sulphate ($CaSO_4.2H_2O$) and not of chalk, which is calcium carbonate ($CaCO_3$). Since carbon dioxide (CO_2) is a gas that is heavier than air, it will stay in the tube or other vessel when the latter is right side up, just as though you had water (H_2O) in it.

A Better Way to Make Carbon Dioxide. Where you want to make a small amount of this gas for experimental

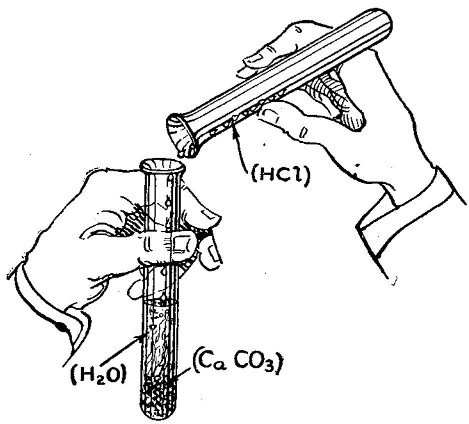

FIG. 54.—A Simple Way to Make Carbon Dioxide.

purposes, take a 4-ounce or 8-ounce, wide-mouth bottle with a tight-fitting cork; now bore a hole in the latter and push a piece of glass tube with a ½-inch or ⅝-inch bore—or you can use a test tube from which you have cut the closed end—through it; into the mouth of this fit another cork and push the short end of a bent glass tube with a ⅜-inch bore through it, all of which is shown in Fig. 55. To make the joints gas-tight, put some melted paraffin on them.

Use in suitable quantities the same materials called for in connection with Fig. 54.

Where you want a still larger amount of the gas, use a pint jar and fit the cork with a glass funnel tube that is long enough to reach from the outside to the bottom of the

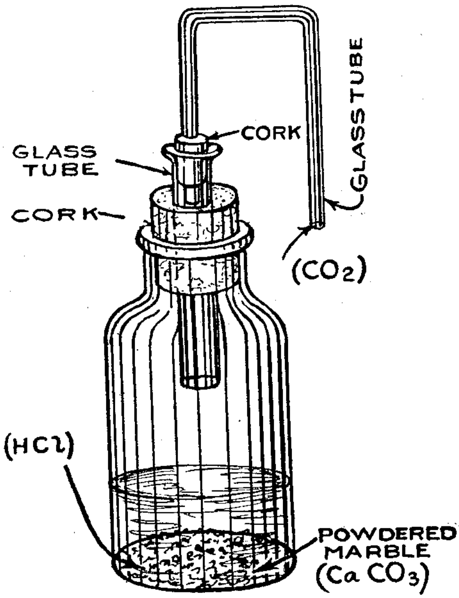

FIG. 55.—A Better Way to Make Carbon Dioxide.

jar, and a delivery tube bent as shown in Fig. 56. If you will use powdered marble ($CaCO_3$) instead of chalk you will get a supply of nearly pure carbon dioxide (CO_2). This gas is heavier than air, and has, therefore, a tendency to stay in the bottom of the jar; but as it is set free from the marble in large quantities it is soon under pressure and this drives it out of the delivery tube.

To Show that Carbon Dioxide Will Not Support Combustion. Fill a wide-mouth bottle. or a glass jar, with car-

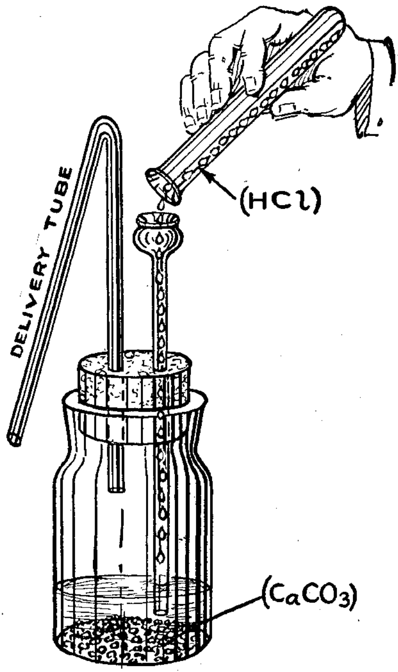

FIG. 56.—To Make a Larger Amount of Carbon Dioxide.

bon dioxide (CO_2) and lower a lighted candle into it, and the flame will be extinguished. You can do this experiment as a trick, for to the average person the bottle, or jar, is, to all intents, an empty one; now lower half a dozen lighted candles into the jar one after the other, and the flame of each one will go out as it reaches the surface of the gas. The effect is most mysterious.

Moreover, the smoke from the candle when it goes out does not rise into the air as it is expected to do in the natural order of things but, instead, it floats on top of the unseen gas in a strange and uncanny way, very like a London fog, and if you shake the jar it will set up miniature waves in imitation of the old ocean itself. The reason the smoke clings to the surface of the gas is because it easily mixed with the latter and this holds it down.

To Show that Carbon Dioxide Destroys Life. Carbon dioxide (CO_2) is different from nitrogen (N) in that it kills not only because it cannot support combustion, and, hence, life, but by virtue of the fact that it is poisonous. And yet as high as 6 per cent of it can be breathed without harm when it is mixed with the oxygen (O) and nitrogen (N) of the air. If you are a naturalist as well as a chemist you can kill insects for your specimens and preserve them in their original form and brilliancy of color by simply putting them into a jar of carbon dioxide (CO_2).

A Magical Experiment with Air, Carbon Dioxide, and Oxygen. Take three pint glass jars and let the first one contain ordinary air, fill the second one with carbon dioxide (CO_2), and the third one with oxygen (O), and invert the latter one until you are ready to do the trick. Now wrap a wire around a piece of candle, light it, and then lower it into the jar of air first. Of course, the flame will continue to give its light. Now lower it into the jar of carbon dioxide (CO_2), and the flame will mysteriously go out; draw it out of the jar before the wick cools off and dip it into the jar of oxygen (O), and it instantly relights and burns with a dazzling light. Since all the jars are evidently quite *empty*, the average spectator will be at a loss to account

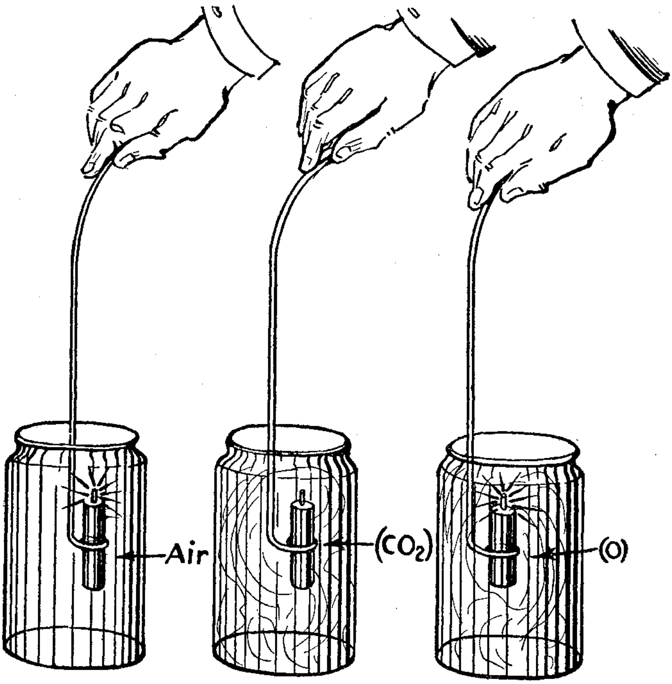

FIG. 57.—A Magical Experiment.

for the different actions that take place. The effects are shown in Fig. 57.

To Show that Carbon Dioxide Has Weight. This is a good magical experiment, too, and for it you need a couple of pint glass jars, one of which you have secretly filled with carbon dioxide (CO_2). Now set a piece of lighted candle in the bottom of the other jar and then pour the contents of the first jar, which is invisible to the spectators but as real as if it were water, into the second jar, as shown in Fig. 58. The candle will be mysteriously extinguished.

To Separate a Candle from Its Flame. Light a candle and lower it into a jar of carbon dioxide (CO_2) far enough

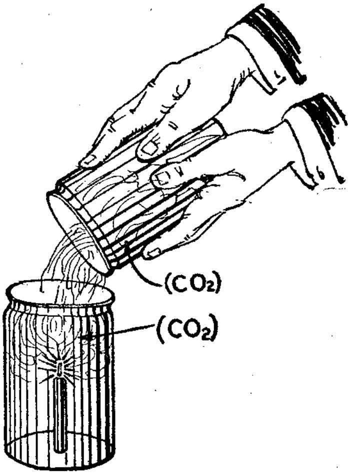

Fig. 58.—Pouring Carbon Dioxide from One Jar into Another.

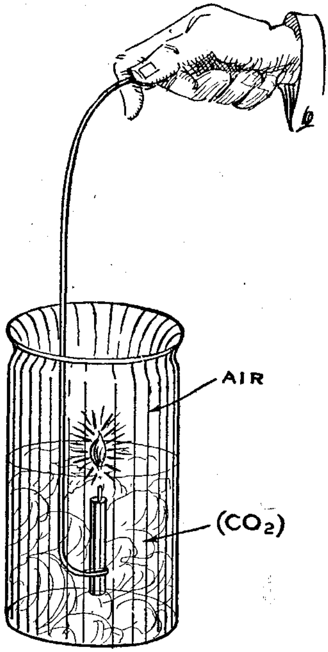

Fig. 59.—Separating the Flame of a Candle from its Wick.

so that the tip of the wick is about ½ inch *below* the surface of the gas. The flame, strange as it may seem, will keep on burning above the surface of the gas although it is entirely cut off from the wick.

How the Experiment Works. This strange effect, which is shown in Fig. 59, is due to the fact that the heat of the wick lasts long enough to vaporize the paraffin of which the candle is made for a few moments after it is submerged in the gas, the hot vapor from it ascends through the latter, where it is supplied with oxygen (*O*) from the air.

The Levitation of a Soap Bubble. Here is an experiment that would do credit to and gain renown for a Hindu magician. Set a large meat-platter or a tray on the table and

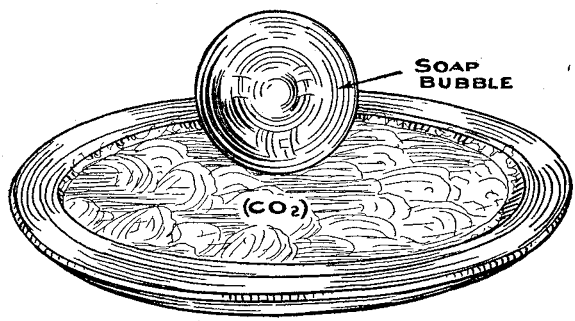

FIG. 60.—The Levitation of a Soap Bubble.

fill it to overflowing with carbon dioxide (CO_2). Now blow a large soap bubble with a clay pipe in the ordinary way, hold it over the platter and let it drop on the surface of the gas that fills it. On striking the layer of carbon dioxide (CO_2) it will bounce up and down on the latter like a rubber ball on the sidewalk, and when it finally does come to rest it looks to the spectators as though it were suspended above the platter, or tray, which, of course, it is by the layer of carbon dioxide (CO_2). The experiment is shown in Fig. 60.

CHAPTER IV.

THE WIZARDRY OF WATER

THE liquid which we call water (H_2O) is as necessary to the existence of living things as air is. Like air, water (H_2O) is formed of two gases, but, differing from air, these are chemically combined and form a liquid nearly 800 times heavier than the former. Water (H_2O) covers three-fourths of the earth's surface, the oceans taking up the larger part of it, and soundings have been made which show that at various points it is more than 5 miles deep. As you have seen in Chapter IV, the air has a large amount of water (H_2O) in it in the form of vapor, and the so-called dry land is saturated with it, while both plants and animals are made up of from 50 to 75 per cent of it, hence without it life could not exist.

Some Characteristics of Water. Water (H_2O) when pure is colorless in small amounts, tasteless, and odorless, and in this state it is a non-conductor of electricity. The water (H_2O) of oceans, lakes, and rivers has a blue or green color, and this is due to the natural color of the gases of which it is formed, the refraction and reflection of the light that strikes it, and to the mineral and other substances in it.

Like other liquids, water (H_2O) is almost incompressible and it remains a liquid at temperatures between 32 degrees and 212 degrees of *Fahrenheit's* thermometer. At 32 degrees it freezes into a solid which we call *ice*, and at 212 degrees it boils and passes into the air as a vapor which we call *steam*. To reach this form it expands 1700 times in volume, or bulk, which means that 1 pint of water will make 1700 pints of steam.

What Water is Made of. Water (H_2O) is formed of two elements and these are hydrogen (H) and oxygen (O), and, as you know, both of these are gases. To form water (H_2O) they must be chemically combined in the proportions of 2 parts of hydrogen (H) to 1 part of oxygen (O), that is, H_2O, by volume, or bulk, or in the proportion of 2 parts of hydrogen (H) and 16 parts of oxygen (O) by weight, which is the same thing. These measures are easily proved to be correct both by analyzing, that is, decomposing, water (H_2O), and by measuring and weighing the gases separately, and also by taking these gases in the above proportions and chemically combining them, upon which synthetic[1] water (H_2O) results. How to analyze water (H_2O) and how to produce it synthetically will be explained in the next chapter.

What Water Is Good for. Water (H_2O) is not only necessary to drink, to bathe in, and for the construction of living plants and animals and their maintenance, but it has many other uses as well. For instance, it is one of the chemist's allies in that it is a great solvent, for more substances can be dissolved in it than in any other liquid, hence, it is always used first when a substance is to be analyzed and it forms the basis of many solutions. Because it cannot be com-

[1] A synthetic compound is one that you have built up of the same elements as those used by nature.

pressed, it is used in hydraulic presses and other machinery, while in the form of ice it is largely used as a cooling medium, and in the form of steam it has a wide application as a power, or prime mover.

How to Purify Water. Water (H_2O) is never found pure in nature; rain water (H_2O) is the purest, but even that has foreign matter in it. In making chemical experiments where water (H_2O) is to be used, it must be pure or the results may not be at all what you expect them to be. Now water (H_2O) can be purified by several methods, and

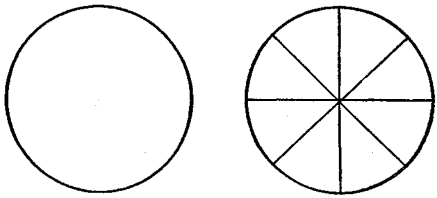

FIG. 61.—How the Filter Paper is Creased.

chief among those are by filtration, by boiling, and by distillation. Where water (H_2O) is filtered, only the larger particles of matter in it are removed. Boiling kills all of the germs in it, and much of the suspended matter will fall to the bottom when it is allowed to settle, so that for ordinary experiments you can use boiled water (H_2O), which should then be filtered. The only way to get pure water (H_2O), though, is to distil it.

How to Filter Water. To filter water (H_2O) in order to get rid of any solid particles in a solution you need a glass funnel, as shown in Fig. 17 in Chapter I. The filter paper