4. Non-metals

Let us assess

1. Question

Some chemical substances are given below. From these, find out the substances required for the preparation of nitrogen and hydrogen, in the laboratory.

Sulphuric acid, hydrochloric acid, sodium nitrite, zinc, potassium permanganate, ammonium chloride, water.

Answer

Preparing nitrogen (N_2) in laboratory:

Heating a mixture of sodium nitrite and ammonium chloride gives ammonium nitrite (NH_4NO_2) which is highly unstable.

$NaNO_2 + NH_4Cl \rightarrow NH_4NO_2 + NaCl$

Ammonium chlorate readily decomposes to give nitrogen gas.

$NH_4NO_2 \rightarrow N_2 + 2H_2O$

Preparing hydrogen (H_2) in the laboratory:

a) Zinc (Zn) when treated with sulphuric acid (H_2SO_4) liberates hydrogen gas.

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

b) Zinc when treated with hydrochloric acid (HCl) also liberates hydrogen gas.

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

c) Water upon electrolysis gives hydrogen and oxygen. Electrolysis is the process of decomposition produced when an electric current is passed through a solution.

$$2H_2O \xrightarrow{\text{Electrolysis}} 2H_2 + O_2$$

2 A. Question

Find the gases for which the following statements are related.

Combustible gas obtained by the electrolysis of water

Answer

Hydrogen (H_2)

Water upon electrolysis gives hydrogen and oxygen.

$$2H_2O \xrightarrow{\text{Electrolysis}} 2H_2 + O_2$$

Hydrogen is a combustible gas. That is it can catch fire or burn easily. Oxygen itself is not a combustible gas, but it supports combustion (it helps in burning of fuels).

2 B. Question

Find the gases for which the following statements are related.

Gas used for the purification of water

Answer

Chlorine (Cl_2)

Chlorine acts as a disinfectant, and hence is added in a limited amount to water to kill certain microbes. If it is overly used, then it can cause health problems.

2 C. Question

Find the gases for which the following statements are related.

Gas interacting with the rhizobium bacteria in the soil

Answer

Nitrogen (N_2)

The rhizobium bacteria are present in the root nodules of leguminous plants (like pea plants). They convert the atmospheric nitrogen into nitrogen compounds (like ammonia). In this form, plants are able to absorb these compounds that help in their growth. This process of converting atmosphere N_2 into nitrogen compounds is called nitrogen fixation.

2 D. Question

Find the gases for which the following statements are related.

Gas formed by the thermal decomposition of $KMnO_4$

Answer

Oxygen (O_2)

Potassium permanganate ($KMnO_4$) is a strong oxidising agent and on heating gives potassium manganate (K_2MnO_4), manganese dioxide (MnO_2) and oxygen.

$$2KMnO_4 \xrightarrow{\text{Heat}} K_2MnO_4 + MnO_2 + O_2$$

3. Question

Certain non-metals and their uses are given in the wrong order in the table below. Match them correctly.

Element	Use
Hydrogen	Disinfectant
Oxygen	Refrigerant
Chlorine	Fuel
Nitrogen	Biodegradation

Answer

Hydrogen – Fuel

Hydrogen is a combustible gas and burns in the presence of air to produce high amounts of energy. Unlike traditional fuel sources (fossil fuels), it does not produce products that pollute the environment. It burns in the presence of oxygen to produce water and releases energy. It is widely used in fuel cells.

$2H_2 + O_2 \rightarrow 2H_2O$ + energy

Oxygen – biodegradation

Biodegradation is the process of disintegrating or breaking down of materials like remains of plants and animals by microorganisms like bacteria, fungi etc. This can happen in the presence or absence of oxygen. The process is called aerobic biodegradation, if it occurs in the presence of oxygen.

Chlorine – disinfectant

Chlorine is a very powerful disinfectant which deactivates/destroys harmful microorganisms present in drinking water, or water bodies. It can be easily applied, and is very cheap as well. It also prevents spread of contagious diseases up to an extent.

Nitrogen – refrigerant

Liquid nitrogen is used as a refrigerant. It is used to store substances at a very low temperature. This is widely used as coolants for computers, and also in cold storage units to store blood, body cells, etc. Nowadays, it has found applications in cooking as well.

4 A. Question

What are the chemicals used for the preparation of chlorine in the laboratory?

Answer

The chemicals used for the preparation of chlorine are potassium permanganate ($KMnO_4$) and concentrated hydrochloric acid (HCl).

The reaction is as follows:

$2KMnO_4 + 16HCl \rightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$

4 B. Question

Why is chlorine passed through sulphuric acid during its preparation?

Answer

Concentrated sulphuric acid is a very effective drying agent. The chlorine obtained as the product from the above reaction contains traces of water vapour, and hydrogen chloride (HCl) vapours. HCl vapours are removed by passing the gas through water, and the traces of water vapour are removed by passing through conc. sulphuric acid.

4 C. Question

How will you prepare bleaching powder?

Answer

Bleaching powder is prepared by passing chlorine gas over dry slaked lime (calcium hydroxide – $Ca(OH)_2$). The reaction involved is:

$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

(bleaching powder)

4 D. Question

Name the gas that comes out of bleaching powder in the presence of water.

Answer

Chlorine gas is liberated when bleaching powder reacts with water.

$CaOCl_2 + H_2O \rightarrow Ca(OH)_2 + Cl_2$

Chlorine is responsible for the bleaching/disinfection action.

5. Question

“We should give up chemical fertilizers completely and promote the use of organic fertilizers”. Do you agree with this statement? Substantiate your answer.

Answer

Before coming to a conclusion, let us look at the advantages and disadvantages of organic and chemical fertilisers.

Organic Fertilisers:

Advantages	Disadvantages
Made from plant/animal waste; hence soil is not polluted when applied	Effectiveness of breakdown of these fertilisers varies with seasons/environmental conditions.
Upon breakdown, it increases the soil structure and the water holding quality	Effect on the plants is slow when compared to chemical fertilisers (generally speaking)
Biodegradable, sustainable and eco-friendly	Amount of nutrients contained in a package is less than that of chemical fertilisers.
Possible to make organic fertilisers at home	

Chemical Fertilisers:

Advantages	Disadvantages
Nutrients are available to the plant directly; effect can be seen within days.	Made from fossil fuels. There is possibility of harming the soil
Amount of nutrients is known	Repeated or over-usage can destroy plants as well as the soil quality
Mostly inexpensive	Upset the ecosystem in the long run

So, it would be better if one uses organic fertilisers as there is little to no risk involved when applying it to the soil. It may not be commercially productive for farmers in a large scale. Hence, people tend to use chemical fertilisers as they provide results in a smaller time scale.

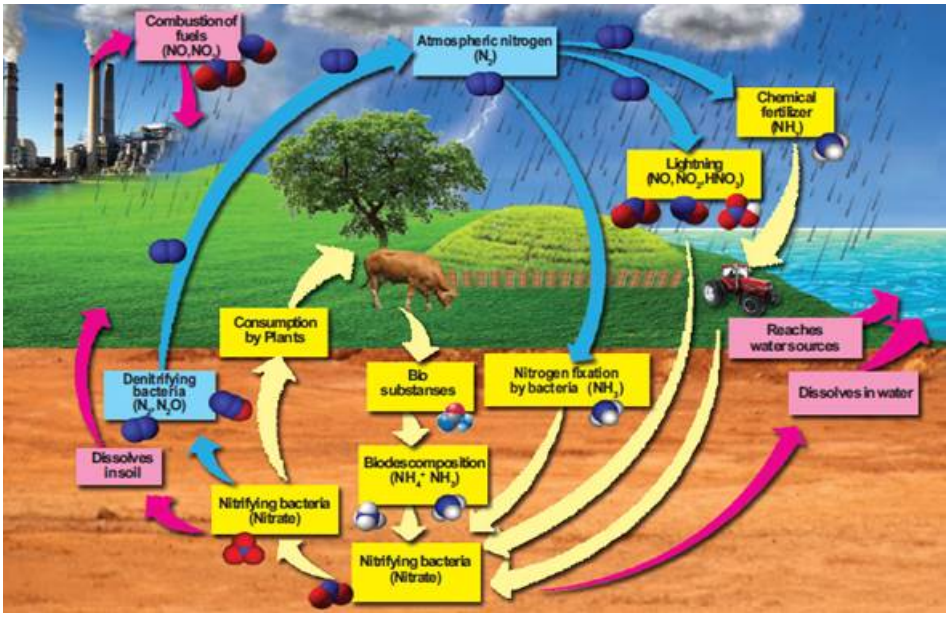
Extended activities

1. Question

Organize a discussion on how nitrogen cycle is helpful to plants and animals.

Answer

Nitrogen cycle can be defined as the circulation of nitrogen in various forms in different aspects of the nature.



Various processes are involved in this cycle. The important processes are mentioned here briefly.

•The atmospheric nitrogen is converted to nitrogen compounds (for e.g., nitrates) by nitrogen fixation caused by lightning, and rhizobium bacteria.

•The oxides of nitrogen as a result of combustion of fuels, combine with water to form acids, which seeps into the ground, later forming nitrates.

•These compounds (nitrates, nitrites etc) can be consumed by plants for their growth.

•These plants are later consumed by animals, and they excrete nitrogenous wastes, which are converted to useful nitrates by nitrifying bacteria.

•The dead animals/plants also decompose to produce nitrogen content in the soil.

•Again, these nitrates are in a usable form for plants for their intake.

•The cycle is completed when the nitrogen compounds are denitrified into nitrogen gas.

Here, animals get sufficient amount of nitrogen by eating plants, and plants get sufficient amount of nitrogen from the soil as a result of nitrification, or decomposition of dead organic matter. Hence both parties are benefitted by the nitrogen cycle.

2. Question

Organize a seminar based on the topic “Depletion of ozone layer and its remedial measures”.

Answer

Ozone layer is the layer formed by ozone (O_3) and is found in the Earth's stratosphere. This layer protects the earth from the ultraviolet (UV) radiation coming from the sun, by absorbing them.

The increased content of Chlorofluorocarbons (CFCs) arising from usage of aerosol sprays, and cleaning solvents caused a huge breakdown of ozone, resulting in ozone layer depletion.

This has resulted in UV radiation entering the atmosphere and caused a sudden increase in overall temperature, due to the trapping of the heat by greenhouse gases like carbon dioxide. This ultimately leads to "global warming". This leads to the melting of polar ice caps, and other environmental issues. Humans on exposure to UV radiation can cause skin cancers as well.

To resolve the ozone layer depletion problem internationally, policies were introduced to minimise or avoid the usage of CFC included aerosol sprays, and refrigerants. On an individual basis, one could,

•plant more trees so that the increased amount of greenhouse gases are absorbed by the trees.

•usage of aerosol sprays or refrigerants that do not contain CFCs.

•replacing incandescent light bulbs with fluorescent lamps, as they are void of halogen content.

•limit the usage of private vehicles whenever necessary, so as to minimise the emission of greenhouse gases.

3. Question

Take 5 mL hydrogen peroxide solution in a test tube. Add a pinch of manganese dioxide to it. Show a burning match stick that is about to get extinguished into the test tube. What do you observe? Give reasons for your observation.

Answer

One can see that the dying flame gets "rejuvenated" or begins to burn properly (or one can say, the flame looks "live").

Hydrogen peroxide (H_2O_2) by itself slowly decomposes into water and oxygen. When manganese dioxide (MnO_2) is added, the rate of decomposition is made faster, and O_2 is liberated at a faster rate. The oxygen supports the burning of match stick, and that is why one can see it burning effectively.

There is not any reaction involved, but the rate of decomposition of H_2O_2 is increased. Here, MnO_2 acts as a catalyst.

$$2H_2O_2 \xrightarrow{MnO_2} 2H_2O + O_2$$