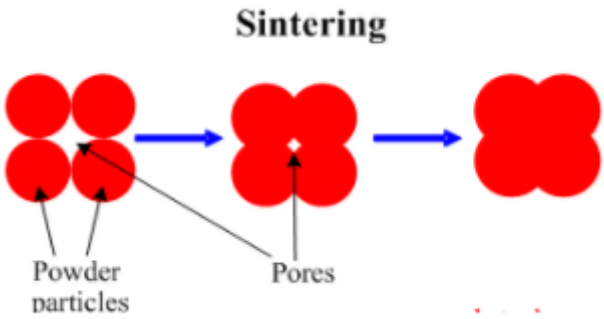
Ans.

(i) Compaction:

- A controlled amount of the mixed powder is introduced into a precision die and then it is pressed or compacted at a pressure in the range 100 MPa to 1000 MPa.
- The compacting pressure required depends on the characteristics and shape of the particles, the method of mixing, and on the lubricant used.
- This is generally done at room temperature. In doing so, the loose powder is consolidated and densified into a shaped model.
- The model is generally called “green compact.” As is comes out of the die, the compact has the size and shape of the finished product.
- The strength of the compact is just sufficient for in – process handling and transportation to the sintering furnace.

(ii) Sintering:

- During this step, the green compact is heated in a protective atmosphere furnace to a suitable temperature, which is below the melting point of the metal.
- Typical sintering atmospheres are endothermic gas, exothermic gas, dissociated ammonia, hydrogen, and nitrogen.
- Sintering temperature varies from metal to metal; typically these are within 70 to 90% of the melting point of the metal or alloy.



- Sintering is a solid state process which is responsible for producing physical and mechanical properties in the PM part by developing metallurgical bond among the powder particles.
- It also serves to remove the lubricant from the powder, prevents oxidation, and controls carbon content in the part.
- The structure and porosity obtained in a sintered compact depend on the temperature, time, and processing details.
- It is not possible to completely eliminate the porosity because voids cannot be completely closed by compaction and because gases evolved during sintering.
- Porosity is an important characteristic for making PM bearings and filters.

Q.6. (b) (i) What are fiber reinforced composite? [3 M]

Ans.

Fibre reinforced composite material:

- Fibre reinforced composite can be made from metals, ceramics, glasses or fibre that have been turned into graphite which is known as carbon fibre.
- These composites are very expensive as reinforcement of fibre into matrix is difficult.
- Fibre pull is possible and while increasing or decreasing length bond breaking is observed.
- In time trial racing bicycle frame carbon fibre is used along with matrix phase which is made up of thermosetting plastic.
- In racing car glass fibre is used along with thermosetting plastic.
- There are 2 types of fiber reinforced composites:

i) Continuous & aligned composite

ii) Discontinuous fibre reinforced composite

Q.6. (b) (ii) Explain how areas of cathode and anode affect the rate of corrosion. [2 M]

Ans.

Relative areas of the Anodic and Cathodic Parts:

When 2 dissimilar metals are in contact, the corrosion of the anodic part is directly proportional to the ratio of areas of the cathodic part and anodic part. Thus, mathematically,

$$Rate\ of\ Corrosion \propto \frac{Acathode}{Aanode}$$

This is because when the cathode area is larger than the anodic area, then the demand for electrons by the cathodic area will be more which can only be met by the anodic area by undergoing faster corrosion. Thus, smaller the area of the anode, faster is the rate of corrosion. Thus,

$$Corrosion \propto \frac{1}{Anode\ Area}$$

Q.6. (c) Explain the determination of % moisture and % volatile matter in a coal sample. [4 M]

Ans.

% Moisture:

- A known weight of powdered and air dried coal sample is taken in a crucible and it is placed in preheated oven for 1 hour at 110 C. Then the coal is cooled in a dessicator and weighed out.

- If the initial weight of the coal is m gms and final weight is m1 gms.
- Then the loss in weight corresponds to moisture in coal.
- Moisture %= $\frac{loss\ in\ weight}{weight\ of\ coal\ sample} \times 100 = \frac{m-m1}{m} \times 100$

% Volatile Matter:

- Moisture free coal left in the crucible in the first experiment is covered with a lid loosely. Then it is heated at 925 C in a furnace for 7 minutes.
- The crucible is taken out and cooled in a dessicator. Then it is weighed again. The loss in weight is due to loss of volatile matter in the m gms of the coal sample.
- % volatile matter = $\frac{weight\ of\ volatile\ matter}{weight\ of\ air\ dried\ coal} \times 100 = \frac{m1-m2}{m} \times 100$
- The volatile matter % can also be determined by taking the fresh weight of the air dried coal but the loss in weight at 925 C, will be due to loss of moisture and volatile matter both.
- If w is he weight of air dried coal and w2 is the mass of coal left at 925 C heating then,
- % Volatile Matter= $\frac{loss\ in\ weight\ due\ to\ moisture\ and\ V.M.}{Weight\ of\ coal\ sample} \times 100$