

EXPERIMENT 209—Zinc hydroxide

Place a small piece of zinc and 1 measure of sodium bisulphate in a test tube. It is used in making calcium hydroxide and slaked lime. Warm this solution until the solids are all dissolved, and after cooled a little add a few drops of sodium hydroxide solution.

EXPERIMENT 210—Cobalt hydroxide

Dissolve 1 measure of cobalt chloride in a test tube half full of water and add some of this powder—2 teaspoonfuls—on a small tin can lid and heat over a gas flame. Heat so that the limestone becomes white hot and after twenty minutes allow to cool. The compound remaining is quick lime or calcium oxide. Lime-water or calcium carbonate, upon heating, decomposes into calcium oxide and carbon dioxide gas.

EXPERIMENT 211—Magnesium hydroxide

Dissolve 2 measures of magnesium sulphate in a test tube half full of water. Add a heavy white precipitate of magnesium hydroxide solution. A heavy white precipitate of magnesium hydroxide is formed.

EXPERIMENT 212—Calcium hydroxide

Dissolve 2 measures of calcium chloride in a test tube half full of water. Now add slaked lime and a white precipitate of calcium hydroxide will form. This calcium hydroxide is the same substance that is obtained when liquid and test it with red litmus paper. This liquid is a solution of calcium oxide. It is a weak base and is used in medicine as lime water.

EXPERIMENT 213—Chromium hydroxide

Dissolve 2 measures of chrome alum in a test tube $\frac{1}{4}$ full of water. To this add a few drops of sodium hydroxide solution. A beautiful green precipitate of chromium hydroxide is formed.

Potash or potassium carbonate is an important compound and is essential for growth. It is absorbed by plants from the soluble compounds in the earth or soil.

EXPERIMENT 214—Obtaining potash from wood ashes

Potash was formerly obtained by leeching out the soluble material in wood ashes with water.

Put 4 spoonfuls of wood ashes in a glass half full of water and stir well for 10 minutes. Now allow this mixture to stand for a few minutes and then filter off the liquid into a test tube. Test this liquid by adding 2 or 3 drops of phenolphthalein solution. Notice that the solution turns red. Potassium carbonate is found in wood ashes and is removed in this way. By evaporating the liquid down to dryness on a sheet of paper. This is plaster of Paris.

ALKALINE EARTH METALS, CALCIUM, STRONTIUM, BARIUM

The term "alkaline earth" was originally applied to the oxides of these metals because they resemble both the alkalis and the earths, the latter term being applied to the oxides of aluminum and iron.

These metals do not occur free in nature, but largely as carbonates and sulphates. They are light and active, resembling each other closely in physical and chemical properties. They react with the oxygen in the air and decompose water, liberating hydrogen, similar to the alkali metals.

Calcium carbonate is found in nature in large quantities as limestone or marble. Calcium carbonate is found in nature in large quantities as limestone or marble. Also gypsum (calcium sulphate) and phosphate rock (calcium phosphate) are found extensively.

lime or calcium oxide is prepared from limestone by heating in large furnaces or in a lime kiln. It is used in making calcium hydroxide and slaked lime.

EXPERIMENT 215—Burning limestone to quick lime

Break a few pieces of limestone, marble or oyster shells and break them up into small pieces.

Place some of this powder—2 teaspoonfuls—on a small tin can lid and heat over a gas flame. Heat so that the limestone becomes white hot and after twenty minutes allow to cool. The compound remaining is quick lime or calcium oxide. Lime-water or calcium carbonate, upon heating, decomposes into calcium oxide and carbon dioxide gas.

EXPERIMENT 216—Slaked lime or calcium hydroxide

On a test tube add $\frac{1}{2}$ inch of powdered lime and 5 or 6 drops of water. Notice that lime puffs up after a few minutes and appears to be perfectly dry. This forms what is known as slaked lime and is really calcium hydroxide.

Now fill the test tube $\frac{1}{4}$ full of water and shake the contents of the tube. Filter off the liquid and test it with red litmus paper. This liquid is a solution of calcium oxide. It is a weak base and is used in medicine as lime water.

Lime, which is used in stone foundations for buildings, is made by mixing together slaked lime and slaked lime. On exposure to the air mortar sets or becomes hard. This is because the carbon dioxide in the air reacts with the slaked lime to form an insoluble compound called calcium carbonate or limestone.

EXPERIMENT 217—Making mortar

Take three measures of calcium oxide and mix this together thoroughly with three measures of sand. Then add a few drops of water to make a paste.

Spread this paste on a board and allow it to stand for several days. Notice that the plaster becomes hard and sets.

Plaster of Paris is made from gypsum or calcium sulphate by heating until all the water is driven off.

EXPERIMENT 218—To make Plaster of Paris

Take a spoonful of calcium sulphate and heat over the alcohol or gas flame for ten minutes to a high temperature. Allow to cool and then empty the contents of the crucible on a sheet of paper. This is plaster of Paris.

EXPERIMENT 219—Making a cast with plaster of Paris

Break up the plaster of Paris which you made in experiment 218 into a fine powder and mix a little of this with water to the consistency of a paste. Place a coin slightly covered with oil on a paper. Spread some of this paste on the coin. Press the paste on the coin to displace any air bubbles and leave the plaster undisturbed until it is dry. Then remove it and you will notice a perfect imprint of the face of the coin on the plaster.

It is important to call attention to the application of magnesium chloride and magnesium sulphate in the production of plaster cement used for stucco construction. When magnesium oxide is mixed with strong aqueous solutions of these salts, reactions occur, with the formation of oxychlorides and oxysulphates, respectively. These cements form the basis of stuccos, mortars, and sound absorbing materials. This material has found a very extensive use for the construction of office buildings and public buildings.

EXPERIMENT 220—Calcium sulphide light

Expose a piece of calcium sulphide paper to a gas or electric light for several minutes. Now take the paper into a dark room and notice that it is luminous in the dark.

Certain metals or their compounds impart a characteristic color to a flame

the alkaline earths resemble each other in chemical properties, they differ in these snakes are sold around the Fourth of July as fireworks. They are made very by mixing up four Gilbert measures of sugar, two measures of sulphur and two they give to a flame, calcium compounds give a red flame, strontium gives a ball chloride. Place in a spoon and heat. Barium gives a green flame.

The alkali metals and their compounds also give characteristic colors in a flame and a solution. Sodium gives a yellow flame and potassium a purple flame. Copper compounds give a blue-green flame. The alkali metals are soft and can be cut with a knife. They are also very reactive and will react with water, oxygen, and acids. They are also very good conductors of electricity and heat.

Clean the steel wire and make a loop in the cleaned wire. Heat the loop in the flame of the Bunsen burner until there is no color given to the flame by the wire.

Dip the clean wire into some powdered calcium chloride and then heat in the flame. Notice the red flame of calcium. Add some strontium nitrate to the potassium nitrate solution and it will burn with a white-yellow flame, sizzling with a red flame. When it is dry it will burn with a white-yellow flame, sizzling with a red flame.

Mix together thoroughly in a pan one measure of potassium nitrate, one measure of sulphur and one measure of charcoal. Make into a small pile and keep the face of the pile smooth with a match. Notice that the mass takes fire readily and burns brightly to the strontium. The sulphur and charcoal act as fuel. The potassium nitrate furnishes oxygen for the reaction.

Zinc, when in the form of a powder, burns with a green flame.

Repeat experiment 222, using two measures of powdered zinc, two measures of powdered zinc, two measures of powdered zinc, two measures of powdered zinc.

potassium nitrate, two measures of powdered charcoal and one measure of tain a soda water straw and, closing one end by folding it over, fill it with a Notice that this mixture when ignited will burn with a green flame. These mixture of the above substances. Place the straw containing the mixture in a test piece ignited to good advantage by the use of a fuse. The fuse is prepared by and, going out doors into the open, light the open end of the straw. Notice the piece of ordinary string in a strong solution of potassium nitrate and allow full effect produced by the burning mixture. Notice the string to dry.

Sodium when burned produces a yellow flame.

Repeat experiment 223, using one measure of dry sodium chloride, two bright reds, the greens and other colors produced in fireworks on the Fourth of July, one measure of sulphur and two measures of powdered dry depend on the presence of the salt of a metal which has the property of igniting the mixture and notice that it burns with a yellow flame.

Chemicals needed: iodine crystals and ammonia. Apparatus you will need: _____ and filter paper.

Crush several of the iodine crystals and place them in a clean test tube, for instance, a device known as the "fusée," is carried. This is a red flare which about one teaspoonful of ammonia and let this stand for half an hour. Then take man places at the rear of a train that is stalled, or is used to warn the engine not let filtrate spill on the table. Dry the filter paper in dry open air. As an approaching train. In shipping, aviation, in military activities, rockets and is dry just a scratch on the filter paper will explode the crystals. are used for signals.

COLOR IN FIREWORKS

are bright reds, the greens and other colors produced in fireworks on the Fourth of July depend on the presence of the salt of a metal which has the property of imparting a particular color to a flame. In order to impart color, the salt must be volatile, for it is to serve in this way. The beautiful red of Roman candles, sky rockets, produced by salts of lithium or salts of strontium. Barium compounds are among the most common ingredients producing green effects in fireworks. Fireworks also have very practical purposes outside the celebration of the Fourth of July. On railroad tracks, for instance, a device known as the "fusee" is carried. This is a red flare which a brakeman places at the rear of a train that is stalled, or is used to warn the engineer of an approaching train. In shipping, aviation, in military activities, rockets and flares are used for signals.

ALUMINUM, ZINC, MAGNESIUM

These are three very important metals and find wide application in industry. Aluminum is a very important metal because it is very malleable, is easily worked, and more rigid than the same weight of other metals. Its use is increasing in the manufacture of aircraft, and in electric power lines.

Aluminum forms valuable alloys with steel or magnesium.

The compounds of aluminum are important. The silicates are used extensively in the manufacture of cement, brick, tile, earthenware, pottery and porcelain. Valuable gems contain aluminum. The ruby, sapphire and topaz are transparent. In setting off the mixture with a fuse, place the mixture on one end of the string and allow the string to burn to the other end.

The alums, which are double salts containing aluminum sulphate, are used in mordants in dyeing and printing. Because of its acid reaction in water, alum is used in some baking powders.

EXPERIMENT 230—Colored aluminum lake

Put two measures of cochineal in a test tube half full of water, boil over heat experiment 233, using the following proportions of substances: one measure of sodium carbonate and shake until it is all dissolved. Now mix the two solutions and notice the formation of a yellow precipitate. This precipitate is aluminum hydroxide. Aluminum carbonate is a salt of a very weak acid and a weak base. Combine the two solutions and notice the red precipitate. This is aluminum hydroxide. The gas given off in the reaction is carbon dioxide gas.

Alum baking powder or cream of tartar substitute, as it sometimes comes in the market, consists of sodium bicarbonate, starch and potassium alum. The alum is used to keep the materials dry.

Zinc is used in batteries and as a coating for other metals to protect them from the oxygen of the air. Galvanized iron is made by dipping iron into molten zinc.

Zinc dissolves readily in both acids and alkalis producing hydrogen and is well-known experiment on thermite can always be depended upon to arouse interest in the science of chemistry.

Zinc also combines readily with certain other elements as oxygen and sulphur. Without the advice and direction of an older person, and should not be conducted in surroundings where there is danger of fire and injury to property. It is a safe experiment to perform, but the necessary chemicals are not supplied in your set, and must be purchased in the market. For the purpose of this experiment, it is first necessary to prepare a plaster of Paris cone. This is made by mixing the inside of a large funnel with vaseline. A large paper cone is placed in the funnel and it is also coated with vaseline.

Metallic magnesium, because of its extreme lightness and strength, and it is also coated with vaseline. Many of the lightest and strongest metals are constructed of a magnesium alloy. The plaster of Paris cone is now made, using the prepared funnel as a mold. A hole is made in the bottom of the cone. When the plaster is set, it can be very easily slipped from the funnel.

EXPERIMENT 232—Action of zinc on alkalis

To a test tube half full of sodium hydroxide, prepared as directed in experiment 202, add one measure of powdered zinc. Warm, if necessary, to start the reaction. Notice the gas bubbling off. This is hydrogen.

Magnesium occurs abundantly in nature as the carbonate. Metallic magnesium is a rival of aluminum in construction demanding a light metal. Many of the lightest and strongest metals are constructed of a magnesium alloy. The plaster of Paris cone is now made, using the prepared funnel as a mold. A hole is made in the bottom of the cone. When the plaster is set, it can be very easily slipped from the funnel.

EXPERIMENT 233—How to make a white flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of sulphur on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 234—How to make a red flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 235—How to make a green flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 236—Making sparklers

Put together on a sheet of paper one measure of potassium nitrate and two measures of powdered magnesium. Do not rub or grind the mixture. Now melt some paraffin in a spoon and dip a match into the liquid paraffin until it is well coated. Remove the match from the paraffin and after a few seconds roll it in the mixture of magnesium and potassium nitrate. When you have a good covering of the mixture on the match, allow the match to dry thoroughly for several minutes. Now light the end of the match and notice that it will burn and give off bright sparks. The 4th of July sparklers are prepared in a manner similar to this.

EXPERIMENT 237—Thermite fusion

Put together on a sheet of paper one measure of potassium nitrate and two measures of powdered magnesium. Do not rub or grind the mixture. Now melt some paraffin in a spoon and dip a match into the liquid paraffin until it is well coated. Remove the match from the paraffin and after a few seconds roll it in the mixture of magnesium and potassium nitrate. When you have a good covering of the mixture on the match, allow the match to dry thoroughly for several minutes. Now light the end of the match and notice that it will burn and give off bright sparks. The 4th of July sparklers are prepared in a manner similar to this.

EXPERIMENT 238—Thermite fusion

Put together on a sheet of paper one measure of potassium nitrate and two measures of powdered magnesium. Do not rub or grind the mixture. Now melt some paraffin in a spoon and dip a match into the liquid paraffin until it is well coated. Remove the match from the paraffin and after a few seconds roll it in the mixture of magnesium and potassium nitrate. When you have a good covering of the mixture on the match, allow the match to dry thoroughly for several minutes. Now light the end of the match and notice that it will burn and give off bright sparks. The 4th of July sparklers are prepared in a manner similar to this.

EXPERIMENT 239—Thermite fusion

Put together on a sheet of paper one measure of potassium nitrate and two measures of powdered magnesium. Do not rub or grind the mixture. Now melt some paraffin in a spoon and dip a match into the liquid paraffin until it is well coated. Remove the match from the paraffin and after a few seconds roll it in the mixture of magnesium and potassium nitrate. When you have a good covering of the mixture on the match, allow the match to dry thoroughly for several minutes. Now light the end of the match and notice that it will burn and give off bright sparks. The 4th of July sparklers are prepared in a manner similar to this.

EXPERIMENT 240—Thermite fusion

Put together on a sheet of paper one measure of potassium nitrate and two measures of powdered magnesium. Do not rub or grind the mixture. Now melt some paraffin in a spoon and dip a match into the liquid paraffin until it is well coated. Remove the match from the paraffin and after a few seconds roll it in the mixture of magnesium and potassium nitrate. When you have a good covering of the mixture on the match, allow the match to dry thoroughly for several minutes. Now light the end of the match and notice that it will burn and give off bright sparks. The 4th of July sparklers are prepared in a manner similar to this.

EXPERIMENT 241—Thermite fusion

Put together on a sheet of paper one measure of potassium nitrate and two measures of powdered magnesium. Do not rub or grind the mixture. Now melt some paraffin in a spoon and dip a match into the liquid paraffin until it is well coated. Remove the match from the paraffin and after a few seconds roll it in the mixture of magnesium and potassium nitrate. When you have a good covering of the mixture on the match, allow the match to dry thoroughly for several minutes. Now light the end of the match and notice that it will burn and give off bright sparks. The 4th of July sparklers are prepared in a manner similar to this.

EXPERIMENT 242—Thermite fusion

Put together on a sheet of paper one measure of potassium nitrate and two measures of powdered magnesium. Do not rub or grind the mixture. Now melt some paraffin in a spoon and dip a match into the liquid paraffin until it is well coated. Remove the match from the paraffin and after a few seconds roll it in the mixture of magnesium and potassium nitrate. When you have a good covering of the mixture on the match, allow the match to dry thoroughly for several minutes. Now light the end of the match and notice that it will burn and give off bright sparks. The 4th of July sparklers are prepared in a manner similar to this.

EXPERIMENT 243—Thermite fusion

Put together on a sheet of paper one measure of potassium nitrate and two measures of powdered magnesium. Do not rub or grind the mixture. Now melt some paraffin in a spoon and dip a match into the liquid paraffin until it is well coated. Remove the match from the paraffin and after a few seconds roll it in the mixture of magnesium and potassium nitrate. When you have a good covering of the mixture on the match, allow the match to dry thoroughly for several minutes. Now light the end of the match and notice that it will burn and give off bright sparks. The 4th of July sparklers are prepared in a manner similar to this.

EXPERIMENT 244—How to make a red flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 245—How to make a green flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 246—How to make a white flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 247—How to make a red flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 248—How to make a green flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 249—How to make a white flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 250—How to make a red flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 251—How to make a green flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 252—How to make a white flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 253—How to make a red flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 254—How to make a green flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 255—How to make a white flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 256—How to make a red flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 257—How to make a green flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 258—How to make a white flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 259—How to make a red flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 260—How to make a green flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 261—How to make a white flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 262—How to make a red flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 263—How to make a green flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 264—How to make a white flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 265—How to make a red flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

EXPERIMENT 266—How to make a green flashlight powder

Put together on an old pan one measure of powdered magnesium and one measure of potassium nitrate. Do not rub or grind the mixture. Now place one measure of boric acid on top of the mixture and carefully light the sulphur. The sulphur will burn and the mixture will flash, giving off a very brilliant light.

The cone is placed in a large ring on a ringstand, at the base of which and immerse the tube in cold water to cool it again. to prevent the ignition mixture from dropping out. The cone is then filled and you will get a beautiful green precipitate of nickel ammonium mixture of aluminum powder and iron oxide. Other oxides, of course, may be substituted. To insure a good yield of molten metal, a liberal number of iron added to the mixture.

On top of the mixture a very small heap of an oxidizing agent is placed. To this solution add two or three drops of water glass and a thick precipitate of magnesium ribbon is then stuck into the oxidizer, the cone is covered with silicate will be formed.

This demonstration is most dazzling and impressive when shown in a room.

SILICATES

EXPERIMENT 238—Silicic acid

Put $\frac{1}{2}$ inch of water glass in a test tube and add water until the tube is full. Shake to mix the liquids.

In another test tube put four measures of sodium bisulphate and fill the test tube and add water until the tube is one-quarter full.

Pour the sodium bisulphate solution into the water glass. A jelly-like precipitate of tin silicate will form.

will form, and in a few minutes all the liquid in the tube will become solid.

EXPERIMENT 239—Sodium silicate (water glass)

Paint a thin film of water glass on a sheet of paper and let it dry for 15 minutes. Note the smooth transparent glass-like film which results.

Paste together two sheets of paper or two blocks of wood, using water glass adhesive. You will find that it makes an exceptionally strong paste and used for this purpose.

EXPERIMENT 240—Strontium silicate

Dissolve two measures of strontium chloride in half a test tube of water. A bulky white precipitate will form and upon shaking the test tube the whole tube will fill the whole tube.

EXPERIMENT 241—Zinc silicate

Place a small piece of zinc metal and two measures of sodium bisulphate in a test tube and fill the tube half full of water. Heat the liquid for a few moments and the zinc dissolves. Now hold the tube in a glass of cold water for a few moments to completely dissolve the solid. Add to the solution of zinc sulphate thus formed two or three drops of water glass and examine the blue precipitate of copper Zinc silicate will be formed.

EXPERIMENT 242—Aluminum silicate

Place two measures of aluminum sulphate in a test tube and fill the tube half full of water. Shake to completely dissolve the solid. Now add two or three drops of water glass and note the thick white precipitate of aluminum silicate which will be formed.

EXPERIMENT 243—Nickel silicate

Place two measures of nickel ammonium sulphate in a test tube half full of water, and shake half full of water. Warm the solution for a few moments to completely dissolve the precipitate of calcium silicate.

EXPERIMENT 244—Ferrous silicate

Dissolve two measures of ferrous ammonium sulphate in a test tube half full of water. Add two or three drops of water glass and a thick reddish-brown precipitate of ferrous silicate will be formed.

EXPERIMENT 245—Ferric silicate

Dissolve two measures of ferric ammonium sulphate in a test tube half full of water. Add two or three drops of water glass. A very pretty reddish-brown precipitate of ferric silicate will be formed.

EXPERIMENT 246—Tin silicate

One measure of sodium bisulphate, one measure of ammonium chloride, and a piece of tin metal, into a test tube. Add five or six drops of water and heat the test tube and add water until the tube is one-quarter full.

Now add two or three drops of water glass and in a few moments a thick white precipitate of tin silicate will form.

EXPERIMENT 247—Chromium silicate

Dissolve two measures of chrome alum in a test tube full of water. Add two or three drops of water glass and a beautiful thick green precipitate of chromium silicate will be formed.

EXPERIMENT 248—Cobalt silicate

Dissolve one measure of cobalt chloride in half a test tube of water and add three drops of water glass. In this case a beautiful blue precipitate of cobalt silicate is formed.

EXPERIMENT 249—Copper silicate

Dissolve two measures of sodium bisulphate and one measure of copper sulphate in a test tube and fill the tube half full of water. Heat the liquid for a few moments and a clear blue solution of copper sulphate is obtained. Add to the copper sulphate solution two or three drops of water glass and examine the blue precipitate of copper silicate which is formed.

EXPERIMENT 250—Manganese silicate

Dissolve two measures of manganese sulphate in a test tube half full of water and add to this solution two or three drops of water glass. A pale pink precipitate of manganese silicate will be formed.

EXPERIMENT 251—Magnesium silicate

Dissolve two measures of magnesium sulphate in a test tube half full of water. Now add two or three drops of water glass. A white precipitate of magnesium silicate will be formed.

EXPERIMENT 252—Calcium silicate

Dissolve three measures of calcium chloride in a test tube half full of water, and shake half full of water. Warm the solution for a few moments to completely dissolve the precipitate of calcium silicate.

FERROCYANIDES

EXPERIMENT 253—Zinc ferrocyanide

Dissolve two measures of sodium ferrocyanide in a test tube half full of water. In another test tube put a small piece of zinc metal and two measures of bisulphate. Fill the test tube $\frac{1}{4}$ full of water and shake until the solids are dissolved. Now add a few drops of the sodium ferrocyanide solution from the first test tube and a white precipitate of zinc ferrocyanide will be formed.

EXPERIMENT 254—Aluminum ferrocyanide

Dissolve one measure of aluminum sulphate in a test tube half full of water. Add a few drops of the solution of sodium ferrocyanide prepared before and a light blue precipitate of aluminum ferrocyanide will be formed. If this precipitate is washed with water it shows that there is a trace of iron in the aluminum sulphate.

EXPERIMENT 255—Nickel ferrocyanide

Dissolve one measure of nickel ammonium sulphate in a test tube half full of water. Add a few drops of the solution of sodium ferrocyanide prepared before and a green precipitate of nickel ferrocyanide will result.

EXPERIMENT 256—Ferrous ferrocyanide

Dissolve one measure of ferrous ammonium sulphate in a test tube half full of water and add to this solution two or three drops of sodium ferrocyanide solution. A resulting bluish white precipitate which forms is the same thing as Turnbull's blue.

EXPERIMENT 257—Ferric ferrocyanide

Dissolve one measure of ferric ammonium sulphate in a test tube half full of water and add a few drops of sodium ferrocyanide solution. The deep blue precipitate which results is called Prussian Blue, which is ferric ferrocyanide.

EXPERIMENT 258—Manganese ferrocyanide

Dissolve one measure of manganese sulphate in a test tube half full of water. Add to this solution a few drops of sodium ferrocyanide solution and a white precipitate of manganese ferrocyanide is formed.

EXPERIMENT 259—Cobalt ferrocyanide

Dissolve one measure of cobalt chloride in a test tube half full of water. Add to this solution a few drops of sodium ferrocyanide solution and a pretty deep blue precipitate of cobalt ferrocyanide is formed.

EXPERIMENT 260—Chromium ferrocyanide

Dissolve one measure of chrome alum in a test tube $\frac{1}{4}$ full of water. Add a few drops of sodium ferrocyanide solution and a deep green color will appear. This is the formation of chromium ferrocyanide. Notice that in this case the precipitate is in the form of a precipitate as the chromium ferrocyanide is soluble.

EXPERIMENT 261—Tin ferrocyanide

Put one measure of sodium bisulphate, one measure of ammonium chloride, and a small piece of tin metal in a test tube and add five or six drops of water. Heat the solution, allowing it to boil for two or three minutes to dissolve some of the tin. Now pour the clear solution into another test tube and add a few drops of sodium ferrocyanide solution into another test tube and add a few drops of sodium ferrocyanide solution. Note the light bluish green precipitate of tin ferrocyanide which is formed.

PART III

Organic Chemistry and Its Commercial Application to the Industries

CARBON

Organic chemistry is based on our knowledge of the properties and reactions of compounds of the element, carbon. This element is found in nature in the free condition in several forms. The diamond is practically pure carbon, while ordinary coal contains a large percentage of other substances besides carbon as mineral matter. Naturally occurring compounds of carbon are of wide occurrence in nature and are found in the form of gases, liquids or oils and solids. Carbon dioxide is the most familiar gaseous compound of carbon. Manufactured illuminating gas, natural gas from wells and petroleum are all composed chiefly of organic compounds of carbon.

The carbonates, especially calcium carbonate, constitute a very large proportion of the natural rocks and some form of mineral carbonate are found in most localities. Building stone—marble—is a very pure form of calcium carbonate. Carbon constitutes a large percentage of all living organisms, both plant and animal, and is represented in such organic products as proteins, fats, sugars and natural oils. All products of these types are widely utilized by man as food and for the manufacture of useful commercial products. At the present time more than 300,000 organic compounds are known, and the possibilities of new creations as the science of organic chemistry is developed are unlimited. Of all the elements occurring in nature, carbon is the one which is most commonly associated with life itself. Our present world could exist without this element.

Like a modified form of impure carbon, and is used as a fuel in operating steam engines, and also in smelting processes for refining ores. It is made by heating bituminous coal, or, as it is more commonly known, soft coal until all volatile products in it have been expelled. This heating process is conducted without excess of air, and is carried out on a commercial scale in large ovens. The volatile or gaseous products are refined and constitute the raw materials for the manufacture of illuminating gas and low boiling hydrocarbons like benzene.

A very boy and girl is familiar with ordinary charcoal. This is a form of carbon as in the manufacture of illuminating gas. By destructive distillation of organic substances such as wood and sugar, the carbon is separated from the volatile products. The quality of wood charcoal obtained is dependent on the kind of wood which is subjected to destructive distillation. It is in, for example, that the destructive distillation of coconut shells is productive of a very efficient form of absorbent carbon meeting the exacting requirements of the mask. If air was admitted during the distillation process, the charcoal and gaseous products would be burned up completely with formation of carbon dioxide gas and water.

Another form of carbon is graphite. This is the black substance which forms the lead pencils. It is sometimes referred to as lead, but this is not correct. It is a form of carbon, but a modified form of carbon, and can be made by subjecting carbon to a high temperature heat. At about 4000° C. carbon vaporizes, and this vapor on condensing forms graphite. Graphite is used in the manufacture of crucibles, as a lubricant, as a

protective covering for metals such as stove polish, and in the manufacture of pencils.

Lamp black, an amorphous form of carbon, finds wide application in the use of rubber as a toughening agent; in printers' ink as a pigment; in paint stove polishes and lacquers as a pigment; on typewriter ribbons and carbon paper as a black coloring matter. Boneblack is an amorphous carbon produced by distillation of bones. It is used as a deodorizing and decolorizing agent.

THE MANUFACTURE OF ILLUMINATING GAS

Cylindrical ovens of fire clay (B—Figure 31) are filled automatically with soft coal. These ovens are then closed tightly to prevent entrance of air. Under these conditions the coal is heated to a high temperature. The heat decomposes the coal into gases, liquids and coke. The gases contain impurities such as hydrogen sulphide, carbon dioxide, ammonia, tar, benzol and water. These impurities are removed before the gases are passed into receiving tanks.

The first step towards purification of the gases is as follows: The gases pass through a pipe and bubble through running cold water contained in the lower half of a large pipe (C). Here coke dust (carbon), tar oils and ammonia are removed.

Second, the gases are then passed through an arrangement (D) which consists of several hundred feet of pipe. This acts as a condenser and cools the gas down to ordinary temperature and condenses the liquid products of the distillation.

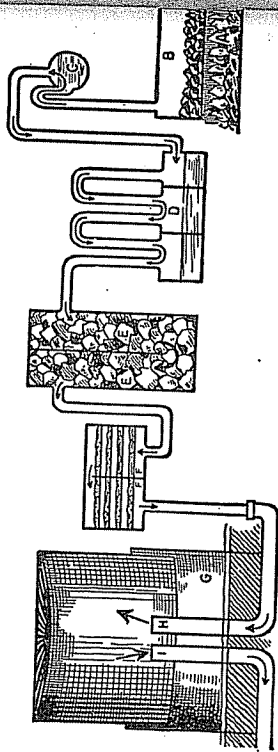


Fig. 31

Third, the gases pass from the condenser through a "scrubber" where they are washed and cleaned. The scrubber (EE) is a large iron tank filled with coke, wood, and scraps of tin, the object being to expose a large surface to the gases. A spray of water is introduced at the top of the scrubber and the material filling the scrubber is kept moist. The remainder of the tar and ammonia salts are here removed and the gases pass on to the purifier.

Fourth, the gases are passed through the "purifier" (FF), a rectangular box filled with layers of quick lime, which absorbs water, carbon dioxide and hydrogen sulphide. After the moisture is removed, the gases, which now consist of hydrogen, nitrogen, marsh gas, olefiant gas, acetylene and carbon monoxide are delivered immediately into the large gas tanks (G). These tanks are constructed in telescopic fashion

that the quantity of gas regulates and controls the size of the tank. From the tank it is pumped through gas mains to the homes of the consumers. (H) is the entrance pipe. (I) is the exit pipe. (K) is the flue or chimney for the fire.

You may have noticed at times the tremendous flame which shoots up in the vicinity of gas tanks. This is especially noticeable at night. The cause of this seems to be mysterious. It is exceedingly simple. When live steam is passed over white hot coke away from air, in an oven for instance, water gas is formed. Water gas cannot be used for lighting purposes alone; it is mixed with the coal gas. Water gas consists of a mixture of hydrogen and carbon monoxide and is produced by the action of steam on hot carbon.

After the steam has been passed into the ovens for a time new coke must be added; in other words, the ovens must be charged regularly. Before emptying the ovens, valves shut off the gas connection of the oven with the rest of the plant. In the ovens there still remains a good deal of gas. This gas must be removed before the ovens are emptied of the coke. The quickest and best way is to burn it away. This is done, and the gas disappears in a tremendous flame. Thus the "aurora borealis" of the city is a mystery no more.

EXPERIMENT 262—Preparation of charcoal—pyro-ligneous acid

Break up a few toothpicks or pieces of wood and place them in the bottom of a test tube. Now put a piece of moistened blue litmus paper over the mouth of the test tube and heat over an alcohol lamp or gas flame. Notice that the paper turns red, proving that an acid is evolved. This acid is called pyro-ligneous acid and is essentially acetic acid. Acetic acid is also present in vinegar. Here it is formed in the process of fermentation resulting by the action of bacteria on sugar.

Now insert the perforated cork with delivery tube, continue heating and light the gas that comes off. Notice that it will burn. This gas is similar to that obtained from the distillation of coal.

When no more gas is evolved, allow the tube to cool, then empty the contents of the test tube on paper. This is charcoal and is practically pure carbon.

When green pine (or green cedar wood) is distilled, turpentine and tar oils are derived from it. The turpentine is the volatile oil, that is, it passes off as a vapor. The tar oils are the heavy resinous oils, brown in color, such as you may see at the bottom of your test tube.

To summarize, when coal is heated without admission of air, coal gas, ammonia and coal tar are obtained. The gas is used for lighting and heating. The ammonia which is derived is purified and finds many uses. From the coal tar are derived intermediates from which aniline dyes, disinfectants such as carbolic acid, high explosives and many other valuable products are manufactured.

It can be seen, therefore, that enormous industries are based upon this process of heating wood and especially coal without admission of air.

THE SMOKING OF HAMS AND MEATS

Pyro-ligneous acid is contained in the smoke of smoke houses where hams and other foods are cured. In the pioneer days of New England agriculture, a smoke house was a common feature of the farmer's equipment. Usually this was built out of doors, but in many cases installed in the attic of the farm house. It is due to the aseptic action of this acid in the smoke that pork and beef products are preserved. The probable action of the gradual deposition of pyro-ligneous acid upon a ham is to gradually kill all of the bacteria or germs which are the cause of decay. The acid also imparts that distinctive taste which is characteristic of smoked foods.

Meats can be cured over night, while in the smokehouse several days are required. This quick curing is a rather new method and is not practiced except experimentally. The ham is painted with pyro-ligneous acid, which seeps into the meat. It has been declared that the quick cured ham is as edible as the slow cured ham and keeps as well.

EXPERIMENT 263—Decolorizing properties of charcoal

Make a solution of potassium permanganate by dissolving a crystal in a test tube half full of water. Shake until all is dissolved and the solution is colored purple. Now put into this solution three measures of powdered charcoal and, closing the mouth of the tube with the thumb, shake vigorously for two or three minutes. Now filter this solution in the funnel and notice the color of the liquid that runs through. It is nearly colorless, showing that charcoal has the property of absorbing color from certain substances.

Repeat this experiment with different colored solutions and notice which of the colors are absorbed by charcoal.

EXPERIMENT 264—Deodorizing properties of charcoal

Prepare some hydrogen sulphide water as shown in a previous experiment and notice the odor. To this solution add three measures of powdered charcoal, close the mouth of the test tube with your thumb and shake the test tube for three or four minutes. Now filter this solution and smell the liquid which runs through. Notice that the odor has been removed by the charcoal.

EXPERIMENT 265—Absorbing properties of charcoal

Dissolve a small piece of quinine pill about the size of a pin head in a test tube half full of water and taste the solution. Notice that it is bitter.

Now add three measures of powdered charcoal, close the mouth of the test tube with your thumb and shake for three or four minutes. Filter this solution and taste a little of the liquid which runs through. Notice that the bitter taste is practically gone.

Charcoal then removes colors, odors and tastes from certain solutions.

ABSORBENT CHARCOAL

EXPERIMENT 266—Absorbing coloring matter with charcoal

Put about $\frac{1}{8}$ measure of cochineal in a test tube $\frac{1}{4}$ full of water. Warm the tube for a few moments until the cochineal dissolves, forming red solution.

Now put two measures of powdered charcoal into the cochineal solution and close the mouth of the test tube with your thumb and shake three or four minutes. Filter the solution after you have shaken it thoroughly in order to separate the charcoal and you will find that the color will be a great deal lighter than it was in the original solution. By repeating this process several times it will be possible to practically all of the color out of this solution.

Try this experiment on logwood solution, or solutions containing little more dyes, or on any other colored liquids.

EXPERIMENT 267—Decolorizing vinegar

Fill a test tube one-quarter full of vinegar which has a brownish or yellow color. Add two measures of charcoal and shake with the solution for four or five minutes. Now separate the charcoal by filtering, and you will find that the color of the vinegar is lighter. The vinegar can be made almost colorless by repeating this several times.

EXPERIMENT 268—Absorbing bitter taste with charcoal

If you can obtain a small amount of quinine you will find that charcoal will absorb the bitter taste. Fill a test tube one-quarter full of water and add a very small amount of quinine, about the size of an ordinary pinhead. Shake this with the water and taste a drop of the solution and notice the bitter taste.

EXPERIMENT 269—Absorbent charcoal from ground coconut shells

Grind up a piece of dry coconut shell and thoroughly bake the material in a copper oven. This should be thoroughly carbonized by this treatment. After baking then grind the particles of dried shell to a powder by rubbing in a mortar. Test the efficiency of this powder as a decolorizing and absorbing agent.

EXPERIMENT 270—Absorbent charcoal from butternut shells

Crack some butternuts and eat the meat of the nuts. Then take the shells and thoroughly crush them and finally carbonize by heating in a copper oven. After this baking, then grind to a powder in a mortar. Test the efficiency of this powder as a decolorizing agent and absorbing agent.

EXPERIMENT 271—Preparation of absorbent charcoal from hickory nut shells

Follow same directions as given for Experiment 270.

EXPERIMENT 272—Preparation of absorbent charcoal from white birch wood

Carbonize some small pieces of white birch wood in a copper oven. After this baking, then grind to a powder in a mortar. Test the efficiency of this powder as a decolorizing agent and absorbing agent.

EXPERIMENT 273—Preparation of absorbent charcoal from pine wood

Follow same directions as given for Experiment 272.

EXPERIMENT 274—Preparation of absorbent charcoal from maple wood

Follow same directions as given for Experiment 272.

EXPERIMENT 275—Preparation of absorbent charcoal from chestnut wood

Follow same directions as given for Experiment 272.

EXPERIMENT 276—Surface tension and the rubber band

Float a thin rubber band on a dish of water and touch the water inside the band with a wire or tooth pick which has been dipped into oil. The band will snap out, forming a circle. Now apply oil to the water outside of the band and the band will again resume its original shape.

This experiment illustrates the effect of surface tension which tends to make liquids assume those forms which expose the least surface for a given volume.

EXPERIMENT 277—Changing the specific gravity of charcoal

Wood charcoal floats in water. Tie a weight on a piece of charcoal with a thread so that it will sink and place it in a test tube one-quarter full of water. Boil the water for several minutes, then remove the weight from the charcoal, and you will find that it no longer floats. This is due to the fact that the air was driven away from the pores of the charcoal by boiling. This experiment illustrates why wood becomes water-logged and does not float.

CARBON DIOXIDE OR CARBONIC ACID GAS

When carbon and any combustible compound of carbon is burned, the carbon is converted into carbon dioxide as the final product of oxidation. This is a gas heavier than air, and is the most commonly known of all carbon derivatives. While it does not support combustion, it does serve a valuable purpose in both human and plant economy. In the plant kingdom, carbon dioxide is absorbed from the air through the cells of the leaves and furnishes the source of carbon for building up plant tissues. The transformation of carbon dioxide in the plant is brought about under the agency of the sun's rays and the influence of the green chlorophyll of the leaves of the plant.

While carbon monoxide is poisonous, carbon dioxide is a harmless gas. It is a waste product thrown off by the lungs during respiration. It has been proved that carbon dioxide in the lungs is responsible for stimulating the respiratory center in the process of breathing. The deep and rapid breathing from extensive violent physical exercise, like baseball and football, is not due directly to the need of oxygen, but rather to the need of eliminating carbon dioxide from the lungs. The increase of the carbon dioxide production is a measure of the work being done under violent exercise. Use is made of carbon dioxide for administration to patients suffering from hiccoughs. Also to increase the breathing rate after an anesthesia and even after carbon monoxide poisoning. While carbon dioxide is not ordinarily considered poisonous, it can, however, be responsible for death, because it will not support combustion. The ordinary procedure of testing the air in a mine or a deep well, or any building or inclosed place having poor ventilation, with a lighted candle is proved to be very wise in many cases.

MEDICAL USES OF CARBON DIOXIDE

Ordinarily we think of carbon dioxide as being associated with fire extinguishers and for this reason it is sometimes hard for most of us to appreciate that carbon dioxide can play an important part of a life-saver and alleviator of pain. We now know that carbon dioxide stimulates respiration and serves as a means of increasing the rate of breathing. Advantage is taken of this effect in certain cases where breathing is suspended, such as during asphyxiation, physical shock, and partial drowning. Machines for administering mixtures of oxygen and carbon dioxide have proved more capable of giving relief in these types of cases than those which use oxygen alone. The breathing stimulating effect of carbon dioxide, and the ventilation produced by oxygen has saved many lives. Carbon dioxide as an aid in the removal of the anesthetic when it is no longer needed, is a general hospital practice.

CARBONATES OF METALS

The carbonates of many metals are insoluble in water and can be precipitated from solutions by means of a soluble carbonate such as sodium carbonate. In the following experiments you will obtain many colors. Filter off your insoluble precipitates and note the color of the carbonate salts.

EXPERIMENT 278—Strontium carbonate

Dissolve one measure of strontium chloride in a test tube half full of water. Another test tube one-quarter full of water dissolve one measure of sodium carbonate. Now add some of the sodium carbonate solution to the strontium chloride solution and a heavy white precipitate of strontium carbonate is obtained.

EXPERIMENT 279—Nickel carbonate

Dissolve one measure of nickel ammonium sulphate in a test tube half full of water. Dissolve one measure of sodium carbonate in another test tube $\frac{1}{4}$ full of water. Now add the sodium carbonate solution a little at a time to the solution of nickel ammonium sulphate and a thick light green precipitate of nickel carbonate will be formed.

EXPERIMENT 280—Zinc carbonate

Put a small piece of zinc metal in a test tube, add one measure of sodium bisulphate and fill the tube $\frac{1}{4}$ full of water. Warm this solution and let it stand for three or four minutes so that some of the zinc metal will dissolve.

Now prepare a solution of one measure of sodium carbonate in a test tube $\frac{1}{4}$ full of water and add some of this solution to the zinc solution. A white precipitate of zinc carbonate will be formed which gradually settles to the bottom of the tube.

EXPERIMENT 281—Aluminum carbonate

Dissolve one measure of sodium carbonate in a test tube $\frac{1}{4}$ full of water. Dissolve one measure of aluminum sulphate in another test tube $\frac{1}{4}$ full of water. Add the sodium carbonate solution to the aluminum sulphate solution a little at a time. Notice that at first an effervescence takes place and then a gelatinous precipitate of basic aluminum carbonate is formed.

EXPERIMENT 282—Chromium carbonate

Dissolve one measure of chrome alum in a test tube half full of water. Add a few drops of sodium carbonate solution as before, and notice that a bluish green precipitate of chromium carbonate forms.

EXPERIMENT 283—Ferrous carbonate

Dissolve one measure of ferrous ammonium sulphate in a test tube half full of water. To this solution add a few drops of a solution of one measure of sodium carbonate in a test tube $\frac{1}{4}$ full of water. A greenish precipitate of ferrous carbonate will form.

EXPERIMENT 284—Cobalt carbonate

Repeat the experiment using one measure of cobalt chloride in place of the ferrous ammonium sulphate.

EXPERIMENT 285—Calcium carbonate

Put one measure of calcium chloride in a test tube half full of water. Shake thoroughly and then add a few drops of sodium carbonate solution prepared as in the preceding experiment. A white precipitate will be formed which is calcium carbonate.

EXPERIMENT 286—Copper carbonate

Place one measure of azurite, which can be purchased at your drug store, and one measure of sodium bisulphate in a test tube. Fill the tube half full of water and shake for a few moments until the solution becomes perfectly clear. Now add a few drops of sodium carbonate solution prepared as before, and a very pretty blue precipitate of copper carbonate will be formed.

EXPERIMENT 287—Manganese carbonate

Dissolve one measure of manganese sulphate in a test tube half full of water. Add a few drops of sodium carbonate solution prepared as before, and you will obtain a white precipitate of manganese carbonate.

EXPERIMENT 288—Magnesium carbonate

Add one measure of magnesium sulphate to a test tube half full of water and dissolve by shaking. Now add a few drops of sodium carbonate solution, as before, and a white precipitate of magnesium carbonate will be formed.

CARBON MONOXIDE

While carbon dioxide is a harmless gas, this member of the carbon family is a violent poison. It is formed when carbon is burned with a diminished supply of oxygen. The gas burns with a blue flame, being converted into carbon dioxide.

Several thousand people are killed each year by carbon monoxide gas, which constitutes a small proportion of the gases expelled through the exhaust pipe of an automobile.

With the return of cold weather, the spectre of carbon monoxide poisoning haunts every automobile driver. Unless humanity has exercised an excess of caution, we may expect occasional news items about persons warming up their motors in closed garages being overcome by this insidious gas. Carbon monoxide is a product of imperfect combustion. When a fuel is burned under perfect conditions, carbon monoxide is not produced. The products of perfect combustion are carbon dioxide and water. Ideal combustion conditions are difficult to realize. Certainly not in the very best of our automobiles. An analysis of the exhaust gases of an average automobile shows about 7% of carbon monoxide. In a certain experiment a dog was left in the driver's seat of an automobile in a closed garage, with the engine running slowly. In twenty minutes the dog was unconscious. Had a man been in the dog's place, the result would probably have been the same. Carbon monoxide overcomes its victim with no warning. The first symptom is a severe pain in the back of the head, but if the concentration is high, the victim may lose consciousness before he can act on this warning. This condition may or may not be preceded by such warnings as headache, dizziness or nausea. Small doses may have no other effect than to cause severe headache, but heavy gassing is a serious matter. Convalescents from carbon monoxide poisoning should be kept in bed even when they protest that they are all right. To avoid carbon monoxide poisoning it needs no more than good ventilation in the garage. Carbon monoxide is lighter than air, and vanishes immediately through an open window or door. A doctor should be called immediately for a person overcome by the gas. An automobile driven by a driver under the influence of carbon monoxide gas constitutes a hazard to the public safety on the highway equal in seriousness to that of another car equipped with faulty brakes. It has been found that an automobile, following closely behind another, particularly in heavy traffic, may pick up a sufficient quantity of the exhaust gas from the preceding car to result in a dangerous mixture within the second automobile, leading to carbon monoxide poisoning.

ETHYL GAS

Every automobile driver is familiar today with the trade term—"ethyl gas." This is an organic compound containing lead which bestows on gasoline the favorable properties characteristic of this reagent (tetraethyl lead). It is a practical anti-knock substance. When ethyl gasoline is used, it tones down the explosions in the cylinders of gas engines, and pushes the cylinder more gently than in the case when ordinary gasoline is used. Tetraethyl lead is a dangerous substance, and warnings, therefore, accompany its use. At every filling station there are warnings posted to the effect that ethyl gas should not be spilled upon the hands or used for cleaning purposes. Ordinary precautions are followed, tetraethyl gasoline presents little danger during use.

EXPERIMENT 289—Preparation of carbon dioxide—(effervescence)

Make a solution of sodium bicarbonate by shaking up a test tube $\frac{1}{8}$ full of water containing two measures of sodium bicarbonate. In another test tube make a solution of tartaric acid by shaking up a test tube $\frac{1}{8}$ full of water containing two measures of tartaric acid. Now pour the tartaric acid solution into the solution of sodium bicarbonate.

Notice the violent effervescence due to the chemical action and liberation of carbon dioxide gas. You will notice that it has no odor. This is the same gas that you see bubbling out of soda-water.

EXPERIMENT 290—Vinegar and baking soda

Obtain some very strong cider vinegar, the stronger the better, and place about 3cc. in a test tube. Then drop into the vinegar a small measure of baking soda. What gas is given off? Test for it.

EXPERIMENT 291—Vinegar and oyster shells

Repeat the above experiment using a piece of oyster shell. Pulverize the shell in a mortar before adding it to the vinegar. Warm the solution and test the gas given off.

EXPERIMENT 292—Vinegar and painters whitening

Repeat the above experiment using some painter's whitening. What is the composition of ordinary whitening?

EXPERIMENT 293—Vinegar and chalk

Repeat the above experiment using some powdered chalk or crayon from your school room blackboard.

EXPERIMENT 294—Vinegar and marble

Repeat the above experiment with some pulverized marble.

EXPERIMENT 295—Vinegar and tooth powder

Repeat the above experiment with a good quality of dental tooth powder. What constituent of tooth powder causes the reaction?

EXPERIMENT 296—Vinegar and old mortar

Repeat the above experiment using some old mortar removed from the walls of an old brick building. Note the evolution of carbonic acid gas.

EXPERIMENT 297—Vinegar and Portland cement

Repeat the above experiment using some pure Portland cement.

EXPERIMENT 298—Carbon dioxide is heavier than air, and will not burn

Light a candle and set it firmly on a board by sticking it to a little melted wax from the flame of the candle. (Figure 32).

Now put one-half teaspoonful of sodium bicarbonate or common baking soda in a glass and add some vinegar or a solution of tartaric acid to the glass. A violent reaction takes place with evolution of carbon dioxide gas. Now pour the gas in the glass on to the flame just as though you were pouring water out of the glass, taking care not to spill any of the acid out of the glass. Notice that the flame goes out, proving that carbon dioxide is heavier than air and will settle to the earth and also that it will not burn.

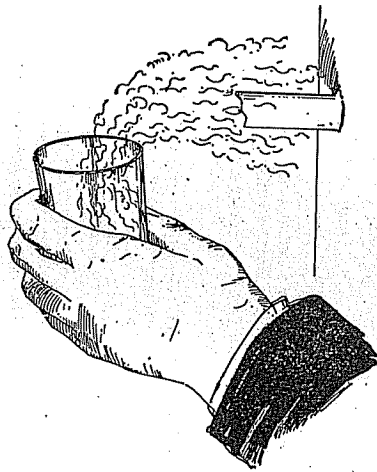


Fig. 32

COLORLESS
CONE
YELLOW CONE
DARK CONE
OF UNBURNED
GAS

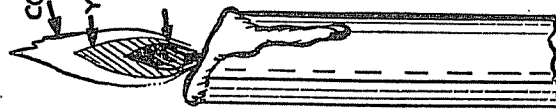


Fig. 33

EXPERIMENT 299—Chemistry of the flame

Examine closely an alcohol lamp flame or candle flame and observe that it consists essentially of three cones. (Fig. 33). First a dark cone just around the wick; second, a yellow cone which produces light; and third, a semi-transparent cone of heat around the outside.

The dark cone of the flame consists of unburned gases which are given off from the wick of the candle. The paraffin is melted by the heat and drawn into the wick by capillary action. In the wick the paraffin is converted into a gas by the heat of the flame. To prove this, hold one end of a hollow glass tube in the flame just over the wick. Now apply a flame to the other end of the tube and it takes fire. The gas in this cone is relatively cool, for if a match stick is placed in it that portion of the stick which was in the dark cone will not burn as soon as the portion passing through the sides of the flame.

The second or yellow cone of the flame consists of particles of carbon that have been heated to white heat so that they glow brightly.

Hold a cold spoon or glass rod in this cone for a minute and notice that it is covered with a black deposit of carbon called lampblack, thus proving that this cone consists of small particles of carbon. The cold spoon chilled the flame, thereby causing the carbon particles to be deposited. Lampblack is made upon this principle on a manufacturing scale.

The third or outer cone of the flame consists of the gases formed by the complete burning of the carbon particles to carbon dioxide gas. This is the hottest portion of the flame, and whenever heating a liquid in a test tube, for example, it is important, in order to obtain the highest heat possible and to prevent the deposit of soot, to hold the test tube at the tip of the luminous or light-giving part of the flame.

EXPERIMENT 300—Carbon dioxide from a burning candle

Make some lime water by putting two measures of calcium oxide in a test tube half full of water and shaking well for three or four minutes. Allow this solution to stand until clear, then pour the clear liquid into another test tube. You now have a clear solution of lime water or calcium hydroxide.

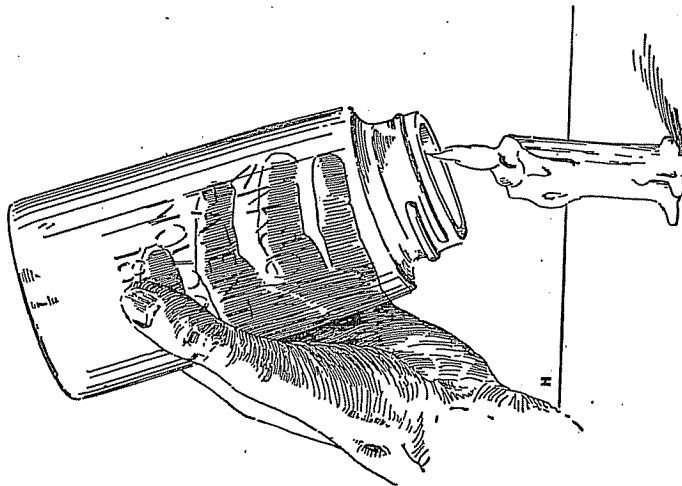


Fig. 34

Now hold a wide mouthed bottle or fruit jar over a candle flame as shown in Figure 34 so that the burning gases from the flame may enter the mouth of the bottle. After allowing the gases to enter the bottle for about a minute, close the mouth of the bottle with the palm of the hand, and, inverting the bottle, pour the lime water into it. Again put the palm over the mouth of the bottle and shake for a moment. Notice that the lime water becomes turbid or milky. This turbidity is due to a white precipitate or calcium carbonate formed by the action of carbon dioxide on calcium hydroxide.

EXPERIMENT 301—The structure of a flame—A gas factory

If you will look closely at a candle flame you will see that it consists of three parts. First, a dark zone just around the wick.

Second, a bright yellow zone which gives the light.