

# CHEMISTRY

**Standard IX**

**Part-2**



**Government of Kerala**  
**Department of General Education**

State Council of Educational Research and Training (SCERT) Kerala

2019

## THE NATIONAL ANTHEM

Jana-gana-mana adhinayaka jaya he  
Bharatha-bhagya-vidhata,  
Punjab-Sindh-Gujarat-Maratha  
Dravida-Utkala-Banga  
Vindhya-Himachala-Yamuna-Ganga  
Uchchala-Jaladhi-taranga  
Tava subha name jage,  
Tava subha asisa mage,  
Gahe tava jaya gatha.  
Jana-gana-mangala-dayaka jaya he  
Bharatha-bhagya-vidhata,  
Jaya he, jaya he, jaya he,  
Jaya jaya jaya jaya he!

## PLEDGE

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect, and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

---

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*Dear Students,*

*Science is the knowledge that man has gained through the process of experimentation, observation and analysis. Much of our material gains owe to the development happening in the field of science. Study of science is a pre-requisite for all those who aim at better growth and success. Science text books are instruments for this. Study of science should be made a pleasant experience by giving emphasis to the basic methods of science like experimentation, observation, analysis and elucidating inferences. While familiarising ourselves with new concepts and areas of knowledge, we should also be keen on acquiring and developing certain values and attitudes. It is indeed needed to scale greater heights by ensuring the continuation and development of knowledge and capabilities gained in lower classes. These aims have been kept in mind while preparing the new chemistry text book.*

*Chemistry has played a significant role in giving new dimensions to human civilization and also in improving the living standards of individuals. It can be said without doubt that there is no branch of science other than chemistry that has influenced mankind to such a great extent. The contributions of chemistry to the field of agriculture, industry, medicine and daily life is incomparable. Hence it can be said that the study of chemistry is the study of the progress of man.*

*The educational portal 'Samagra' and the Q.R.code incorporated text book make the class room learning process effortless and stimulating. National Skills Qualification Framework (N.S.Q.F), Disaster management techniques relevant to contemporary issues and the ICT possibilities are considered in this textbook.*

*Study of science should be made a joyous experience by making the maximum use of, the learning activities, experiences and discussions provided in the Textbooks as well as the facilities available in the school premises and laboratories. Let this book help you in cultivating a scientific temper along with values while acquiring knowledge.*

*Wishing you the best...*

**Dr. J.Prasad**  
Director, SCERT

# CONSTITUTION OF INDIA

## Part IV A

### FUNDAMENTAL DUTIES OF CITIZENS

#### ARTICLE 51 A

*Fundamental Duties- It shall be the duty of every citizen of India:*

- (a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;
- (b) to cherish and follow the noble ideals which inspired our national struggle for freedom;
- (c) to uphold and protect the sovereignty, unity and integrity of India;
- (d) to defend the country and render national service when called upon to do so;
- (e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;
- (f) to value and preserve the rich heritage of our composite culture;
- (g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;
- (h) to develop the scientific temper, humanism and the spirit of inquiry and reform;
- (i) to safeguard public property and to abjure violence;
- (j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievements;
- (k) who is a parent or guardian to provide opportunities for education to his child or, as the case may be, ward between age of six and fourteen years.

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## THE SYMBOLS USED IN THE TEXTBOOK



Additional Information  
(Need not be assessed)



ICT Possibilities for Concept Clarity



Let Us Assess



Extended Activities





You have learned about acids and alkalies in the previous classes. What all methods can be used to identify them?

-----  
Find the characteristics of the substances given in the table below using litmus papers.

Substance	Change in the colour of litmus	Characteristics
Vinegar		
Lime water		
Soap solution		
Hydrochloric acid		

Table 5.1

You have identified acids and alkalies.

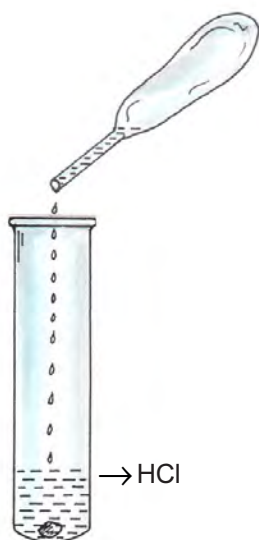


Fig 5.1

Now let's do another experiment. Take a small piece of zinc in a test tube as shown in the figure. Add 2ml of dilute hydrochloric acid using a dropper. Show a burning match stick at the mouth of the test tube. Record the observation.

-----  
 -----

What would be the reason?

-----

Now complete the chemical equation of this reaction.



Acids react with reactive metals to form hydrogen gas.

Will the same gas be formed when acids react with carbonates? Let's do an experiment.

Take some calcium carbonate (marble pieces) in a boiling tube as shown in figure 5.2. Add dilute hydrochloric acid to it through a thistle funnel. Pass the evolving gas through clear lime water taken in a test tube.

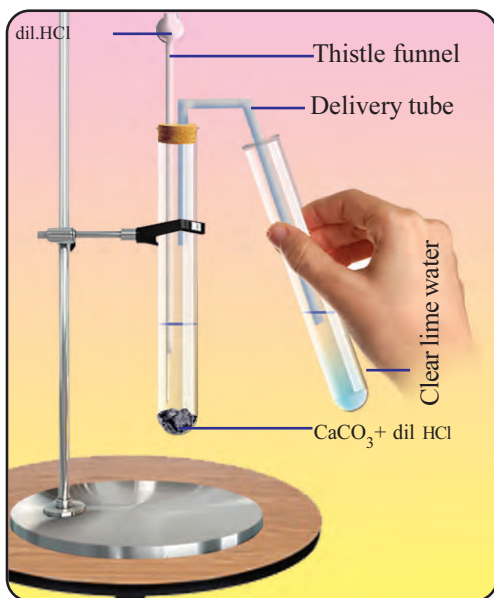


Fig 5.2

- Which is the gas that comes out through the delivery tube?  
 -----
- What is your observation when this gas is passed through clear lime water?  
 -----

When acids react with carbonates, carbondioxide (CO<sub>2</sub>) gas is liberated.

From the characteristics given below, find out those suitable for acids and put (✓) Mark.

- Have alkaline taste.
- Turn blue litmus red.



- React with carbonates to form carbon dioxide gas.
- Soapy to touch.
- Liberate hydrogen on reaction with highly reactive metals like Mg and Zn.
- Have sour taste.
- Turns red litmus blue.

### Common component in acids

The name of some familiar acids and their chemical formulae are given in the table below. Complete the table.

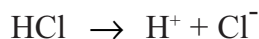
Name of acid	Chemical formula
Hydrochloric acid	HCl
Nitric acid	.....
Carbonic acid	.....
Sulphuric acid	.....

Table 5.2

Which component is responsible for the common properties of acids?

-----

Chemical equations showing the formation of oppositely charged ions when hydrochloric acid (HCl) and nitric acid (HNO<sub>3</sub>) dissolve in water are given.



Which are the ions present in HCl solution?

-----

Which are the ions present in HNO<sub>3</sub> solution?

-----

Which is the ion common to both?

-----

The properties of acids are due to the presence of Hydrogen ions (H<sup>+</sup>) present in them. Can you define acids?



Acids are substances which can increase the concentration of hydrogen ( $\text{H}^+$ ) ions in an aqueous solution.

Since  $\text{H}^+$  ions have no independent existence they combine with  $\text{H}_2\text{O}$  molecules to form hydronium ( $\text{H}_3\text{O}^+$ ) ions.



List the acids that are present in lime juice, curd, tamarind, vinegar etc.

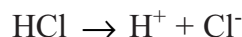


-----  
The natural substances with sour taste and which we use in our daily life contain organic acids in low concentration.

All acids are not to be tasted. Mineral acids like hydrochloric acid, sulphuric acid, nitric acid, etc. are strong acids.

### Basicity of acids

The chemical equation for the ionisation of  $\text{HCl}$  is given.



How many hydrogen ions are released when one molecule of  $\text{HCl}$  is ionised?

-----  
The number of hydrogen ions that can be donated by one molecule of an acid is its basicity.

If the basicity is 1, it is called monobasic acid.

Write the ionisation equation of nitric acid ( $\text{HNO}_3$ ) and find its basicity.

-----  
The chemical equation for the ionisation of the sulphuric acid ( $\text{H}_2\text{SO}_4$ ) is given.





How many hydrogen ions are released when one molecule of  $\text{H}_2\text{SO}_4$  gets ionised? What is its basicity?

-----

If the basicity of an acid is 2, it is said to be a dibasic acid.

Complete the ionisation equation of phosphoric acid ( $\text{H}_3\text{PO}_4$ ).

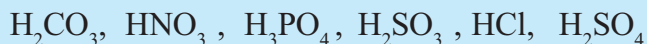


What is the basicity of  $\text{H}_3\text{PO}_4$ ?

-----

If the basicity is 3, the acid is called a tribasic acid.

The chemical formulae of some acids are given in the box. Pick out monobasic and dibasic acids.



You are familiar with soda water, aren't you? How do you make it? The equation of this reaction is given below.



Similarly complete the equation of dissolution of  $\text{SO}_2$  in water.



$\text{CO}_2$ ,  $\text{SO}_2$  and  $\text{NO}_2$  are non-metallic oxides. Generally compounds formed by the reaction of non-metallic oxides with water are acidic.

In industrial areas and townships the chances of air pollution are very high. In such regions, gases like  $\text{SO}_2$  and  $\text{NO}_2$  reach the



atmosphere in larger amounts. These gases dissolve in rain water and reach the soil as acids. This is known as 'acid rain'.

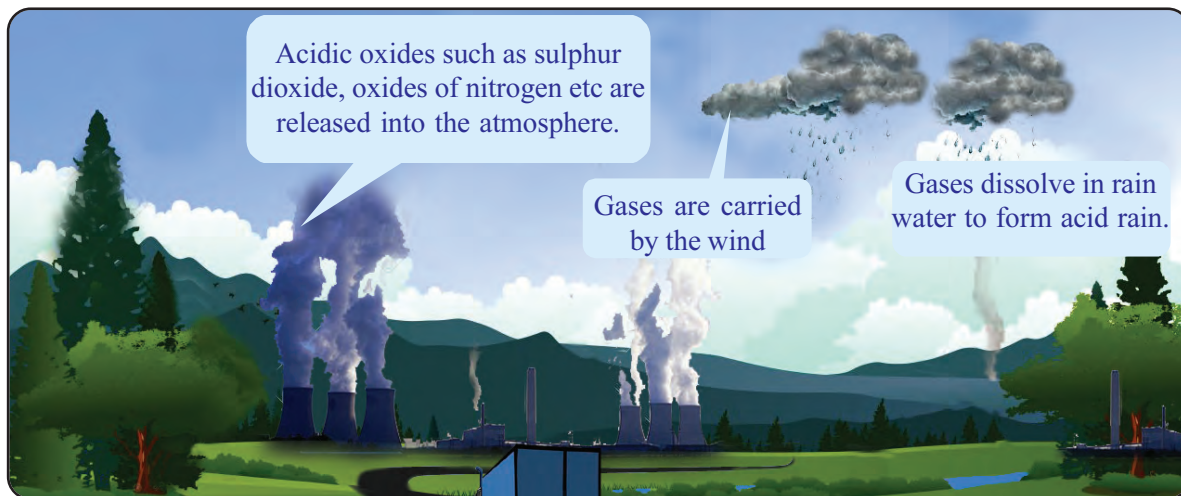


Fig 5.3



What are the environmental problems caused by acid rain? Discuss.

- Plants lose their ability to produce carbohydrates through photosynthesis as their leaves are destroyed.
- Severe acid rain destroys the greenery of a region.
- The acidic nature of water causes the death and destruction of fish and corals.
- 

What measures are to be taken against the environmental issues caused by acid rain? Discuss.

- Reduce the excessive use of fossil fuels.
- Before using fossil fuels, remove sulphur compounds from them as far as possible.
- 

### Alkalies

You have learned the common characteristics of alkalies.

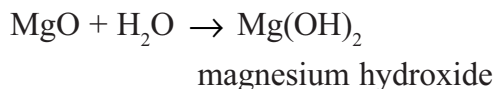
List them. Let's do an activity. Burn a neatly rubbed and cleaned magnesium ribbon. Record the observation. What would be the white powder obtained?

-----

Take the product in a watch glass and add two or three drops of

water. Find its nature using litmus paper.

-----  
Observe the chemical equation of this reaction.

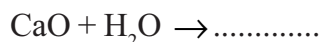


Let's do another activity.

Take some water in a beaker, add some quick lime (calcium oxide) and stir it. Take some clear solution in a test tube from the beaker and add a drop of red litmus solution.

What do you observe? -----

What is the substance formed when calcium oxide reacts with water? Complete the chemical equation of the reaction.



What do you infer about the nature of this substance from this litmus test?

Are MgO and CaO metallic oxides or non-metallic oxides?

-----  
Metallic oxides generally exhibit characteristics of bases.  
The bases that dissolve in water are called alkalis.

From the oxides given below, find out the basic oxides.

K<sub>2</sub>O, SO<sub>2</sub>, P<sub>2</sub>O<sub>5</sub>, MgO, CaO, NO<sub>2</sub>

Chemical names and formulae of some familiar alkalis are given in the table. Complete the table.

Can you find out the common factor in alkalis?

Chemical name of alkalis	Chemical formula
Sodium hydroxide	NaOH
Calcium hydroxide	.....
Ammonium hydroxide	NH <sub>4</sub> OH
Potassium hydroxide	.....

Table 5.3





## Bases and alkalis.

All bases are not alkalis. Water soluble bases are called alkalis.

NaOH and KOH are alkalis. But even though  $\text{Al}(\text{OH})_3$  and  $\text{Cu}(\text{OH})_2$  are bases, they are not considered as alkalis as they are not soluble in water.

Metallic oxides are generally basic in nature. But a few of them have both acidic as well as basic character. Such oxides are called amphoteric oxides.

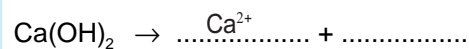
Example  $\text{Al}_2\text{O}_3$ ,  $\text{ZnO}$

They can react with acids as well as bases.

Observe the equation of the dissolution of sodium hydroxide in water.



Now complete the given equation of the ionisation of calcium hydroxide.



Which is the common ion released when alkalis dissolve in water?

Alkalis are substances which can increase the concentration of hydroxide ( $\text{OH}^-$ ) ions in an aqueous solution.

The common names of some alkalis, their chemical names and chemical formulae are given in the table 5.4.

Common name	Chemical name	Chemical formula
Caustic soda	Sodium hydroxide	NaOH
Milk of lime	Calcium hydroxide	$\text{Ca}(\text{OH})_2$
Caustic potash	Potassium hydroxide	KOH

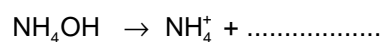
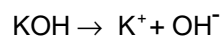
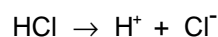
Table 5.4

### Arrhenius' Theory



Svante Arrhenius  
(1859-1927)

The equations representing the ionisation of some acids and alkalis are given below. Fill in the blanks



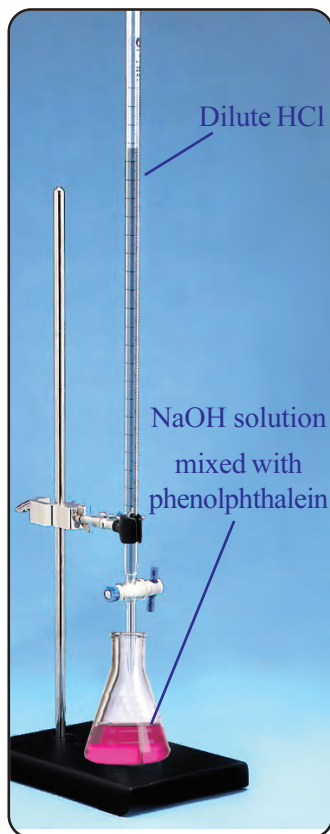


Fig 5.4

In 1887, the Swedish scientist Svante Arrhenius put forward a scientific theory regarding acids and bases. He proposed that any acid or base, when dissolved in water, dissociates into ions. According to his theory, acids are substances which liberate  $H^+$  ions in aqueous solution and bases are substances which liberate  $OH^-$  ions in aqueous solutions.

### Neutralisation reaction

What happens when dilute hydrochloric acid and dilute sodium hydroxide solutions are mixed? Let's do an experiment and find out.

Take 50mL of dilute hydrochloric acid (HCl) in a burette. Using a pipette measure 20mL of dilute sodium hydroxide (NaOH) solution in a conical flask. Add one or two drops of phenolphthalein to the sodium hydroxide solution. Note down the colour of the solution.

Hold the conical flask below the burette and add dilute HCl gradually. Mix the solution well by shaking the conical flask continuously. Observe the colour change of the NaOH solution. As colour fades, add HCl drop by drop and stir. Stop adding HCl when the colour disappears completely with just one drop of HCl. Record the volume of HCl consumed by noting the level of acid in the burette.

- What was the colour of NaOH solution when phenolphthalein was added?
- Which nature of the NaOH solution is indicated here?
- What do you infer from the decrease in the intensity of colour of the NaOH solution on adding HCl?
- When the colour disappears completely will there be any NaOH left behind in the conical flask?

Add a few drops of NaOH solution to the completely decolourised solution. What change can you observe? What will be the reason.

-----

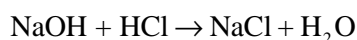
- To this again add dilute HCl drop by drop and stir it.  
What do you observe?

-----



Acid and alkali react with each other to nullify their individual properties. Such chemical reactions are called neutralisation reactions.

Write the chemical equation for the neutralisation reaction between sodium hydroxide and dilute hydrochloric acid.



You have already recorded the volume of HCl used for neutralisation of 20mL NaOH in the earlier experiment.

Change the concentration of the acid and repeat the experiment. Is there any change in the volume of HCl?

-----

-----

Can you find out more examples for neutralisation reaction?

- 
- 

Now you understand that concentration is an important factor in neutralisation reactions.

You have also learnt in biology class that hydrochloric acid helps the process of digestion in the stomach.

What happens when the acid level in the stomach is high?

-----

What do we do in such situations?

The medicines used for reducing acidity in the stomach are known





## Antacid



Hydrochloric acid produced in the stomach helps the digestion process. But, an increase in the acid level results in acidity which may lead to peptic ulcer and cancer. Antacids are medicines used to reduce acidity in the stomach. Chemicals like calcium carbonate, aluminum carbonate, aluminum hydroxide, sodium bicarbonate and magnesium hydroxide are the main components of antacids.

as antacids. What types of substance are present in antacids?

How do they work?

-----  
Isn't it the same process that takes place when slaked lime is sprinkled in farms with acidic soil?

There are instances of increased acidity in the soil. Similarly, there are instances of increased alkali level also. What types of substances are added in such situations?

Acid/base

It can be possible only if the property of the soil is known.

Hence isn't it necessary to test the soil?

Let's examine how we can express the strength of substances with acidic/alkaline nature?

### pH value

Take equal quantities of dilute hydrochloric acid, sodium hydroxide solution and distilled water in three test tubes. Use red litmus paper and blue litmus paper to find out the nature of the solutions.

Also add two or three drops of phenolphthalein solution to the three test tubes. Record the observation and find out the nature of the substances.

Do you notice any colour change in distilled water? What property of water is revealed here?

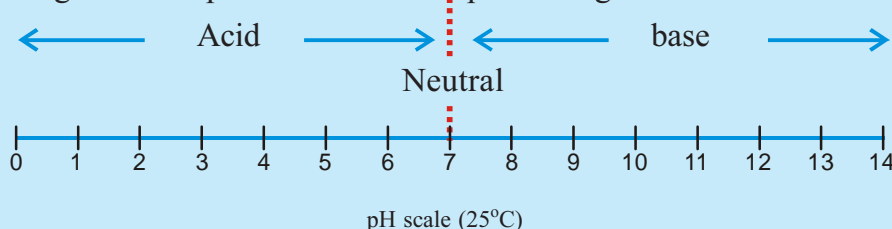
Equal amounts of  $H^+$  ions and  $OH^-$  ions are formed in the neutral solvent water due to slight ionisation.

What happens to the amount of  $H^+$  ions when a little acid is added to water?

What happens if alkali is added?



Determination of pH value is the scientific method for finding the acidic/alkaline nature of substances. The Danish scientist Sorensen devised the pH scale for this. The pH scale was devised based on the  $H^+$  ion concentration in the solution. Observe the diagrammatic representation of the pH scale given below.



Observe the pH scale and answer the questions given below.

What is the pH value of a neutral solution?

-----

What is the nature of the solution having pH value more than 7?

-----

What is the nature of the solution having pH value less than 7?

The pH scale is the method used to express the acidic /basic nature of a substances based on the amount of  $H^+$  ions present in their aqueous solutions. On the basis of the pH scale the pH value of a neutral solution is 7. The pH value of acids is less than 7 and that of bases is greater than 7.

The pH values of different solutions can be found out and compared. A pH paper, pH solution or a pH meter can be used for this purpose.

Add a drop of pH solution to the solution whose pH is to be determined or dip the pH paper into it. The pH value of the solution can be determined by comparing with the pH colour chart. (Fig 5.5)



IT@School Edubuntuവിലെ  
PhETസോഫ്റ്റ്‌വെയറിൽ  
നിന്നും pH Scale  
Application തുറന്ന് ആശയ  
വ്യക്തത വരുത്തൂ.



pH values and colours

Fig 5.5



Find the pH value of the following substances using the pH paper and complete the table given below.

Name of substance	colour of pH paper	pH value	acid/base
Vinegar	.....	.....	.....
Lime water	.....	.....	.....
Dilute hydrochloric acid	.....	.....	.....
Water	no colour change	7	Neutral
Washing soda solution	.....	.....	.....
Ammonia solution	.....	.....	.....
Potassium nitrate solution	.....	.....	.....
Sodium chloride solution	no colour change	.....	Neutral

Table 5.5



## pH meter

The pH meter is a device used for the determination of the pH of aqueous solutions. A pH meter measures the voltage between two electrodes and converts it into its equivalent pH value. The probe is the most important part of this equipment. It is a sensor attached to the end of a rod like portion made of glass. The pH is measured by dipping the probe in the solution.



## Agricultural crops and pH value



The nature of soil is not the same everywhere on the earth's surface. There exists a relation between the nature of soil and crops. This is the reason for the diversity of crops in different parts of the world. The weather at a particular place, the

availability of water and the nature of the soil are the factors which influence the growth of crops. Usually, soil having the pH in the range 6.5 to 7.2 is suitable for majority of crops. A pH of 7 to 8 is suitable for crops like carrot, cabbage etc. Soil pH value about 5 is suitable for crops like potato.

Is it the acidic nature or basic nature that increases with an increase in the pH value?

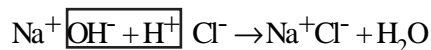
Does the amount of  $H^+$  ions increase or decrease with an increase in the pH value?

The pH of soil is an important factor for crops. It is important to identify whether the soil of a region is suitable for a particular crop. Acidic soil is suitable for some crops while basic soil for a few others.

Is it now clear that it is better to determine the pH of soil before farming?

## Salts

What are the products of the reaction between dilute hydrochloric acid and sodium hydroxide solution?



Name the product formed when the common component of an acid and the common component of an alkali combine together.

-----

Which is the positive ion present in sodium hydroxide? Which is the negative ion present in hydrochloric acid?

Write the chemical formula of the compound formed by the combination of these two ions. Identify this substance.

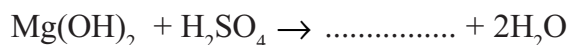
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Sodium chloride is a salt formed by the reaction between HCl and NaOH.

*Neutralisation is the process in which acid and alkali react with each other to form salt and water.*

Salts are usually ionic compounds.

Complete the equation for the reaction between dilute sulphuric acid ( $\text{H}_2\text{SO}_4$ ) and magnesium hydroxide  $\text{Mg}(\text{OH})_2$ .



What are the products formed?

-----

Identify the salts given in the table and find out the acids and alkalies required for the formation of salt.

Salt	Chemical formula	Acid	Alkali
Magnesium chloride	$\text{MgCl}_2$	HCl	$\text{Mg}(\text{OH})_2$
Calcium sulphate	$\text{CaSO}_4$		
Aluminium sulphate	$\text{Al}_2(\text{SO}_4)_3$		
Sodium nitrate	$\text{NaNO}_3$		
Potassium phosphate	$\text{K}_3\text{PO}_4$		

Table 5.6



Salts dissociate into positive and negative ions when dissolved in water or when melted.

The name and symbol of some positive ions and negative ions are given in the table.

Name of positive ions	Symbols	Name of negative ions	Symbols
Potassium ion	$K^+$	Hydroxide ion	$OH^-$
Zinc ion	$Zn^{2+}$	Carbonate ion	$CO_3^{2-}$
Ferrous ion	$Fe^{2+}$	Bicarbonate ion	$HCO_3^-$
Ferric ion	$Fe^{3+}$	Nitrate ion	$NO_3^-$
Cuprous ion	$Cu^+$	Sulphate ion	$SO_4^{2-}$
Cupric ion	$Cu^{2+}$	Bisulphate ion	$HSO_4^-$
Ammonium ion	$NH_4^+$	Phosphate ion	$PO_4^{3-}$
Manganous ion	$Mn^{2+}$	Dihydrogen phosphate ion	$H_2PO_4^-$

Table 5.7

The name of few salts and their chemical formulae are given in the table 5.8. Complete the table adding names of more salts and write the positive ions and negative ions.

Name of Salt	Chemical formula	Positive ion	Negative ion
Sodium chloride	$NaCl$	$Na^+$	$Cl^-$
Magnesium sulphate	$MgSO_4$	$Mg^{2+}$	$SO_4^{2-}$
Calcium carbonate	$CaCO_3$	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....

Table 5.8

What is the number of positive ions in a 'molecule' of  $NaCl$ ?

What is the number of negative ions in a 'molecule' of  $NaCl$ ?

What would be the sum of the charges of the positive ions and negative ions in a 'molecule' of  $NaCl$ ?

-----



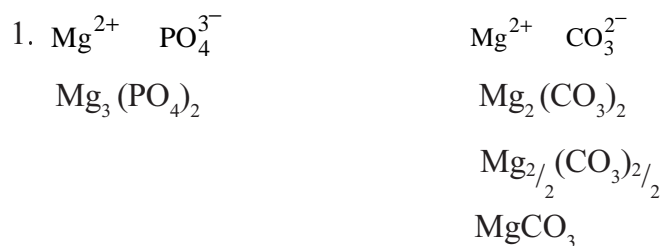
What is the number of positive ions in a 'molecule' of  $\text{MgCl}_2$ ? ....  
 What is the number of negative ions in a 'molecule' of  $\text{MgCl}_2$ ? ....  
 What would be the sum of the charge of the positive ions and negative ions in a 'molecule' of  $\text{MgCl}_2$ ?

Salts are electrically neutral. The sum of the charge of the positive ions and negative ions in a salt will be zero.

### The method of writing chemical formulae of salts

- While writing the chemical formula, first write the symbol of the positive ion and then the symbol of the negative ion.
- Write the numbers indicating the charge of each ion as subscripts after interchanging them.
- Simplify the subscripts and write them in the smallest whole number ratio.

Understand the different stages in writing the chemical formulae of compounds formed by the combination of magnesium ion ( $\text{Mg}^{2+}$ ) with phosphate ion ( $\text{PO}_4^{3-}$ ) and carbonate ion ( $\text{CO}_3^{2-}$ ).



Some positive ions and negative ions are given in the table. Write the name and chemical formulae of the maximum possible salts formed by them.

Positive ion	Negative ion
$\text{Ca}^{2+}$ (calcium ion)	$\text{Cl}^-$ (chloride ion)
$\text{NH}_4^+$ (Ammonium ion)	$\text{SO}_4^{2-}$ (sulphate ion)
	$\text{PO}_4^{3-}$ (Phosphate ion)

Table 5.9

Find out the chemical formulae of more compounds using the symbols given in the table 5.7.

### Uses of salts

You have learned that various elements are required for the growth



of plants. Isn't it from the soil that plants get these elements?

-----  
Do these elements exist in all types of soils?

What measures can be adopted to compensate the deficiency of these elements in soil? -----

Some salts that are used as fertilizers are given below.

- Ammonium sulphate  $(\text{NH}_4)_2\text{SO}_4$
- Potassium chloride  $\text{KCl}$
- Sodium nitrate  $\text{NaNO}_3$

We use various salts in our daily life. A list of some of these salts and their chemical formulae are given in the table. Analyse the table and complete.(Table 5.10)

Name of the salt	Chemical name	Chemical formula	Use
Table salt	Sodium chloride	$\text{NaCl}$	• Making of freezing mixture •
Sylvine/ Muriate of potash	Potassium chloride	$\text{KCl}$	• •
Blue vitriol	Copper sulphate	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	• Fungicide •
Baking soda	Sodium bicarbonate	$\text{NaHCO}_3$	• •
Washing soda	Sodium carbonate	$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$	• Manufacture of glass •
Gypsum	Calcium sulphate	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	• •

Table 5.10

Find the uses of the salts given above and complete the table. Find the names of more salts and their uses and add them to this list.

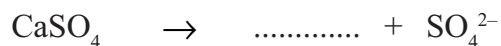




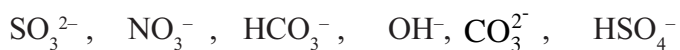


### Let's assess

1. Complete the chemical equations for the following ionisation reactions.



2. Identify the symbols of ions from the box and write against their names.



Carbonate -

Bisulphate -

Sulphite -

Nitrate -

Hydroxide -

Bicarbonate -

3. (a) Name the salt formed by the reaction between magnesium hydroxide  $[\text{Mg(OH)}_2]$  and dilute hydrochloric acid (HCl).
- (b) Write the equation for the reaction.
- (c) Which is the acid required for the preparation of magnesium sulphate?



4. List the cations and anions of the substance given in the table.

Substance	Chemical formula	Cation	Anion
Potassium chloride	KCl	K <sup>+</sup>	Cl <sup>-</sup>
Magnesium chloride	MgCl <sub>2</sub>	.....	.....
Sodium nitrate	NaNO <sub>3</sub>	.....	.....
Ammonium chloride	NH <sub>4</sub> Cl	.....	.....
Aluminium sulphate	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	.....	.....
Calcium phosphate	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	.....	.....

5. A little distilled water is taken in a beaker.

A. What is the pH value of the distilled water?

B. What happens to the pH value when the following substances are added to the water ? Justify your answer.

i) Caustic soda

ii) Vinegar

6. Match the column A, B and C by identifying the correct chemical formulae and the use of the salts.

Salt	Chemical formula	Use
Washing soda	CuSO <sub>4</sub> .5H <sub>2</sub> O	Fire extinguisher
Gypsum	NaHCO <sub>3</sub>	Fungicide
Blue vitriol	Na <sub>2</sub> CO <sub>3</sub> .10H <sub>2</sub> O	manufacture of Cement
Baking soda	CaSO <sub>4</sub> .2H <sub>2</sub> O	manufacture of Glass



7. The pH values of some substance are given in the table. Analyse the table and answer the questions.

Substance	pH value
Vinegar	4.2
Lime water	10.5
Milk	6.4
Water	7
Tooth paste	8.7
Blood	7.36

- Is blood acidic or basic in nature?
- The pH value of pure milk is 6.4. Does the pH value increase or decrease when milk changes to curd. Justify your answer.
- Among the substances given in the above table
  - Which one is strongly basic?
  - Which one has weak acidic nature?

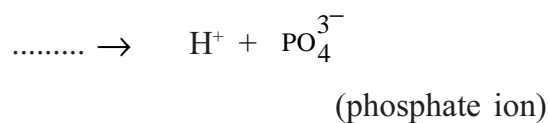
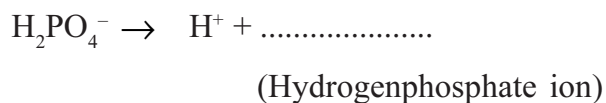
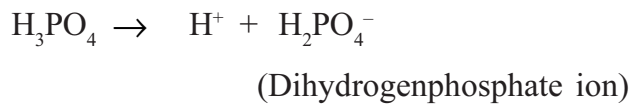


### *Extended activities*

- Organic acids are present in a number of substances we use in our daily life.  
(eg. Tomato, orange, apple, grapes, curd etc)  
Identify the organic acids in each of them and tabulate.
- Haven't you conducted an activity to find the pH value of the soil related to different crops? Identify the pH values of soil samples collected from different places.  
  
Prepare a list of the crops that are suitable for the soil of each area on the basis of its pH value.

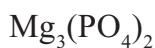


3. a) Complete the equations of the ionization of phosphoric acid.

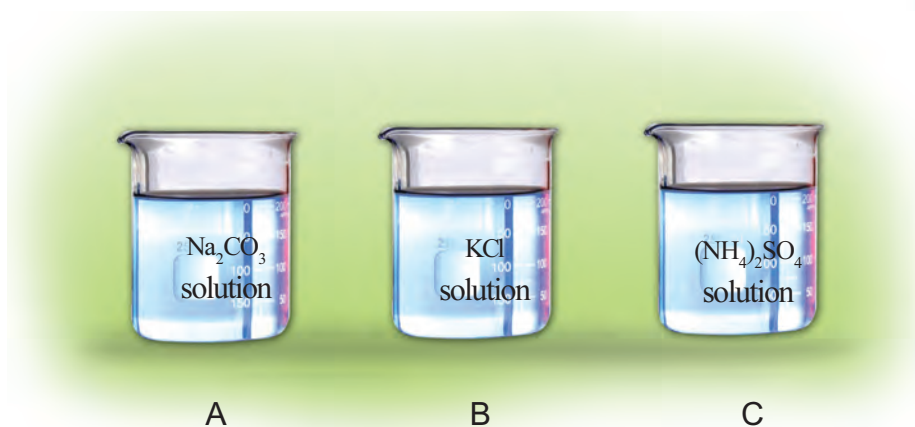


- b) How many types of salts can be formed by phosphoric acid? Why?

- c) Write the chemical name of the following salts.



4. Solution of sodium carbonate, potassium chloride and



ammonium sulphate are taken in separate beakers.

Dip a litmus paper (red, blue) in each beaker.

Salt	Colour of litmus paper	Nature of the substance
A		
B		
C		

- i Observe the colour change of litmus paper and tabulate.
- (ii) Name the acid and alkali that react to form each salt given above?
- (iii) Can you explain the colour change of the litmus paper on the basis of the nature of the acid and alkali that react to form the salt?

(hint:Potassium chloride is a salt formed by the reaction between a strong acid and a strong alkali)







6



## NON- METALS



You know that elements are divided into metals and non-metals. You've learned about metals in previous classes.

Which are the non-metals familiar to you?

In which situations do we use them?

- Is it interesting to see the balloons flying up in the air? Which is the gas filled in these balloons?
- Which gas is mainly filled in cylinders used in hospitals for artificial respiration?
- Which is the gas filled in tyres to increase their efficiency?



All the elements used in these situations are non-metals. Let's learn more about some non-metals that are equally important as metals.

Which are the gases contained in the atmospheric air?

Analyse the figure 6.1 and table 6.1 given below.

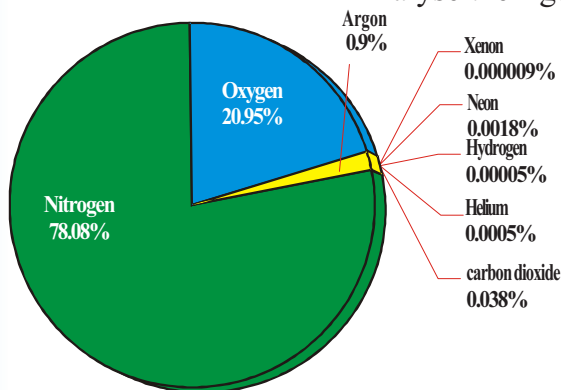


Fig 6.1

Components	Percentage
Nitrogen	78.08
Oxygen	20.95
Argon	0.9
Carbondioxide	0.038
Others	0.032

Table 6.1

Which is the most abundant gas in the atmospheric air?

Let's examine the elements present in food materials.

Carbohydrate : carbon, hydrogen, oxygen

Protein : carbon, hydrogen, oxygen, nitrogen

Fat : carbon, hydrogen, oxygen.

Now, let's examine the component elements present in plastics.

PVC : carbon, hydrogen, chlorine

Polythene : carbon, hydrogen

Carbon, hydrogen, oxygen, nitrogen, chlorine etc are non-metals. Non-metals are of prime importance not only for life activities, but also in industrial field. Let's familiarize some non-metals.

## Hydrogen

What do you know about hydrogen gas?

Hydrogen is the major component in the sun and stars. A very small quantity of hydrogen is seen in the atmosphere in free state.





## Discovery of hydrogen



Henry Cavendish  
1731 - 1810

In 1766, Henry Cavendish, a British scientist, discovered hydrogen. He called it 'the inflammable air'. The name hydro

gen is derived from the word 'Hydrogens' which means something that produces water.

Water is a major compound of hydrogen. Hydrogen is present in large amounts in bio substances.

List out the hydrogen compounds known to you.

- $\text{H}_2\text{SO}_4$
- 

### Let us Prepare Hydrogen

Take 5ml of dilute hydrochloric acid in a test tube and then add some zinc granules into it.(Fig.6.2)

Bring a burning match stick at the mouth of the test tube. What do you observe?



-----  
Which is this gas that burns with a pop sound?

Let's write the balanced equation of this chemical reaction.

-----



What are the reactants and products in this reaction?

How is zinc chloride formed along with hydrogen gas in this chemical reaction?

During this chemical reaction which atom replaces hydrogen in hydrochloric acid?

That is, the zinc atom takes the place of hydrogen atom in hydrochloric acid molecule by replacing it. This type of reactions where an element in a compound is displaced by another element is called **Displacement Reactions/ Substitution Reactions.**

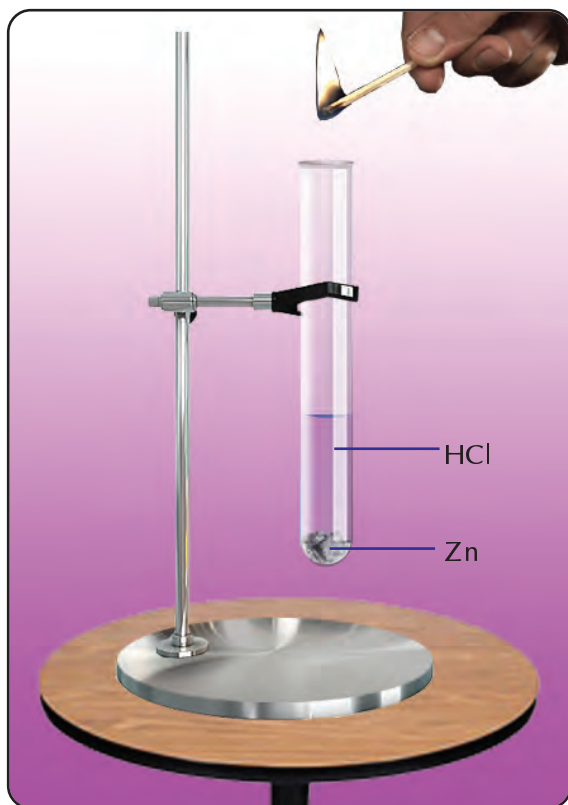


Fig 6.2

Reactions between metals and dilute acids are examples for displacement reactions.



Some other examples for displacement reactions



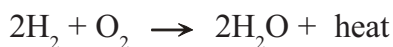
Find more examples for this type of reactions from your Chemistry text book.

You have seen hydrogen balloons fly up in the air. What can you infer about the density of hydrogen from this?

### Some Reactions of Hydrogen

#### 1. Reaction between hydrogen and oxygen.

Hydrogen burns in oxygen to form water. This is an exothermic reaction. (Water is also formed when electric sparks are passed through a mixture of hydrogen and oxygen)



Which are the substances that take part in chemical reaction here?

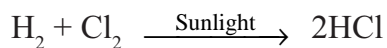
You can see that the molecules of hydrogen and oxygen combined to form the new substance water.

The reaction in which two or more simple substances (elements/ compounds) combine to form a compound is called **Combination Reaction**.

#### 2. Reaction between hydrogen and chlorine

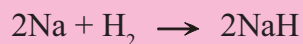
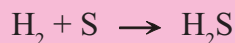
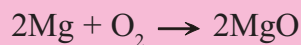
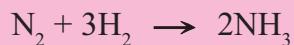
Hydrogen combines with chlorine in the presence of sunlight to form hydrogen chloride.





Isn't it a combination reaction? Find more examples for combination reactions.

More examples for combination reactions



Some uses of hydrogen are given.

- For the industrial production of ammonia and methanol.
- To saturate unsaturated oils.
- As a fuel
- 

### Hydrogen as a Fuel

Hydrogen is a combustible gas. It is a good fuel.

Look at the graph which shows the amount of heat energy produced by burning 1g of different fuels. (fig 6.3)

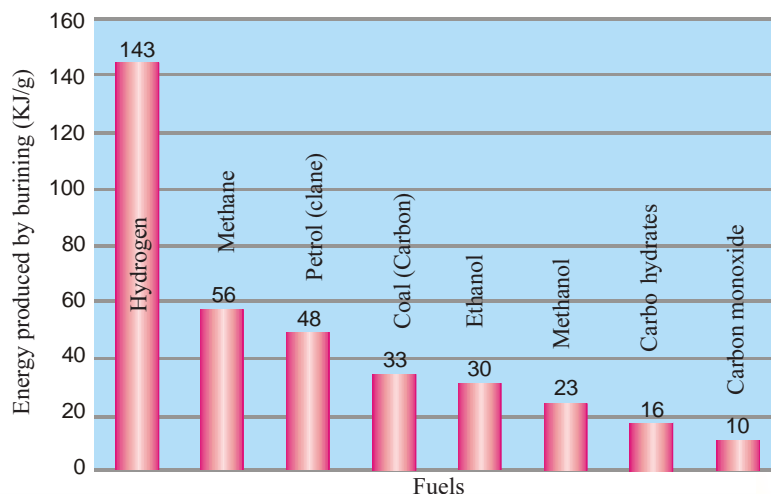


Fig 6.3





The calorific value of a fuel is the heat energy released from one unit mass of that fuel on complete combustion.

Which fuel has the highest calorific value among these?

What will be the product formed when hydrogen burns in air?

What are the advantages of hydrogen as a fuel? List out.

- Availability is plenty
- 
- 



## Fuel Cell

Hydrogen-oxygen fuel cells are special devices that produce electricity using hydrogen gas and oxygen gas.

Advantages of these cells

- 1) *Pollution free*
- 2) *High efficiency*

Now a days fuel cells are used in space crafts and submarines.

Even though hydrogen has these advantages, it is not used as a domestic fuel. There are some limitations. Hydrogen is a gas which burns with explosion. It is very difficult to store and transport this. If we overcome these limitations hydrogen will become a universal fuel. The problems like the scarcity of fossil fuels and environmental pollution can be overcome through this.

Prepare and present a short note on the possibilities of using hydrogen as a fuel in future.

## Oxygen - The breath of life

Oxygen which is known as the breath of life is essential for the existence of life. List out some compounds containing oxygen.

- $C_6H_{12}O_6$
- $CuO$
- $CaCO_3$
- 
- 

It is necessary to maintain the amount of atmospheric oxygen at a constant level. Prepare and present a short note on the role of plants in maintaining the oxygen level.





## Presence of Oxygen in Nature

Oxygen is the most abundant element in the earth's crust. There are so many oxygen compounds in rocks and soil. Oxygen is seen in free or combined state in atmospheric air, water, minerals, living organisms etc.

Analyse table 6.2 to understand the presence of oxygen on the earth.

You've realised that the amount of oxygen in nature is quite abundant.



### Discovery of oxygen



Joseph Priestley  
(1733-1804)

In 1774 a scientist named Joseph Priestley discovered oxygen. But its name oxygen was given by the French scientist Lavoisier. The name 'oxygen' is derived from the word 'oxygenes' which means the acid producer.

Earth's crust	45 - 50%
Water	88 - 90%
Minerals	45 - 50%
Atmospheric air	21%
Plants	60 - 70%
Animals	60 - 70%

Table 6.2

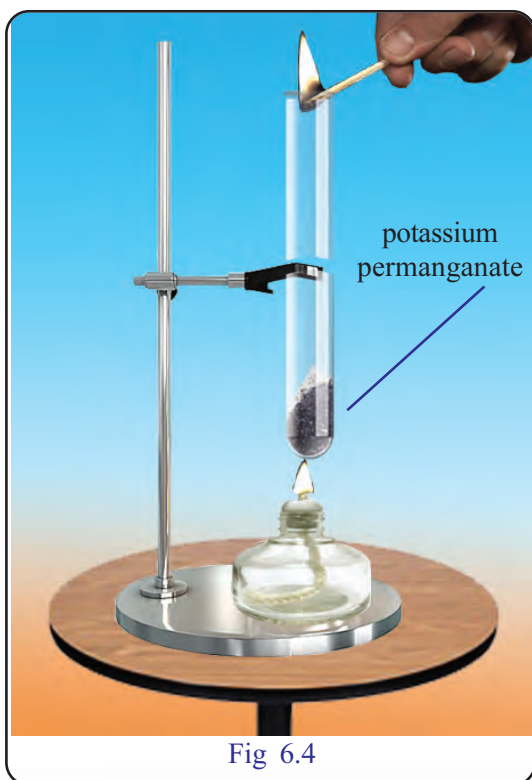


Fig 6.4



### Let's Prepare Oxygen

Observe the figure which shows the preparation of oxygen in laboratory. (Fig 6.4)

Which are the materials used to prepare oxygen?

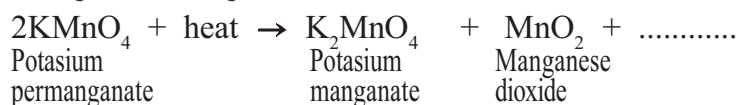
- Moisture free boiling tube.
- Crystals of potassium permanganate.
- 

Heat the boiling tube containing potassium permanganate.

Introduce a glowing matchstick into the boiling tube. What do you observe?

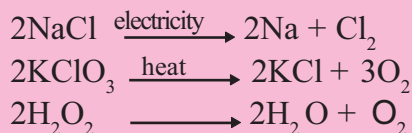
-----  
Presence of which gas is indicated by the flaring up of the glowing matchstick?

-----  
Complete the equation of this chemical reaction.



In this reaction which compound has decomposed to form oxygen(O<sub>2</sub>). What are the products of this decomposition?

This type of chemical reaction is known as **Decomposition**. Decomposition is the process of forming two or more products due to the decomposition of a compound. Let's find out other examples for decomposition.



You've learned the electrolysis of water.



Can we prepare oxygen through this process? This chemical reaction is also an example for decomposition.

Put tick mark (✓) against the true statements related to oxygen from those given below.

Colour	Yes/ No
Odour	Yes/No
Solubility in water	Soluble/Insoluble
Nature of combustion	Burns/Helps burning

Now let's familiarise some chemical reactions of oxygen.

The burning of a substance in oxygen is called combustion.



Take some sulphur in a spatula and burn it. What do you observe?

Are you familiar to the odour felt?

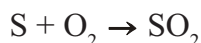
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## Biodecomposition

You know that the remains of plants and animals undergo biodecomposition. This happens due to the action of micro organisms like bacteria and fungi in their biomolecules. These micro organisms generate the energy required for their metabolic activities by oxidising biomolecules.

The reason for that smell is the formation of sulphur dioxide by the combination of sulphur and oxygen.



Like this, oxygen reacts with the non- metals such as carbon and hydrogen to produce carbon dioxide and water respectively. Complete the equation of chemical reactions.



Haven't you noticed some metals like aluminium and iron losing lustre in the course of time. The reaction of oxygen with these metals to form their oxides is

one of the reasons for this process.

What are the other uses of oxygen?

- For combustion.
- As oxidising agent in rocket fuels.
- For artificial respiration.
- 

## Ozone

Oxygen is seen as diatomic molecule that is formed by combining two oxygen atoms.

But ozone is a triatomic molecule containing three oxygen atoms.(O<sub>3</sub>)

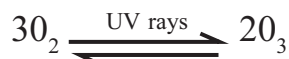
Ozone is found in the stratosphere, a layer of atmosphere. Atmospheric oxygen is decomposed by absorbing ultraviolet rays having high energy. The oxygen atoms formed combine with oxygen (O<sub>2</sub>) molecules to form ozone (O<sub>3</sub>) molecules.





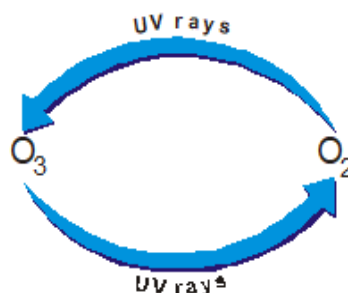
## Chlorofluorocarbons

Chlorofluorocarbons or CFC is a type of compounds that contain atoms such as chlorine, fluorine and carbon. They can be easily liquefied by applying pressure. When the liquefied CFCs evaporate they produce extreme cold. Therefore they are used in refrigerators, AC etc. When these equipments left useless they cause CFC emission. CFC causes the depletion of ozone layer. For the awareness of the conservation of ozone layer, September 16 is observed as International Ozone Day.



Ozone is again changed to oxygen by absorbing ultra violet rays having less energy. As a result of this cyclic process, the amount of ozone in the atmosphere remains constant.

The energy for these process is obtained from the



ultraviolet rays coming from the sun. Therefore these dangerous rays do not reach excessively to the earth.

### Ozone Layer Depletion

Chlorofluorocarbons (CFC) cause the depletion of ozone layer.



Chlorofluorocarbons released into the atmosphere reach the stratosphere and undergoes self decomposition. This chlorine decomposes the ozone molecule into oxygen. This disturb ozone-oxygen cyclic equilibrium leading to reduction in the amount of ozone in the stratosphere.

Ozone depletion in atmosphere decreases the rate of absorption of ultra violet radiation.

What will be the consequences on environment, if excess amount of ultra violet radiation reaches the earth? Prepare notes.





## Layers of Atmosphere

The atmosphere of the earth has five layers that are determined by the changes in temperature that happens with the increasing altitude from the earth.

1. Troposphere: This is the atmospheric layer which lies nearest to the surface of the earth. Climate changes occur in this layer. (It extends from the surface about 8-14.5 km).
2. Stratosphere: Lies just above the troposphere. The ozone layer is seen here. (It extends upto about 50km).
3. Mesosphere: This is the coldest layer of the atmosphere. This layer lies just above the stratosphere. (Extends upto about 85km).
4. Thermosphere : The temperature in this layer is very high due to the heat of the sun. (It extends upto about 600km).
5. Exosphere: This is the next layer of the atmosphere. (It extends about 10,000km upto the space)

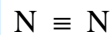
What can we do to make sure the protection of ozone layer and thereby ensure the safety of living beings?

List out.

Nowadays use of CFC is regulated in many countries. Other compounds are being used instead of harmful CFCs. This contributes to a decrease in the rate of ozone layer depletion.

### Nitrogen

The major component in atmosphere is Nitrogen. Have you ever thought of the benefits of increased amount of nitrogen in the atmosphere?

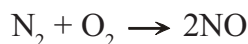


There is a triple bond in nitrogen molecule. Nitrogen is inactive due to this strong bond. Combustion happens in the presence of oxygen in the atmospheric air. Nitrogen has a major role in controlling the rate of combustion. Nitrogen is essential for the growth of plants. Even though nitrogen is abundant in atmosphere, plants can't absorb it directly. What are the different ways in which nitrogen is obtained by plants? Note down the ways which are known to

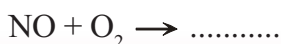
you.

It will be easy for plants to absorb nitrogen when it is mixed in the soil in the form of compounds.

The triple bond in nitrogen molecule is broken down when there is thunder and lightning and the nitrogen combines with atmospheric oxygen to form nitric oxide (NO).



Nitric oxide formed like this combines with more oxygen to form nitrogen dioxide (NO<sub>2</sub>). Balance the equation of this chemical reaction after completing it.

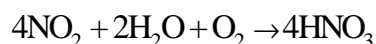




## Nitrogen fixation in plants

Rizobium bacteria in the roots of leguminous plants absorb atmospheric nitrogen and converts it into compounds. This helps to increase the nitrogen level in the soil.

In the presence of oxygen nitrogen dioxide dissolves in rainwater and reaches the soil as nitric acid. ( $\text{HNO}_3$ )



This nitric acid reacts with the minerals in soil and forms nitrate salts and the plants absorb them. Therefore thunder and lightning are blessings for plants. Plants get only a small amount of

nitrogen in this way.

One of the ways of getting greater amount of elements required for the growth of plants is through the decaying of plants and animals.

Can you list out which other means are there?

- Use of organic fertilizers.

List out the advantages and limitations of organic fertilizers.

- Eco-friendly
- Keeps the originality of the soil.

Compare it with the use of chemical fertilizers.

What are the other uses of nitrogen?

- In production of nitrogenous fertilizers.
- To fill in the tyres of vehicles.
- Liquefied nitrogen as a refrigerant.
- To avoid the presence of oxygen in packed foods.



## Chlorine

Haven't you seen bleaching powder being used for water purification? Aren't you familiar with the smell of bleaching powder? That is the smell of chlorine which is the major component of bleaching powder.





## Discovery of chlorine



Carl William Scheele  
(1742-1786)

In 1774 a scientist called Carl William Scheele discovered chlorine gas. But, he didn't recognize it

as an element at that time. It was Humphery Davy who confirmed that chlorine also is an element. The name 'chlorine' was derived from the word 'chloros' which means greenish yellow.

Chlorine is not seen in nature in free state. The high reactivity of chlorine is the reason for it.

List out the chlorine compounds you are familiar with.

- Hydrogen chloride (HCl)
- 
- 

## Preparation of Chlorine

The arrangement of apparatus used for preparation of chlorine in laboratory is shown below.(Fig.6.5)

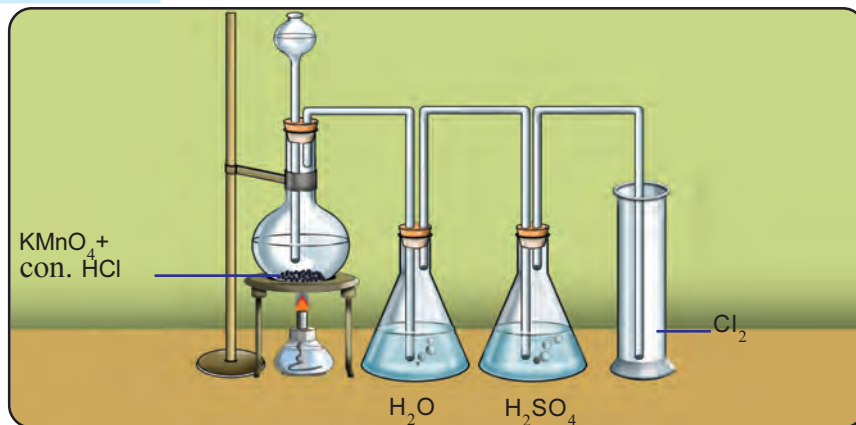


Fig 6.5

See how the balanced equation of this chemical reaction is written.



What are the reactants required for the preparation of chlorine?

-----

What are the products? -----

Do you know why chlorine gas is passed through water? It is done



to remove the traces of hydrogen chloride vapours that comes out along with chlorine.

How can we remove the water vapour formed along with chlorine?



### Is chlorine a savior or a destroyer?



Chlorine gas was a major component of the chemical weapons used by Germany in First World War. At that time too many people were killed and injured severely through the chemical weapons.

Now chlorine is one of the major disinfectant used for water purification in order to prevent diseases. We use many chlorine compounds daily.

Sulphuric acid can absorb the water vapour in chlorine gas when it is passed through the concentrated sulphuric acid.

Observe how the chlorine gas is collected in gas jar.

List out the qualities of chlorine gas.

Colour	
Smell	
Density	

### Bleaching Action of Chlorine

Prepare dry chlorine and collect in two jars. Put a litmus paper, bits of coloured cloth and pieces of coloured paper in one jar in wet condition. Put similar dry objects in another jar. What do you observe?

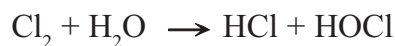
Materials in which jar are decolourised?

Isn't it clear that chlorine gas has the capacity to decolourise wet objects.

That means bleaching activity of chlorine take place only in the presence of moisture.

### Chemistry of Bleaching

Equation of the reaction of chlorine with moisture is given.



Here hypochlorous acid HOCl formed as a product is unstable and hence it decomposes.

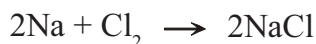


Complete the equation.



Can the change happening to HOCl be considered as a decomposition reaction? Here, the nascent oxygen formed due to decomposition oxidises coloured objects to make them colourless. This is the basis of the bleaching activity of chlorine. Bleaching activity of chlorine is an oxidation reaction. Why?

Now it is clear why bleaching activity doesn't happen in the absence of moisture. One of the important compounds of chlorine is sodium chloride (NaCl), which is familiar to us in the name common salt. This compound is present in nature in sea water and in the form of rock salt.



Is this reaction of combining of sodium with chlorine an example of simple combination?

### Uses of Chlorine

- For bleaching
- To prepare pesticides
- To remove stain from clothes.
- To purify water
- To prepare bleaching powder.

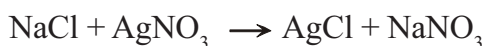
Bleaching powder is prepared by passing dry chlorine gas over dry slaked lime. You know that bleaching powder, as a disinfectant, was used in cleaning activities during the time of flood in Kerala. Chlorine, liberated when bleaching powder reacts with water, helps disinfection. Bleaching powder is a good source of chlorine.

### Identification of Chlorides

Take a little sodium chloride solution in a test tube. Add a few drops of silver nitrate solution in it. What do you observe?



What is the characteristic of precipitate formed here?

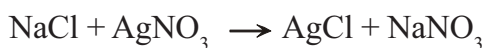


Add some ammonium hydroxide to the curdy white precipitate of silver chloride.

What happens to the precipitate?

This experiment can be used to identify chloride salts.

When silver nitrate solution is added to the given salt solution, if a white curdy precipitate soluble in ammonium hydroxide solution, is formed the presence of chloride salt can be confirmed.



Analyse the chemical equation given above.

Which is the ion combined with sodium ion in the first reactant NaCl?

To which metal ion, is this ion combined in the product?

Nitrate ion was with the silver ion in the second reactant silver nitrate.

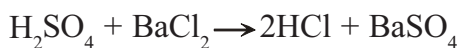
To which metal ion is this nitrate ion combined now in the product.

Are the ions interchanged here?

That is both the reactants interchange their ions.

Double decomposition is a reaction in which two compounds when react with each other, interchange their ions to form two new compounds.

Can you find more examples of such reactions in which two compounds interchange their constituents in the molecules.



Arrange the chemical reactions given below in a table under the heads combination reaction, decomposition, displacement reactions and double decomposition.

- a)  $2\text{KCl} \rightarrow 2\text{K} + \text{Cl}_2$
- b)  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
- c)  $2\text{HI} \rightarrow \text{H}_2 + \text{I}_2$
- d)  $\text{KCl} + \text{AgNO}_3 \rightarrow \text{AgCl} + \text{KNO}_3$
- e)  $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$
- f)  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
- g)  $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$
- h)  $\text{Na}_2\text{SO}_4 + \text{BaCl}_2 \rightarrow \text{BaSO}_4 + 2\text{NaCl}$

Combination reaction	Decomposition reaction	Displacement reaction	Double decomposition reaction

Table 6.3





### Let's assess

1. Some chemicals are given in the box. Find out and write down the chemicals needed to prepare oxygen and hydrogen in laboratory.

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

2. Find out to which gases are the following statements related?
  - a) The gas which is combustible and is formed through the electrolysis of water
  - b) The gas that is used for water purification.
  - c) The element inevitable for the growth of plants.
  - d) The gas formed by the thermal decomposition of  $\text{KMnO}_4$
3. Some non-metals and their uses are given in wrong order. Match them in right order.

Element	Use
Hydrogen	Disinfectant
Oxygen	cooling agent
Chlorine	Fuel
Nitrogen	Biodegradation

4. a) What are the chemicals used to prepare chlorine in the laboratory?
  - b) Why is chlorine gas passed through sulphuric acid during the time of preparation?
  - c) How is bleaching powder prepared?
  - d) Which is the gas coming out from bleaching powder in the presence of water?
5. "We should avoid chemical fertilizers completely and promote organic fertilizers." What is your opinion to this argument? Substantiate your answer.
6. Classify the given chemical reactions in the table below.
  - a)  $\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$
  - b)  $\text{H}_2 + \text{I}_2 \rightarrow 2\text{HI}$



- c)  $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$   
 d)  $\text{NaCl} + \text{AgNO}_3 \rightarrow \text{AgCl} + \text{NaNO}_3$   
 e)  $\text{ZnSO}_4 + \text{BaCl}_2 \rightarrow \text{BaSO}_4 + \text{ZnCl}_2$   
 f)  $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$   
 g)  $\text{FeSO}_4 + \text{Zn} \rightarrow \text{ZnSO}_4 + \text{Fe}$   
 h)  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$

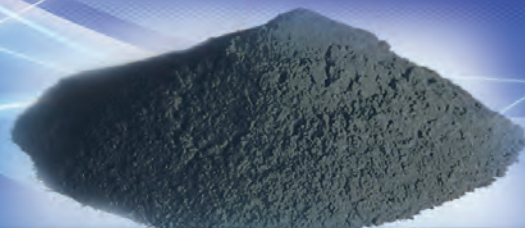
Combination reaction	Decomposition reaction	Displacement reaction	Double decomposition reaction



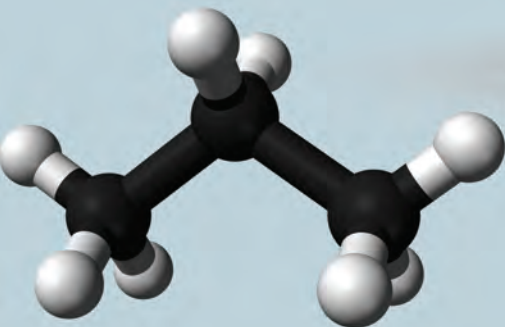
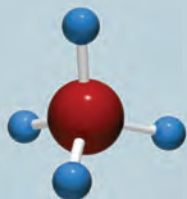
### Extended Activities

1. Conduct a discussion on how nitrogen cycle benefits plants and animals.
2. Conduct a seminar on 'Ozone Depletion and its Solutions'
3. Take 5 ml hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) solution in a test tube. Add a little manganese dioxide to it. Bring a burning matchstick into the test tube. What do you observe? Find reason for your observation?





## THE WORLD OF CARBON



Carbon is an element that is very familiar to you. This element also has a lot of specialities. Food, cloth, oils, soap, cosmetics, fuels, medicines, plant-animal body, paints, rubber, paper, plastic etc. are primarily carbon compounds.

### **Presence of carbon in nature**

Carbon is one of the elements seen in nature both in elemental and combined states. The charcoal residue left behind when the substances undergo combustion is due to the presence of carbon compounds in them. The black smoke formed when substances burn is also due to the presence of carbon. New compounds of carbon are being discovered or created almost everyday. Even all



the total number of compounds formed by all other elements can't be equal to one tenth of the compounds of carbon. What do you know about carbon that is able to make so many compounds?

Complete the table given below with the help of Periodic table.

Symbol	.....
Atomic number	.....
Electronic configuration	.....
No. of electrons in the outermost shell	.....
Valency	.....
Metal/non-metal?	.....

Table 7.1

### Allotropes of Carbon

Different forms of the same element having different physical properties but with same chemical properties are known as **Allotropes** and this phenomenon is called **Allotropy**. Diamond, graphite, fullerene, graphene etc are the crystalline allotropes of carbon.

#### Diamond

Diamond is the hardest allotrope of carbon.

Look at the characteristics of diamond.



#### Thermal conductivity of diamond

Diamond the hardest allotropic form of carbon is also an excellent conductor of heat. The strong covalent chemical bonding in diamond is responsible for this property. The thermal conductivity of diamond is about five times that of copper. The thermal conductivity of diamond is made use of in identifying fake diamonds.

- Very hard
- Transparent
- Not a conductor of electricity
- High thermal conductivity
- High refractive index

Some uses of diamond are given

- Used to make ornaments
- Used for cutting glass





## Coloured diamonds

Chemically and structurally pure diamonds are colourless. The presence of certain elements impart colour to diamonds. For example the presence of boron imparts blue colour and the presence of nitrogen imparts yellow colour to diamonds. The refractive index of diamond is very high. If diamond is cut into certain shapes, the light entering the diamond will undergo total internal reflection and get separated into its component colours. This makes diamond attractive.

Which are the characteristics of diamond that make it useful for these purposes? Find out.

What could be the reason for the unique properties of diamond? See the crystal structure of diamond given in fig.7.1. Here each carbon atom is linked by covalent bonds with four other carbon atoms surrounding it. This strong bonding is responsible for the hardness of diamond. Due to the absence of free electrons in this crystal structure, diamond does not conduct electricity.

## Graphite

Graphite is the softest crystalline allotrope of carbon.



Let's list out the characteristics of graphite.

- Soft and slippery
- Grey in colour
- Conductor of electricity
- Non volatile



Given below are some uses of graphite.

- Used to make 'pencil lead'
- Used to make electrodes of dry cells
- Used as a solid lubricant.

Find the characteristics of graphite that make it useful for these purposes?

Look at the crystal structure of graphite given in figure 7.2.

In graphite, each carbon atom is covalently bonded with three surrounding carbon atoms and forms a sheet like structure. These sheets or layers are

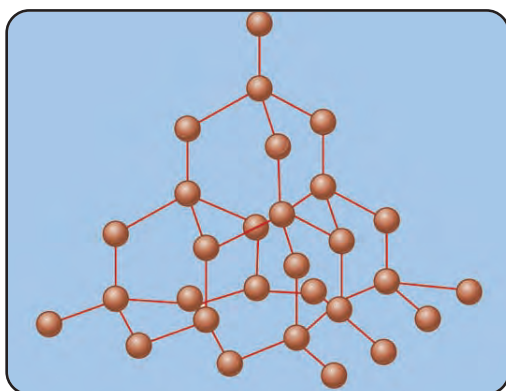


Figure 7.1

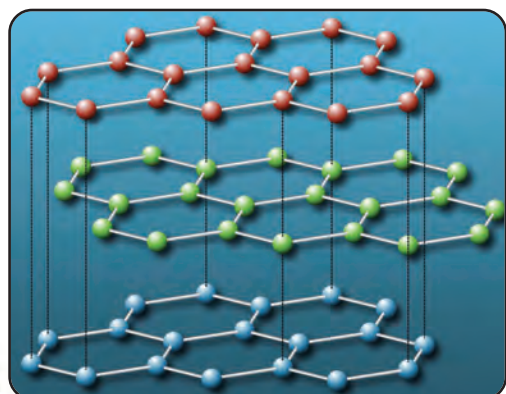


Figure 7.2

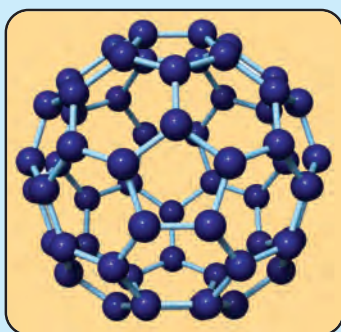


## The origin of the name

Graphite got its name from the Latin word 'Graphien' which means 'capable of writing'. Since graphite was grey in colour and smooth and could make marks in paper, it was eventually used for writing. In the initial stages graphite was mistaken for lead. It was due to this reason that graphite pencils got the name lead pencils.



## Fullerenes



Look at the structure of yet another allotrope of carbon. Fullerenes have a hollow structure consisting of pentagons and hexagons. They are known as Bucky balls. Fullerenes with cylindrical structure are called carbon nano tubes and they are known as Bucky tubes.

They could revolutionise the field of information technology.

stacked one above the other to form the structure.

Each layer is made up of hexagons. There is no covalent bonding between these layers. These layers are held together by weak van der Waals' forces. Hence one layer can slide over another.

The presence of free electrons which are not involved in covalent bonding make graphite a conductor of electricity.

## Amorphous carbon

Coke, coal, charcoal, bone charcoal, etc. are non crystalline allotropes of carbon. These are commonly called amorphous carbon.

## Carbondioxide (CO<sub>2</sub>)

- Which is the main carbon compound present in the atmosphere?  
-----
- Which is the main compound formed during the combustion of carbon or carbon compounds?  
-----

The arrangement of the preparation of carbon dioxide in laboratory is shown here.

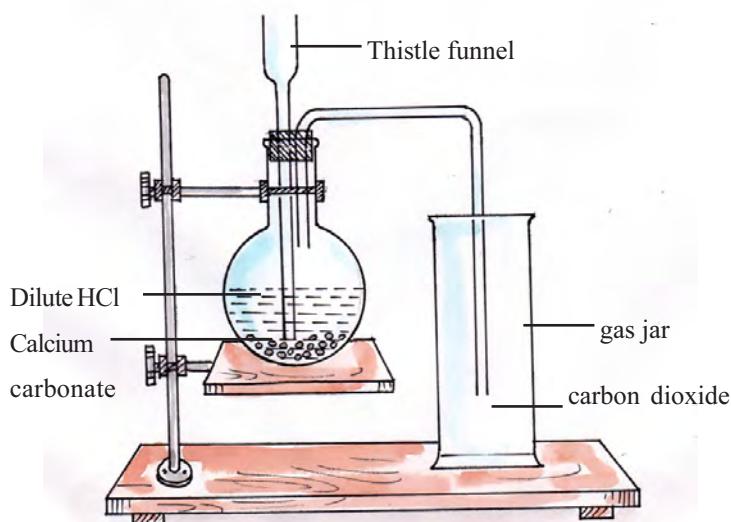
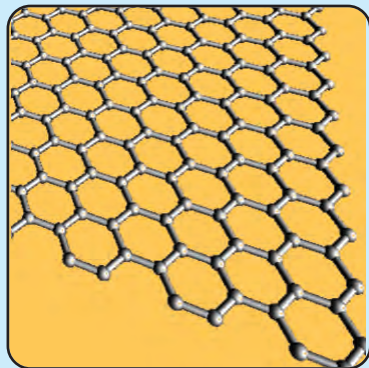


Figure 7.3



## Graphene



Graphenes are two dimensional sheets of hexagonal rings formed by carbon. Graphenes resemble a single layer of graphite. It can be said that graphenes are the basic units of the allotropes of carbon, like graphite and fullerene.

Let's list some of the characteristics of graphene.

- Two hundred times stronger than steel.
- Conductor of heat and electricity.

Graphene has already emerged as a material that has revolutionized the field of nanotechnology.

- Which are the reactants used?
- Complete the equation of the reaction



- How can we identify that the gas formed here is  $\text{CO}_2$ ?
- Which properties of  $\text{CO}_2$  are familiar to you?

Tick the correct ones given below.

- Coloured/colourless
- Supporter of combustion/not a supporter of combustion
- Has odour / odourless
- Denser than air/lighter than air
- Whether the aqueous solution of  $\text{CO}_2$  is acidic or alkaline?
- Write the chemical formulae and uses of some carbonates.

Let's examine how carbonates can be identified?

Add some dilute HCl to the given salt. If a colourless gas that turns lime water milky is formed, that salt will be a carbonate. You know that the gas formed is  $\text{CO}_2$ .

The variety of carbon compounds is essential for the existence of life on the earth. Figure 7.4 shows the ways in which carbon dioxide is exchanged over the earth. This is known as carbon cycle.



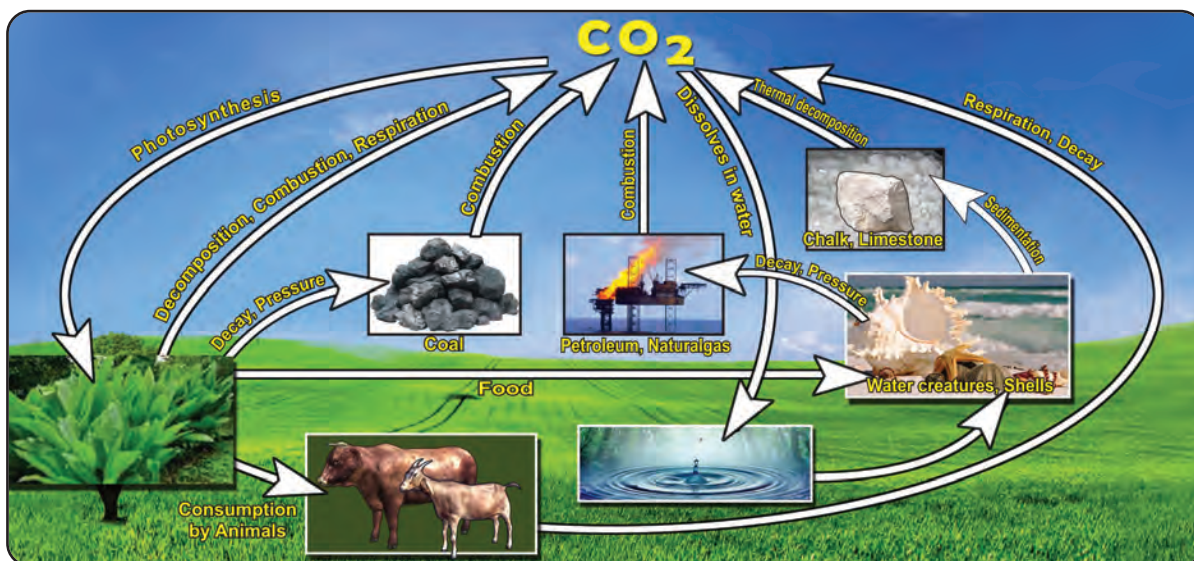


Figure 7.4

- Name the process by which carbon dioxide is utilised by plants?
- What are the activities that increase the amount of carbondioxide in air?
- Is the tremendous increase in the amount of  $\text{CO}_2$  in atmosphere advantages?

You have learnt that ultraviolet and infrared rays also reach the earth's surface along with sun rays. Infrared rays are heat radiations. Carbon dioxide present in the atmosphere traps a part of the infrared radiation that is reflected and radiated from the earth. This is responsible for the existing temperature of the earth and its atmosphere. What happens if the amount of  $\text{CO}_2$  is increased? More infrared radiations get trapped. What will be its consequences?

The process of increasing atmospheric temperature due to the increase in the amount of carbon dioxide in the atmosphere is called green house effect.

As a result of the green house effect, the average temperature of the earth and atmosphere increases. This is known as global warming.

- Discuss the consequences of global warming in the following.



## Dry Powder Fire Extinguisher



You have noticed the equipment which is kept for extinguishing fire in your school and nearby. It is an equipment which comes under the category of dry powder fire extinguisher. A chemical known as ABC dry powder is used in this device. (It is a mixture of monoammonium phosphate and ammonium sulphate). The powder sprayed by this device melts, creates a covering on the burning substance and prevents further spreading of fire. When liquids catch fire, this powder prevents the evaporation of the liquid and so it avoids the spreading of fire. This type of extinguisher are also known as DCP fire extinguisher.

- In ice layers
- In ocean islands
- In the field of agriculture
- In the climate

Suggest some measures to resist global warming effectively.

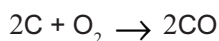
### Use of carbon dioxide

- Used in fire extinguishers.
- Used to make soda water and soft drinks.
- Used in the manufacture of washing soda and baking soda.
- Used in the manufacture of chemical fertilisers like urea.
- Used in carbogen (95% oxygen and 5% carbon dioxide) used for artificial respiration.
- The solid form of carbon dioxide (dry ice) is used as a refrigerant and also to create foggy effects in stage shows.

### Carbon monoxide (CO)

Carbon dioxide is the gas formed when carbon reacts with excess of oxygen.

However, if the relative amount of carbon increases or that of oxygen decreases, the reaction takes place as given below.



The gas formed is carbon monoxide. It is a poisonous gas.

Carbon monoxide is formed by the incomplete combustion of carbon in a limited supply of oxygen.

When carbon monoxide is inhaled, it reacts with the haemoglobin in the blood and forms carboxy haemoglobin. As a result, the oxygen carrying capacity of blood decreases leading even to death.

What measures can be taken to avoid situations that produce carbon monoxide? Discuss.

Though carbon monoxide is a poisonous gas, it has several uses. The following are some of the uses of carbon monoxide.

- Used as a gaseous fuel.
- Used to produce industrial gases like water gas ( $\text{CO} + \text{H}_2$ ) and producer gas ( $\text{CO} + \text{N}_2$ ).
- Used as a reducing agent in metallurgy.

### Carbonates and Bicarbonates

Carbonates and bicarbonates are another set of compounds containing carbon.

Washing soda ( $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ ), baking soda ( $\text{NaHCO}_3$ ) and marble ( $\text{CaCO}_3$ ) are certain compounds of this category.

### Organic Compounds

Organic compounds are carbon compounds except the inorganic compounds like  $\text{CO}$ ,  $\text{CO}_2$ , carbonates, bicarbonates etc. You know that the number of carbon compounds is very large. Let's examine why carbon is able to form such a large number of compounds.



- How many electrons are there in the outermost shell of carbon?
- What is the valency of carbon?

Carbon has four electrons in its outermost shell. So it shows the tendency to form covalent bonding. Complete the table given below.

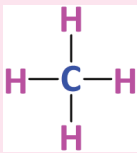
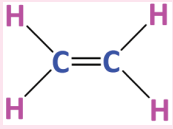

Compound	Types of covalent bonds
1. 	Single bond
2. 	.....
3. 	.....

Table 7.2





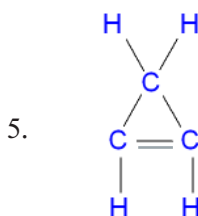
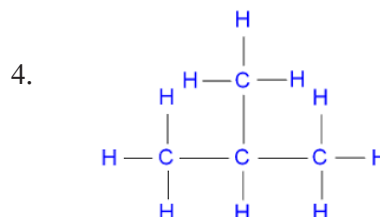
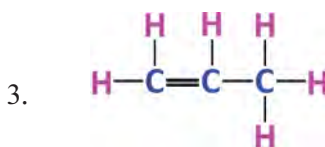
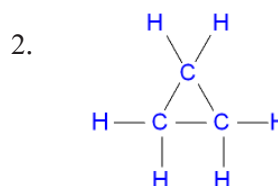
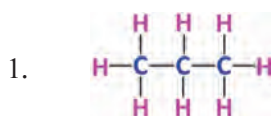
The compounds in the table belong to the category of hydrocarbons.

Hydrocarbons are compounds containing only carbon and hydrogen.

### Catenation

Catenation is the ability of the atoms of an element to combine among themselves. In comparison to other elements, the ability of carbon for catenation is very high.

Look at the structure of hydrocarbons given below.



Think whether the following characteristics are responsible for the increase in number of carbon compounds.

- Valency of carbon is 4.
- Ability of catenation is high.
- Single, double and triple bonds are possible between carbon atoms.
- Carbon atoms combine together to form many straight chain, ring or branched chain compounds.

We have understood what are hydrocarbons and also some of their characteristics. Carbon compounds have diverse properties and

complex structures. There is a separate branch of chemistry which deals with the study of carbon compounds. This branch of chemistry is called organic chemistry. You can learn more about carbon compounds, their naming and other characteristics in higher classes.



### Let's assess

1. The names of some allotropes of carbon, their properties and uses are given in the table, but not in the correct order. Match them suitably.

Diamond	electric conductor	smooth	manufacture of ornaments.
Graphite	Transparent	high refractive index	lubricant

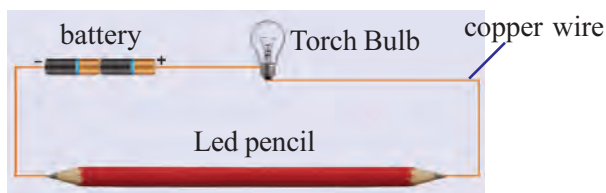
2. Some statements related to carbon monoxide and carbon dioxide are given. Classify them correctly.
  - a) formed as a result of the incomplete combustion of carbon compounds.
  - b) aqueous solution shows acidic nature.
  - c) poisonous gas
  - d) used in fire extinguishers
  - e) can be used as a fuel
  - f) formed as a result of the complete combustion of carbon compounds.
  - g) can be prepared from carbonates and bicarbonates.
  - h) is a component of producer gas and water gas.
3.
  - a) Write the chemical formula of calcium carbonate.
  - b) Which gas is formed when calcium carbonate reacts with acids?
  - c) What is the name of an aqueous solution of this gas?
4. Graphite, which is an allotrope of carbon, is a conductor of electricity. But diamond, another allotrope is not a conductor of electricity. Why?
5. Write the structure of a straight chain and a ring hydrocarbon having four carbon atoms.





### Extended activities

1. Arrange the objects as shown in the figure and conduct the experiment. Based on your observations, what is the conclusion that you reach at?

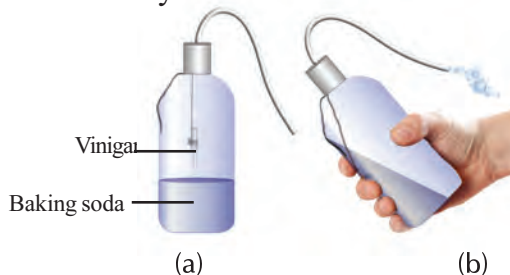


2. Lighted candles of different lengths are arranged in a trough as shown in the figure. Pour a saturated solution of sodium bicarbonate (baking soda) into the trough. Add a little vinegar to the solution. What do you observe? Give reasons for the observation.



3. Let's make a fire extinguisher.

Arrange the apparatus as shown in the figure (a). Add the vinegar contained in a test tube to the sodium bicarbonate (baking soda) solution (Figure b) by tilting the wash bottle. Introduce the resultant gas to a candle flame. Record your observation. What is your inference?



4. Construct and display the ball and stick models of some hydrocarbons.
5. Prepare a write up, on the topic "Importance of organic chemistry" and present it in your class.



## Notes

A series of horizontal dashed lines for writing notes, contained within a red rectangular border.





## Notes

A large rectangular area with a red border, containing 20 horizontal dashed lines for writing notes.







## Let's save water

Keralites mainly depend on wells as the main source of drinking water. We should conserve the wells which are the primary source of ground water in and around our locality. The contamination of such sources of water causes water-borne diseases like typhoid, cholera, jaundice etc.

Precautions to be taken to avoid contamination of ground water sources (wells)

- ▶ Do not bath or wash clothes near wells.
- ▶ Keep the well covered with nets of proper size.
- ▶ Keep the bucket and rope used to draw water clean.
- ▶ Cattle sheds, compost pits etc., should be built at least 7.5m away from wells.
- ▶ Septic tanks and toilets should be built at a safe distance away from the well.
- ▶ Prevent rain water from flowing into the well by constructing suitable walls around the well.
- ▶ Disinfect well water at adequate intervals.

### *How to disinfect well water?*

Add 2.5 g bleaching powder to 1000 litre water (approx. to size of a small match box). Allow it to settle and pour the clear liquid into the well. This well water can be used for domestic purposes after 6 hours. The following table shows the presence of certain components and their permissible quantity in drinking water. It is also essential to assess the quality of drinking water often. There are government analytical laboratories under different departments for testing the quality of water. Make use of their service.

### *The admissible amount of contents in drinking water:*

Constituent	Permissible quantity
Foul smell/taste	Nil
pH	6.5 - 8.5
Soluble content	500 mg/l
Hardness	300mg/l
Iron	0.3mg/l
Fluoride	0.6 - 1.2 mg/l
Chloride	250mg/l
Choliform bacteria	Nil

---

### **Kerala State Pollution Control Board**

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