be perfectly dry outside, upon the scales and accurately balance it by weights. Then heat the test-tube and decompose the mercuric oxide. The red powder will gradually waste away, globules of mercury collect on the side of the tube above the heat, while the oxygen passes into the first flask and drives the water over into the second. Leave the apparatus at rest for a short time till the tube becomes cold, and it will be found that the balance is undisturbed. The whole weight is just the same as the first.

Hence we infer that *No loss of matter takes place in Chemical Decomposition.*

**First Great Principle in Modern Science.** Many accurate experiments similar to the preceding have been made by chemists, and have proved beyond doubt that matter is never destroyed. Substances may disappear and seem to be lost, but the loss of matter is only apparent. During all the chemical changes through which substances may go, the balance shows that the weight remains the same; and when weight remains the same we are only following to its legitimate consequences the great principle established by Newton: *When weight remains we are persuaded that the material remains.* The *indestructibility of matter* is the first great principle of modern science, and to Lavoisier belongs the glory of having first distinctly asserted it.

The second great principle of modern science is that energy, which has been defined to be "The capacity, or power, of any body, or system of bodies, when in a given condition to do a measurable quantity of work," is also indestructible; but the consideration of this belongs to Physics rather than to Chemistry.

**Constant Composition.** The first great law concerning chemical combination discovered by the use of the balance is that of the invariable proportions of the constituents in any chemical compound. In whatever way any given chemical compound may be prepared, or in whatever manner its composition may be accurately ascertained, it is found always to contain a fixed and definite quantity of each of its constituent elements, *and this is a distinguishing characteristic of a chemical compound, as opposed to a mere mechanical mixture, the constituents of which may be present in any varying proportions.* Thus in the last experiment the 2.16 grams of mercuric oxide will yield two grams of mercury and .16 of a gram or 112 cubic centimetres of oxygen, and although the oxide can be prepared in several ways, the weight of mercury and volume of oxygen obtained are always found to be the same from the same weight of the oxide.

A great many experiments have been made in the same direction, and it has been found that every chemical compound which possesses a group of characters serving to define it, and so distinguish it from all other forms of matter, exhibits the remarkable constancy of composition exhibited by mercuric oxide. The inference clearly to be drawn from this is that *Chemical compounds are constant in composition.*

**Law of Definite Proportions.**—The admission of the constancy of composition of chemical compounds leads us to suspect that chemical combination takes place in *definite proportions.* Were it otherwise it would be impossible to give any adequate explanation of the fact that the constituents of mercuric oxide are always found in that body in fixed proportions. This may be put to the test by the following experiment:—

**Exp. 13.**—Into a small beaker pour about fifty cubic centimetres of hydrochloric acid, and drop into it little by little, powdered sodium carbonate. Effervescence takes place, showing that gas is escaping, and that chemical action is going on. Continue until the last small quantity of the sodium carbonate produces no effervescence. The acid is then all neutralized. Then carefully stir in drops of the acid until with the last drop the last of the small quantity of solid carbonate disappears. The slightest quantity of either, beyond a certain *definite proportion*, remains unchanged. Hence we are led to the following law;—

**First Law of Chemical Combination.**—*The proportions in which bodies unite together chemically are definite and constant.*

**Chemical Compounds and Mechanical Mixtures.**—We find a variety of compound bodies in many cases closely resembling chemical compounds. To these various names are applied according to the nature of the substance, such for instance as *mechanical mixture*, solution, alloy, etc. But there is always a marked difference between them and true chemical compounds. The following experiment will illustrate this:—

**Exp. 14.**—Make a mixture of iron filings and sulphur in the proportion of thirty-six parts by weight of sulphur. A greenish gray powder results, but (1) distinct particles of both iron and sulphur can easily be recognized by a good magnifying glass. (2) Gently stir a portion of the powder into a tumbler of water. The heavy particles of iron fall quickly to the bottom of the tumbler, while the lighter sulphur more slowly subsides and collects as a distinct layer. (3) Stir the mixture with a small magnet, and the particles of the iron will firmly adhere to the magnet, while the sulphur can easily be blown away.

Hence we see that, *The constituents of the mixture can easily be separated by mechanical means, and that it partakes of the properties of both iron and sulphur.*

**Exp. 15.**—Heat a small portion of the mixture of iron and sulphur in a test-tube. The mixture becomes pasty and then glows for a short time, showing that chemical action is taking place. Break the test-tube and grind up its contents in a mortar. (1) When examined with a magnifying glass no particle of iron or sulphur can be detected. (2) It is no longer attracted by the magnet, or at least very little, and therefore contains little or no free iron. (3) *The iron and sulphur are no longer separable by mechanical means.* (4) If a small quantity be put into a test-tube and dilute sulphuric acid be added, a gas possessing a very offensive odor is evolved. Neither iron nor sulphur possess the property alone, of evolving this gas. The iron and sulphur have chemically combined forming iron sulphide, which possesses a definite group of characters which not only serve to distinguish it from the free elements iron and sulphur, or a mixture of them, but from all other bodies.

Hence we can distinguish a *chemical compound* from a mechanical mixture by the following characteristics:—

(1) The properties of a *chemical compound* differ entirely from those of its constituents.

(2) No purely mechanical means will suffice to separate the constituents of a *chemical compound* from each other.

The constituents of a *mechanical mixture* can always be separated by mechanical means.

(3) A *chemical compound* always contains a fixed and definite quantity of each of its constituents.

The constituents of a *mechanical mixture* may be present in any varying proportions.

The last characteristic is the one which, above all others, enables us to assert positively that a given body is or is not a chemical compound.

**Exp. 16.**—Take two copper wires, each about twenty centimetres in length, flatten an end of each, and to the flattened ends solder a strip of platinum, about two centimetres long by five millimetres broad. When these wires are connected with the wires from the battery they are usually spoken of as the *poles* of the battery. Dip the wires in melted paraffine, and wrap round each of them a thread of lamp-wick, previously soaked in paraffine. This will protect the copper from the action of the acid. Take a tumbler three-fourths full of water and add to it a teaspoonful of sulphuric acid for the purpose of increasing the conducting power of the water. Bend the copper wires over the sides of the tumbler so that the tops of the platinum strips may be about two centimetres below the surface of the water. Fill two test-tubes with water, acidulated with sulphuric acid, and place them over the platinum strips, keeping the tubes as near together as possible. Connect the wires with the galvanic battery and minute bubbles of gas will immediately be given off. It will soon be seen that twice as much gas is given off from the pole connected with the zinc end of the battery as from the pole connected with the platinum end; when the former is full the latter is only half full. As soon as the tube connected with the zinc end of the battery is full, close its mouth with the thumb, raise it out of the water, and examine its contents.

(1). Observe that the gas is colorless.

(2). Invert the tube and apply a match to its mouth; the gas takes fire and burns with a pale blue flame.

(3. Refill the tube. Turn its mouth upward and smell it. No odor is perceived. Hold the tube in this position for a few seconds, and then apply a lighted match to its mouth, no combustible gas is found in it. The gas has escaped, and is, therefore, lighter than air.

The gas possessing the above properties is called **Hydrogen.** It is considered to be an elementary body. It will be fully treated of *in a future number.*

If the gas in the other test-tube be examined in the same way, it will be found that it will not take fire. Immerse in a glowing