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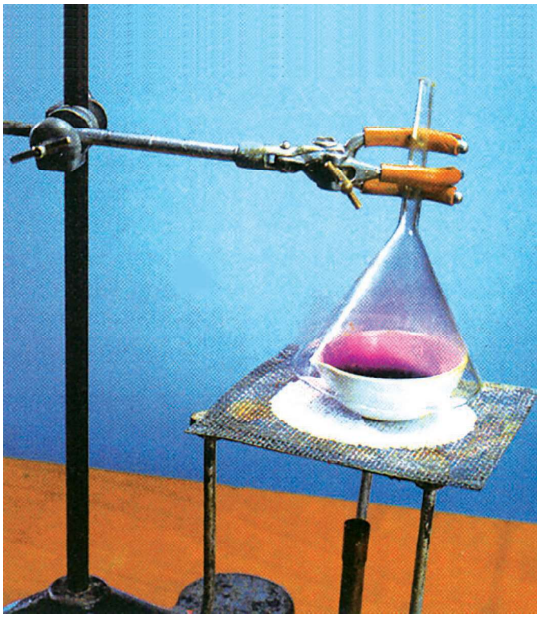


IS MATTER AROUND US PURE

If we observe some sugar and some soil (*mitti*) placed on two different sheets of paper with a magnifying glass, we will find that the colour, shape and size of all the particles of sugar are the same, but the soil contains particles of different colours, shapes and sizes. For example, the soil contains clay particles, some grass particles and even some dead insects, etc. Now, sugar which contains particles of only one kind is called a pure substance whereas soil which contains particles of different kinds is called an impure substance (or mixture). From this we conclude that **all the matter around us is not pure. The matter around us is of two types : pure substances and mixtures**. The mixtures are impure substances. We will now discuss pure substances and mixtures in a little more detail.

(*a*) Sugar is a pure substance

(*b*) Soil is an impure substance (or mixture)

Figure 1. The matter around us is of two types : pure substances and mixtures.

Pure Substances : Elements and Compounds

A pure substance is one which is made up of only one kind of particles. These particles may be atoms or molecules. So, we can also say that *a pure substance is one which is made up of only one kind of atoms or*

molecules. For example, sulphur element is made up of only one kind of particles (called sulphur atoms), therefore, sulphur is a pure substance. Similarly, water is made up of only one kind of particles (called water molecules), therefore, water is a pure substance. **All the elements and compounds are pure substances** because they contain only one kind of particles. Thus, all the elements like **hydrogen, oxygen, nitrogen, chlorine, bromine, iodine, carbon, sulphur, iron, copper, silver, gold, mercury and silicon, are pure substances.** Similarly, all the compounds such as **water (including ice and steam), carbon dioxide, sodium chloride, sugar, copper sulphate, alum (aluminium potassium sulphate), calcium oxide, sodium hydroxide, hydrochloric acid, sulphuric acid, nitric acid, potassium permanganate, camphor, naphthalene and sand (silicon dioxide), are pure substances**. A pure substance is homogeneous throughout its mass. A pure substance cannot be separated into other kinds of matter by any physical process. A pure substance has a fixed composition as well as a fixed melting point and boiling point.

Impure Substances : Mixtures

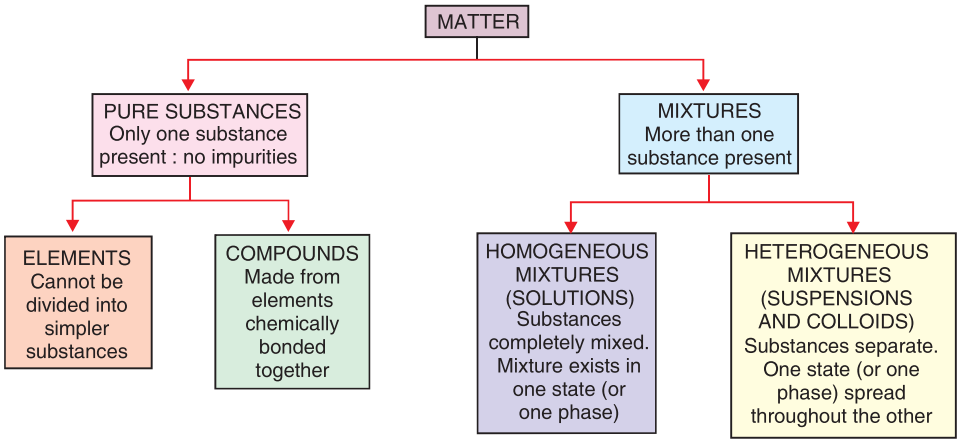
A mixture is one which contains two or more different kinds of particles (atoms or molecules). In other words, **a mixture contains two or more pure substances mixed together**. For example, salt solution is a mixture of two pure substances : salt and water. And milk is a mixture of water, fat and proteins, etc. **All the mixtures are impure substances** because they contain more than one kind of particles. Some of the **examples of the mixtures are : salt solution, sugar solution, milk, sea-water, air, sugarcane juice, soft drinks, *sharbat*, jaggery (*gud*), rocks, minerals, petroleum, LPG, biogas, tap water, tea, coffee, paint, wood, soil and bricks**. A mixture may be homogeneous or heterogeneous. A mixture can be separated into other kinds of matter by physical processes. A mixture does not have a fixed composition or a fixed melting point and boiling point. **Most of the matter around us exists as mixtures of two or more pure substances.**

Figure 2. Gold is an element. It is a pure substance.

Figure 3. Sodium chloride is a compound. It is also a pure substance.

Figure 4. Jaggery (*gud* or Indian raw sugar) is a mixture. It is an impure substance.

From the above discussion we conclude that on the basis of their properties, **all the matter can be divided into three general classes : elements, compounds and mixtures**. A schematic representation of the different types of matter is given below.



We will now discuss the three types of matter, elements, compounds and mixtures, in detail.

Before we discuss elements, we should know the meaning of three terms which are used in distinguishing metal elements from non-metal elements. These are malleability, ductility and brittleness.

(*i*) The property which allows the metals to be hammered (or beaten) into thin sheets (without breaking), is called **malleability**.

(*ii*) The property which allows the metals to be drawn (or stretched) into thin wires (without breaking) is called **ductility**.

(*iii*) The property due to which non-metals break into pieces on hammering, is called **brittleness.** Brittleness is the opposite of malleability and ductility.

ELEMENTS

An element is a substance which cannot be split up into two or more simpler substances by the usual chemical methods of applying heat, light or electric energy. For example, hydrogen is an element because it cannot be split up into two or more simpler substances by the usual methods of carrying out chemical reactions by applying heat, light or electricity. Similarly, oxygen is an element because it cannot be broken down into simpler substances by chemical methods. On the other hand, water is not an element because it can be split up into two simpler substances, hydrogen and oxygen, by electricity.

An element cannot be split up into two (or more) simpler substances because it is made of only one kind of atoms. This gives us another definition of an element which can be stated as follows : **An element is a substance which is made of only one kind of atoms.** For example, copper metal is made of only one

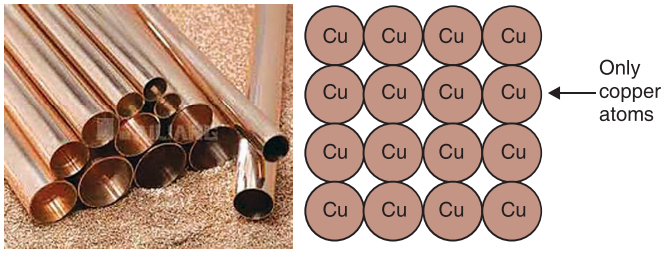


Figure 5. Copper is an element. It is made of only copper atoms.

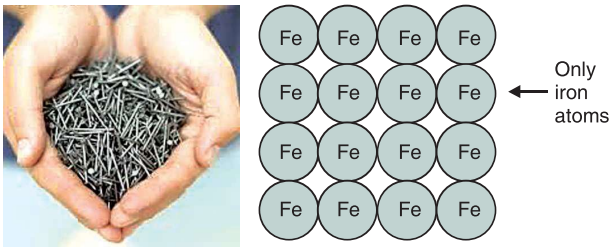


Figure 6. Iron is an element. It is made of only iron atoms.

kind of atoms called 'copper atoms', so copper metal is an element (see Figure 5). Similarly, iron metal is made of only iron atoms, so iron metal is also an element (see Figure 6). It is clear from the above discussion that an element is made of same kind of atoms. In other words, all the atoms of an element are identical. The atoms of different elements differ in size and composition.

There are 115 elements known at present, out of which 92 elements occur in nature, while the remaining 23 elements have been prepared artificially. **Every substance in this world is made up of one or more of these elements.** Some of the common elements are : hydrogen, helium, oxygen, nitrogen, carbon, sulphur,

(*a*) Sodium

(*b*) Diamond (a form of carbon element)

(*c*) Chromium

(*d*) Mercury

Figure 7. These pictures show some of the elements which occur in nature.

phosphorus, chlorine, bromine, iodine, sodium, potassium, magnesium, calcium, aluminium, copper, silver, gold, zinc, iron, silicon, tin and mercury. Diamond and graphite are also elements. They are the allotropic forms of carbon element. Each element is represented by a separate symbol.

Elements can be solids, liquids or gases. Some elements are solids, some elements are liquids whereas other elements are gases at the room temperature. For example, sodium and carbon elements are solids, mercury and bromine elements are liquids, whereas hydrogen and oxygen elements are gases, at the room temperature. In fact, majority of the elements are solids. Eleven elements are gases whereas **only two elements (mercury and bromine) are liquids at the room temperature**.

Most of the materials around us are made up by the combination of two or more elements. For example, water is a common material which is made up of two elements : Hydrogen and Oxygen. Similarly, sugar is a common material which is made up of three elements : Carbon, Hydrogen and Oxygen. **Just as 26 letters of the 'English alphabet' combine in various different ways to make a very large number of words, in the same way, a few elements combine together in various different ways to make an extremely large number of materials and objects.** Even the human body is made up of complex compounds formed by the combination of only certain elements. For example, the human body contains 65% oxygen element, 18% carbon element, 10% hydrogen element, 3% nitrogen element, 2% calcium element and 2% other elements.

Figure 8. Water (H_2O) is a common material which is made up of two elements : Hydrogen (H) and Oxygen (O).

Metals, Non-Metals and Metalloids

On the basis of their properties, **all the elements can be divided into three groups :**

1. **Metals,**
2. **Non-metals,** and
3. **Metalloids**

We will now discuss these three groups of elements in somewhat detail, one by one. Let us start with metals.

METALS

A metal is an element that is malleable and ductile, and conducts electricity. Some of the examples of metals are : Iron, Copper, Aluminium, Zinc, Silver, Gold, Platinum, Chromium, Sodium, Potassium,

(*a*) Aluminium (*b*) Magnesium (*c*) Zinc (*d*) Silver

Figure 9. Aluminium, magnesium, zinc and silver are all metals.

Magnesium, Nickel, Cobalt, Tin, Lead, Cadmium, Mercury, Antimony, Tungsten, Manganese and Uranium. **All the metals are solids except one metal mercury, which is a liquid**.

Properties of Metals

The important physical properties of metals are given below :

1. Metals are Malleable. This means that metals can be beaten into thin sheets with a hammer (without breaking). Gold and silver metals are some of the best malleable metals. Aluminium and copper metals are also highly malleable metals. All these metals can be beaten with a hammer to form very thin sheets called foils. For example, silver metal can be hammered into thin silver foils because of its high malleability. The silver foils are used for decorating sweets. Similarly, aluminium metal is quite malleable and can be converted into thin sheets called aluminium foils. **Aluminium foils are used for packing food items like biscuits, chocolates, medicines, cigarettes,** etc. Milk bottle caps are also made of aluminium foil. Aluminium sheets are used for making cooking utensils. Copper metal is also highly malleable. So, copper sheets are used to make utensils and other containers. Thus, **malleability is an important characteristic property of metals.**

2. Metals are Ductile. This means that metals can be drawn (or stretched) into thin wires. All the metals are not equally ductile. Some are more ductile than the others. Gold and silver are among the best ductile metals. For example, just 100 milligrams of a highly ductile metal like silver can be drawn into a thin wire about 200 metres long. Copper and aluminium metals are also very ductile and can be drawn into thin wires which are used in electrical wiring. Thus, **ductility is another important characteristic property of metals.** From the above discussion we conclude that **metals are malleable and ductile.** It is due to the properties of malleability and ductility that metals can be given different shapes to make various articles.

3. Metals are Good Conductors of Heat and Electricity. This means that metals allow heat and electricity to pass through them easily. Metals are generally good conductors of heat (The conduction of heat is also called thermal conductivity). **Silver metal is the best conductor of heat.** It has the highest thermal conductivity. Copper and aluminium metals are also very good conductors of heat. **The cooking utensils and water boilers, etc., are usually made of copper or aluminium metals because they are very good conductors of heat.** The poorest conductor of heat among the metals is lead. Mercury metal is also a poor conductor of heat.

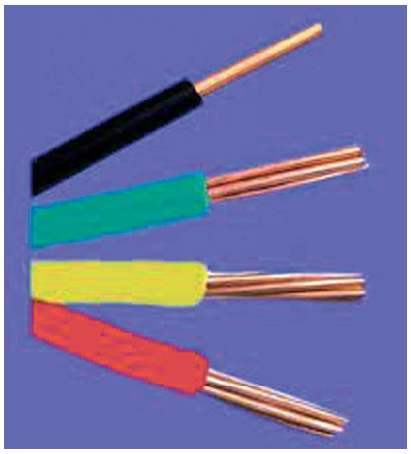


Figure 10. These electric wires are made of copper metal.

Metals are good conductors of electricity. The metals offer very little resistance to the flow of electric current and hence show high electrical conductivity. **Silver metal is the best conductor of electricity.** Copper metal is the next best conductor of electricity followed by gold, aluminium and tungsten. **The electric wires are made of copper and aluminium metals because they are very good conductors of electricity.** The metals like iron and mercury offer comparatively greater resistance to the flow of current, so they have lower electrical conductivity.

4. Metals are Lustrous (or Shiny), and can be Polished. For example, gold, silver and copper are shiny metals and they can be polished. The property of a metal of having a shining surface is called metallic lustre (*chamak*). The shiny appearance of metals makes them useful in making jewellery and decoration pieces. For example, gold and silver are used for making jewellery because they are bright and shiny. The shiny surface of metals makes them good reflectors of light. Silver metal is an excellent reflector of light.

5. Metals are Generally Hard (except sodium and potassium which are soft metals). Most of the metals are hard. But all the metals are not equally hard. The hardness varies from metal to metal. Most of the metals like iron, copper, aluminium, etc., are very hard. They cannot be cut with a knife. There are some exceptions. Sodium and potassium are soft metals which can be easily cut with a knife.

6. Metals are Usually Strong. They Have High Tensile Strength. This means that metals can hold large weights without breaking. For example, iron metal (in the form of steel) is very strong having a high tensile strength. Due to this iron metal is used in the construction of bridges, buildings, railway lines,

girders, machines, vehicles and chains, etc. Though most of the metals are strong but some of the metals are not strong. For example, sodium and potassium metals are not strong. They have low tensile strength.

7. Metals are Solids at the Room Temperature (except mercury which is a liquid metal). All the metals like iron, copper, aluminium, silver and gold, etc., are solids at the room temperature. **Only one metal, mercury, is in liquid state at the room temperature.**

8. Metals Generally Have High Melting Points and Boiling Points. This means that most of the metals melt and vaporise at high temperatures. For example, iron is a metal having a high melting point of 1535°C. This means that solid iron melts and turns into liquid iron (or molten iron) on heating to a high temperature of 1535°C. Copper metal has also a high melting point of 1083°C. There are, however, some exceptions. For example, **sodium and potassium metals have low melting points** (of less than 100°C). Another metal gallium has such a low melting point that it starts melting in hand (by the heat of our body).

Figure 11. Iron is a very important metal. We use about nine times more iron than all the other metals put together. Iron is made into steel and used for making large things like bridges (see above), as well as small things like needles.

9. Metals Have High Densities. This means that metals are heavy substances. For example, the density of iron metal is 7.8 g/cm^3 which is quite high. There are, however, some exceptions. **Sodium and potassium metals have low densities.** They are very light metals.

10. Metals are Sonorous. This means that metals make a ringing sound when we strike them. It is due to the property of sonorousness of metals that they are used for making bells, plate type musical instruments like cymbals (*manjira)*, and wires (or strings) for stringed musical instruments such as violin, guitar, *sitar* and *tanpoora*, etc.

11. Metals Usually Have a Silver or Grey Colour (except copper and gold). Copper has a reddish-brown colour whereas gold has a yellow colour.

Metals are widely used in our daily life for a large number of purposes. The cooking utensils, electric fans, sewing machines, cars, buses, trucks, trains, ships and aeroplanes, are all made of metals or mixtures of metals called alloys. In fact, the list of articles made of metals which we use in our daily life is unending.

NON-METALS

A non-metal is an element that is neither malleable nor ductile, and does not conduct electricity. Some of the examples of non-metals are : Carbon, Sulphur, Phosphorus, Hydrogen, Oxygen, Nitrogen, Fluorine, Chlorine, Bromine, Iodine, Helium, Neon, Argon, Krypton, and Xenon. Diamond and Graphite

(*a*) Carbon

(*b*) Sulphur

(*c*) Bromine (inside the flask)

(*d*) Chlorine (inside the gas jar)

Figure 12. Carbon, sulphur, bromine and chlorine are all non-metals.

are also non-metals. They are the allotropic forms of carbon. All the non-metals are solids or gases, except bromine which is a liquid non-metal at room temperature.

Properties of Non-Metals

The physical properties of non-metals are just the opposite of the physical properties of metals. The important physical properties of non-metals are given below :

1. Non-Metals are Not Malleable. Non-Metals are Brittle. This means that non-metals cannot be beaten into thin sheets with a hammer. Non-metals break into small pieces when hammered. For example, sulphur and phosphorus are solid non-metals which are not malleable, they cannot be beaten into thin sheets with a hammer. Thus, we cannot get thin sheets from non-metals. Sulphur and phosphorus non-metals are brittle. When beaten with a hammer, they break into small pieces. **Brittleness is a characteristic property of solid non-metals.**

2. Non-Metals are Not Ductile. This means that non-metals cannot be drawn into wires. They are easily snapped on stretching. For example, sulphur and phosphorus are non-metals and they are not ductile. When stretched, sulphur and phosphorus break into pieces and do not form wires. Thus, we cannot get wires from non-metals. From the above discussion we conclude that : **Non-metals are neither malleable nor ductile. Non-metals are brittle.**

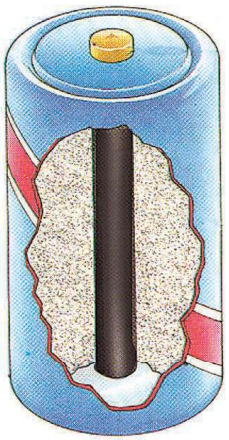


Figure 13. The black electrode in the middle of this dry cell is made of graphite because it is a good conductor of electricity.

3. Non-Metals are Bad Conductors of Heat and Electricity. This means that non-metals do not allow heat and electricity to pass through them. For example, sulphur and phosphorus are non-metals which do not conduct heat or electricity. Many of the non-metals are, in fact, insulators. There are, however, some exceptions. A form of the carbon element, **diamond is a non-metal which is a good conductor of heat.** And another form of carbon element, **graphite is a non-metal which is a good conductor of electricity.** Being a good conductor of electricity, graphite is used for making electrodes (as that in dry cells).

4. Non-Metals are Not Lustrous (Not Shiny). They are Dull in Appearance. Non-metals do not have lustre (*chamak*) which means that non-metals do not have a shining surface. The solid non-metals have a dull appearance. For example, sulphur and phosphorus are non-metals which have no lustre, that is, they do not have a shining surface. They appear to be dull. There is, however, an exception. **Iodine is a non-metal having lustrous appearance.** It has a shining surface (like that of metals).

5. Non-Metals are Generally Soft (except diamond which is extremely hard non-metal). Most of the solid non-metals are quite soft. They can be easily cut with a knife. For example, sulphur and phosphorus are solid non-metals which are quite soft and can be easily cut with a knife. Only one non-metal carbon (in the form of diamond) is very hard. In fact, **diamond (which is an allotropic form of carbon) is the hardest natural substance known.**

6. Non-Metals are Not Strong. They Have Low Tensile Strength. This means that non-metals cannot hold large weights (without breaking). For example, graphite is a non-metal which is not strong. It has a low tensile strength. When a large weight is placed on a graphite sheet, it breaks.

7. Non-Metals may be Solid, Liquid or Gases at the Room Temperature. Non-metals can exist in all the three physical states : solid, liquid and gaseous. For example, carbon, sulphur and phosphorus are solid non-metals; bromine is a liquid non-metal; whereas hydrogen, oxygen, nitrogen and chlorine are gaseous non-metals.

8. Non-Metals Have Comparatively Low Melting Points and Boiling Points (except graphite which is a non-metal having a very high melting point). This means that non-metals melt and vaporise at comparatively low temperatures. For example, sulphur is a non-metal having a low melting point of 119°C. **Only one non-metal graphite has a very high melting point** (of 3700°C). The majority of non-metals have very low boiling points due to which they exist as gases at room temperature.

9. Non-Metals Have Low Densities. This means that non-metals are light substances. For example, sulphur is a solid non-metal having a low density of 2 g/cm^3, which is quite low. The density of gaseous non-metals is very, very low. **One non-metal iodine has, however, high density.**

10. Non-Metals are Not Sonorous. This means that solid non-metals do not make a ringing sound when we strike them.

11. Non-Metals Have Many Different Colours. For example, sulphur is yellow, phosphorus is white or red, graphite is black, chlorine is yellowish-green, bromine is red-brown whereas hydrogen and oxygen are colourless.

Though non-metals are small in number as compared to metals, but they play a very important role in our daily life. In fact, **life would not have been possible without the presence of non-metals on the earth.** For example, carbon is one of the most important non-metals because all the life on this earth is based on carbon compounds. This is because the carbon compounds like proteins, fats, carbohydrates, vitamins and enzymes, etc., are essential for the growth and development of living organisms. Another non-metal oxygen is equally important for the existence of life. This is because the presence of oxygen gas in air is essential for breathing to maintain life. It is also necessary for the combustion (or burning) of fuels which provide us energy for various purposes.

Figure 14. Carbon is a non-metal. Carbon based organic molecules form the basis of all life on earth : animals (including human beings) as well as plants.

We have just studied the characteristic properties of metals and non-metals. We will now compare the properties of metals and non-metals in tabular form by giving the main points of difference between them.

Comparison Among the Properties of Metals and Non-Metals

Metals	*Non-Metals*
1. Metals are malleable and ductile. That is, metals can be hammered into thin sheets and drawn into thin wires.	1. Non-metals are brittle. They are neither malleable nor ductile.
2. Metals are good conductors of heat and electricity.	2. Non-metals are bad conductors of heat and electricity (except diamond which is a good conductor of heat, and graphite which is a good conductor of electricity).
3. Metals are lustrous (shiny) and can be polished.	3. Non-metals are non-lustrous (dull) and cannot be polished (except iodine which is a lustrous non-metal).
4. Metals are solids at room temperature (except mercury which is a liquid metal).	4. Non-metals may be solid, liquid or gases at the room temperature.
5. Metals are strong and tough. They have high tensile strength.	5. Non-metals are not strong. They have low tensile strength.
6. Metals are sonorous. They make a ringing sound when struck.	6. Non-metals are not sonorous.

An element can be identified as being a metal or a non-metal by comparing its properties with the general properties of metals and non-metals. While doing so we should, however, keep the various exceptions to the general properties of metals and non-metals in mind. We will now answer one question based on metals and non-metals.

Sample Problem. State two reasons for believing that copper is a metal and sulphur is a non-metal.

Answer. The two properties which tell us that copper is a metal and sulphur is a non-metal are given below :

Copper	*Sulphur*
1. Copper is malleable and ductile. It can be hammered into thin sheets and drawn into wires. 2. Copper is a good conductor of heat and electricity.	1. Sulphur is neither malleable nor ductile. It is brittle. Sulphur breaks into pieces when hammered or stretched. 2. Sulphur is a bad conductor of heat and electricity.

METALLOIDS

There are a few elements which show some properties of metals and other properties of non-metals. For example, they look like metals but they are brittle like non-metals. They are neither conductors of electricity like metals nor insulators like non-metals, they are semiconductors. **The elements which show some properties of metals and some other properties of non-metals are called metalloids**. Their properties are intermediate between the properties of metals and non-metals. Metalloids are also sometimes called semi-metals. **The important examples of metalloids are : Boron (B), Silicon (Si), and Germanium (Ge).**

(*a*) Boron

(*b*) Silicon

(*c*) Germanium

Figure 15. Boron, silicon and germanium elements are metalloids.

MIXTURES

A mixture is a substance which consists of two or more elements or compounds not chemically combined together. For example, air is a mixture of gases like oxygen, nitrogen, argon, carbon dioxide and water vapour, etc. The various gases of the air are not chemically combined with one another. Similarly, gunpowder is a mixture of potassium nitrate, sulphur and charcoal (charcoal is a form of carbon), whereas brass is a mixture of copper and zinc. **All the solutions are mixtures.** For example, salt-solution (brine) is

Figure 16. Milk is a mixture of water, fat, proteins, sugar, minerals and vitamins.

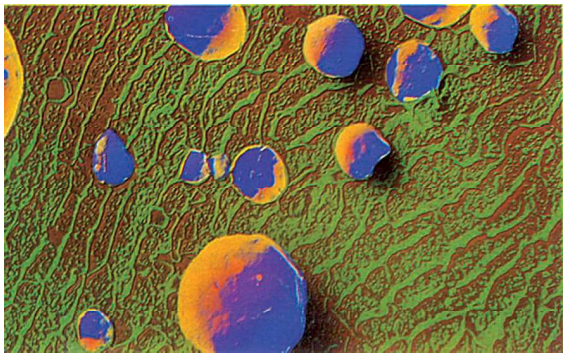


Figure 17. This picture shows fat globules in milk as seen under the high power microscope.

a mixture of common salt (sodium chloride) in water. Please note that **the various substances present in a mixture are known as "constituents of the mixture" or "components of the mixture".** Some of the examples of mixtures are : Air, Gunpowder, Brass, Salt solution, Sugar solution, Milk, Sea-water, Ink, Kerosene oil, Petrol, Petroleum, Lime-water, Paint, Glass, Coal, Soil, Wood, Blood, Starch solution, Soap solution, Iron and sulphur mixture, Dyes, Alcohol and water, Petrol and water, Chalk-water mixture, Soda water, Soft drinks, Lemonade, Vinegar, Muddy river water, Flour in water, Milk of Magnesia, Butter, Cheese, Face cream, Shaving cream, Hair spray, Smoke, Fog and Mist.

Types of Mixtures

Mixtures are of two types :

1. **Homogeneous mixtures,** and
2. **Heterogeneous mixtures.**

Those mixtures in which the substances are completely mixed together and are indistinguishable from one another, are called homogeneous mixtures. A homogeneous mixture has a uniform composition throughout its mass. It has no visible boundaries of separation between the various constituents. A mixture of sugar in water (called sugar solution) is a homogeneous mixture because all the parts of sugar solution have the same sugar-water composition and appear to be equally sweet ! There is no visible boundary of separation between sugar and water particles in a sugar solution. A mixture of two (or more) miscible liquids is also a homogeneous mixture. For example, a mixture of alcohol and water is a homogeneous mixture. Unpolluted air is a homogeneous mixture of gases like oxygen, nitrogen, argon, carbon dioxide and water-vapour, etc. **All the homogeneous mixtures are called solutions.** Some of the **examples of homogeneous mixtures (or solutions)** are : Sugar solution, Salt solution, Copper sulphate solution, Sea-water, Alcohol and water mixture, Petrol and oil mixture, Soda water, Soft drinks, Lemonade, Vinegar, Brass, Air, Kerosene oil, and Petrol. Please note that kerosene and petrol are not single substances, they are mixtures of various compounds of carbon and hydrogen (called hydrocarbons).

(*a*) Copper sulphate solution is a homogeneous mixture

(*b*) Chalk and water mixture is a heterogeneous mixture

Figure 18. Mixtures can be homogeneous or heterogeneous.

Those mixtures in which the substances remain separate and one substance is spread throughout the other substance as small particles, droplets or bubbles, are called heterogeneous mixtures. A heterogeneous mixture does not have a uniform composition throughout its mass. It has visible boundaries of separation between the various constituents. The mixture of sugar and sand is a heterogeneous mixture because different parts of this mixture will have different sugar-sand compositions. Some parts of this mixture will have more of sugar particles whereas other parts will have more of sand particles. There is a visible boundary of separation between sugar and sand particles. **The suspensions of solids in liquids are also heterogeneous**

mixtures. For example, a suspension of chalk in water is a heterogeneous mixture. **A mixture containing two (or more) immiscible liquids is also a heterogeneous mixture**. For example, a mixture of petrol and water is a heterogeneous mixture. As we will learn after a while, **all the suspensions and colloids are heterogeneous mixtures**. Some of the **examples of heterogeneous mixtures** are : Sugar and sand mixture, Salt and sand mixture, Polluted air, Gunpowder, Milk, Ink, Petroleum, Paint, Glass, Coal, Soil, Wood, Blood, Starch solution, Soap solution, Iron filings and sulphur Mixture, Dyes, Petrol and water mixture, Chalk and water mixture, Muddy river water, Flour in water, Milk of Magnesia, Butter, Cheese, Face cream, Shaving cream, Hair spray, Fog and Mist. **Most of the mixtures are heterogeneous, only solutions and alloys are homogeneous mixtures**. We will now take one example to understand the characteristics of mixtures.

To Study the Properties of a Mixture of Iron and Sulphur

When iron filings (or iron powder) and sulphur powder are mixed together, a greyish-yellow mixture is obtained. Let us study the properties of this mixture.

1. If we put a magnet in the mixture of iron filings and sulphur, the iron particles are attracted by the magnet, they stick to the magnet and get separated from sulphur (see Figure 19). Sulphur is not attracted by the magnet, so it is left behind. Thus, a mixture of iron filings and sulphur has been separated into its constituents, iron and sulphur, by the physical method of using a magnet.

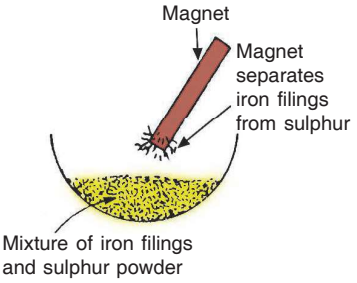


Figure 19. A mixture of iron and sulphur can be separated by using a magnet.

Alternatively, if we shake the mixture of iron filings and sulphur with an organic liquid known as carbon disulphide (CS_2), then sulphur dissolves in it but iron does not dissolve. On filtration, iron is obtained as a residue and sulphur is recovered from the filtrate by evaporating carbon disulphide. Thus, a mixture of iron filings and sulphur has been separated by another physical method of using carbon disulphide solvent (followed by filtration and evaporation). From these two experiments we conclude that **a mixture can be separated into its constituents by physical processes (like filtration, evaporation, sublimation, distillation, solvents, magnet, etc.).**

2. If dilute sulphuric acid is added to the mixture of iron filings and sulphur, the iron part reacts with sulphuric acid and hydrogen gas is produced (which is a colourless and odourless gas). Sulphur remains unchanged. This shows that a mixture of iron and sulphur shows the properties of iron. Now, if this mixture of iron and sulphur is treated with carbon disulphide, the sulphur part dissolves in it leaving the iron unchanged. This means that a mixture of iron filings and sulphur also shows the properties of sulphur. If we combine these two results, we can say that a mixture of iron filings and sulphur shows the properties of both its constituents, iron as well as sulphur. In general we can say that **a mixture shows the properties of all the constituents present in it.**

3. When iron filings are mixed with sulphur powder to prepare the mixture, heat is neither evolved nor absorbed. In general, **energy (in the form of heat, light, etc.) is usually neither given out nor absorbed in the preparation of a mixture.** So, the formation of a mixture is a **physical change**.

4. We can mix any amounts of iron filings and sulphur powder to get mixtures having different compositions. Thus, a mixture of iron filings and sulphur has a variable composition. Since its composition is variable, no definite formula can be given to a mixture of iron filings and sulphur. From this discussion we conclude that **the composition of a mixture is variable, the constituents can be present in any proportion by mass.** Due to its variable composition, a mixture does not have a definite formula.

5. A mixture of iron filings and sulphur does not melt at a single fixed temperature. From this we conclude that **a mixture does not have a definite melting point, boiling point, etc.**

6. If we examine the mixture of iron filings and sulphur powder with a magnifying glass, it is found that though the iron particles are quite close to the sulphur particles, at some places there are more of iron particles whereas at other places there are more of sulphur particles. That is, a mixture of iron filings and sulphur is not homogeneous, it is heterogeneous. Though most of the mixtures are heterogeneous, some mixtures called solutions and alloys are, however, homogeneous. From this we conclude that **a mixture is usually heterogeneous (except solutions and alloys which are homogeneous mixtures).** We will now discuss compounds.

COMPOUNDS

A compound is a substance made up of two or more elements chemically combined in a fixed proportion by mass. For example, water (H_2O) is a compound made up of two elements, hydrogen and oxygen, chemically combined in a fixed proportion of 1 : 8 by mass (Atomic masses : H = 1 u, O = 16 u, so H_2 : O = 2 u : 16 u or 1 : 8). Similarly, common salt (sodium chloride, NaCl) is a compound made up of two elements, sodium and chlorine; ammonium chloride (NH_4Cl) is a compound made up of three elements, nitrogen, hydrogen and chlorine; sand (silicon dioxide, SiO_2) is a compound of silicon and oxygen, and marble (calcium carbonate, $CaCO_3$) is a compound made up of calcium, carbon and oxygen elements.

(*a*) Calcium carbonate (in the form of marble)

(*b*) Sodium hydroxide (in the form of pellets)

(*c*) Copper sulphate

Figure 20. Calcium carbonate, sodium hydroxide and copper sulphate are compounds.

Some more **examples of compounds** are : Ammonia (NH_3), Carbon dioxide (CO_2), Ice (H_2O), Steam (H_2O), Chalk (Calcium carbonate, $CaCO_3$), Limestone (Calcium carbonate, $CaCO_3$), Lime or Quicklime (Calcium oxide, CaO), Slaked lime [Calcium hydroxide, $Ca(OH)_2$], Methane (CH_4), Glucose ($C_6H_{12}O_6$), Sugar or Canesugar ($C_{12}H_{22}O_{11}$), Starch [$(C_6H_{10}O_5)_n$], Baking soda (Sodium hydrogencarbonate, $NaHCO_3$), Washing soda (Sodium carbonate, Na_2CO_3), Potassium nitrate (KNO_3), Potassium sulphate (K_2SO_4), Sodium sulphate (Na_2SO_4), Copper sulphate ($CuSO_4$), Iron sulphide (FeS), Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3), Hydrogen bromide (HBr) and Sodium hydroxide (NaOH). We have given the formulae of all these compounds so that you may be able to write the names of the elements present in them. **Compounds can be further divided into three classes : acids, bases and salts, on the basis of their properties**. For example, sulphuric acid is an acid, sodium hydroxide is a base whereas sodium sulphate is a salt. We will now take one example to understand the characteristic properties of a compound.

To Study the Properties of a Compound of Iron and Sulphur

When the mixture of iron filings and sulphur powder is heated, a black compound known as iron sulphide (FeS) is formed. Let us examine the properties of this compound to find out the difference between a compound and a mixture.

1. If a magnet is put in the iron sulphide compound, iron does not get separated from sulphur (see Figure 21). Even carbon disulphide solvent cannot separate the sulphur from iron sulphide compound. This means that the iron sulphide compound cannot be separated into its constituents by physical methods. In general we can say that **a compound cannot be separated into its components by physical methods.**

2. When dilute sulphuric acid is added to iron sulphide compound, we get a colourless, foul smelling gas called hydrogen sulphide (having the smell of rotten eggs). No hydrogen gas is formed in this case. This means that iron sulphide does not show the properties of iron present in it. Even the sulphur present in iron sulphide compound cannot be dissolved by carbon disulphide. This means that iron sulphide compound does not show the properties of sulphur. From this we conclude that iron sulphide compound does not show the individual properties of its constituents, iron and sulphur. The properties of iron sulphide compound are entirely different from those of its constituents, iron and sulphur. In general we can say that **the properties of a compound are entirely different from those of its constituent elements.**

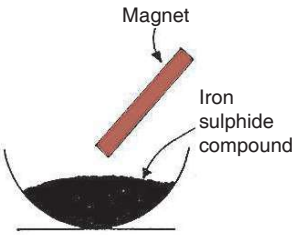


Figure 21. The compound of iron and sulphur (iron sulphide) cannot be separated by using a magnet.

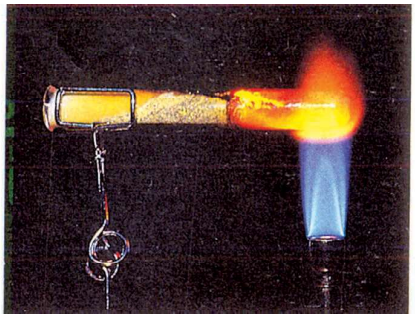
3. Iron sulphide compound is prepared by heating together iron filings and sulphur. Once the reaction starts, a lot of heat and light are produced during the preparation of iron sulphide compound. From this we conclude that **energy (in the form of heat, light, etc.) is usually either given out or absorbed during the preparation of a compound.** The formation of compound is a **chemical change**.

4. Iron sulphide compound (FeS) is prepared by heating together 7 parts by mass of iron and 4 parts by mass of sulphur (Atomic masses : Fe = 56 u, S = 32 u, so Fe : S = 56 u : 32 u or 7 : 4). If we take more of iron or sulphur, the excess part remains unreacted. Thus, iron sulphide compound is always made up of the same elements, iron and sulphur, combined together in a fixed proportion by mass. Since the composition of iron sulphide compound is fixed, it has a definite formula, FeS. From this discussion we conclude that **the composition of a compound is fixed, the constituents are present in a fixed proportion by mass.** A compound has a definite formula.

5. Iron sulphide compound melts at a definite temperature. From this we conclude that **a compound has a fixed melting point, boiling point, etc.**

6. If the iron sulphide compound is viewed through a magnifying glass, no separate particles of iron or sulphur are seen and it appears to be just the same throughout its mass. From this we conclude that **a compound is a homogeneous substance.**

(*a*) By mixing iron filings and sulphur powder, we can obtain a mixture (without any chemical reaction taking place). We can still see the yellow sulphur in the mixture and we can pull away iron filings with a magnet



(*b*) But if we heat the mixture of iron filings and sulphur powder (taken in a boiling tube) strongly, with a burner, a chemical reaction takes place and a new chemical compound is formed

(*c*) The new chemical compound formed is iron sulphide (which is black in colour). It contains sulphur but we cannot see any yellow colour of sulphur. It contains iron but we cannot pull away this iron with a magnet

Figure 22. Experiment to study the differences in the properties of a mixture of iron filings and sulphur powder, and iron sulphide compound.

We will now write down the differences between compounds and mixtures in a tabular form.

Differences Between Mixtures and Compounds

In order to decide whether the given substance is a mixture or a compound, the following points of

difference between mixtures and compounds should be remembered.

Mixtures	*Compounds*
1. A mixture can be separated into its constituents by the physical processes (like filtration, evaporation, sublimation, distillation, solvents, magnet, etc.).	1. A compound cannot be separated into its constituents by physical processes (It can only be separated into its constituents by chemical processes).
2. A mixture shows the properties of its constituents.	2. The properties of a compound are entirely different from those of its constituents.
3. Energy (in the form of heat, light, etc.) is usually neither given out nor absorbed in the preparation of a mixture.	3. Energy (in the form of heat, light, etc.) is usually given out or absorbed during the preparation of a compound.
4. The composition of a mixture is variable, the constituents can be present in any proportion by mass. A mixture does not have a definite formula.	4. The composition of a compound is fixed, the constituents are present in fixed proportion by mass. A compound has a definite formula.
5. A mixture does not have a fixed melting point, boiling point, etc.	5. A compound has a fixed melting point, boiling point, etc.

Though a compound is always homogeneous, a mixture may be heterogeneous or homogeneous. So, being homogeneous or heterogeneous is usually not helpful in deciding whether a substance is a mixture or a compound and, therefore, this point has not been included in the above table.

In order to find out whether a given substance is a mixture or compound, we should remember that :

1. (*i*) If the substance can be separated into its constituents by physical methods, it is a mixture.
   (*ii*) If the substance cannot be separated into its constituents by physical methods, it is a compound.
2. (*i*) If the substance shows the properties of its constituents, it is a mixture.
   (*ii*) If the properties of the substance are entirely different from those of its constituents, it is a compound.
3. (*i*) If no heat or light, etc., is given out or absorbed during the preparation of the substance, it is a mixture.
   (*ii*) If heat or light, etc., is given out or absorbed during the preparation of the substance, it is a compound.
4. (*i*) If the composition of the substance is variable, it is a mixture.
   (*ii*) If the composition of the substance is fixed, it is a compound.
5. (*i*) If the substance does not have a fixed melting point, boiling point, etc., it is a mixture.
   (*ii*) If the substance has a fixed melting point, boiling point, etc., it is a compound.

Keeping these five points in mind, we will now answer some important questions on mixtures and compounds.

Sample Problem 1. Explain why, air is considered a mixture and not a compound.

Solution. Air is considered a mixture because of the following reasons :

(*i*) Air can be separated into its constituents like oxygen, nitrogen, etc., by the physical process of fractional distillation (of liquid air).

(*ii*) Air shows the properties of all the gases present in it. For example, oxygen supports combustion and air also supports combustion; carbon dioxide turns lime water milky and air also turns lime water milky, though very, very slowly.

(*iii*) Heat and light, etc., are neither given out nor absorbed when air is prepared by mixing the required proportions of oxygen, nitrogen, carbon dioxide, argon, water vapour, etc.

(*iv*) Air has a variable composition because air at different places contains different amounts of the various gases. It does not have a definite formula.

(*v*) Liquid air does not have a fixed boiling point.

Sample Problem 2. Explain why, water is a compound and not a mixture.

Solution. Water is considered a compound because of the following reasons :

(*i*) Water cannot be separated into its constituents, hydrogen and oxygen, by the physical methods (such as filtration, evaporation, distillation, sublimation, magnet, etc.).

(*ii*) The properties of water are entirely different from those of its constituents, hydrogen and oxygen. For example, water is a liquid whereas hydrogen and oxygen are gases; water does not burn whereas hydrogen burns; water does not support combustion whereas oxygen supports combustion.

(*iii*) Heat and light are given out when water is prepared by burning hydrogen in oxygen.

(*iv*) The composition of water is fixed. It contains hydrogen and oxygen combined together in a fixed proportion of 1 : 8 by mass. It has a definite formula, H_2O.

(*v*) Water has a fixed boiling point of 100°C under standard atmospheric pressure.

Sample Problem 3. Classify the following into elements, compounds and mixtures :

Sodium, Soil, Sugar solution, Silver, Calcium carbonate, Tin, Silicon, Coal, Air, Soap, Methane, Carbon dioxide, Blood **(NCERT Book Question)**

Solution. We can classify the given materials into elements, compounds and mixtures as follows :

Elements	*Compounds*	*Mixtures*
Sodium	Calcium carbonate	Soil
Silver	Soap	Sugar solution
Tin	Methane	Coal
Silicon	Carbon dioxide	Air
		Blood

Sample Problem 4. Give the names of the elements present in the following compounds :

(*a*) Quicklime (*b*) Hydrogen bromide (*c*) Baking soda (*d*) Potassium sulphate **(NCERT Book Question)**

Solution. (*a*) Quicklime is calcium oxide, CaO. The elements present in it are : Calcium (Ca) and Oxygen (O).

(*b*) Hydrogen bromide is HBr. The elements present in it are : Hydrogen (H) and Bromine (Br).

(*c*) Baking soda is sodium hydrogencarbonate, $NaHCO_3$. The elements present in it are : Sodium (Na), Hydrogen (H), Carbon (C) and Oxygen (O).

(*d*) Potassium sulphate is K_2SO_4. The elements present in it are : Potassium (K), Sulphur (S) and Oxygen (O).

The Case of Solutions

The solutions are homogeneous substances and heat is also usually evolved or absorbed in the preparation of a solution. Even then **a solution is considered a mixture** because : (*i*) it can be separated into its components by physical methods, (*ii*) it shows the properties of its constituents, (*iii*) it has a variable composition, and (*iv*) it does not have a fixed boiling point.

For example, **salt-solution is considered a mixture** because of the following reasons :

(*i*) Salt-solution can be separated into salt and water by the physical process of distillation.

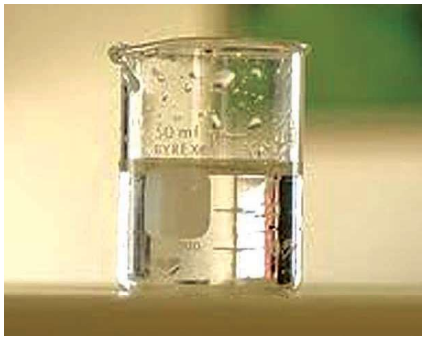


Figure 23. Salt-solution is considered a mixture.

(*ii*) Salt-solution shows the properties of both its constituents, salt as well as water.

(*iii*) The composition of salt-solution is variable. Different amounts of salt can be dissolved in the same amount of water to get salt solutions having different compositions. The salt solution does not have a definite formula.

(*iv*) Salt-solution does not have a fixed boiling point.

Suppose we are given two liquids, one a pure compound and the other a solution, and we have to find out which one is compound and which one is solution (or mixture). In order to distinguish between the two, we should evaporate them separately. **The liquid which evaporates completely, leaving no residue, is a pure compound.** On the other hand, **the liquid which leaves behind a residue on evaporation, is a solution or mixture**. For example, pure water can be distinguished from aqueous salt-solution by evaporation. Pure water evaporates completely leaving no residue, but salt-solution leaves behind salt as residue on evaporation (Please do not say that salt-solution can be distinguished from pure water "by tasting it"!).

The Case of Alloys

Alloys are homogeneous mixtures of metals and cannot be separated into their components by physical methods. Even then **an alloy is considered a mixture** because : (*i*) it shows the properties of its constituents, and (*ii*) it has a variable composition. For example, brass is a homogeneous substance composed of copper and zinc, and cannot be separated into its constituents by physical methods. **Brass is considered a mixture** because : (*i*) it shows the properties of its constituents, copper and zinc, and (*ii*) it has a variable composition (The amount of zinc in brass can vary from 20 to 35 per cent). Before we go further and discuss solutions, suspensions and colloids, **please answer the following questions :**

Figure 24. Brass is an alloy of copper and zinc. Brass is considered to be a mixture. This bucket is made of brass.

Very Short Answer Type Questions

1. State whether the following statement is true or false :
   Milk is a pure substance.
2. Name three mixtures found in nature.
3. Which of the following is a mixture ?
   Salt, Air, Water, Alum, Sugar
4. Name one metal and one non-metal which exist as liquids at room temperature.
5. Name a metal which is soft and a non-metal which is hard.
6. Name a non-metal which is a good conductor of electricity.
7. Name a liquid which can be classified as a pure substance and conducts electricity.
8. Name one solid, one liquid and one gaseous non-metal.
9. Name the property :
   (*a*) which allows metals to be hammered into thin sheets.
   (*b*) which enables metals to be drawn into wires.
10. Which type of elements, metals or non-metals, show the property of brittleness ?
11. What is meant by saying that metals are malleable and ductile ?
12. What is meant by saying that non-metals are brittle ?
13. What is meant by saying that metals are sonorous ?
14. What is meant by saying that metals are lustrous ?
15. What is the general name of the materials which contain at least two pure substances and show the properties of their constituents ?

16. ''The properties of the product are different from those of the constituents". State whether this statement best describes an element, a compound or a mixture.

17. Name one element, one compound and one mixture.

18. What is the major difference between a solution and an ordinary mixture ?

19. What name is given to those elements which are neither good conductors of electricity like copper nor insulators like sulphur ?

20. Fill in the following blanks with suitable words :

(*a*) An element is made up of only one kind of .....

(*b*) Brine is a .....whereas alcohol is a..... .

(*c*) Brass is an alloy which is considered a .....

(*d*) The three important metalloids are....., ... and .....

(*e*) The elements which are sonorous are called.....

Short Answer Type Questions

21. Classify the following into elements and compounds :

(*i*) H_2O (*ii*) He (*iii*) Cl_2 (*iv*) CO (*v*) Co

22. Classify the following as elements or compounds :

Iron, Iron sulphide, Sulphur, Chalk, Washing soda, Sodium, Carbon, Urea

23. What elements do the following compounds contain ?

Sugar, Common salt

24. What are pure substances ? Give two examples of pure substances.

25. What are the two types of pure substances ? Give one example of each type.

26. Which of the following are 'pure substances' ?

Ice, Milk, Iron, Hydrochloric acid, Calcium oxide, Mercury, Brick, Wood, Air

27. What is the other name for impure substances ? Give two examples of impure substances.

28. Which of the following substances are elements ?

Water, Salt, Mercury, Iron, Marble, Diamond, Wood, Nitrogen, Air, Graphite, Hydrogen, Oxygen, Sugar, Chlorine

29. State three reasons why you think air is a mixture and water is a compound.

30. Name two solid, two liquid and two gaseous elements at the room temperature.

31. Explain why, hydrogen and oxygen are considered elements whereas water is not considered an element.

32. What are the three groups into which all the elements can be divided ? Name two elements belonging to each group.

33. State two physical properties on the basis of which metals can be distinguished from non-metals.

34. Compare the properties of metals and non-metals with respect to (*i*) malleability (*ii*) ductility, and (*iii*) electrical conductivity.

35. State any two properties for believing that aluminium is a metal.

36. Give reason why :

(*a*) copper metal is used for making electric wires.

(*b*) graphite is used for making electrode in a dry cell.

37. How would you confirm that a colourless liquid given to you is pure water ?

38. Choose the solutions from among the following mixtures :

Soil, Sea-water, Air, Coal, Soda-water

39. Is air a mixture or a compound ? Give three reasons for your answer.

40. Give two reasons for supposing that water is a compound and not a mixture.

41. Define a compound. Give two points of evidence to show that sodium chloride is a compound.

42. Define a mixture. Give two points of evidence to show that sugar solution is a mixture.

43. State two reasons for supposing that brass is a mixture and not a compound.

44. List five characteristics by which compounds can be distinguished from mixtures.

45. Explain why, a solution of salt in water is considered a mixture and not a compound.

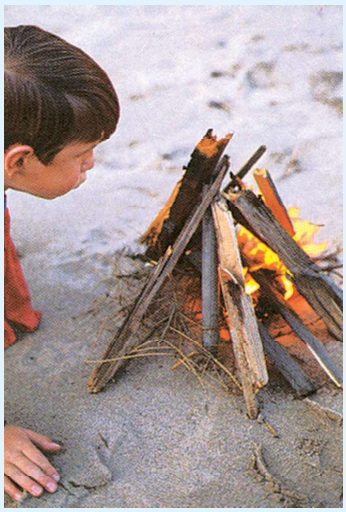
46. State one property in which a solution of sugar in water resembles a mixture of sugar and sand, and one property in which it differs from it.

47. You are given two liquids, one a solution and the other a compound. How will you distinguish the solution from the compound ?

48. Name a non-metal :
(*a*) which is lustrous
(*b*) which is required for combustion
(*c*) whose one of the allotrophic forms is a good conductor of electricity. Name the allotrope.
(*d*) other than carbon which shows allotropy
(*e*) which is known to form the largest number of compounds

49. Name a metal :
(*a*) which can be easily cut with a knife
(*b*) which forms amalgams
(*c*) which has no fixed shape
(*d*) which has a low melting point
(*e*) which is yellow in colour

50. Which of the following are not compounds ?
Chlorine gas, Potassium chloride, Iron powder, Iron sulphide, Aluminium foil, Iodine vapour, Graphite, Carbon monoxide, Sulphur powder, Diamond



Air is needed for the combustion (or burning) of fuels. Which component of air actually supports combustion ?

Long Answer Type Questions

51. (*a*) State the main points of difference between homogeneous and heterogeneous mixtures.
(*b*) Classify the following materials as homogeneous mixtures and heterogeneous mixtures :
Soda-water, Wood, Air, Soil, Vinegar, Alcohol and water mixture, Petrol and water mixture, Chalk and water mixture, Sugar and water mixture, Copper sulphate solution.

52. (*a*) What is meant by (*i*) elements (*ii*) compounds, and (*iii*) mixtures ? Write down the names of two elements, two compounds and two mixtures.
(*b*) Classify the following into elements, compounds and mixtures :
Marble, Air, Gold, Brass, Sand, Diamond, Graphite, Petroleum, Common salt, Sea-water, Chalk

53. (*a*) What are (*i*) metals (*ii*) non-metals, and (*iii*) metalloids ? Give two examples each of metals, non-metals and metalloids.
(*b*) Classify the following into metals, non-metals and metalloids :
Silicon, Mercury, Diamond, Sulphur, Iodine, Germanium, Sodium, Carbon, Magnesium, Copper, Boron, Helium

54 (*a*) What is a mixture ? Give two example of mixtures.
(*b*) What is meant by (*i*) homogeneous mixtures, and (*ii*) heterogeneous mixtures ? Give two examples of homogeneous mixtures and two of heterogenous mixtures.
(*c*) What is the other name of homogenous mixtures ?

55. (*a*) What are the three general classes of matter ? Give one example of each type.
(*b*) Draw a flow-chart for the schematic representation of different types of matter.

Multiple Choice Questions (MCQs)

56. Which of the following is not an element ?
(*a*) graphite (*b*) germanium (*c*) silica (*d*) silicon

57. Which of the following are compounds ?
(*i*) CO (*ii*) No (*iii*) NO (*iv*) Co
(*a*) (*i*) and (*ii*) (*b*) (*ii*) and (*iii*) (*c*) (*i*) and (*iii*) (*d*) (*ii*) and (*iv*)

58. One of the following substances is neither a good conductor of electricity nor an insulator. This substance is :
(*a*) chromium (*b*) germanium (*c*) gallium (*d*) potassium

59. Which of the following is not a mixture ?
(*a*) kerosene (*b*) air (*c*) alcohol (*d*) petrol

60. The element which is not common between the compounds called baking soda and soda ash is
(*a*) sodium (*b*) hydrogen (*c*) oxygen (*d*) carbon

61. "Is malleable and ductile" best describes :
(*a*) a solution (*b*) a metal (*c*) a compound (*d*) a non-metal

62. Which one of the following is not a metalloid ?
(*a*) boron (*b*) silicon (*c*) gallium (*d*) germanium

63. The elements which normally exist in the liquid state are :
(*a*) bromine and iodine (*b*) mercury and chlorine
(*c*) iodine and mercury (*d*) bromine and mercury

64. When a mixture of iron powder and sulphur powder is heated strongly to form iron sulphide, then heat energy is :
(*a*) released (*b*) first absorbed and then released
(*c*) absorbed (*d*) neither absorbed nor released

65. The property/properties which enable copper metal to be used for making electric wires is/are :
(*a*) copper metal is malleable and ductile
(*b*) copper metal is a good conductor of electricity
(*c*) copper metal is ductile and has low electrical resistance
(*d*) copper metal is sonorous and an excellent conductor of electricity

66. On the basis of composition of matter, milk is considered to be :
(*a*) a pure substance (*b*) an impure substance (*c*) an element (*d*) a compound

67. Which of the following statements are true for pure substances ?
(*i*) pure substances contain only one kind of particles
(*ii*) pure substances may be compounds or mixtures
(*iii*) pure substances have the same composition throughout
(*iv*) pure substances can be exemplified by all elements other than nickel
(*a*) (*i*) and (*ii*) (*b*) (*i*) and (*iii*) (*c*) (*iii*) and (*iv*) (*d*) (*ii*) and (*iii*)

68. Which of the following are homogeneous in nature ?
(*i*) ice (*ii*) wood (*iii*) soil (*iv*) air
(*a*) (*i*) and (*iii*) (*b*) (*ii*) and (*iv*) (*c*) (*i*) and (*iv*) (*d*) (*iii*) and (*iv*)

69. Two chemical substances X and Y combine together to form a product P which contains both X and Y

$$X + Y \rightarrow P$$

X and Y cannot be broken down into simpler substances by simple chemical reactions. Which of the following statements concerning X, Y and P are correct ?
(*i*) P is a compound (*ii*) X and Y are compounds
(*iii*) X and Y are elements (*iv*) P has a fixed composition
(*a*) (*i*), (*ii*) and (*iii*) (*b*) (*i*), (*ii*) and (*iv*)
(*c*) (*ii*), (*iii*) and (*iv*) (*d*) (*i*), (*iii*) and (*iv*)

70. Which of the following does not have a fixed melting point/boiling point ?
(*a*) gold (*b*) ethanol (*c*) air (*d*) oxygen

Questions Based on High Order Thinking Skills (HOTS)

71. In the following set of substances, one item does not belong to the set. Select this item and explain why it does not belong to the set :
Hydrogen, Oxygen, Steam, Chlorine

72. Iron powder and sulphur powder were mixed together and divided into two parts A and B. When part A was heated strongly over a burner, then a substance C was formed. The part B was, however, not heated at all. When dilute hydrochloric acid was added to substance C, then gas D was evolved and when dilute hydrochloric acid was added to part B then gas E was evolved.

(*a*) What type of substance is B ?

(*b*) What type of substance is C ?

(*c*) Name the gas (*i*) D, and (*ii*) E ?

(*d*) State one characteristic property of gas D.

(*e*) Write one test to identify gas E.

73. There are three substances X, Y and Z. The substance X does not have a fixed melting point or boiling point and it still shows the individual properties of its constituents. The substance Y is a pure substance which occurs in nature as such. The substance Y has a fixed melting point and boiling point but it cannot be broken down into simpler substances by any chemical means. The substance Z is also a pure substance whose properties are entirely different from those of its constituents. The substance Z can, however, be divided by electrolysis into two substances which belong to the same class of substances as Y.

(*a*) What type of substance could X be ? Name one substance like X.

(*b*) What type of substance could Y be ? Name one substance like Y.

(*c*) What type of substance could Z be ? Name one substance like Z.

(*d*) Which process involves absorption or release of an appreciable amount of energy : formation of substance X or formation of substance Z ?

(*e*) Name the three groups into which all the substances like Y are divided on the basis of their properties.

74. There is a large group of materials P which can be divided into three groups Q, R and S on the basis of their properties. The substances belonging to group Q can be solids, liquids or gases. The solids belonging to group Q are usually electrical insulators. Most of the substances of group R are solids which are good conductors of electricity. The substances belonging to group S are neither insulators like Q nor good conductors like R. The properties of S are intermediate between those of Q and R.

(*a*) What could the group of materials P be ?

(*b*) Name the substances Q. Give two examples of such substances.

(*c*) Name the substances R. Write two examples of such substances.

(*d*) Name the substances S. Give two examples of such substances.

(*e*) Out of Q, R and S, which substances are malleable and ductile ?

75. A, B and C are all liquids. Liquid A has a comparatively low boiling point. On heating, liquid A vaporises completely without leaving behind any residue. Liquid A is being used increasingly as a fuel in motor vehicles either alone or by mixing with petrol. Liquid B has a very high boiling point. It also vaporises completely on heating, without leaving any residue. Liquid B is a conductor of electricity and used in making thermometers. Liquid C has a moderate boiling point. On heating, liquid C vaporises leaving behind a white solid D which is used in cooking vegetables. The condensation of vapours from C give a liquid E which turns anhydrous $CuSO_4$ to blue.

(*a*) Which liquid could be an element ? Name this element.

(*b*) Which liquid could be a mixture ? Name this mixture.

(*c*) Which liquid could be a compound ? Name this compound.

(*d*) What could the solid D be ?

(*e*) What do you think is liquid E ?

ANSWERS

1. False **3.** Air **7.** Mercury **15.** Mixtures **16.** A compound **19.** Metalloids **20.** (*a*) atoms (*b*) mixture ; compound (*c*) mixture (*d*) boron ; silicon ; germanium (*e*) metals **21.** Elements : He, Cl_2 and Co; Compounds : H_2O and CO **23.** (*i*) Sugar is $C_{12}H_{22}O_{11}$. It contains C, H and O elements (*ii*) Common salt is sodium chloride, NaCl. It contains Na and Cl elements **48.** (*a*) Iodine (*b*) Oxygen (*c*) Carbon ; Graphite (*d*) Sulphur (*e*) Carbon **49.** (*a*) Sodium (*b*) Mercury (*c*) Mercury (because it is a liquid) (*d*) Sodium (*e*) Gold **54.** (*c*) Solutions **56.** (*c*) **57.** (*c*) **58.** (*b*) **59.** (*c*) **60.**(*b*) **61.** (*b*) **62.** (*c*) **63.** (*d*) **64.** (*b*) **65.** (*c*) **66.** (*b*) **67.** (*b*) **68.** (*c*) **69.** (*d*) **70.** (*c*) **71.** Steam does not belong to the set. This is because all others are elements whereas steam is a compound **72.** (*a*) Mixture (Fe + S) (*b*) Compound (Iron sulphide, FeS) (*c*) (*i*) Hydrogen sulphide, H_2S (*ii*) Hydrogen, H_2 (*d*) Smell of rotten eggs (*e*) Burns with a 'pop' sound **73.** (*a*) Mixture ; Salt solution (*b*) Element ; Sulphur (*c*) Compound ; Water (*d*) Formation of Z (which is a compound) (*e*) Metals, Non-metals and Metalloids **74.** (*a*) Elements (*b*) Non-metals ; Carbon and Sulphur (*c*) Metals ; Copper and Aluminium (*d*) Metalloids ; Boron and Silicon (*e*) Susbtances R (metals) **75.** (*a*) B ; Mercury (*b*) C ; Salt solution (*c*) A ; Alcohol (*d*) Sodium chloride (Common salt) (*e*) Water.