1.Definitions

i)HCV:-

It is defined as the amount of heat generated, when a unit mass or volume of the fuel is completely burnt and the products of the combustion are cooled down to room temperature i.e.(18°C)

ii)LCV:-

It is defined as the amount of heat generated, when a unit mass or volume of the fuel is completely burnt and the products of the combustion are allowed to escape.

Unit:- a) kj kg^{-1} (kj/kg)
b) Kcal/m^3

2.Characteristics of good fuel {any(6)}

(1) The **calorific value should be high** since it indicates the amount of heat generated by the combustion of fuel.

(2) The **moisture content should be low** as moisture lowers the calorific value.

(3) The **ash content should be low** as ash being the non-combustible matter lowers the calorific value.

(4) It **should have moderate velocity of combustion.** If it is too low, then higher temperature cannot be achieved. If it is too high, then the heat generated may get wasted before utilization.

(5) It should be **easily available and at an affordable cost.**

(6) It should have **a moderate ignition temperature**, i.e., the lowest temperature at which fuel starts burning. If it is **too low, then it is dangerous to store** and transport fuel safely. If it **is too high, then it may cause difficulty in initial ignition of fuel**.

3. Describe the determination of percentage of moisture in a coal sample with its significance.

Ans:-

(1)

i)% Moisture determination: A known weight of powdered and air dried coal sample (m) is taken in a previously weighed crucible. The crucible is then kept in an electric oven at 105-110°C for 1 hour. After 1 hour, the crucible is taken out and cooled in a desiccator. The crucible is reweighed till constant weight is obtained. The weight of the coal sample is calculated (m1). Weight of moisture in the coal sample can be calculated as loss in weight of coal due to moisture (m – m1).

% Moisture =

$$\frac{Weight\ of\ moisture}{weight\ of\ coal\ (air\ dried)} X100$$

ii**)Significance:** Moisture lowers the calorific value of coal since a considerable amount of heat is required to drive off the moisture during combustion of fuel. Also, moisture increases the weight of the coal and hence the transportation cost rises. Hence, a good coal should contain less amount of moisture.

4.Dry Corrosion. Name the different types of oxide layer formed and state which oxide layers are non- protective in nature

1)Dry corrosion:- Dry corrosion occurs mainly by direct contact of atmospheric gasses such as O_2, SO_2, CO_2, halogens etc.

2)The oxide films formed are classified in 3 categories:

a)Stable oxide film:-

1.Porous metal oxide (Ca, Mg etc)

2.Non-porous metal oxide (Al, Cr, Cu, Pb etc)

b)Unstable oxide film:-

Silver (Ag), Gold (Au), Platinum (Pt)

c)Volatile oxide film:-

Molybdenum (Mo)

5.Corrosion:-

1)Corrosion is a chemical or electrochemical process that results in the deterioration of a material due to its reaction with the surrounding environment.

2)

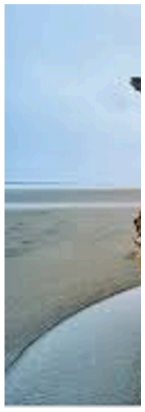
a.Wet Corrosion:-

Wet / Electrochemical Corrosion

- Electrochemical corrosion involves flow of electrons between anode and cathode.
- The anodic reaction involves dissolution of metal liberating free electrons.

$$M \longrightarrow M^{n+} + ne^-$$

- The cathodic reaction consumes electrons with either the evolution of hydrogen or the absorption of oxygen which depends on the nature of the corrosive environment.



b.Acidic medium:-

A. In Acidic Medium

- In an acidic medium corrosion occurs by the **evolution of hydrogen.**

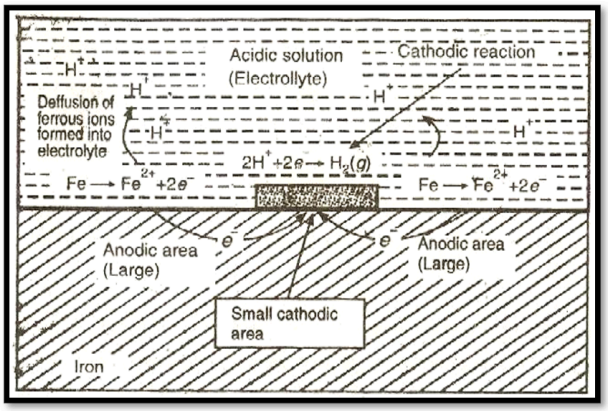
$Fe \longrightarrow Fe^{2+} + 2e^-$ (Oxidation at anode)

$2H^+ + 2e^- \longrightarrow H_2$ (Reduction at cathode)

The overall reaction is

$Fe + 2H^+ \longrightarrow Fe^{2+} + H_2$

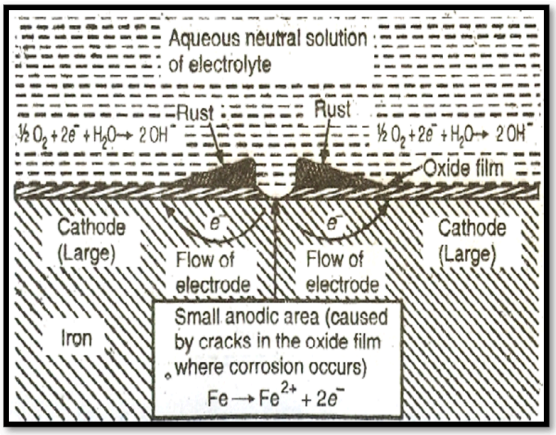
- This type of corrosion causes the displacement of hydrogen ions from the solution by metal ions.
- The anodes are large areas, whereas cathodes are small areas.



Mechanism of wet corrosion by hydrogen evolution

C.neutral medium:-

B. In Neutral Medium



Mechanism of wet corrosion by absorption of oxygen

In neutral medium corrosion occurs by the **absorption of oxygen.**

At anode:

$Fe \longrightarrow Fe^{2+} + 2e^-$ (Oxidation)

At cathode:

The released electrons flow from anode to cathode through iron metal.

$\frac{1}{2}O_2 + H_2O + 2e^- \longrightarrow 2OH^-$ (Reduction)

$Fe^{2+} + 2OH^- \longrightarrow Fe(OH)_2$

If oxygen is in excess, ferrous hydroxide is easily oxidized to ferric hydroxide.

$4Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 4Fe(OH)_3$

The product called yellow rust corresponds to

$Fe_2O_3 . xH_2O$.

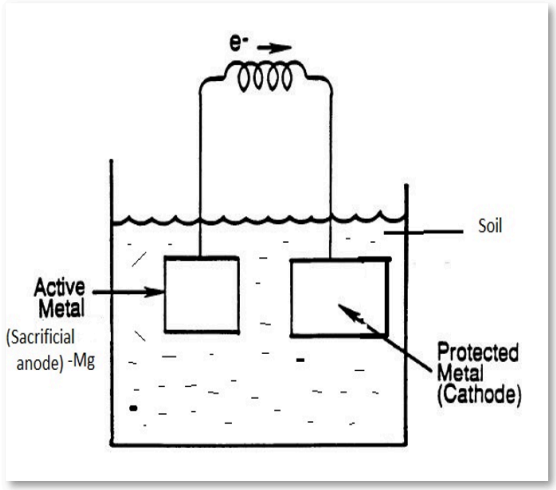
***you have to write any one of Acidic / Neutral as asked in exam**

6.Differentiation:-

Galvanization	Tinning
The process of applying a a protective layer of Metal that is at higher rank in the electrochemical series on the surface of an Iron article or metal that should be protected is known as **Galvanization.**	**The process of applying a thin sheet or layer of Tin** on the surface of the Iron article or metal that should be protected is known as **tinning.**
Galvanization is done for Iron articles that are in continuous contact with water.	This process is applied for making cans and boxes used for the packaging of food, vegetables, and meat.

*you can expand this as your perspective..it is not mandatory that answer should be same like this

7.Cathodic protection:-



- The metal structure can be protected from corrosion by connecting it with wire to a more anodic metal.
- As this more active metal is sacrificed in the process of saving metal from corrosion, it is known as a sacrificial anode.
- The metals, commonly used as sacrificial anodes are Mg, Zn, Al, and their alloys.

8.Alloys:-

An Alloy is an intimate mixture of two or more elements out of which one must be a metal. Alloys are formed from metals and non-metals.

9.Purpose of making alloy:-

1. Improving Strength and Durability

Example: Steel (iron + carbon)

Applications: Construction, bridges, machinery

2. Enhancing Corrosion Resistance

Example: Stainless Steel (iron + chromium + nickel)

Applications: Kitchen utensils, medical instruments, outdoor structures

3. Increasing Hardness

Example: Bronze (copper + tin)

Applications: Tools, weapons, sculptures

4. Improving Workability

Example: Aluminium Alloys (aluminium + copper/magnesium)

Applications: Aerospace parts, lightweight structures

5. Enhancing Electrical and Thermal Conductivity

Example: Brass (copper + zinc)

Applications: Electrical contacts, plumbing fittings

6. Achieving Specific Aesthetic Qualities

Example: Gold Alloys (gold + silver/copper)

Applications: Jewellery, decorative items

7. Reducing Material Costs

Example: Aluminium Alloys (alternative to titanium/steel)

Applications: Consumer goods, automotive parts

8. Optimizing Specific Functional Properties

Example: Nitinol (nickel + titanium)

Applications: Medical devices, precision instruments