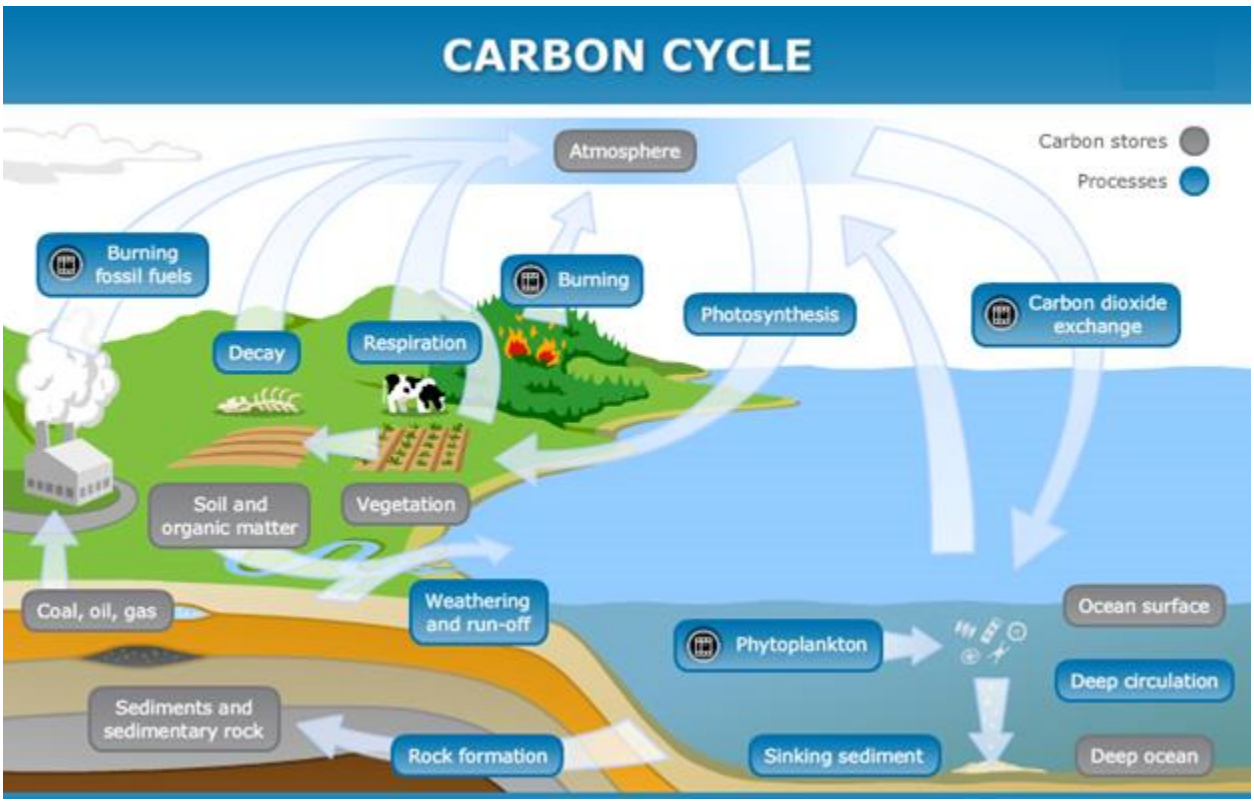
CARBON AND CARBONATES

Introduction:-

Carbon is found in the Earth's crust as the free element. There are two forms in which carbon exists, viz. DIAMOND and GRAPHITE. Diamond is a hard and clear solid. Graphite is a dark and greasy solid. Diamond and Graphite are the allotropes of carbon. There are thousands of carbon compounds in nature; in living things, in the soil, in the oceans, and in the atmosphere. Human body consists of 75% of water by mass, and around 20% of carbon.

The carbon cycle:-

Carbon moves between compounds in the atmosphere, living things, the soild and the ocean, in a non-stop journey called the carbon cycle.



- Carbon moves between the atmosphere, ocean and living things in the form of carbon dioxide.
- Carbon dioxide is
  - Removed from the atmosphere by photosynthesis and dissolving in the ocean
  - Added to it by respiration and the combustion of fuels that contain carbon.

Removing carbon dioxide from the atmosphere:-

(a) By photosynthesis:- in this process, carbon dioxide and water react in plant leaves to give glucose and oxygen. Chlorophyll, a green pigment in leaves is a catalyst for the reaction. Sunlight provides the energy.

$$6CO_2 + 6H_2O \text{ ---------> } C_6H_{12}O_6 + 6O_2$$

The plant uses the glucose to make the other carbon compounds it needs. Then animals eat the plants, so the carbon compounds get passed along the food chain.

(b) By dissolving:- Some carbon dioxide from the air dissolves in the ocean. It provides carbonate ions, which shellfish uses along with calcium ions from the water to build their shells. Fish also use them in building their skeletons. But only a certain percentage of carbon dioxide will dissolve. A balance is reached between its concentation in the air and the ocean.

Adding carbon dioxide to the atmosphere:-

(a) By respiration:- This is the process that takes place in our cells to provide energy.

$$C_6H_{12}O_6 + 6O_2 \text{ ---------> } 6CO_2 + 6H_2O + \text{Energy}$$

We get glucose from food. The energy keeps us warm and allows us to move and enables other reactions to go on in our bodies.

(b) By the combustion of fuels:- Natural gas or methane burns as,

$$CH_4 + 2O_2 \text{ ----------> } CO_2 + 2H_2O$$

The carbon cycle and fossil fuels:-

In the ocean, the remains of dead organisms fall to the ocean floor, and are burried. Over millions of years, their soft parts turn into petroleum and natural gas. Trees and other vegetation get burried in warm swamps. Over millions of years, they turn into coal. In this way, carbon dioxide from the air ends up in the fossil fuels and when we burn this it is released again.

Some carbon compounds:-

Carbon Dioxide:-

The gas carbon dioxide (CO2) occurs naturally in air. It is also a product in these three reactions.

1. The combustion of carbon compounds in plenty of air. When natural gas burns in plenty of air, the reaction is,

   $$CH_4 + 2O_2 \text{ ----------> } CO_2 + 2H_2O$$

2. The reaction between the glucose and oxygen in our body cells.

   $$C_6H_{12}O_6 + 6O_2 \text{ ---------> } 6CO_2 + 6H_2O + \text{Energy}$$

3. The reaction between the dilute acids and carbonates. For example, between hydrochloric acid and calcium carbonate.

   $CaCO_3 + 2HCl$ ---------- > $CaCl_2 + CO_2 + H_2O$

Carbonates:-

Carbonates are compounds that contain carbonate ion. For example, calcium carbonate which occurs naturally as limestone, chalk and marble. These are the main properties of carbonates.

On heating calcium carbonate breakdown in to an oxide and carbon dioxide.

$CaCO_3$ <----------> $CaO + CO_2$

Methane:-

Methane is the compound CH_4

It is found in gas deposits in the ocean floor and on land as natural gas.

It also forms whenever bacteria breakdown plant material in the absence of oxygen. Some animals give out methane as waste gas. They include cattle, sheep goat, camel, buffalo etc.

CARBONATES

All carbonates are insoluble in water except sodium, potassium and ammonium carbonate.

All carbonates react with dilute acids, they all fizz and dissolve giving off carbon dioxide and leaving a solution of salt.

$CaCO_3 + 2HCl$ ---------- > $CaCl_2 + CO_2 + H_2O$

They decompose on heating to form metal oxide and carbon dioxide.

Sodium, potassium carbonate, however are too stable to decompose. That is, they have high thermal stability.

Name	Formula	Chemical Name	Colour
Limestone	$CaCO_3$	Calcium Carbonate	White
Lime (Quicklime)	CaO	Calcium Oxide	White
Slaked lime	$Ca(OH)_2$	Calcium Hydroxide	White

A solution of calcium hydroxide is called lime water. When CO2 gas is bubbled through lime water, the insoluble calcium carbonate appears as a white suspension. The lime water goes milky.

$CO_2 + Ca(OH)_2$ ----------> $CaCO_3 + H_2O$

Uses of Calcium Carbonate (Limestone):-

(a) Manufacture of cement:- Cement is made by heating together limestone and clay
(b) Manufacture of iron:- To remove sand impurities.
(c) Neutralize acidity in the soil
(d) Manufacture of Lime (Calcium Oxide):- Limestone is heated to high temperature. It decomposes to calcium oxide and carbon dioxide.

$CaCO_3$ <----------> $CaO + CO_2$

Calcium Oxide has important uses. It can be readily converted to calcium hydroxide Ca(OH)2 by adding water.

$CaO + H_2O$ ---------- > $Ca(OH)_2$

As both lime and slaked lime form in water alkaline solution, they are used to neutralize acidity in the soil and neutralize acidic gases & industrial acidic wastes.

Flue gas desulfurization:

Flue gas desulfurization means the removal of sulfur dioxide from the waste gases at power stations, before they go out the flue (chimney). It is usually carried out using a runny mixture of powdered limestone, or slaked lime, and water. The mixture is sprayed through the waste gases, or the gases are bubbled through it.

When slaked lime is used, the reaction that removes the sulfur dioxide is:

$$\underset{\text{calcium hydroxide}}{Ca(OH)_2\,(s)} + \underset{\text{sulfur dioxide}}{SO_2\,(g)} \longrightarrow \underset{\text{calcium sulfite}}{CaSO_3\,(s)} + \underset{\text{water}}{H_2O\,(l)}$$

Then the calcium sulfite can be turned into hydrated calcium sulfate:

$$\underset{\text{calcium sulfite}}{2CaSO_3\,(s)} + \underset{\text{oxygen}}{O_2\,(g)} + \underset{\text{water}}{4H_2O\,(l)} \longrightarrow \underset{\text{hydrated calcium sulfate}}{2\,CaSO_4.2H_2O\,(s)}$$

Hydrated calcium sulfate is known as gypsum. It is used in making cement, plaster board, plaster for broken limbs, and other products.

Making use of Limestone: