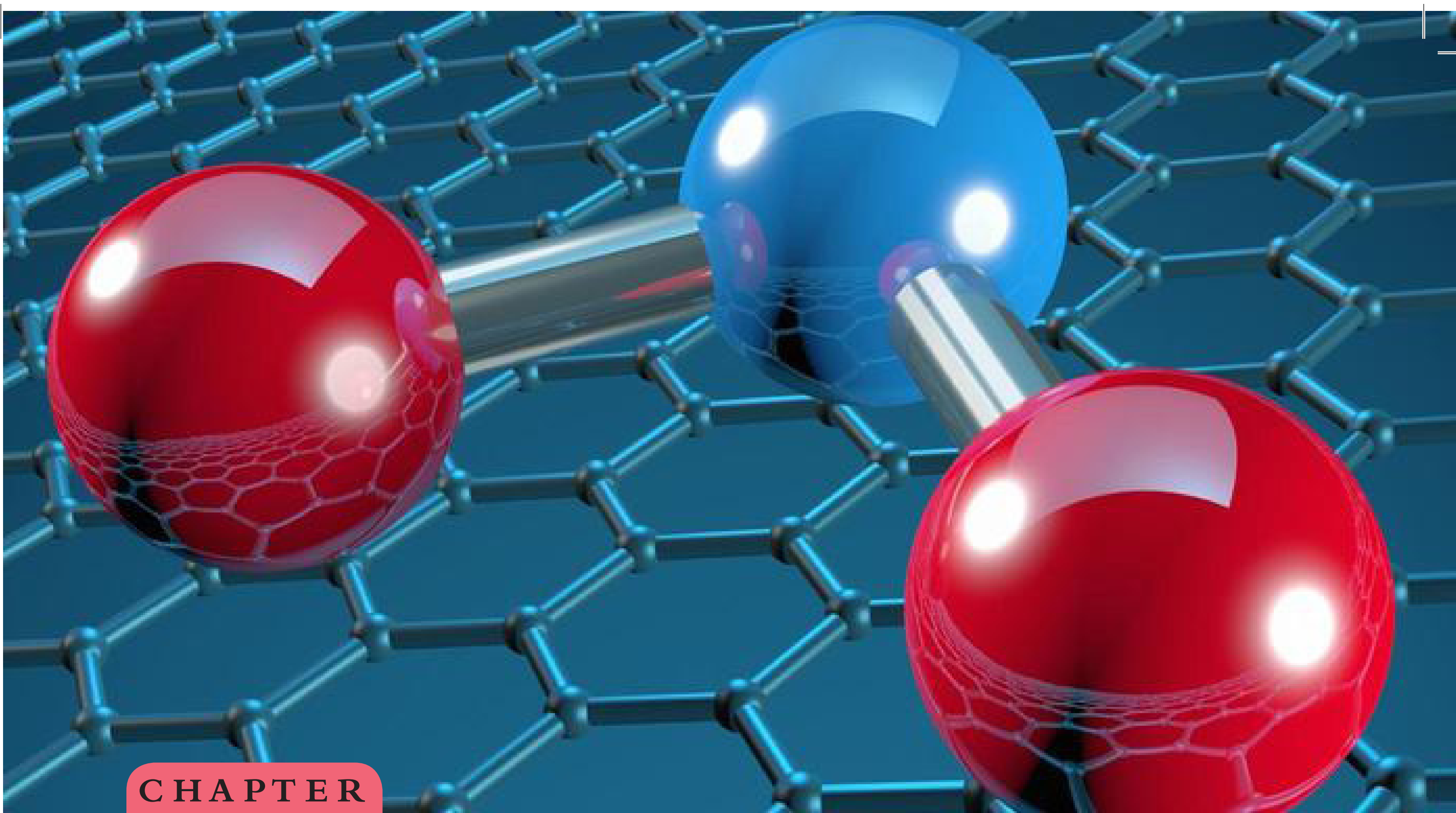


CHAPTER

3 Chemical Substances and Processes

In the previous class, we learnt some basic facts about matter and its nature. Matter exists in three states—**solid, liquid** and **gas**. All matter is made up of small particles called **atoms**. Atoms combine to form **molecules**. Materials, which are made up of same kind of particles, that is, has same atoms or molecules, are called **pure substances**. Pure substances can be further classified as 'elements' and 'compounds'.

An **element** is a pure substance which is made up of atoms of the same kind. For example, iron is an element which is made up of iron atoms.

A **compound** is a pure substance which is made up of molecules of the same kind. A molecule of a compound consists of atoms of two, or more, different elements that have combined in a fixed ratio. For example, water is a compound made up of water molecules. Each molecule of water contains two atoms of hydrogen and one atom of oxygen combined together.

In addition to elements and compounds, we also have mixtures. A **mixture** contains two or more substances mixed in any proportion. The components of a mixture are not chemically combined with each other. A mixture is, therefore, not a pure substance.

Activity 1

Classify the following materials into pure substances and mixtures.

Material	Pure Substance/Mixture
Air	
Iron	
Water	
Soil	
Lemonade	
Gold	
Oxygen	

Chemical Symbols

Chemical substances are often represented by symbols. Earlier chemists (Alchemists) used pictorial symbols to represent different elements. However, the symbols of different elements are now represented by the letters of the English alphabet.

The present day chemical symbols of some common elements are given below:

Name of the element	Symbol
Hydrogen	H
Sodium	Na
Magnesium	Mg
Aluminium	Al
Calcium	Ca
Potassium	K
Iron	Fe

Name of the element	Symbol
Copper	Cu
Gold	Au
Silver	Ag
Carbon	C
Oxygen	O
Sulphur	S
Nitrogen	N
Phosphorus	P
Chlorine	Cl
Bromine	Br
Iodine	I

Chemical Formula

The **chemical formula** of a substance is based on the composition of that substance. It indicates the type and number of atoms of each kind present in that substance.

For example, the chemical formula of water is written as H_2O. This means that a water molecule is formed by the combination of two atoms of hydrogen and one atom of oxygen.

Similarly, the formula of carbon dioxide is CO_2. This means that a carbon dioxide molecule is formed by the combination of one atom of carbon and two atoms of oxygen.

How to Write the Chemical Formula?

To write the chemical formula of a substance, the chemical symbols of all the elements are written and the number of atoms of each element is written as a subscript to the right side of its symbol. For example, nitric acid contains one atom of hydrogen, one atom of nitrogen and three atoms of oxygen. The chemical formula of nitric acid is, therefore, written as HNO_3 (one is not written as a subscript). Similarly, glucose contains six atoms of carbon, twelve atoms of hydrogen and six atoms of oxygen. Its chemical formula is, therefore, written as $C_6H_{12}O_6$.

Many substances are made up of positively and negatively charged particles, called **ions**. Let us learn to write the chemical formula of such substances. For this, we need to know the symbols and charges of the different ions present in a given substance.

For the Teacher

Tell the students that they will learn the details of this concept in higher classes. At present they only have to learn the names of some common positive and negative ions.

The names and symbols of some common ions, along with their charge, are given below:

Name of the ion	Symbol
Sodium	Na^+
Magnesium	Mg^{2+}
Aluminium	Al^{3+}
Calcium	Ca^{2+}
Hydrogen	H^+
Copper	Cu^{2+}
Iron	Fe^{2+}
Zinc	Zn^{2+}
Ammonium	NH_4^+

Name of the ion	Symbol
Chloride	Cl^-
Oxide	O^{2-}
Hydroxide	OH^-
Carbonate	CO_3^{2-}
Sulphate	SO_4^{2-}
Nitrate	NO_3^-
Acetate	CH_3COO^-
Phosphate	PO_4^{3-}

In the name of a chemical substance, made up of a positive and a negative ion, generally, the name of the positive ion is mentioned first followed by the name of the negative ion. For example, the chemical name of common salt is sodium chloride. Here, the name of the positive ion (Sodium, Na^+) is mentioned first and the name of the negative ion (Chloride, Cl^-) is mentioned afterwards. In the chemical formula also, the symbol for the positive ion is written first followed by the symbol for the negative ion. Hence, the chemical formula of sodium chloride is written as NaCl (and not as ClNa).

We summarise below the procedure followed for writing the chemical formula of a substance:

1. Symbols of positive and negative ions are written and their charge is written on the top-right corner of the symbol.
2. Common factor, if any, is removed (from the numbers) in the charges of the two ions.
3. Charges of two ions are 'criss-crossed'; these (criss-crossed) numbers are now written at the bottom-right of the symbols of the two ions. This gives us the chemical formula of the substance.

Let us take some examples to understand this.

Example 1: To write the formula of sodium oxide, we write the symbol for sodium and oxide ions along with their charges.

$$Na^{+1} \quad O^{2-}$$

There is no common factor in the numbers corresponding to their charges. We now 'criss-cross' their charges.

$$Na^{+1} \times O^{2-} \longrightarrow Na_2O_1 = \boxed{Na_2O}$$

Hence, the chemical formula of sodium oxide is Na_2O.

(**Note:** The subscript (1) is not written as a subscript in the chemical formula.)

Example 2: To write the formula of aluminium sulphate, we first write the symbols for aluminium and sulphate ions along with their charges.

$$Al^{3+} \quad (SO_4)^{2-}$$

There is no common factor in the numbers corresponding to their charges. We now criss-cross their charges and write the criss-crossed numbers as subscripts against the two symbols.

$$Al^{3+} \times (SO_4)^{2-} \longrightarrow Al_2(SO_4)_3$$

Hence, the chemical formula of aluminium sulphate is $Al_2(SO_4)_3$.

Example 3. To write the formula of calcium carbonate, we first write the symbols for calcium and carbonate ions along with their charges.

$$Ca^{2+} \quad (CO_3)^{2-}$$

Here, the common factor between the numbers corresponding to the two charges is 2. When we remove this common factor, we are left with the number 1 with both the symbols. Since the subscript 1 is not to be written, the formula for calcium carbonate would be just $CaCO_3$.

Chemical Changes

In the previous class, we have learnt that substances can undergo different types of changes. We have also learnt that these changes may be slow or fast; reversible or irreversible; physical or chemical.

Activity 2

Classify the changes given below into suitable categories.

Name of the Change	Physical/ Chemical	Slow/Fast	Reversible/ Irreversible
1. Melting of ice			
2. Burning of candle			
3. Curdling of milk			
4. Breaking of a glass			

We have already learnt that in a physical change, the substance may undergo a change in its physical state, shape, size or colour but it does not change into another substance.

During a chemical change, a substance changes into another substance. When suitable substances are mixed in appropriate amounts, they may undergo chemical interaction resulting in the formation of a new substance.

For example, when iron comes in contact with moisture and air, it gets rusted. Copper articles get coated with a green substance when exposed to moist air. Similarly, burning of wood in air converts it into ash and carbon dioxide. The process, in which a chemical change causes one substance to change into another, is called a **chemical reaction**.

Substances which undergo a chemical change in a reaction are called the **reactants** whereas the new substances which are formed are called the **products.**

Chemical Equation

We have learnt above that chemical substances can be represented by appropriate symbols. A chemical reaction, occurring between different substances, can also be represented by using appropriate symbols and formulae. The represention of a chemical reaction, using symbols and formulae of substances, involved in the reaction, is called a **chemical equation**.

When we write a chemical equation, we put the symbols of the reactants on the left-hand side and those of the products on the right-hand side. An arrow is put between them as shown below:

$$\text{Reactants} \longrightarrow \text{Products}$$

The physical state of the reactants and products is written in bracket along with their symbols. The letter 's' is used to denote solid state, 'l' for liquid, 'g' for gas and 'aq' for an aqueous solution (solution of a substance in water). For example, when carbon and oxygen react with each other, carbon dioxide is formed as a product. This reaction is represented as a chemical equation as follows:

$$\underset{\text{carbon}}{C(s)} + \underset{\text{oxygen}}{O_2(g)} \longrightarrow \underset{\text{carbon dioxide}}{CO_2(g)}$$

Balancing of Chemical Equations

A chemical equation should be balanced. A **balanced chemical equation** is that in which the number of atoms of each element are the same on both sides of the equation. In order to balance the number of atoms of various elements, on either side of the equation, the chemical formula of a substance is **not** changed. Instead, a suitable coefficient (number) is written before the formula of that substance. For example, reaction between hydrogen and oxygen gas gives water. This is written as a chemical equation as follows:

$$\underset{\text{hydrogen}}{H_2(g)} + \underset{\text{oxygen}}{O_2(g)} \longrightarrow \underset{\text{water}}{H_2O(g)}$$

Here, the number of oxygen atoms is not same on both sides of the equation. To make their number the same, the coefficient '2' is written, with the formula of water, on the right-hand side of the equation.

$$H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$$

Now, we need to balance the number of hydrogen atoms. For this, the coefficient '2' is written, with the formula of hydrogen, on the left-hand side of the equation. We now get

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$$

This is now the required balanced chemical equation for the reaction.

For the Teacher

Give more examples of balancing of simple equations like

- $2Na + Cl_2 \longrightarrow 2NaCl$
- $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

Types of Chemical Reactions

Chemical reactions can be classified into different types, depending upon the type of chemical change, occurring during the reaction. Let us study the different types of reactions one by one.

1. **Combination reaction:** A chemical reaction, in which two or more substances (reactants) combine to form a new substance (product), is called a **combination reaction**.

Combination reactions are very useful in synthesising various chemicals. For example:

(i) Combination of hydrogen and oxygen gas yields water.

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$$

(ii) Combination of nitrogen and hydrogen gas yields ammonia gas.

$$\underset{\text{nitrogen}}{N_2(g)} + \underset{\text{hydrogen}}{3H_2(g)} \longrightarrow \underset{\text{ammonia}}{2NH_3(g)}$$

2. **Decomposition reaction:** A chemical reaction, in which more than one product is obtained from a single reactant, is called a **decomposition reaction**.

For example:

(i) Breaking up of water, into hydrogen and oxygen gases, on passing an electric current, is an example of a decomposition reaction.

$$2H_2O(l) \xrightarrow{\text{electric current}} 2H_2(g) + O_2(g)$$

(ii) On strong heating, limestone (calcium carbonate) decomposes into quick lime (calcium oxide) and carbon dioxide gas.

$$\underset{\text{limestone}}{CaCO_3(s)} \xrightarrow{\text{heat}} \underset{\text{quick lime}}{CaO(s)} + \underset{\text{carbon dioxide}}{CO_2(g)}$$

3. **Displacment reaction:** A chemical reaction, in which one element displaces another in a compound, is called a **displacement reaction**.

To understand this, let us perform the following activity.

Activity 3

Take some crystals of copper sulphate in a beaker. Dissolve them in 50 ml of water. A blue-coloured solution is obtained. Put an iron nail in the solution and keep it there for 5-10 minutes.

What do you observe?

The blue colour of the solution changes into light green and a brown coating appears on the iron nail. This happens because iron displaces copper from copper sulphate and forms iron sulphate which is green in colour. Copper deposits as a brown coating on the iron nail.

The chemical equation for this reaction is given below:

$$\underset{\text{iron}}{Fe(s)} + \underset{\substack{\text{copper sulphate solution}\\ \text{(blue)}}}{CuSO_4(aq)} \longrightarrow \underset{\substack{\text{iron sulphate solution}\\ \text{(green)}}}{FeSO_4(aq)} + \underset{\text{copper}}{Cu(s)}$$

4. **Neutralisation reaction:** A chemical reaction, between an **acid** and a **base**, is called a **neutralisation reaction**. A neutralisation reaction always leads to the formation of a salt and water.

$$\text{Acid} + \text{Base} \longrightarrow \text{Salt} + \text{Water}$$

For example:

(i) the reaction between hydrochloric acid and sodium hydroxide (a base) yields sodium chloride (a salt) and water.

$$\underset{\substack{\text{sodium}\\ \text{hydroxide}}}{NaOH(aq)} + \underset{\substack{\text{hydrochloric}\\ \text{acid}}}{HCl(aq)} \longrightarrow \underset{\substack{\text{sodium}\\ \text{chloride}}}{NaCl(aq)} + \underset{\text{water}}{H_2O(l)}$$

(ii) the reaction between magnesium hydroxide (a base) and sulphuric acid yields magnesium sulphate (a salt) and water.

$$\underset{\substack{\text{magnesium}\\ \text{hydroxide}}}{Mg(OH)_2(aq)} + \underset{\substack{\text{sulphuric}\\ \text{acid}}}{H_2SO_4(aq)} \longrightarrow \underset{\substack{\text{magnesium}\\ \text{sulphate}}}{MgSO_4(aq)} + \underset{\text{water}}{2H_2O(l)}$$

Keywords

balanced chemical equation	equation having same number of atoms of each element on both sides.
chemical equation	representation of a chemical reaction using symbols and formulae of substances involved in the reaction.
chemical formula	representation of chemical composition of a substance.
chemical reaction	the process which leads to a chemical change of one substance to another.
combination reaction	chemical reaction in which two or more substances combine to form a new substance.
compound	a pure substance which is made up of molecules of the same kind.
displacement reaction	a chemical reaction in which one element displaces another in a compound.
element	a pure substance which is made up of atoms of the same kind.
mixture	is made up of two or more substances, which are mixed together in any ratio but are not chemically combined.
neutralisation reaction	a chemical reaction between an acid and a base leading to the formation of salt and water.
products	the new substances formed after a chemical reaction.
pure substances	materials which are made up of same kind of particles, that may be, atoms or molecules.
reactants	substances which undergo a chemical change in a reaction.

You Must Know

1. Materials, which are made up of same kind of particles, are called pure substances.
2. Pure substances are classified as elements and compounds.
3. An element is made up of atoms of same kind.
4. A compound is made up of molecules of the same kind.
5. Mixtures are not pure substances.

6. Chemical substances are often represented by 'symbols'; the symbols are usually derived from the name of the element itself.
7. The chemical formula of a substance represents the chemical composition of that substance.
8. In the chemical formula of a substance, the number of atoms of each element is written as a subscript with the symbol of that element.
9. Many substances are made up of positively and negatively charged particles, called ions.
10. While naming a chemical substance, made up of ions, the name of the positive ion is written first followed by the name of the negative ion.
11. To write the chemical formula of a substance (made up of ions), the charges of two ions are criss-crossed and are written as subscripts with the symbols of the ions. Common factor, if any, in the charges of the two ions, is removed.
12. During a chemical change, a substance changes into another substance.
13. The process which leads to a chemical change is called a chemical reaction.
14. Substances, undergoing change in a chemical reaction, are called reactants. The new substances, which are formed, are called the products of that chemical reaction.
15. The representation of a chemical reaction using symbols and formulae of substances involved in the reaction is called a chemical equation.
16. A balanced chemical equation has equal number of atoms of each element on both sides of the equation.
17. Chemical reactions can be classified into different types depending upon the type of chemical change occurring during the reaction. For example,
    - (i) Combination reaction: in which two or more substances combine to form a new substance.
    - (ii) Decomposition reaction: in which more than one product is obtained from a single reactant.
    - (iii) Displacement reaction: in which one element displaces another element in a compound.
    - (iv) Neutralisation reaction: in which an acid reacts with a base to form salt and water.

Something To Know

A. Fill in the blanks.

1. Materials made up of same kind of particles are called ____________.
2. The type and number of particles of each kind present in a substance is given by its ____________.
3. The chemical formula of water is ____________.
4. Iron gets rusted on coming in contact with ____________ and ____________.
5. The process that leads to a chemical change is called a ____________.
6. In a neutralisation reaction, ____________ and ____________ are formed.

B. Write True or False for the following statements.

1. All matter is made up of atoms. ☐
2. Compounds are substances consisting of two or more elements chemically combined in a fixed ratio. ☐
3. The symbol of element copper is Cu. ☐
4. Formula of sodium chloride is written as ClNa. ☐
5. The chemical formula of aluminium sulphate Al_2SO_4 is. ☐
6. New substance formed in a chemical reaction is called product. ☐
7. Magnesium hydroxide is an acid. ☐

C. Tick (✓) the correct option.

1. The chemical symbol Ag represents the element—

☐ sodium ☐ aluminium

☐ silver ☐ sulphur

2. One molecule of nitric acid is made up of—

- [ ] two atoms of hydrogen, two atoms of nitrogen and two atoms of oxygen.
- [ ] one atom of hydrogen, one atom of nitrogen and three atoms of oxygen.
- [ ] one atom of hydrogen, one atom of nitrogen and two atoms of oxygen.
- [ ] one atom of hydrogen, two atoms of nitrogen and three atoms of oxygen.

3. The chemical formula of magnesium phosphate is—

- [ ] $Mg(PO_4)_2$
- [ ] $Mg_2(PO_4)_3$
- [ ] $Mg_3(PO_4)_2$
- [ ] $Mg(PO_4)_3$

4. The following reaction is an example of a—

$$Fe(s) + CuSO_4(aq) \longrightarrow FeSO_4(aq) + Cu(s)$$

- [ ] combination reaction
- [ ] displacement reaction
- [ ] decomposition reaction
- [ ] neutralisation reaction

5. The chemical formula of quicklime is—

- [ ] CaO
- [ ] $CaCO_3$
- [ ] $Ca(OH)_2$
- [ ] $CaCl_2$

D. Answer the following questions in brief.

1. What are elements?
2. Give the chemical symbol of iron and chlorine.
3. Write the chemical formulae of the following compounds:

   (a) Aluminium oxide (b) Zinc acetate

4. Balance the following equation:

$$Ca(OH)_2 + HCl \longrightarrow CaCl_2 + H_2O$$

5. What does a chemical equation represent?
6. What are reactants and products in a chemical equation?
7. Give one example of a combination reaction.

E. Answer the following questions.

1. Write the steps involved in writing the chemical formula of calcium phosphate.

2. How is a chemical change different from a physical change?

3. 'Neutralisation reaction is a chemical change.' Justify this statement with the help of an example.

4. Define a decomposition reaction and give an example of the same.

5. Classify the following reactions into different types, giving reason.

   (a) $CaO(s) + SiO_2(g) \longrightarrow CaSiO_3(s)$

   (b) $KOH(aq) + HCl(aq) \longrightarrow KCl(aq) + H_2O(l)$

   (c) $Cu(s) + 2AgNO_3(aq) \longrightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

   (d) $BaCO_3(s) \xrightarrow{\text{heat}} BaO(s) + CO_2(g)$

Value Based Question

The school principal told her students that she would like them to follow a 'special practice' of the Japanese schools. Their schools do not keep staff members for cleaning as such. The students, themselves, work as a team and take pride in maintaing the cleanliness of their school. She went on to say that she would like them to replace their old habits by new, better habits in a way similar to a 'displacement reaction' in which one element replaces another in a compound.

1. State two values displayed by the students of Japanese schools.

2. Why did the principal tell her students that the suggested ideas, in a way, similar to what happens in a displacement reaction?

3. Give one example of a displacement reaction.

Something To Do

1. **List any five physical and chemical changes that you see around you.**

2. **Think of a small activity to show that rusting of iron requires both oxygen and water.**

CHAPTER

4 Acids, Bases and Salts

We all know that there are wide varieties of materials around us. They differ from one another in their colour, odour, taste, physical state and other properties. We often use such properties to classify substances and materials into different categories.

Some materials, like lemon, vinegar and tamarind have a sour taste. These materials taste sour due to the presence of chemicals called **acids**. Other materials, like baking soda and soap, have a bitter taste. It is due to the presence of chemicals called **bases**.

Caution: It is dangerous to taste any unknown substance, either at home, or in school.

The term acid has been derived from the Latin word '*acidus*', which means 'sour'. All sour-tasting materials contain acids. Acids are classified into two categories:

- ## Mineral Acids

  Acids, which are prepared from the minerals present in the earth, are called **mineral acids**. Hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3), sulphurous acid (H_2SO_3) and phosphoric acid (H_3PO_4) are some of the well-known mineral acids.

Do You Know?

Sulphuric acid is often known as the 'King of Chemicals.' It is used in the manufacture of a wide variety of materials.

Organic Acids

Acids, which are naturally occurring and are found in plants and animals, are called **organic acids**. Many fruits and vegetables contain organic acids. For example, guava contains oxalic acid. Orange, lemon and *amla* contain citric acid. Grapes, tamarind and gooseberries contain tartaric acid. Sour milk contains lactic acid. Vinegar contains acetic acid (CH_3COOH).

These contain citric acid

These contain tartaric acid

Sting of bees, red ants, wasps and stinging nettle contain formic acid ($HCOOH$) which causes a shooting pain.

Acids, like hydrochloric acid, nitric acid, sulphuric acid and phosphoric acid, are strong acids. Acids, like citric acid, acetic acid, carbonic acid and formic acid, are weak acids. We will learn more about strong and weak acids in higher classes.

Acids, manufactured in the factories, are highly concentrated, that is, the water content in them is very low. Their concentration can be decreased by adding water to them. Acids, having a low concentration, are called **dilute acids**.

For the Teacher

Explain to the students that concentrated acid must always be diluted by adding acid to water slowly and not by adding water to acid directly.

Do You Know ?

Gases, like carbon dioxide, sulphur dioxide, nitrogen dioxide, etc., are released in the air by factories, power houses and automobile exhausts. These gases mix with rain water and form acids. Rain water, thus, becomes acidic. When this 'acid rain' falls on buildings, made of marble (which is calcium carbonate), the acid reacts with marble. Acid rain is the main cause of yellowing of Taj Mahal. Buildings and monuments, made of marble, (like Taj Mahal), thus, get affected by the action of 'acid rain'.

Bases and Alkalies

Bases are substances which react with acids to form water and salt. Bases are bitter in taste and have a soapy feel.

Some bases are soluble in water. Such bases are called **alkalies**. For example, sodium hydroxide and aluminium hydroxide are both bases. However, sodium hydroxide is also termed as an alkali because it is soluble in water.

Some bases, like sodium hydroxide ($NaOH$) and potassium hydroxide (KOH) are strong bases. Others, like ammonium hydroxide (NH_4OH), aluminium hydroxide ($Al(OH)_3$) and copper hydroxide ($Cu(OH)_2$), are weak bases.

Indicators

Acids and bases can be identified not only through their taste but also with the help of substances called **indicators**. An **indicator** is a substance which shows different colours in an acidic and a basic medium. The colour of the indicator can, thus, help in identifying acids and bases.

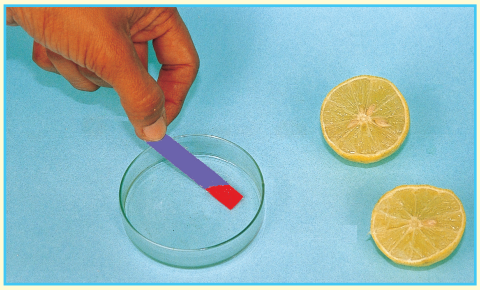
An indicator, used very often, is litmus. It is obtained from lichens and is purple in colour. Its colour changes to red in an acidic medium and to blue in a basic medium.

Litmus can be used as an indicator in the form of a solution. In practice, it is more common to use a paper strip that has been dipped in litmus solution and allowed to dry. Such a paper strip is called **litmus paper**.

Let us now perform two activities to understand how litmus can be used to identify an acid and a base.

Activity 1

Take some lemon juice in a petridish and dip a strip of blue litmus paper in it. The colour of the litmus paper changes to red due to the presence of an acid in the lemon juice.



Activity 2

Take some soap solution in a petridish and dip a strip of red litmus paper in it. The colour of litmus changes to blue. This happens due to the presence of a base in the soap solution.

Turmeric can also act as an indicator. It turns red in a basic medium and remains yellow in an acidic medium. Have you ever noticed what happens when soap is rubbed on a turmeric stain on your handkerchief or shirt?

Juice of China rose (Hibiscus) petals can also be used as a natural indicator. It turns dark pink (magenta) when added to an acid and turns green when added to a base.

Another commonly used indicator is phenolphthalein. It is colourless in an acidic medium and turns pink in a basic medium.

Neutralisation and Formation of Salts

A chemical reaction between an acid and a base is known as a **neutralisation reaction**. When such a reaction takes place, water and salt are formed. During neutralisation, the acid and the base 'cancel' the effect of each other.

Let us perform an activity to understand the process of neutralisation.

Activity 3

Take 10 ml of dilute hydrochloric acid in a conical flask and add two drops of (blue) litmus solution to it. It turns red [see Fig. (i)]. Now, add a solution of sodium hydroxide, drop by drop, to the flask and keep on swirling the solution constantly while the addition is being done. At some point, addition of another drop of base (sodium hydroxide) to the flask, would change the colour of solution from red to blue (see Fig. (ii)). This happens when all the acid in the flask has been neutralised by the base and addition of an extra drop of base make the solution basic. Hence, the colour of solution changes to blue.

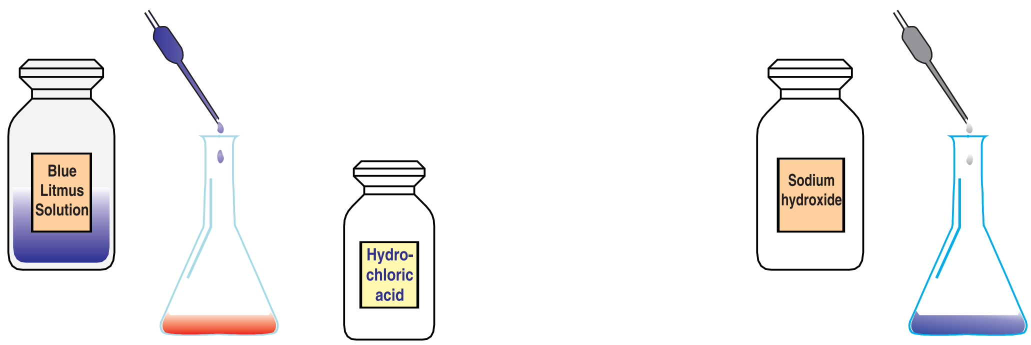


Fig. (i) Fig. (ii)

Do You Know ?

Hydrochloric acid, present in small quantities in our stomach, helps in digestion of food. However, when an excess of this acid gets secreted in the stomach, it causes uneasiness, nausea and pain. To cure this problem, we have to take medicines, called **antacids.** These contain a mild base which 'neutralises' the excess acid present in the stomach.

Some examples of neutralisation reactions are given below in the form of chemical equations:

$NaOH$ Sodium hydroxide (Base)	+	HCl Hydrochloric acid (Acid)	$\longrightarrow$	$NaCl$ Sodium chloride (Salt)	+	H_2O Water
$2KOH$ Potassium hydroxide (Base)	+	H_2SO_4 Sulphuric acid (Acid)	$\longrightarrow$	K_2SO_4 Potassium sulphate (Salt)	+	$2H_2O$ Water
$Mg(OH)_2$ Magnesium hydroxide (Base)	+	$2HNO_3$ Nitric acid (Acid)	$\longrightarrow$	$Mg(NO_3)_2$ Magnesium nitrate (Salt)	+	$2H_2O$ Water

Naming of Salts

The salts of different acids are named as follows:

- Salts of sulphuric acid (H_2SO_4) are named as **sulphates**.
- Salts of hydrochloric acid (HCl) are named as **chlorides**.
- Salts of nitric acid (HNO_3) are named as **nitrates**.
- Salts of sulphurous acid (H_2SO_3) are named as **sulphites**.
- Salts of carbonic acid (H_2CO_3) are named as **carbonates**.
- Salts of acetic acid (CH_3COOH) are named as **acetates**.

For example, $CaSO_4$ is a salt formed from calcium hydroxide and sulphuric acid. It is named as calcium sulphate. Similarly, $NaNO_3$ is named as sodium nitrate; NaCl is named as sodium chloride; Na_2SO_3 is named as sodium sulphite; Na_2CO_3 is named as sodium carbonate and CH_3COONa is named as sodium acetate.

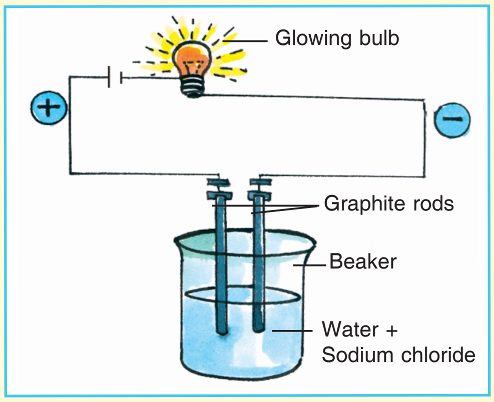
Properties of Salts

1. Salts are formed through reactions between acids and bases.
2. Most of the salts are readily soluble in water.
3. Salts do not conduct electricity in their solid state. However, molten salts and solution of salts in water conduct electricity.

Let us now perform an activity to show that solutions of salts, in water, can conduct electricity.

Activity 4

Take a beaker and fill it half with water. Dissolve some common salt (sodium chloride) in this water. Connect two graphite rods with the two terminals of a battery, with a zero watt LED bulb in between, as shown in the figure. Now dip these graphite rods in the solution of sodium chloride. The bulb starts glowing indicating the flow of electric current. This shows that a solution of sodium chloride can conduct electricity.



Classification of Salts

Salts are classified as neutral, acidic and basic.

Neutral Salts

Salts, formed by the reaction of a strong acid with a strong base, are **neutral salts**. Solution of a neutral salt in water is neutral, that is, it is neither acidic nor basic. Hence, such a salt solution does not change the colour of the litmus paper.

Sodium chloride (NaCl) is a neutral salt as it is formed by the reaction of a strong acid (HCl) and a strong base (NaOH). KCl, KNO_3, Na_2SO_4 are some other examples of neutral salts.

Activity 5

Take a solution of sodium chloride in water in a petridish. Dip a strip of blue litmus paper in the solution. What do you observe? The colour of litmus paper does not change. Next, dip a strip of red litmus paper in this solution. The colour of litmus paper again does not change. This shows that the solution is neither acidic nor basic, that is, it is neutral.

Acidic Salts

Salts, formed by the reaction of a strong acid and a weak base, are **acidic salts**. Solution of an acidic salt in water is acidic, that is, it would changes the colour of blue litmus paper to red.

Aluminium chloride ($AlCl_3$) is an acidic salt as it is formed by the reaction of a strong acid (HCl) and a weak base ($Al(OH)_3$). NH_4NO_3, $ZnSO_4$, $CuCl_2$ are some other examples of acidic salts.

Activity 6

Take a solution of aluminium chloride in water in a petridish. Dip a strip of blue litmus paper in the solution. The colour of litmus paper changes to red. This shows that the solution of this salt is acidic in nature.

- ## Basic Salts

Salts, formed by the reaction of a weak acid and a strong base, are **basic salts**. Solution of a basic salt in water is basic, that is, it changes the colour of red litmus paper to blue.

Sodium acetate (CH_3COONa) is a basic salt as it is formed by the reaction of a weak acid (CH_3COOH) and a strong base ($NaOH$). CH_3COOK, $HCOONa$, Na_2CO_3 are some other examples of basic salts.

Activity 7

Take a solution of sodium acetate in water in a petridish. Dip a strip of red litmus paper in the solution. The colour of litmus paper changes to blue. This shows that the solution of this salt is basic in nature.

Keywords

acids	chemicals which are sour in taste.
alkalies	bases which are soluble in water.
acidic salts	salts formed by the reaction of a strong acid and a weak base.
bases	chemicals which have a bitter taste and a soapy feel.
basic salts	salts formed by the reaction of a weak acid and a strong base.
indicator	a substance which shows different colours in an acidic and a basic medium.
mineral acids	acids which are formed from the minerals present in the earth.
neutralisation reaction	a reaction, between an acid and a base, resulting in the formation of salt and water.
neutral salts	salts formed by the reaction of a strong acid with a strong base.
organic acids	naturally occuring acids that are found in plants and animals.

You Must Know

1. Materials around us differ from one another in their colour, taste, physical state and other properties.
2. Some materials taste sour due to the presence of chemicals called acids. Some other materials have a bitter taste and a soapy feel, and are called bases.
3. Acids are classified as mineral acids and organic acids.
4. Mineral acids are formed from the minerals present in the earth. Acids, like hydrochloric acid, sulphuric acid, etc., are mineral acids.
5. Naturally occurring acids are called organic acids. Acids, like acetic acid, lactic acid, citric acid, etc., are organic acids.
6. Acids may be strong (like hydrochloric acid), or they may be weak (like acetic acid).
7. Acids, manufactured in factories, are highly concentrated. They are mixed with water to lower their concentration. Acids of low concentration are called dilute acids.
8. Bases, which are soluble in water, are called alkalies.
9. Some bases (like sodium hydroxide) are strong bases. Some other bases (like ammonium hydroxide) are weak bases.
10. Acids and bases can be identified with the help of substances called indicators.
11. The indicators show different colours in an acidic and a basic medium.
12. Litmus (paper or solution), turmeric, China rose and phenolphthalein are some of the indicators that are used very often.
13. A chemical reaction, between an acid and a base, is known as a neutralisation reaction.
14. During neutralisation reaction, salt and water are produced.
15. Most of the salts are readily soluble in water. Salts do not conduct electricity in their solid state. Salts conduct electricity in their molten state and in the form of their solution in water.
16. Salts are classified as neutral, acidic and basic.
    - Neutral salts are formed by reaction of a strong acid and a strong base.
    - Acidic salts are formed by the reaction of a strong acid and a weak base.
    - Basic salts are formed by the reaction of a weak acid and a strong base.

Something To Know

A. Fill in the blanks.

1. Acids which are present in plants and animals are called ______________.
2. Bases taste ______________ and have a ______________ feel.
3. Acids turns the colour of blue litmus paper to ______________.
4. The products of neutralisation reaction are ______________ and ______________.
5. Salts of nitric acid (HNO_3) are named as ______________.
6. Sodium acetate (CH_3COONa) is a basic salt formed by the reaction of ______________ and ______________.

B. Match the following:

1. Lemon juice	(a) Oxalic acid
2. Tamarind	(b) Lactic acid
3. Vinegar	(c) Citric acid
4. Red ants	(d) Acetic acid
5. Sour milk	(e) Tartaric acid
6. Guava	(f) Formic acid

C. Tick (✓) the correct option.

1. Bases have a—

☐ bitter taste and a rough feel ☐ sour taste and a rough feel

☐ bitter taste and a soapy feel ☐ sour taste and a soapy feel

2. An example of a natural indicator is—

☐ methyl orange ☐ ink

☐ phenolphthalein ☐ litmus

3. An acid, that contributes to the sour taste of some fruits, is—

- [ ] hydrochloric acid
- [ ] sulphuric acid
- [ ] citric acid
- [ ] nitric acid

4. Which of the following is a strong acid?

- [ ] acetic acid
- [ ] citric acid
- [ ] nitric acid
- [ ] carbonic acid

5. Substances, produced through a chemical reaction between acids and bases, are known as—

- [ ] salts
- [ ] indicators
- [ ] antacids
- [ ] alkalies

6. An indicator, that turns red in a basic medium, is—

- [ ] turmeric
- [ ] phenolphthalein
- [ ] blue litmus
- [ ] hibiscus

7. The general taste, of acids and bases, is respectively—

- [ ] sweet and salty
- [ ] sour and salty
- [ ] sour and sweet
- [ ] sour and bitter

D. Answer the following questions in brief.

1. What are mineral acids?
2. Give two examples each of mineral acids and organic acids.
3. Name any two substances that can be used as indicators.
4. Write the meaning of the term 'neutralisation reaction.'
5. Give any two properties of salts.
6. Classify the following salts as neutral, acidic or basic. Also, write their names.

   (a) Na_3PO_4

(b) K_2CO_3

(c) NH_4NO_3

E. Answer the following questions.

1. 'All alkalies are bases but all bases are not alkalies'. Justify this statement.

2. Suggest an activity that can help one to decide whether a given solution is acidic or basic in nature.

3. Write chemical equations for the following reactions:

   (a) Calcium hydroxide reacts with nitric acid.

   (b) Acetic acid reacts with calcium hydroxide.

   (c) Hydrochloric acid reacts with sodium hydroxide.

   (d) Ammonium hydroxide reacts with sulphuric acid.

4. State the difference between neutral, acidic and basic salts. Give one example of each.

5. Describe an activity to show that solutions of salts, in water, can conduct electricity.

Value Based Question

The Physical Training (PT) teacher noticed that two of her students were having very heated arguments with each other. She immediately went to them, calmed them down and made them sit together. She listened patiently to both of them and then explained to them the merits, of the 'other point of view' and the importance of 'team work'. The students agreed to follow her advice and instructions.
The chemistry teacher, who was watching all this, remarked that she sees a lot of similarity between the role of the PT teacher and the 'neutralisation reactions' between acids and bases.

1. State the values displayed by the PT teacher.

2. Do you agree with the remarks of the chemistry teacher? Give reason.

3. Write the chemical equations for two neutralisation reactions, giving names of all the compounds relevant to the reaction.

Something To Do

1. **Common names of some substances are given below. Find out the chemical formulae, chemical names and the uses of these substances, and write them in the table given below:**

Common Name	Formula	Chemical Name	Use
Caustic soda			
Caustic potash			
Baking soda			
Washing soda			
Limestone			
Quicklime			
Lime water			
Plaster of paris			
Blue vitriol (*neela thotha*)			

2. **Solve the crossword puzzle with the help of the clues given below:**

Across →

1. A basic salt present in washing powders.

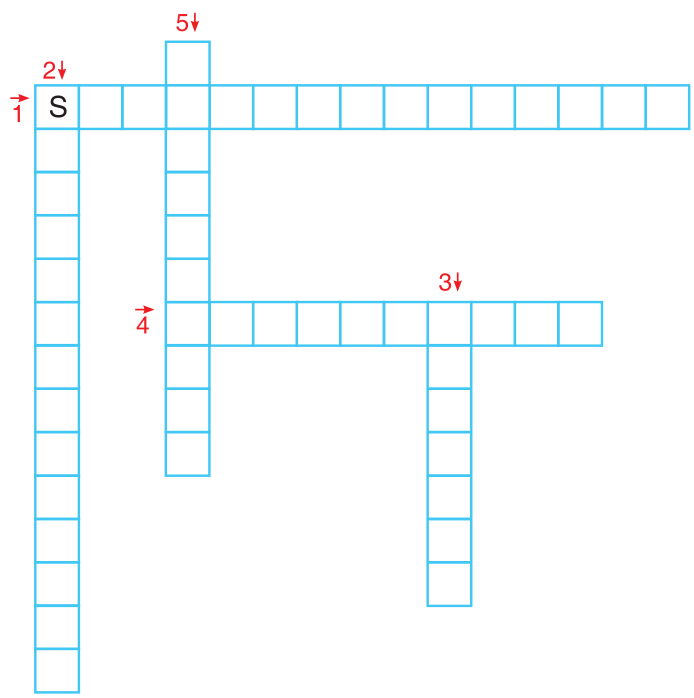
4. A weak acid present in vinegar.

Down ↓

2. An acid whose salts are called sulphites.

3. A substance used to reduce acidity in our stomach.

5. An acid present in oranges and lemons.



3. **Some acids, bases and salts are commonly used in our daily life. Find out the names of such substances, specify whether they are acids, bases or salts and write their uses.**

5 Heat

We are all familiar with the sensations of 'hot' and 'cold'. On a hot summer day, we find it uncomfortable to walk barefoot on a cemented floor, as it is too 'hot'. During winter months, we will find that very floor as being too 'cold'.

We express the degree of hotness of a body through its **temperature**. The more is the temperature of a body, the hotter it is and vice-versa.

Heat as Energy

We know from our daily experience, that a bottle of ice-cold milk, left on a table on a hot summer day, soon warms up. A glass tumbler, of boiling-hot milk, kept on the same table, cools down after a while. It shows that when the temperatures of a body and its surroundings are different, there is a transfer of energy between the body and its surroundings. This transfer continues till the body and its surroundings attain the same temperature. In the case of ice-cold milk bottle, heat flows from the surroundings to the bottle; in the case of boiling-hot milk tumbler, it flows from the glass tumbler to the surroundings. Based on such experiences, we say that:

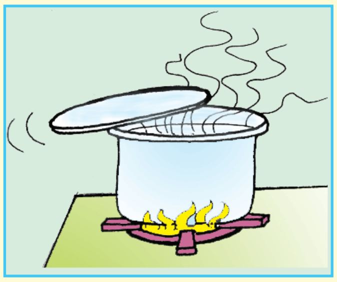
1. Heat is a form of energy (heat energy/thermal energy), that is transferred from one body to another, due to the existence of a temperature difference between them.

2. Transfer of heat energy/thermal energy always takes place from the body at a higher temperature to that at a lower temperature.

Let us now perform an activity which shows that heat is a form of energy and it can be converted into other forms of energy.

Activity 1

To show that we can get other forms of energy from heat.



Take a vessel half filled with water. Cover it with a light aluminium lid and heat it over a flame. We will see that the water starts boiling after a while. The lid then 'rises up', and 'falls down', again and again. Here, the steam (formed by the heated water) could raise the lid. It, therefore, does mechanical work. This shows that heat is a form of energy and it can be used to do mechanical work.

Do You Know?

In early days, heat was considered as a fluid (liquid) that flowed from a hotter body to a colder body. This (weightless and colourless) fluid was called the '**calorific**'. This theory was shown to be incorrect by the experiments of physicists, like Davy, Count Rumford and Joule, who showed that heat is just a form of energy.

Heat and Temperature

We often observe that when we heat a body, its temperature rises. This indicates that heat and temperature are related to each other. Heat is the **energy** of a body that is due to the motion of its constituents particles (molecules). Temperature, on the other hand, is just an **indicator** of this energy. Even a cold object possesses **heat energy** due to the motion of its particles (molecules). When we add, (or remove) heat (from) a body, motion of its molecules becomes **faster** (or **slower)**.

Effects of Heat

When a body is heated, various types of physical and chemical changes are observed to take place. We list below some of the main effects of heat.

Physical changes

(a) **Change in temperature:** We all know that addition, or removal, of heat to, or from, a body brings about a change in its temperature. Addition of heat to a body (usually) raises its temperature, whereas, removal of heat, from a body (usually), lowers its temperature.

(b) **Change of state:** Under appropriate conditions, addition, or removal, of heat to, or from, a body, can also bring about a change in its state. For example, on putting a tray of water (liquid form) in the freezer compartment of a refrigerator, the water freezes to form ice. Ice, as we know, is the solid form of water. Similarly, when water is heated over a flame, it starts boiling and gets converted into steam. Steam, as we know, is the gaseous or vapour form of water.

(c) **Thermal exapansion:** Most of solids, liquids and gases, are known to expand on heating. This phenomenon is called **thermal expansion**. For example, the metal rim, to be put on a cart wheel, is designed to have a (slightly) smaller diameter than that of the wheel. When this rim is heated, it becomes 'red-hot', expands, and slips on to the wheel easily. When it is cooled, it contracts and grips the wheel firmly.

Chemical changes

Many chemical changes take place only when the reactants are heated up. For example, we can prepare oxygen, in the laboratory, by heating potassium chlorate (along with manganese oxide as a catalyst) over a flame.

Do You Know?

It is interesting to note that ice and cast iron are two of the few solids that contract on heating. Cold water, at 4°C, is known to expand on cooling. This special property of water helps us to understand (i) why water pipes sometimes burst at very cold places and (ii) a soft drink glass bottle often cracks when left in the freezer compartment for a long time. It is also linked with the survival of aquatic animals even at places where the (surrounding) atmospheric temperature goes down well below 0°C.

Measurement of Temperature

We now know that heat is a form of energy and temperature is an indicator of that energy. We often feel that we can get 'an estimate' of the temperature of a body by just touching it. However, though our senses do give us an idea of temperature, they are often unreliable and misleading. For example, if we remove an ice tray, and a packet of frozen vegetables, from the freezer compartment, the ice tray may appear colder to our hand even though both are at the same temperature.

We, therefore, need a more reliable method to know the relative hotness or coldness, i.e. the temperature of a given body. We use special instruments for this purpose. All such instruments, or devices, are known as **thermometers**.

Activity 2

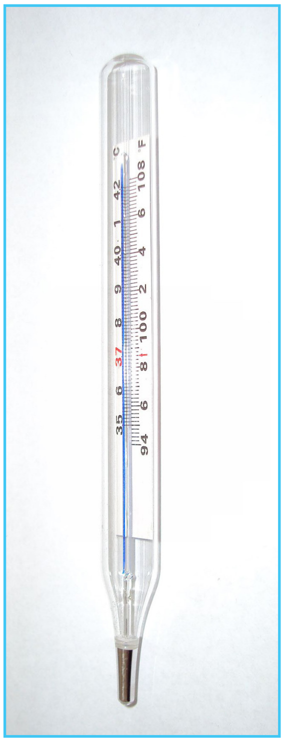
To get an idea about the importance of determining temperature accurately.

List your ideas, about the 'needs' of different persons, to know the temperature of different objects accurately. Jot down your ideas in a tabular form as shown below.

Person who needs to know temperature	The likely purpose
1. A Parent	
2. A Child	
3. A Doctor	
4. A Farmer	
5. A Mechanic	
6. A Pilot	
7. A Weather Reporter	
8. A Cook/Chef	
9. A Cricket Official	
10. A Tourist	

The Thermometer

We find that many of the physical properties, (like thermal expansion, pressure, volume) of different materials, change with temperature in a regular and systematic manner. We can, therefore, use these properties as a way of measuring temperature. The simplest thermometer, with which we all are familiar, is the **mercury in glass thermometer**. It is based on the thermal expansion of mercury. This thermometer is shown in the figure here.



Glass Thermometer

It consists of a narrow capillary tube of glass that is closed at its upper end and has a bulb at its lower end. The bulb is filled with mercury. Inside the capillary tube we can see a small shining thread of mercury. The mercury, present in the bulb of the thermometer, expands when heated. The extent of its expansion, and, therefore, the length of mercury thread in the capillary tube, depends on the extent of heating of the thermometer. This, in turn, depends on the temperature of the object with which the thermometer bulb has been put in contact. The length of the mercury thread (in the thermometer) can, thus, give us a measure of the temperature of the object.

Do You Know?

Mercury expands in a uniform way, and also remains in its liquid state, over a wide temperature range. It also does not stick to the walls of the glass capillary tube and is a shining silvery liquid. It is because of these reasons that mercury is often used in ordinary thermometers.

Reading a thermometer

For measurement purpose, the temperarture scale is calibrated to assign a numerical value to a given temperature. Depending on the purpose, and use, of a thermometer, two fixed reference points (lowest temperature and highest temperature) are choosen. The difference, in the temperature of the two fixed reference points, is called the **range** of the thermometer. The interval, between these fixed points, is divided into an equal (fixed) number of divisions.

Two scales, that have been in common use, are the **Fahrenheit** and the **Celsius scales**. Most of the countries now use the Celsius scale to measure the temperature of an object. Our school laborartory thermometer is one such thermometer.

Do You Know?

The temperature 'T' in degrees celsius (°C) is equal to the temperature 'T' in degrees Fahrenheit (°F) minus 32, times 5/9. T (°C) = [T (°F) – 32] × 5/9.

Comparison of Fahrenheit (°F) and Celsius (°C) scale readings

Normal room temperature	23°C	72°F
Normal human body temperature	36.9°C	98.4°F
Water boils at	100°C	212°F
Water freezes at	0°C	32°F

The range of a laboratory thermometer can be from –10°C to 110°C.

Thermometers, in the range 0°C to 100°C, are found more often in school laboratories.

Activity 3

To find the range and least count of different thermometers.

Record your observations in a tabular form as shown below:

Thermometer	Range (°C)	Least Count (°C)
1.		
2.		
3.		
4.		

Least count of measuring instrument is the smallest quantity that can be measured as per the calibration of that instrument.

$$\text{Least Count of an instrument} = \frac{\text{difference between two marked readings}}{\text{total number of division between them}}$$

Clinical Thermometer

We use a specially designed, and calibrated, (mercury in glass) thermometer to measure our body temperature. Such a thermometer is known as the **clinical,** or **doctor's, thermometer**.

The clinical thermometer differs, from an ordinary (mercury in glass) laboratory thermometer, in two respects:

(i) It is calibrated from 35°C to 42°C only. This is so because this is the range over which the temperature of the normal human body can vary.

(ii) It has a slight 'bend', or kink, in its capillary tube. This kink is given the name **constriction**.

The constriction ensures that mercury thread does not fall back, by itself, after this thermometer has been used to measure the temperature of a person. The reading can, therefore, be taken conveniently. This would not be the case if an ordinary laboratory thermometer was used for this purpose.

Do You Know?

- The normal human body temperature is the average body temperature of a large number of healthy persons. It is quite close to 36.9°C (or 98.4°F). A body temperature close to 40°C (or 104°F) indicates a condition of 'high fever.'
- Now a days Digital (electronic) thermometers are preferred over the conventional mercury thermometers. These thermometers are easy to read as they give a 'LCD display' of the temperature of the person. They are also mercury free.

Activity 4

To measure the human body temperature using a clinical thermometer.

Before measuring the body temperature, wash the thermometer with an antiseptic solution. Hold it firmly and give it a few jerks. The jerks will bring the level of mercury below 35°C. Now place the thermometer gently under the tongue of the person being observed. Let it remain there for about one minute. Now take out the thermometer and note its reading. While reading, keep the line of sight along the convex meniscus of the level of mercury in the thermometer. This is the body temperature of the person under observation.

Caution: The person, under observation, must close her/his mouth, around the thermometer bulb, very gently. The bulb should not break as any amount of mercury, going inside the body, can prove quite dangerous. Also, NEVER put the thermometer in the mouth of a child.

Repeat these steps for several persons.

Record your observations in a tabular form.

S.No.	Name	Body Temperature (°C)
1.		
2.		
3.		
4.		
5.		
6.		

Transfer of Heat

We often observe the transfer of heat from a hot body to a cold body. Simple situations, like the ones given below, indicate such a heat transfer.

(i) When one end of a metal rod is put in a flame, its other end also soon becomes very hot.

(ii) When a glass of hot water is left on a table, it becomes lukewarm after some time.

(iii) When a metal chair is left out in the sun, on a hot summer day, it becomes too hot to sit on.

In all these cases, transfer of heat takes place, with the hot object losing some of its heat, and the cold object gaining the 'heat'. We, therefore, say that there is a (net) transfer of heat from the hot object to the cold object.

In nature, there are three different methods of transfer of heat. They are known as **conduction**, **convection** and **radiation**. Let us understand them one by one.

Conduction

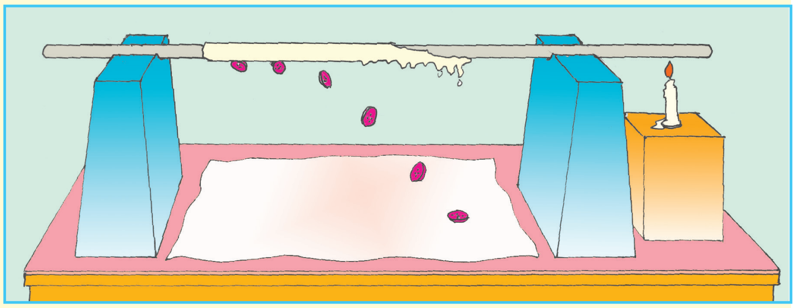
This is the most significant method of transfer of heat in solids. In this method, heat is transferred from one particle (molecule), of the object, to the next, and then to the next, and so on, without the particles leaving their places. The particles just vibrate about their mean positions, and keep on passing heat energy, to their 'next-in-line' neighbours.

We can perform a simple activity to observe this method of heat transfer.

Activity 5

Take a metal rod. Coat it with a thick layer of (softened melted) wax. [Do the coating carefully without letting the (hot) melted wax to cause any burns (A suitable spatula/ rod may be used for this purpose)]. Fix some small buttons, on the wax, at regular intervals of, say, 5 cm each. Allow the wax to solidify and harden up.

Fix the rod on two metal stands and heat the rod at one of its two ends. After sometime, we will observe that the buttons start falling down, one by one, from the side being heated up. This happens because of the transfer of heat, through the metal, and subsequent (sequential) melting of the wax.



Let us now see whether heat energy is able to 'go along' easily through all solids. We know that when we put one end of a metal rod in a flame, its other end also soon becomes too hot to touch. This shows that heat 'goes through' quickly along a metal rod. Metals are, thus, good **conductors** of heat.

On doing the same experiment, with a wooden rod, we find that the end of the wooden rod held by us, does not become hot even after a long time while the (other) end may well have burnt out by then. This shows that heat cannot easily 'go along' a wooden stick. Wood is, thus, a **bad conductor** of heat. Bad conductors of heat are also known as (heat) **insulators**.

All metals are good conductors of heat with some of them better than the others. Wood, ebonite, cotton, plastic, cork, thermocole, air and water are all bad, or poor, conductors of heat, i.e. they are 'heat insulators.'

We put both good and bad conductors to many uses in our daily life. For example,

1. We use metals to make cooking utensils. Metals, being good conductors, quickly transfer the heat of the flame to the food items kept inside. The food items then get heated up and cooked. Metals are also used for making kettles, boilers and boiler tubes, for the same reason.

2. We use wooden, or plastic, handles for holding tea kettles, or cooking utensils. These handles help us to hold them even when the objects themselves are quite hot. This is because, being insulators, they do not let the heat to get transferred to our hands.

3. Use of bricks and mud, for making houses, helps to shield us from the heat of the sun during summer. These materials are bad conductors of heat and hence, do not let the outside heat to reach easily inside the house. We can now also understand why rooms, with tin roofs, often become very hot during summer.

4. Air is known to be a bad conductor of heat. Blankets, woolen clothes, and quilts, help us to stay warm in winter. They all make use of the bad conductivity of air. They trap a layer of air between themselves and our body. (Such trapping of air is much better in a new quilt than in an old one). Our body heat, then, does not easily escape out, through this trapped air layer, and we stay warm.

5. Ice boxes are often made as double walled containers. The layer of air, trapped between the two walls, does not easily let the outside heat reach the ice, kept inside the box. The ice, therefore, does not melt quickly.

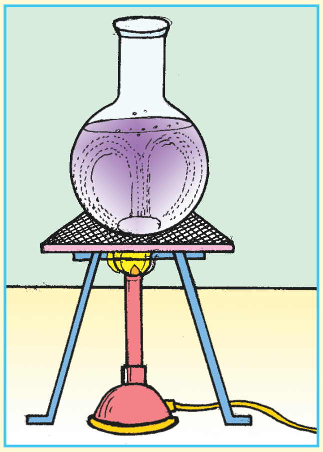
Convection

We have noted above that water is a poor conductor of heat. How does then, the water, put in a kettle, get heated up when it is put over a flame?

The molecule in liquids (and gases) are quite free to move. This is unlike solids whose molecules are quite rigidly fixed. It is this ability of liquid molecules (to move around) that causes a liquid to get heated up. We call this method of heat transfer, in liquids (and gases), as **convection**. To see how heat is transferred, by convection, let us look at a simple activity.

Activity 6

Take a round bottom flask and fit it in a stand. Now, take a tripod stand with a wire gauge on top of it. Keep the flask over the wire gauge, kept on top of the tripod stand. Half fill the flask with water and put some crystals of potassium permanganate into it. Now put a burner below the tripod stand, light it up and start heating the flask.



We will soon observe streaks of colour, moving up, and then coming down. This cyclic movement, of coloured streaks, will continue for a while. Soon the whole water acquires colour; it also get heated up.

How do we understand this cyclic movement of the coloured streaks in water? The water at the bottom of the flask, gets heated up first. As a result, it becomes lighter. As the water molecules are free to move, these heated up (lighter) molecules (coloured by contact with the potassium permanganate crystals) move up. The colder, and heavier, molecules at the top, then move down to take the place vacated by these molecules. It is these movements that we see in the form of the coloured streaks 'going up and down.' Because of these movements, the whole water soon gets heated up.

Liquids, and gases too, are, thus, seen to transfer heat throughout their volume, by the (actual) movement of their molecules. We call this method of heat transfer as **convection**. We often refer to these cyclic movements of molecules, in liquids and gases, as **convection currents**.

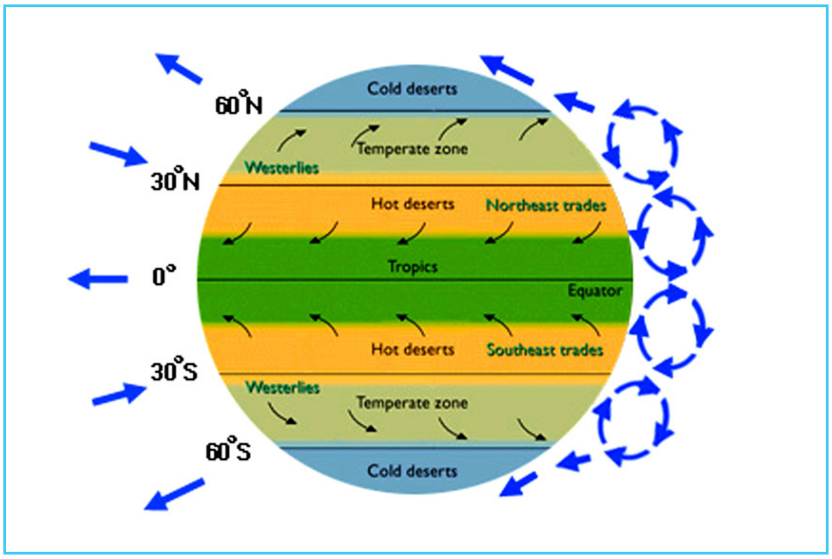
We make considerable use of convection currents in our daily life. The use of windows and ventilators in rooms, use of chimneys in factories, and the radiators, in cars, are some common applications that are based on convection currents.

Convection currents also have a significant effect on weather and climate. When the air, at a place, gets heated up, it expands and occupies more space. It, therefore, becomes lighter and moves up. The air pressure, at that place, then gets lowered. Hence, air from surrounding places, rushes in to take the vacated place. This sets up convection currents in air leading to **winds** and **storms**.

- ### Global wind patterns

It is easy to realise that there would always be an uneven heating of the earth. It is this uneven heating that results in **global wind patterns**.

The places, near to the equator, receive maximum heat energy from the sun. The air, at these places, gets heated up, rises, and, thus, leaves a low pressure area behind it. The cooler air, mainly from places between 0 to 30 degree latitude, and the equator, then moves in towards the equator. The greater the difference in pressure, the faster does the air move in. These winds (moving air) blow, from north and south, towards the equator.



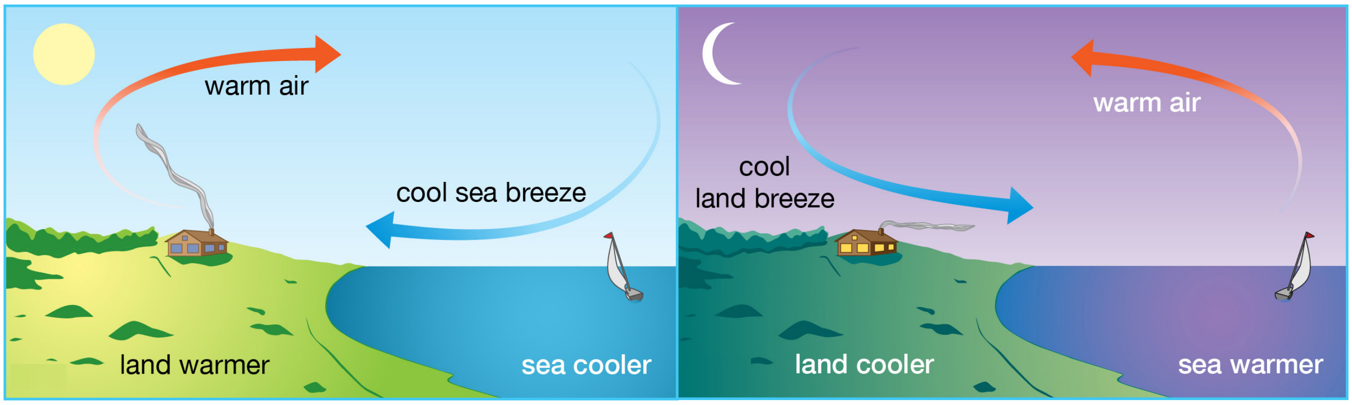
Global air patterns

At the poles, the air is colder than that at latitudes of say, about 60 degrees. Hence, the wind currents here are set up from the poles towards the warmer latitudes.

Land and Sea Breezes

Water gets heated up slowly than land during day time. Hence, the air above the land gets heated up more quickly and rises up. Cooler air, from above the sea, then rushes in to take its place. We call this movement of air as a **Sea breeze**.

During night, water cools more slowly than land. The air, above the water, therefore, becomes warmer and rises up. Its place is taken up by the cooler air above the land. This movement of air is called as **Land breeze**.

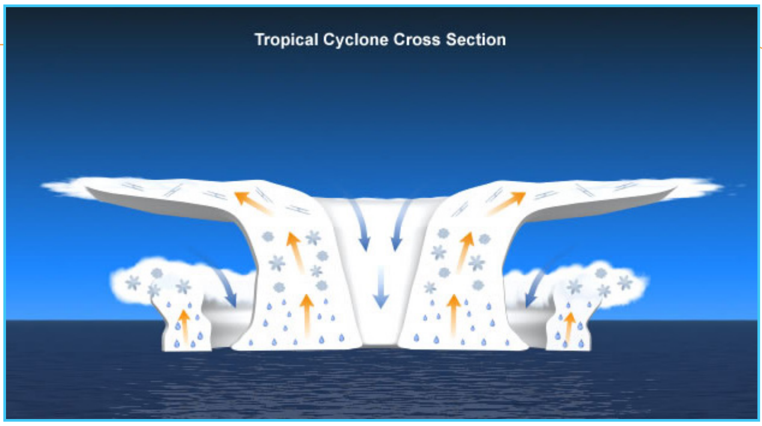


Day time

Night time

These land, and sea, breezes help in maintaining the temperature of air at a more or less uniform value through the day and the night. We, therefore, have an equitable climate on places near the sea.

Do You Know?



The wind speed, wind direction, temperature and humidity, of a place, all contribute to the development, of the atmospheric convection currents, into storms and cyclones. The strong wind sometimes forms a cloud and grows into a thunderstorm (having speed of 80–150 km/hr). Cyclone is a huge storm, having strong spiralling winds, going inwards and upwards, at a speed of around 150 km/hr over warm ocean regions. Cyclones rotate in anticlockwise/clockwise (northern hemisphere/southern hemisphere) direction around the centre of the storm (eye) which is the calmest, and low pressure, region. The difference, in the pressure, determines the intensity of the cyclone and the strength of the winds. Once a mature cyclone forms, it can last up to a week, depending upon the atmospheric and oceanic conditions. When cyclones come on to the land, the accompanying heavy rain, strong winds and large waves, can damage buildings, trees and cars.

Do You Know?

In summer, at places near the equator, the land warms up faster. Hence, most of the time, the land temperature is higher than that of water in the oceans. The air over the land gets heated up and rises. This casues the wind to flow from the oceans towards the land. These winds carry water and bring rain. We call these winds as **monsoon winds.**

Radiation

We feel hot when we stand out in the sun or when we are near a fire place. How does the heat of the sun, or the fire place, reach us?

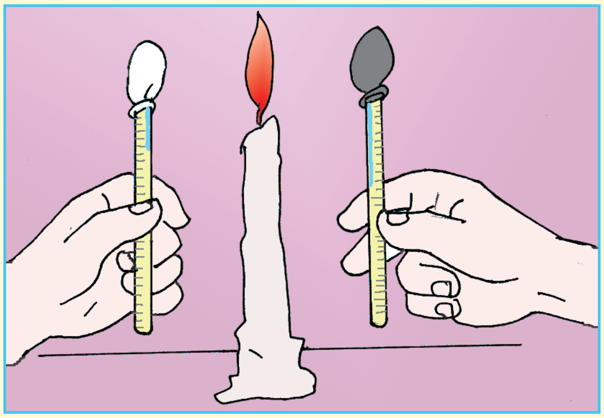
The heat of the sun does not reach us either by conduction or by convection. This is because there is (mostly) empty space (vacuum) between the sun and the earth. Conduction and convection, both require a material medium for the transfer of heat.

It follows then that, there must be a third method of heat transfer. We call this method of heat transfer as **radiation**. It may be defined as a method of heat transfer in which no material medium is required.

The heat energy, received by an object through radiation, is called **radiant energy**. We say that all hot objects give out, or radiate, heat energy.

When radiant energy falls on any matter, a part of it is reflected back and a part of it is absorbed by the matter. It is the absorbed part of radiant energy that heats up the object. We find, through practical experience, that black objects are very good absorbers of radiant energy. Highly polished, or white objects, on the other hand, absorb very little amount of the radiant energy falling on them. The following activity will help us to verify this fact.

Activity 7



Take two identical thermometers and keep them side by side. Wrap a piece of black paper on the bulb of one of the thermometers and a piece of white paper on the bulb of the other thermometer. Now keep both of them at equal distance, from a fire place, or a 'lighted up' candle.

We observe that the temperature of the thermometer, having black paper on its bulb, rises (a little) faster than that of the other thermometer. This shows that black objects absorb heat better than white objects.

The difference between the absorption, and emission, properties of black and polished surfaces has many practical uses. We list below some of these:

1. The bottom of cooking utensils is often kept black. This enables the utensils to better absorb the heat of the flame.

2. We prefer white, or light coloured, clothes in summer, they absorb less heat from the surroundings.

3. Tea, or coffee, pots are often made shining bright. They, therefore, radiate out less heat. The tea, or coffee, kept in the them, therefore, stays hot for a longer time.

4. Fire brigade men often use shining brass caps. These caps absorb very little heat and therefore, help the firemen while they are putting off the fire.

5. Houses generally have light colours on their outer walls. These absorb, and radiate, less heat. This helps to keep the houses cool in summer and warm in winter.

6. Many buildings, in the cities, have coated shining glass as their 'outer walls.' These absorb and radiate, very little heat. This helps to improve the efficiency of the 'air conditioning systems' in the building.

7. The thermos flask is used to carry, in it, hot or cold drinks. It makes use of the property of shining, or polished, surfaces of absorbing, as well as radiating, very little heat. (It also makes use of the bad conductivity of air/vacuum through its 'double walled' structure).

Keywords

clinical thermometer	a device used to measure the temperature of human body.
conduction	mode of transfer of heat in solids in which heat moves from molecule to molecule without any movement of the molecules themselves.
conductor of heat	material which allow heat to flow through it with ease.
convection	mode of transfer of heat, in liquids and gases, in which molecules themselves move to carry heat.
degree celsius	a unit for measurement of temperature.
heat	energy in transit.
insulator of heat	material which does not allow heat to flow through it.
laboratory thermometer	a device used to measure temperature in laboratory.
land breeze	the breeze that flows, from land surface to sea surface, during night.
least count	the minimum reading that an instrument can measure.
radiation	mode of transfer of heat which does not require any material medium.
thermal expansion	expansion of matter on heating.
thermometer	a device used to measure the temperature.
temperature	an indicator of the degree of hotness or coldness of an object or a substance.
sea breeze	the breeze that flows, from sea surface to land surface, during day time.

You Must Know

1. Heat is a form of energy that gets transferred from a body at a higher temperature to a body at a lower temperature.
2. Heat can be converted into other forms of energy.
3. Temperature is an indicator of the degree of hotness or coldness of an object.
4. When a body is heated, various type of physical and chemical changes are observed.
5. Thermometer is a device used to measure temperature.
6. Clinical thermometer is used to measure the temperature of the human body.
7. The range of the clinical thermometer is from 35°C to 42°C. While that of the ordinary laboratory thermometer from –10°C to 110°C.
8. The ordinary laboratory glass thermometer is based on the principle of thermal expansion of mercury on heating.
9. There are three modes of transfer of heat—conduction, convection and radiation.
10. In solids, heat is generally, transferred by conduction.
11. In liquids and gases, heat also gets transferred by convection.
12. No material medium is required for transfer of heat by radiation.
13. The materials, which allow heat to pass through them with ease, are called conductors of heat.
14. The materials, which do not allow heat to pass through them, are called bad conductors of heat or (heat) insulators.
15. The cyclic movements of molecules, in liquids and gases, are known as convection currents.
16. Convection currents have significant effect on weather and climate.
17. Land and sea breeze, in coastal areas, occur due to convection currents.
18. When heat falls over an object, some of it is absorbed by the object and some of it gets reflected back.
19. The temperature of an object increases because of absorption of heat.
20. Dark coloured objects absorb (heat) radiations better than the light coloured objects.

Something To Know

A. Fill in the blanks.

1. Heat is a form of ________________.
2. The range of clinical thermometer is from ____________ °C to ____________ °C.
3. Water is a ________________ conductor of heat.
4. Land and sea breezes help to maintain the ________________ of air.
5. Transfer of heat, from the sun to the earth, takes place mainly through the process of ________________.

B. Write True or False for the following statements.

1. Heat cannot be produced by doing work. ☐
2. No gaps are left between the rails of railway tracks. ☐
3. Poor conductors of heat are also good insulators of heat. ☐
4. Ventilators, when provided in rooms, are located near their roofs. ☐
5. A material medium is required for transfer of heat by the process of radiation. ☐

C. Tick (✓) the correct option.

1. A copper ball at 30°C is put in a container, containing water at 30°C. In this case—

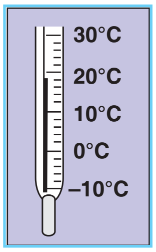
   ☐ heat will get transferred from water to the copper ball.

   ☐ heat will get transferred from the copper ball to water.

   ☐ heat would flow first from copper ball to water and then from water to copper ball.

   ☐ there would be no transfer of heat between the copper ball and water.

2. The reading of the laboratory thermometer, in the figure shown here, is—



- [ ] 10.2°C
- [ ] –10°C
- [ ] 10.8°C
- [ ] 18°C

3. It is not convenient to use the laboratory thermometer to measure our body temperature. This is so because—

- [ ] its range is small.
- [ ] as the thermometer is taken out from the mouth, the level of mercury, in it, immediately starts falling.
- [ ] our body does not transfer heat to its bulb.
- [ ] it takes a very long time to acquire the temperature of the body.

4. When we hold our hands close to the side of a flame, they get warmed up mainly due to—

- [ ] conduction as well as convection
- [ ] conduction
- [ ] radiation
- [ ] convection

5. The freezer compartment in a refrigerator is usually put near its top. This provides good cooling throughout the refrigerator through—

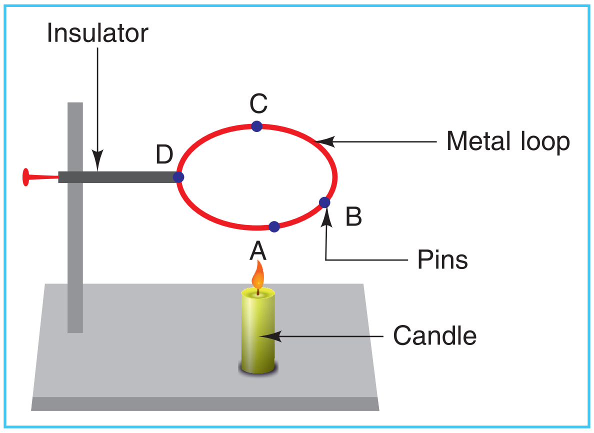
- [ ] the good conductivity of air.
- [ ] the radiation of heat by the food items kept inside the refrigerator.
- [ ] the setting up of 'convection currents', in the air inside the refrigerator.
- [ ] transfer of heat by conduction and radiation.

D. Answer the following questions in brief.

1. In which direction does the transfer of heat normally take place?
2. What is the cause of heat generation in the following situations:
   (a) We apply brakes on our fast moving car.
   (b) People often jump up and down to feel warmer in cold weather.
3. State two types of physical changes that may take place when a substance is heated.
4. In what way(s) does a clinical thermometer differ from an ordinary thermometer?
5. State the mode/different modes, of heat transfer, in the following situations.
   (a) A paper cup, full of hot soup, lying on a table.
   (b) Cooking vegetables in a pan.
   (c) Melting of a chocolate bar, in the school bag, on a hot day.
   (d) Cooking food in a microwave oven.
6. What is meant by sea breeze? When does it occur?

E. Answer the following questions.

1. In the arrangement shown in the figure, pins A, B, C, and D are fixed to a circular metal loop with the help of wax.



The circular metal loop is heated at the point A with the help of a candle flame.

In which order would the pins fall if AB < AD? Justify your answer.

2. Give reasons for the following:

   (a) Iron rims are heated red hot before 'fixing' them on cart wheels.

   (b) A clinical thermometer has a slight bend, or kink, in its capillary tube.

   (c) A new quilt is warmer than an old one.

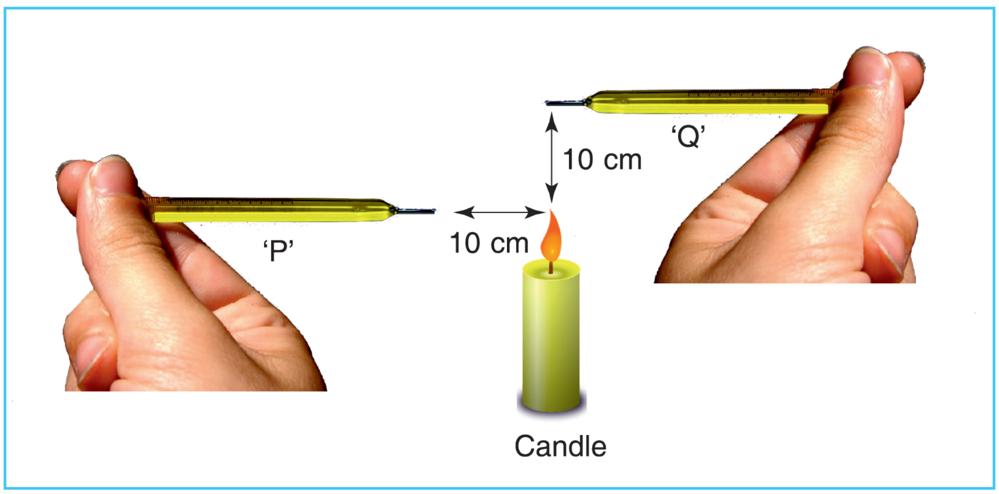
   (d) A brass tumbler feels much cooler than a wooden tray on a chilly day.

   (e) The bottoms of cooking utensils are often kept black.

3. Akshit visited Rishikesh for river rafting during summer holidays. At a campsite, there were two tents, one made with a black fabric and the other with a white fabric. Which one should Akshit prefer? Give reason for the choice. Should Akshit prefer the same tent during winters?

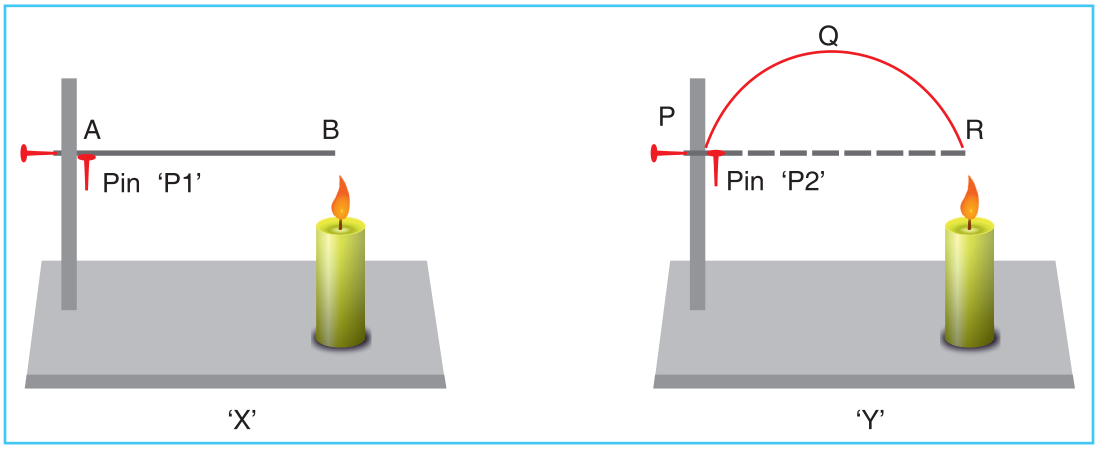
4. Explain briefly how winds are caused.

5. Supriya, while doing an experiment in the Science Laboratory, kept a laboratory thermometer 'P' 10 cm away on one side of the flame of a candle. Her friend Riya kept a similar thermometer 'Q' 10 cm above the flame of the candle as shown in the figure.



   In which of the thermometers, 'P' or 'Q', the rise in temperature will be faster? Give reason for your answer

6. In the two 'set-ups' X and Y, shown on the next page, the wires AB and PQR are made of the same material and have equal 'thickness'. The length of the wire AB, (in the set-up 'X') is equal to the diameter (= PR) of the semi-circle, formed by the wire PQR, (in the set-up 'Y'). Pins, P1 and P2, are attached, to wires AB and PQR respectively, with the help of wax. Which of the two pins, P1 or P2, will fall off later? Give reason for your answer.



Value Based Question

During the summer holidays, Hridyika went to visit her grandparents in their village. During her morning walks there, she observed that a girl in the village would play very good music on her home-made musical instrument. Hridyika was very much impressed by her skill and wanted to learn playing that instrument from her. She, however, felt hesitant to ask her to teach her. When she discussed her problem with her mother, she advised her to politely and keenly request that girl to teach her that skill. She told Hridiyika that just as heat always flows from a hot object to a cold object, knowledge and skill always 'flow' to a pupil from her/his mentor.

1. State the values displayed by Hridiyika's mother.
2. Name the three different modes of transfer of heat and give one example of each.
3. Have a group talk in which students talk about how they learnt some skill from a mentor.

Something To Do

1. **Boil some water in vessel. Cover it with a plate. Remove the plate after sometime. Allow it to cool. We will see droplets of water on the surface of plate. Try to find out why, and how, these water droplets are formed.**
2. **Describe the various ways in which heat energy can enter/escape from our houses. Learn about the measures that are now being taken to reduce such heat transfers.**
3. **Take a cup of hot water/tea. Measure its temperature accurately with a thermometer. What will happen to the hot water/tea if it is left in a room for, say, one hour? Measure the temperature at fixed intervals of five minutes and**

record (your observations) in the given table. Using these readings, try to draw a temperature-time graph.

S.No.	Time (minutes)	Temperature (°C)
________	________	________
________	________	________
________	________	________
________	________	________
________	________	________

4. Take some (moderately) hot water in a tumbler. Dip one end of a steel spoon, a plastic spoon, a glass rod, a wooden stick and a copper rod in the hot water. After waiting for few minutes (say 2-3 minutes) (carefully) touch the other end of each item. Observe which ones become hot and which ones do not. Hence, categorise them as 'Heat conductors' or as 'Heat insulators'.

Heat conductors
____
____
____

Heat insulators
____
____
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