

UNIT I

The Nature of Matter

Chapter 1 Matter

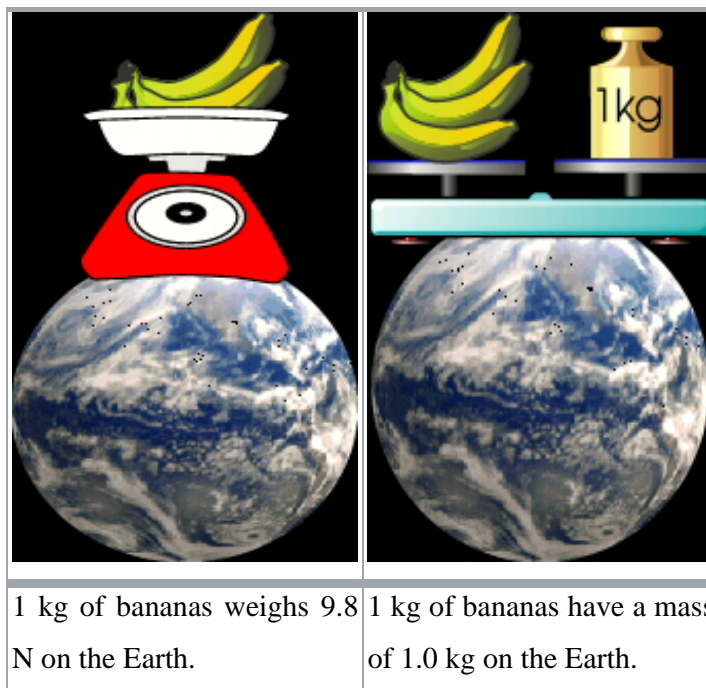
What is matter?

Anything that has mass and occupies space is called matter. Everything in the universe that we can see is matter. Even some things we are not able to see are also matter. For example, we cannot see air but air is matter. Everything you can see in the following pictures is matter.



What are the physical properties of matter?

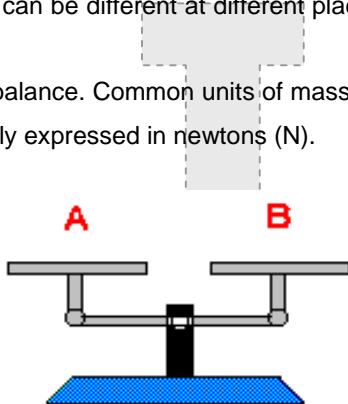
Physical property is the characteristic of matter which can be observed or measured without any chemical change in it. Some important physical properties of matter are discussed below.



Mass

Mass is the amount of matter present in an object. Mass of an object always remains constant and it is sometimes confused with weight but both are different. Weight is the measure of the force of gravity on an object. So, weight of an object can be different at different places in the universe but mass will always remain the same.

Mass is measured by using a balance. Common units of mass in the metric system are milligrams, grams and kilograms while weight is usually expressed in newtons (N).

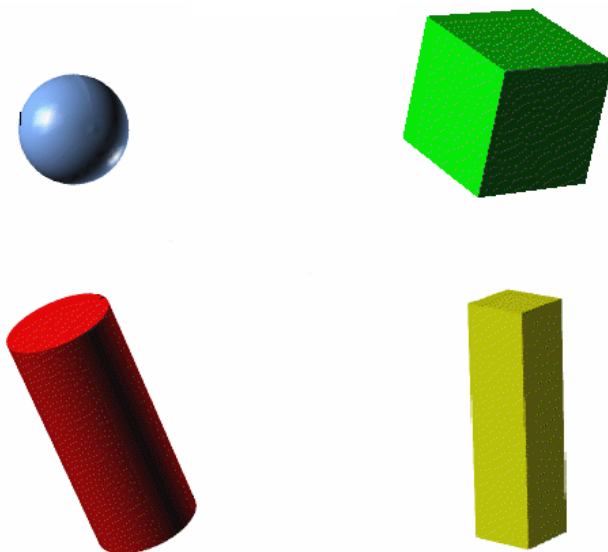


1. READING CHECK

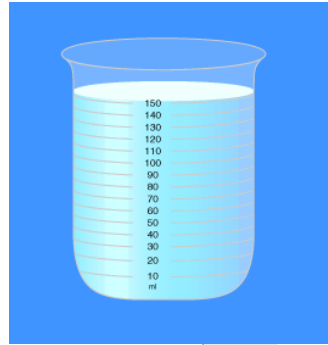
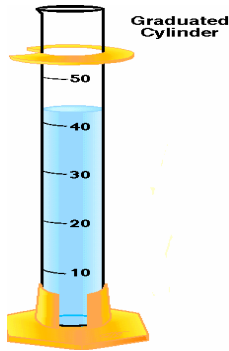
If mass of an object on the earth is 2.0 kg, what will be its mass on the moon?

VOLUME

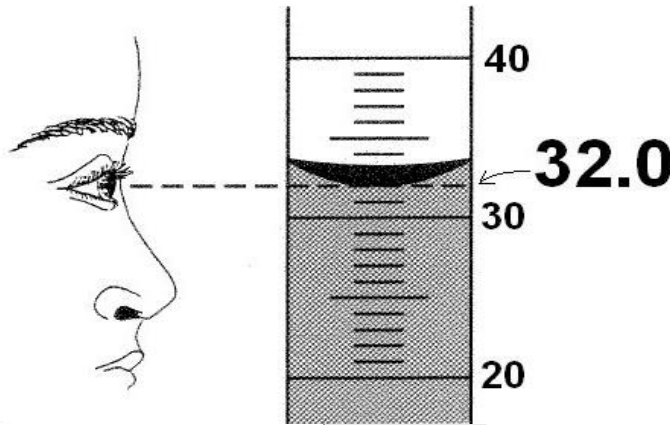
We know that matter has mass and it occupies space. Volume is the measure of the space occupied by matter. For example, a football occupies more volume than a fleck. Common metric units of measuring volume are milliliters and liters.



The volume of a liquid can be measured by using a graduated cylinder, a beaker and a measuring cup.



The measurement of the volume can be done as shown below.



How can we measure the volume of a solid?

In order to measure the volume of a solid, fill any of the above tools with some amount of water and note its volume. Now place the solid in a tool filled with water. The level of the water will rise and again note its volume. The difference in the volume of the water without the object and the volume of the water with the object gives the volume of the solid object.

2. READING CHECK

What is meant by the volume of the object?

3. READING CHECK

What are the common metric units for the measurement of volume?

4. READING CHECK

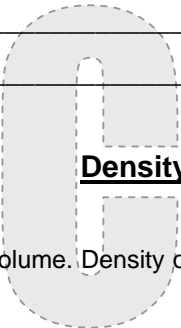
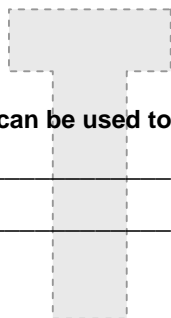
What are the tools used for the measurement of the volume?

5. READING CHECK

Name any three measuring tools which can be used to measure the volume of the liquid.

6. READING CHECK

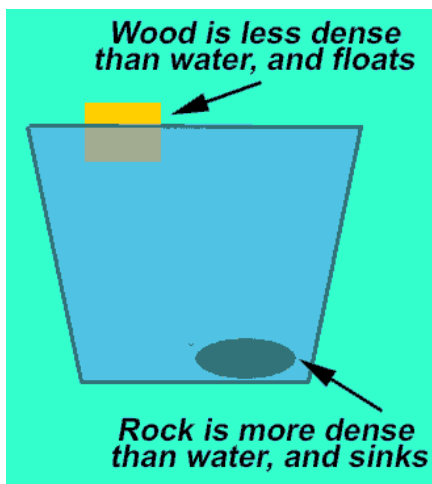
While measuring the volume of a solid Andy found that the volume of the water filled in a beaker without the solid is 500 mL and the volume of the water filled in a beaker with the solid placed in it is 525 mL. What is the volume of the solid?



Density

Density is the mass of an object per unit volume. Density of an object is obtained by dividing the mass of the object with the volume

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$



Density of an object is the unique property and is used to identify materials. Density is independent of its size and shape and depends only on the identity of the material. Common metric units of density are gram/cubic centimeter or gram/milliliter

7. READING CHECK

If mass of an object is 100 g and its volume is 25 mL, what will be the density of the object?

8. READING CHECK

Why density is used to identify different materials?

9. READING CHECK

Can two objects having the same volume have different densities?

10. READING CHECK

Can two objects having same mass have different densities?

11. READING CHECK

How density of an object is related to its mass and volume?

Other important physical properties

There are several other physical properties that are helpful in identifying and classifying matter. These are color, size, shape, texture, malleability, conductivity, melting point and boiling point. These physical properties can be determined without any change in the identity of the matter.

Weight and Mass

An astronaut in the space is weightless but has mass. What is the difference between mass and weight? As we know, mass of an object is the amount of matter present in that object, so mass is always the same



at any place in the universe. An object having mass of 10 g will always have mass of 10 g , no matter it is on the earth , the moon or on any other planet



On the other hand, weight measures the gravitational pull. Since the gravitational pull of the moon is lesser than that of the earth, an object will weigh less on the moon than on the earth. Same will be the case for a planet having gravitational pull less than that of the earth,

12. READING CHECK

If the gravitational pull of some planets decreases in the order, Jupiter > Earth > Mars > Pluto, then on which of these planets, an object will have the minimum weight?

13. READING CHECK

What is the difference between mass of an object and its weight?

14. READING CHECK

Out of mass and weight, which is related to the gravitational pull?

15. READING CHECK

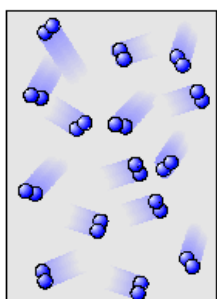
Can mass of an object vary with change in the location of the object in the universe?

Solids, Liquids, and Gases

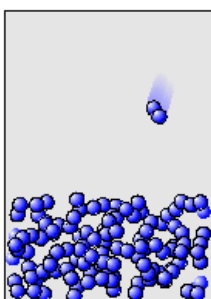


Solid, liquid and gases are three states of matter. In these three states the arrangement and motion of particles (atoms and molecules) is different. In case of solids the particles are arranged in a regular pattern. The particle motion is negligible. Therefore, solids have a rigid structure. So solids possess fixed volume and fixed shape. In case of liquids the particles are loosely bound as compared to that solid so the particle motion is more. Liquids have fixed volume but not a fixed shape. In case of gases the particles are less loosely arranged. There is a very rapid random motion of particles. These are large spaces among the particles. So the gases neither have definite shape nor the definite volume.

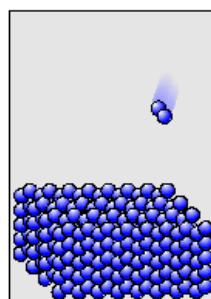
States of Matter



gas
disorder



liquid
short range order



solid
long range order

16. READING CHECK

Give any three examples of matter which have a definite volume but not a definite shape.

17. READING CHECK

In which state of the matter the motion of the particles (atoms and molecules) is maximum?

18. READING CHECK

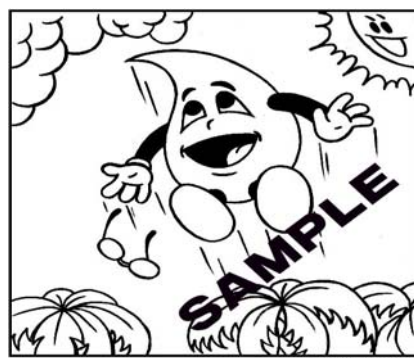
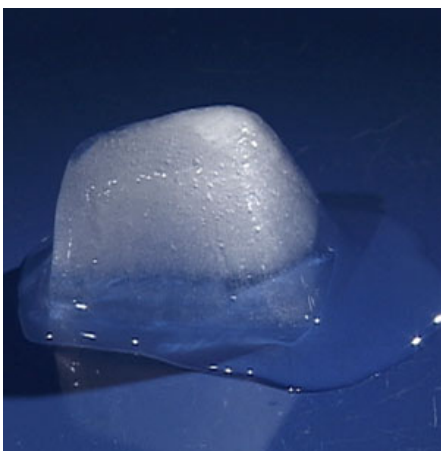
In which state of the matter the distance between the particles is minimum?

Changes in matter

Physical changes

These are the changes during which the identity of the material does not change, i.e. the chemical composition of the substances remain the same. Some examples of physical changes are breaking of glass, cutting a paper into small pieces, melting of ice-cream, freezing of ice, etc. Physical changes are normally reversible.

An important type of physical changes is a phase change. The phase change takes place by absorption or evolution of energy. Some examples of physical changes in which phase of the matter changes are melting, freezing, evaporation /boiling, condensation ,and sublimation. In melting, solid states change to liquid state, in freezing, liquid state changes to solid state, in evaporation or boiling, liquid state changes to gaseous state. In condensation, gaseous state changes to liquid state, in sublimation, solid state changes to gaseous state.



Drippy...
EVAPORATES

READING CHECK

How will you explain physical changes? Give examples.

READING CHECK

What happens to the composition of the material during a physical change?

READING CHECK

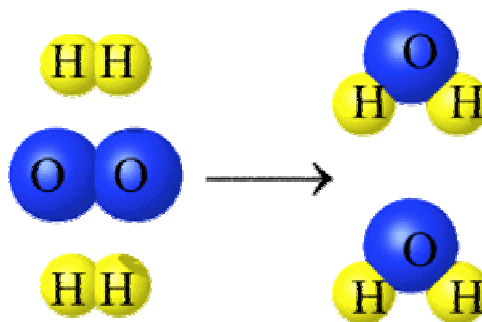
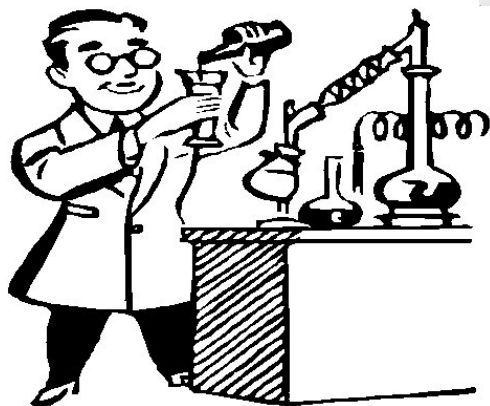
What are the states involved in the sublimation?

READING CHECK

Explain the phase change in case of water with the absorption and evolution of energy

Chemical changes

These are the changes in which the chemical composition of the material changes. In these types of changes, a new substance is formed with entirely different properties. These types of changes are normally irreversible. They involve rearrangement of atoms that results in making or breaking of chemical bonds.



The new compound/s formed during the chemical changes usually has/have color, texture, density, volume, etc. Few examples of chemical changes are digestion of food, rusting of metals, burning of wood, photosynthesis, etc.

READING CHECK

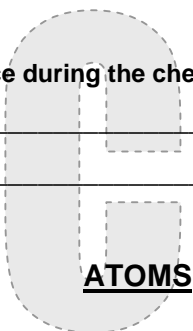
How chemical changes are different from physical changes?

READING CHECK

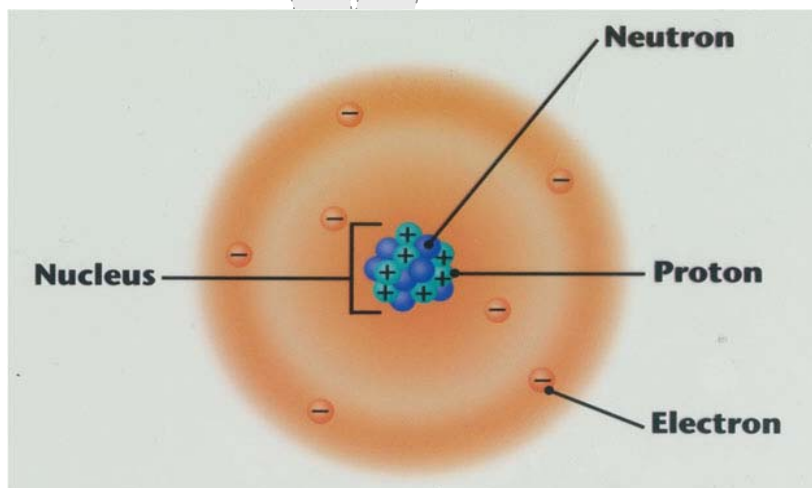
Give any two examples of chemical changes?

READING CHECK

How rearrangement of atoms takes place during the chemical changes?



An atom is the smallest unit of a substance that still has the same chemical properties of that substance. An atom consists of a highly dense positively charge nucleus which contains positively charge protons and electrically neutral neutrons. The nucleus is surrounded by the heavy cloud of electrons which are negatively charged. Atoms are too small that they cannot be seen even with the best microscopes. The structure of atom is shown below.



The nucleus is very small as compared to the total diameter of the atom (about 1/100,000 of the total diameter of the atom) but it is highly dense. Most of the mass of the atom is present in the nucleus.

The type of atom is identified by the number of protons present in it. The number of protons present in an atom is known as its atomic number. The change in the number of protons will change the identity of the atom. A neutral atom has the same number of protons and electrons. Change in the number of electrons will change the chemical properties of the atom but not its identity. The mass of the electron is very small as compared to the mass of the protons and neutrons. It is relatively easy to remove electrons from the atom as compared to that of protons. Atoms which are present close to the nucleus are more tightly bound as compared to the electrons which are present farther away from the nucleus in an atom.

Different atoms can interact in many different ways. Electrons can be transferred from one atom to another resulting in the formation of salt or electrons can be shared between different atoms to form molecular compounds such as water. The charge and mass of the different components of the atom is shown below.

Components	Electric Charge	Mass
Electron	-1	negligible
Proton	+1	about 1,840 times more than electron
Neutron	0	little more than proton

READING CHECK:

How atoms are defined?

READING CHECK:

What are the different components of an atom?

READING CHECK:

What is the mass and charge present on the different components of the atom?

READING CHECK:

How atoms of different types can be identified?

READING CHECK:

What is the effect of change in the number of protons and change in the number of electrons on an atom?

READING CHECK:

How location of an electron in the nucleus determines how easy or difficult it is to remove it from an atom?

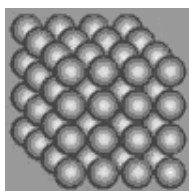
READING CHECK:

How atoms of different types can interact with each other?

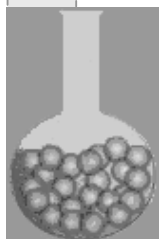
MOTION OF ATOMS AND MOLECULES

Atoms and molecules always remain in a constant motion. Motion of the atoms and molecules depends upon the available energy. Their motion can either be decreased by removing energy or increased by providing energy. Moving particles possess kinetic energy. Temperature is used to measure the average kinetic energy of the particles. Fast-moving atoms and molecules will have higher temperature and slow-moving atoms and molecules will have lower temperatures.

When heat, which is a form of energy, is supplied to a solid state, the atoms and molecules will start moving faster. At a specific temperature the rigid arrangement of the atoms in a solid breaks and the material turns into a liquid. When more heat is supplied at a specific temperature the arrangement of particles in a liquid breaks and the material turns into a gas. In the gaseous state the motion of the particles and the spaces between them are maximum. On the other hand, if we remove the energy from a state of matter the above process is reversed. So, the phase change is reversible.



Solid



Liquid



Gas

READING CHECK:

How available energy affects the motion of atoms and molecules?

READING CHECK:

What information is provided by the temperature about the motion of atoms and molecules?

READING CHANGE:

How temperatures affect the phase change?

READING CHECK:

How phase change is reversed?
