How the Experiment Works. The reaction will give you potassium chloride (KCl) and water (H_2O), thus:

HCl	+	KOH	=	KCl	+	H_2O
Hydrochloric acid		Potassium hydroxide		Potassium chloride		Water

Evaporate the solution that remains after heating the acid and the base together and the potassium chloride (KCl) will remain behind in the form of a crystalline salt.

How to Make Potassium Nitrate. Potassium nitrate (KNO_3) or just *saltpetre*, as it is usually called for short, is also a white crystalline salt and is chiefly used for making black gunpowder. Now while sodium nitrate ($NaNO_3$) is cheaper than potassium nitrate (KNO_3), the former cannot be used in making gunpowder, as it is *deliquesent*, that is, it absorbs moisture from the air, while the latter does not. To make potassium nitrate (KNO_3) on a commercial scale, potassium chloride (KCl) from the Stassfurt potash beds is added to a hot solution of sodium nitrate ($NaNO_3$).

You can make a sample of potassium nitrate (KNO_3) by using the same process as described for the foregoing salts, but in this case add nitric acid (HNO_3) to potassium hydroxide (KOH), and potassium nitrate (KNO_3) and water (H_2O) will result.

How the Experiment Works. The reaction is this:

HNO_3	+	KOH	=	KNO_3	+	H_2O
Nitric acid		Potassium hydroxide		Potassium nitrate		Water

The water (H_2O) is then evaporated as explained before, and the potassium nitrate (KNO_3) salts are left behind.

CHAPTER IX.

THE MYSTIC METALS

THEIR ALLOYS AND AMALGAMS.

ALL the elements can be classified under two general headings, namely, those that are *metals* and those that are *non-metals*. Now while it is easy to tell a metal from a non-metal when you see it, it is not at all easy to define the difference; it will, however, serve the purpose to say that a metal is an element which is opaque, has a metallic lustre, is a good conductor of electricity, and, finally, and most important of all, is able to take the place of the hydrogen (H) in an acid and to form a salt.

There are two ways in which metals occur in nature, and these are in a *native*, or *free*, state, that is, they are found in a pure form, and when they are mixed, or combined, with other substances, and when these are hard they are called *ores*. Copper (Cu), lead (Pb), silver (Ag), gold (Au), platinum (Pt), and some other metals are found in a free state.

Of the ores, there are several chief kinds, and these are the *oxides*, the *sulphides*, and the *carbonates*.

Among the oxides are those of iron (FeO) and (Fe_2O_3), zinc (ZnO), tin (SnO_2), or *tin stone*, as this ore is called, copper (Cu_2O), which is called *ruby copper*, etc. Among the sulphides are those of iron (FeS_2), or *iron pyrites*, nickel

(NiS), cobalt ($CoAsS$) or *cobaltite*, as this ore is called, antimony (Sb_2S_3), or *stibnite*, lead (PbS), etc. Finally, among the carbonates are those of iron ($FeCO_3$), lead ($PbCO_3$), zinc ($ZnCO_3$) and copper ($Cu_2(OH)_2CO_3$) or *malachite*.

The Activity of the Metals. The power of a metal to displace hydrogen (H) in dilute acids and water (H_2O) is called its *activity*. Now the most active metal is potassium (K), as the table given below shows, while lead (Pb) is the least active, and all those below the Zero or hydrogen(H) line will not dissolve in water (H_2O) or weak acids, and, hence, will not replace the hydrogen (H) in them at all, and they are, therefore, called the *inactive* metals. These metals can, however, be dissolved in strong acids.

TABLE OF ACTIVITIES.

13. Potassium (K)	2. Tin (Sn)
12. Sodium (Na)	1. Lead (Pb)
11. Lithium (Li)	0. Hydrogen (H)
10. Calcium (Ca)	1. Copper (Cu)
9. Magnesium (Mg)	2. Bismuth (Bi)
8. Aluminum (Al)	3. Antimony (Sb)
7. Manganese (Mn)	4. Mercury (Hg)
6. Zinc (Zn)	5. Silver (Ag)
5. Chromium (Cr)	6. Platinum (Pt)
4. Iron (Fe)	7. Gold (Au)
3. Nickel (Ni)	

There are many other metals than those given in the preceding table, but these are the best known, and their distinguishing features, various uses, and experiments with them will follow in the above order.

Potassium, the Softest Metal. The Latin word for potassium (K) is *kalium*, and since P is the symbol used for phosphorus (P), which was a much earlier known element, the letter K was chosen for potassium (K). This metal was discovered in 1807 by Sir Humphrey Davy, who made it by passing a current of electricity through some potassium hydroxide (KOH), causing minute drops of the pure metal to be formed on the negative wire. In the early days, potassium hydroxide (KOH) was obtained from wood-ashes, and when these were leached, boiled, and evaporated, the remaining substance was called *pot-ashes*, then just *potash*, and from this we get the name potassium (K).

Potassium (K) is a silvery-white metal with a bright metallic lustre and so soft that you can knead it with your fingers at room temperature, just as you would a piece of wax. Owing to its great activity when it comes into contact with water (H_2O), it must be kept in oil so that the moisture of the air cannot get to it. It is so light that it floats on water (H_2O), and it melts at a much lower temperature than that at which water (H_2O) boils.

Compounds of Potassium. While potassium (K) is of little use by itself, the compounds made with it are of great value. Its chief compounds are potassium iodide (KI), which is used for testing starch, in medicine, and in photography; potassium hydroxide (KOH), which is used largely for making other compounds of potassium (K); potassium nitrate (KNO_3), which is used for preserving meats and for making gunpowder and fireworks; potassium chlorate ($KClO_3$), which is used in making oxygen (O) and in medicine, and potassium carbonate (K_2CO_3), which is used as a fertilizer.

An Experiment with Potassium. Take a piece of potassium (K) out of the bottle of oil with your tweezers, cut off a piece the size of a pea, and drop it into a bowl of water (H_2O); instantly the hydrogen (H) of the latter will be set free and the heat produced will ignite the potassium (K);

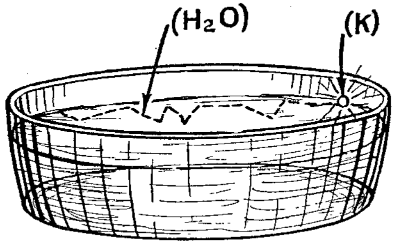

FIG. 118.—The Reaction of Potassium on Water.

the gas will then force the burning metal through the water (H_2O), as shown in Fig. 118, and as it darts along it will make explosive sounds like a bunch of miniature firecrackers going off.

How the Experiment Works. When you drop the potassium (K) on the water (H_2O), the chemical action sets the hydrogen (H) free so fast that it develops enough heat to ignite both the gas and the metal, and the mechanical reaction between the escaping gas and the metal forces the latter along on the water (H_2O). The chemical reaction that takes place between the potassium (K) and the water

(H_2O) forms potassium hydroxide (KOH) and hydrogen (H) thus:

K	+	H_2O	=	KOH	+	$H \uparrow$
Potassium		Water		Potassium hydroxide		Hydrogen

Sodium, Another Alkali Metal. Since S is the symbol of sulphur (S) one of the earliest known elements, the letters Na, are used for sodium (Na), because in Latin the latter was called *natrium*, which means *soda.* This metal was also discovered by Davy, who made it in 1808 by bringing a pair of wires from a battery into contact with sodium hydroxide ($NaOH$), that is, caustic soda. Sodium (Na) is a soft, shining, silvery metal, and it behaves very much like potassium (K) when it is dropped into cold water, but since it is not so active as the latter metal it does not produce enough heat to ignite the hydrogen (H) which is set free around it.

Compounds of Sodium. The pure metal is chiefly of interest for experimental work, but it is widely employed by nature and the chemist in making various salts, and in combination with carbon (C) compounds it is used for both dyes and drugs. The chief compounds in which it occurs are sodium chloride ($NaCl$), that is, common table salt; sodium nitrate ($NaNO_3$), which is the starting-point in making potassium nitrate (KNO_3), or saltpetre, and of nitric acid (HNO_3); sodium carbonate (Na_2CO_3), which in turn, is used for making *sodium bicarbonate* ($NaHCO_3$), or baking soda, etc.

An Experiment with Sodium. Drop a small piece of sodium (Na) into a dish of cold water (H_2O) and watch its action. Having made the above experiment, thicken the water (H_2O) with a little starch ($C_6H_{10}O_5$), which will cause the heat developed to be concentrated, and then the hydrogen (H) will ignite and the sodium (Na) will burn with a brilliant yellow color.

How the Experiment Works. The reaction that takes place when sodium (Na) comes in contact with water (H_2O) is that they form sodium hydroxide ($NaOH$) and hydrogen (H). The following equation shows at a glance what takes place:

Na	+	H_2O	=	$NaOH$	+	$H \uparrow$
Sodium		Water		Sodium hydroxide		Hydrogen

Lithium, the Lightest Metal. This metal gets its name from the Greek word *lithium*, which means *stone*. Now it happens that while lithium (Li) is obtained from stone-like minerals, such as *lapidolite*, which is a kind of mica and is, therefore, quite heavy, the metal itself is the lightest of them all, and what is more, it is the lightest solid known; in fact, it is so light that it not only floats on water but on the oil in which it is kept.

Traces of lithium (Li) are found in the water of various mineral springs, in the soil, in the ashes of tobacco, and in beets. It is made by passing a current of electricity through fused lithium chloride ($LiCl$). When brought into contact with water (H_2O), it acts like potassium (K) and sodium (Na), except that it is not so active, but different from these metals, it is quite hard.

Compounds of Lithium. Lithium (Li) forms compounds with hydrogen (H), nitrogen (N), and oxygen (O), but unlike those of the other alkali metals the hydroxide ($LiOH$) formed of it does not dissolve easily in water (H_2O).

An Experiment with Lithium. Drop a piece of lithium (Li) into a test tube half full of cold water (H_2O), and then drop a piece into a like amount of warm water (H_2O), and you will see that it combines with the latter very much faster than with the former. When the lithium is dissolved, the compound that is formed is lithium hydroxide ($LiOH$).

Calcium, the Fourth Alkaline Metal. The Latin word for *lime* is *calx*, and from this we get the word calcium (Ca), which is the chemical name for lime. The metal in its pure state looks like silver (Ag), and melts when brought to a cherry-red heat. It is not quite as soft as lead (Pb) and, like the latter, it can be cut, drawn, and rolled.

Calcium (Ca) is never found in a free state, but is very plentiful in different compounds, especially in calcium carbonate ($CaCO_3$), of which chalk, marble, and limestone are formed; it is also found in calcium sulphate ($CaSO_4$), which is gypsum, and as calcium phosphate ($Ca_3(PO_4)_2$), in the minerals *apatite* and *phosphorite*, and in fluoride (CaF_2), that is, *fluor-spar*. It is also found in plants, in the bones of animals, and in sea-shells, while coral and pearls are made of it.

Compounds of Calcium. Like the other alkaline metals, calcium (Ca) is of but little use in its pure state, but its compounds are very valuable. Chief among these are calcium chloride ($CaCl_2$), calcium oxide (CaO), that is, quicklime, calcium hydroxide ($Ca(OH)_2$), or slaked lime, calcium carbonate ($CaCO_3$), which, as I have said so many times before, is limestone.

Now limestone ($CaCO_3$) will dissolve in water (H_2O) that has carbon dioxide (CO_2) in it, which then acts like a weak acid and, indeed, it is called carbonic acid (H_2CO_3). When the water (H_2O) of a river runs over limestone ($CaCO_3$), it dissolves it and sometimes forms a cave, or a cavern; on the other hand, when water (H_2O) has calcium bicarbonate ($Ca(HCO_3)_2$) in it and it seeps drop by drop through the ceiling of the cave, or cavern; it loses its carbon dioxide (CO_2) and the calcium carbonate ($CaCO_3$) gets hard and forms *stalactites*, the name given to needles which hang from the ceiling, and *stalagmites*, needles which rise from the floor.

Experiments with Calcium. Take a piece of calcium (Ca), stand about 3 feet from a clean brick wall and throw it as hard as you can against it, and the metal will ignite and burn with a brilliant white flame.

Spread some calcium sulphide (CaS), which is a compound made by heating pulverized calcium sulphate ($CaSO_4$) and charcoal (C) together, on a sheet of paper and lay it where the sunlight will strike it. After you have thus exposed it for half an hour or so, take it into a dark room and it will shine with a cold light. Calcium sulphide (CaS) and barium sulphide (BaS), which also shines in the dark, are used for making *luminous paint.*

Magnesium, the Metal that Burns. Magnesium (Mg) gets its name from Magnesia, a district in Asia Minor, where magnesium carbonate ($MgCO_3$), or magnesite, as it is called, was first found. When Davy was experimenting with the action of an electric current on various substances, he discovered that magnesium carbonate ($MgCO_3$) was a compound of a metal with carbon (C) and oxygen (O); then in 1830, Bussy, a French chemist, separated the metal. This he did by treating magnesium chloride ($MgCl_2$), a salt that is found in salt deposits, with potassium chloride (KCl), causing the potassium (K) to combine with the chlorine (Cl) and leave the magnesium (Mg) in a pure state.

It is now obtained by passing a current of electricity through melted magnesite ($MgCO_3$), potassium chloride (KCl), and sodium chloride ($NaCl$). It is a silvery-white metal, quite soft and very light and brittle. Magnesium (Mg) is used chiefly for making flash-lights for taking photographs, as it is rich in violet rays, which act strongly on a photographic plate, for making fireworks and signal lights, and for making silver polish and tooth powders.

Compounds of Magnesium. Chief among the compounds of magnesium (Mg) are magnesium oxide (MgO) and the hydroxide ($Mg(OH)_2$). The former is made by heating magnesium carbonate ($MgCO_3$), when the product is called *calcined magnesia*, and as even the highest temperatures will not affect this, it is used for making crucibles and lining furnaces. When water (H_2O) is poured over magnesium oxide (MgO), they combine slowly and form magnesium hydroxide ($Mg(OH)_2$). When magnesium (Mg) is combined with oxygen (O), carbon (C), and hydrogen (H), they form a *magnesium alba*, as it is commonly called, and this is largely used in medicines and cosmetics.

Experiments with Magnesium. Magnesium (Mg) can be bought in the form of thin ribbon coiled up, or in a powder. Take a piece of the ribbon and light the end of it with a match and it will give out a light of dazzling brightness,