Mass of copper oxide = 1.824

Mass of oxygen = 1.824 − 1.457 = 0.367

$$\% \text{ of copper in copper oxide} = \frac{1.457}{1.824} \times 100 = 79.9\%$$

Mass of compou

$$= \frac{0.144}{0.24} \times 100 = 60$$

DALTON'S ATOMIC THEORY

The scientists started thinking to give appropriate explanation to the laws of combinations. Guided by the laws of chemical combinations and other facts, John Dalton provided the basic theory about the nature of matter. He took the name atoms for the smallest particle of matter as given by the Greek. Based on the laws of chemical combination, he proposed a model of an atom known as **Dalton's atomic theory.**

The main postulates of the Dalton's atomic theory are :

1. All matter is made up of very small particles. These small particles are called **atoms.**
2. Atoms cannot be further broken down. They are tiny, indivisible and indestructible ultimate particles.
3. Atoms can neither be created nor destroyed in a chemical reaction.
4. All the atoms of a given element are identical in all respects having the same mass, size and chemical properties.
5. Atoms of different elements are different and have different mass, size and chemical properties.

6. During chemical combination, atoms of different elements combine in a simple whole number ratio to form compounds.
7. The relative number and kinds of atoms are constant in a given compound.
8. Atoms of same element can combine in more than one ratio to form more than one compound. For example, hydrogen and oxygen combine to give water and hydrogen peroxide. In water, two atoms of hydrogen combine with one atom of oxygen while in hydrogen peroxide, two atoms of hydrogen combine with two atoms of oxygen.

Thus, the Dalton's atomic theory gave the **concept of atom** as the smallest particle of matter.

ATOM : AN ULTIMATE PARTICLE OF MATTER

What is an Atom?

According to Dalton an atom is something that cannot be divided further. This is the ultimate particle of an element that maintains its chemical identity throughout all chemical and physical changes. Thus, the atoms are the building blocks of all matter.

How big are atoms ?

The atoms are very small. In fact they are smaller than anything we can imagine or campare with. More than millions of atoms when stacked one on top of the other would make a layer barely as thick as the sheet of this paper. The size of an atom is expressed as atomic radius. It is generally measured in nanometres. The nanometres are related to metres as

$$1\ \text{nm} = 10^{-9}\ \text{m or} = \frac{1}{10^{9}}\text{m}$$
$$\text{or } 1\ \text{m} = 10^{9}\ \text{nm}$$

The relative sizes of atoms and molecules as compared to other common species are given below :

Species	Atom of hydrogen	Molecule of water	Molecule of hemoglobin	Grain of sand	Ant	Watermelon
Approx. atomic radius (in m)	10^{-10}	10^{-9}	10^{-8}	10^{-4}	10^{-2}	10^{-1}

We might think that if atoms are so insignificant in size then why should we care about them. In fact, we cannot ignore atoms because our entire world is made up of atoms. We may not be able to see them because they are extremely small. But atoms are there and are constantly affecting us whatever we do.

Modern technology has made it possible to take photographs of atoms. It can be done with the help of sophisticated instrument called **Scanning Tunneling Microscope** (STM). It was developed in 1981. It can produce the image of the surfaces of elements which show the individual atoms. An image of surface of silicon constructed with STM has been shown in Fig. 2. In this image, the silicon atoms are shown to be arranged in a regular pattern.

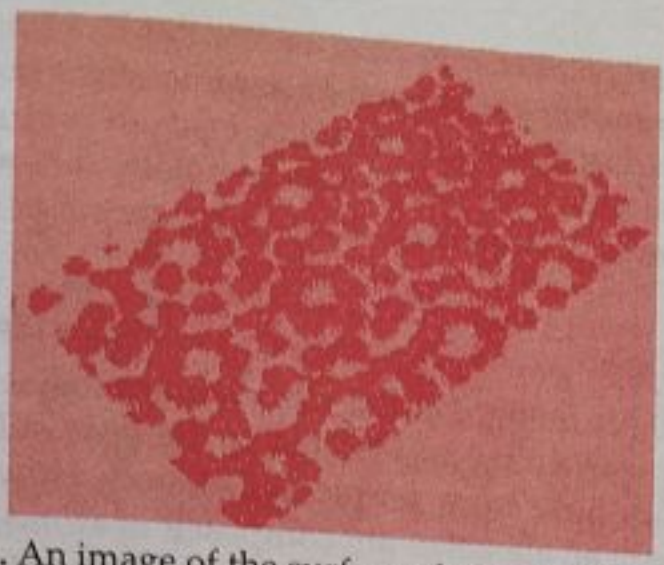

Fig. 2. An image of the surface of silicon constructed with scanning tunneling microscope (STM).

Explanation of Laws of Chemical Combination by Dalton's Atomic Theory

Dalton's atomic theory provided a simple explanation for the laws of chemical combination.

1. Explanation for the law of conservation of mass.

According to Dalton's atomic theory matter is made up of atoms and atoms can neither be created nor destroyed during any physical or chemical change. This means that the number of various types of atoms in the products of a chemical reaction is the same as the number of all these atoms in the reactants. A chemical reaction only involves rearrangement of atoms to form the products. Since the same number of atoms are present in products as those in the reactants, therefore, there will be no change in mass. Hence, the total mass of products is equal to the total mass of reactants. Thus, the law of conservation of mass is supported by Dalton's atomic theory.

2. Explanation of Law of Constant proportions

According to one of the postulates of Dalton's atomic theory, the relative number and kind of atoms in a given compound is fixed. Since the kind of atoms in a compound is fixed, this means that a compound is always made up of the same elements. Moreover, the number of atoms in different elements in the compound is fixed and all the atoms of a given element are identical in mass, this means that a compound will always have the same elements combined together in the same proportion by mass. This is law of constant proportions and hence the law is supported by Dalton's atomic theory.

Drawbacks of Daltons atomic theory

Dalton's atomic theory gave a powerful initiative to scientists in the begining of 19th century. But later work by scientists about the nature of atom pointed out some limitations of this theory.

The main limitations of Dalton's atomic theory are:

(*i*) Atoms have been found to be made of still smaller subatomic particles — electron, proton and neutron. Therefore, atom is no longer indivisable.

(*ii*) Atoms of the same element may have different masses. For example, there are two different types of chlorine atoms having atomic mass 35 and 37, though their chemical properties are same. Such atoms of the same element having different atomic masses are called **isotopes** (discussed later).

(*iii*) Atoms of different elements may be similar in one or more respects. There are certain atoms of different elements which possess same atomic masses. For example, atomic mass of calcium and argon is same (40 a.m.u). but their chemical properties are totally different. Such atoms of different elements having same atomic mass are called **isobars** (discussed later).

Dalton's atomic theory and the terms, elements and compounds

The Dalton's atomic theory helped the scientists to have a mental picture of matter. We have learnt that an element is the pure substance which can neither be broken nor built from simpler substances. However, according to Dalton's atomic theory all elements are composed of atoms. Thus,

an element is a pure substance which is made up of only one kind of atoms.

Thus, the ultimate particle of an element is an atom. To understand this, consider a piece of an element say gold. If we break this into smaller and