guished. The charcoal (carbon) combines with the oxygen forming *Carbon Dioxide*, CO_2, thus:—

$$\underset{\text{Carbon.}}{C^*} + \underset{\text{Oxygen.}}{O_2} = \underset{\text{Carbon dioxide.}}{CO_2}$$

46. Carbonic Acid. Pour about half a tumblerful of water into the bottle and shake it vigorously. The hand will be drawn in, but not as forcibly as in Exp. 6; carbon dioxide is only moderately soluble in water. Pour some of the water into a glass and taste it; it is slightly sour. Pour some of it into litmus solution; the solution is turned a dark-red color. The carbon dioxide has combined with the water, forming *Carbonic Acid*, H_2CO_3, thus:—

$$\underset{\text{Carbon dioxide.}}{CO_2} + \underset{\text{Water.}}{H_2O} = \underset{\text{Carbonic acid.}}{H_2CO_3}$$

47. Meaning of Test. Pour some clear lime-water *into the carbonic acid reserved from the last experiment*; the clear liquid becomes milky, indicating the presence of carbonic acid, as will be hereafter explained. Lime-water is said to be a "test" for carbon dioxide or carbonic acid. *A test is a material for some experiment intended to bring out a property characteristic of the substance under examination, and by which the presence of that body may be detected.*

48. Origin of name Oxygen.—In the preceding experiments the products of combustion in oxygen when combined with water formed acids. The name OXYGEN (from the Greek *oxus*, sour, and *gennao*, I produce), was given by Lavoisier, under the mistaken impression that this element contained a principle common to all acids. This is now known to be an error. Later researches have brought to light a number of compounds containing hydrogen possessed of acid properties in which no oxygen is present. Nevertheless the name was not ill-chosen, for of the many hundreds of acids known there are only about six which do not contain oxygen,

49. Combustion of Sodium in Oxygen.

Exp. 8.—*Take a small piece of metallic sodium, scrape it* clean with a knife, heat it in the deflagrating spoon till it melts and begins to burn, then plunge it into a bottle of oxygen; it will burn with great brilliancy and with a bright yellow flame. A white solid called *Sodium Oxide*, Na_2O, is formed. The reaction is—

$$\underset{\text{Sodium.}}{2Na_2} + \underset{\text{Oxygen.}}{O_2} = \underset{\text{Sodium oxide.}}{2Na_2O}$$

50. Alkalies—Sodium Hydrate.—Add a little water to the bottle, shake it up and taste a few drops of the solution: it does not taste sour, but has a peculiar nauseous taste, and is soapy to the touch. Add a little to blue litmus solution; it is not reddened, but on the contrary becomes rather darker in color. Dip a glass rod into hydrochloric acid, and with it redden some blue litmus solution. Pour into this some of the solution of the sodium oxide; the red solution at once becomes blue. *The solution of sodium oxide acts upon vegetable colors in just the opposite way from acids, and will, in fact, neutralize their action.* It is called an *alkali*, and substances like this which will restore the blue color of reddened litmus are said to have an *"alkaline reaction."* The sodium oxide has combined with a molecule of water, forming a substance called *Sodium Hydroxide* or *Sodium Hydrate*, NaOH, better known by its common name of *Caustic Soda*, thus

$$\underset{\text{Sodium oxide.}}{Na_2O} + \underset{\text{Water.}}{H_2O} = \underset{\text{Sodium hydrate.}}{2NaOH}$$

Similarly, if we burn the metal potassium in oxygen, we obtain *Potassium Oxide*, K_2O, which combines with water, to form *Potassium Hydrate*, KOH.

51. Combustion of Magnesium in Oxygen.

Exp. 9.—Burn 10 or 12 centimetres (4 or 5 inches) of Magnesium ribbon in oxygen. A white solid called *Magnesium Oxide*, MgO, is formed; thus:—

$$\underset{\text{Magnesium.}}{2Mg} + \underset{\text{Oxygen.}}{O_2} = \underset{\text{Magnesium oxide}}{2MgO}$$

52. Bases—Magnesium Hydrate. Pour a small quantity of water into the bottle containing the magnesium oxide and shake it vigorously; it does not seem to dissolve in the water. Add some of it to blue and reddened litmus solutions; it has apparently neither *acid* nor *alkaline* reactions. Dip a piece of white blotting paper in reddened litmus solution, put it into the liquid and leave it for some time; it becomes blue. Half fill a test-tube with water and add to it *one* drop of nitric acid; the solution will readily redden blue litmus paper when dipped into it. Pour the solution into the bottle in which the magnesium was burnt and shake it vigorously; it will no longer redden either blue litmus paper or blue litmus solution. The acid has been *neutralized*. *A body possessing the characteristic of neutralizing an acid, either partly or entirely, is called a* BASE. An *alkali* is only a base, which is freely soluble in water. Acids and bases will be fully discussed in a future chapter. It may be stated here that the characters of taste and reaction belong to all well-marked acids and bases which are soluble in water; but they do not belong to *all* the acids and bases. In this case a molecule of water has combined with the magnesium oxide to form Magnesium Hydrate, $Mg(OH)_2$; thus:—

$$\underset{\text{Magnesium oxide.}}{MgO} + \underset{\text{Water.}}{H_2O} = \underset{\text{Magnesium hydrate.}}{Mg(OH)_2}$$

53. Combustion of Iron or Steel in Oxygen.

Exp. 10.—Take a piece of thin watch-spring, which may be obtained from any watchmaker, heat it in the flame of a spirit-lamp till it is red-hot, and allow it to cool; it will then have lost its elasticity. Coil it into a spiral around a glass tube, clean one end with a file, twist it round a bit of charcoal, and fasten the other end to the cap of the deflagrating spoon, and plunge in into a quart bottle of oxygen, on the bottom of which there is at least an inch of water. The burning cork heats the steel to redness, which then combines with the oxygen burning brilliantly, forming *Magnetic* or *Black Oxide* of Iron, Fe_3O_4, and throwing out abundance of sparks. The sparks are red-hot carbon contained in the steel, which also combine with the oxygen, forming carbon dioxide. The oxidized iron falls to the bottom in black globules, which are so hot that they are apt to melt into the glass and crack it, unless they have to pass through a considerable depth of water. The reaction is:—

$$\underset{\text{Iron.}}{3Fe} + \underset{\text{Oxygen.}}{2O_2} = \underset{\text{Magnetic oxide of iron.}}{Fe_3O_4}$$

* The number of atoms in a molecule of carbon is unknown, and in such cases the symbol for the atom is used in equations.