

separate very rapidly. Now add a small amount of soap solution to the oil and water in the test tube and shake again. This time the oil and water stay mixed together for some time before they separate, and it would be an easy matter to remove the oil while it is held by the soap and water.

EXPERIMENT 371—Laundry soap

Put three or four measures of soap shavings in the mortar and grind it to a paste with four or five drops of water glass. When you have a good mixture scrape it in a pile on a plate or tin pan and let it dry. Laundry soap frequently contains water glass or sodium silicate as well as sodium carbonate.

EXPERIMENT 372—Borax soap

Soap is sometimes mixed with borax and used as laundry soap, etc. Grind together in your mortar five or six measures of soap shavings with two measures of Borax and three or four drops of water. Scrape the paste from the mortar on to a tin pan after it has been thoroughly mixed and then let it dry.

EXPERIMENT 373—Medicated soap

These soaps are mixed with various antiseptic substances, such as carbolic acid, etc. When used a small amount of the antiseptic substances dissolves and comes in contact with the surface to which the soap is applied.

You can make a small quantity of medicated soap by mixing a little soap and boric acid with some water and grinding the mass in the mortar until it is well mixed and then drying the paste.

EXPERIMENT 374—Dissolving grease

Try to dissolve a small piece of lard, or butter, or grease in water. If the water is heated the grease may melt and become distributed through the water, but on standing it will again come into a mass and will not dissolve.

Now put a small piece of grease in a test tube with a few drops of carbon tetrachloride and notice that it dissolves almost immediately. Try to mix carbon tetrachloride with water. Mix some carbon tetrachloride with water containing suspended fat. What becomes of the fat?

EXPERIMENT 375—How biscuits are raised

Put a teaspoonful of flour in a tumbler and add four measures of sodium bicarbonate. Stir this mixture with a little water until you have a dough like bread dough. Now put a piece of this dough about the size of a marble on your spoon and heat it over the alcohol lamp flame. Notice that the dough swells and that it becomes porous or light, due to the gas that is formed in it.

Ordinary baking soda is sodium bicarbonate; when treated it gives off part of the carbon dioxide gas which it contains, so when used in biscuits, cakes, etc., the gas coming off raises the dough and makes it porous. In cooking, sour milk, or other acid, is used with the baking soda. This neutralizes the soda and gives off more carbon dioxide gas.

SOME APPLICATIONS OF CHEMISTRY IN MOTHER'S KITCHEN

EXPERIMENT 376—Protein in the white of an egg

Place in a test tube some white of a boiled egg and mix well with one measure of pulverized calcium oxide. Then add three or four drops of water and heat the mixture

over your alcohol lamp and smell the gas that is generated. Conduct some of the gas evolved over a moistened red litmus paper. Proteins contain nitrogen. Egg white is a protein substance and on heating with calcium oxide is decomposed with liberation of ammonia.

EXPERIMENT 377

Apply the preceding experiment, using a chicken's liver.

EXPERIMENT 378

Apply the test again, using a lamb's kidney.

EXPERIMENT 379

Repeat experiment 376 using a piece of dry cheese.

EXPERIMENT 380

Repeat experiment 376 using the skin of a potato.

EXPERIMENT 381

Repeat experiment 376 using a sample of your mother's breakfast cereal.

EXPERIMENT 382

Repeat experiment 376 using a sample of your mother's favorite glue.

EXPERIMENT 383

Repeat experiment 376 using a piece of rayon silk.

EXPERIMENT 384—Sulphur in proteins

Put a half spoonful of the white of an egg into a test tube and add one measure of copper sulphate and two measures of calcium oxide. Heat the test tube over a flame and allow the mixture to boil for two or three minutes. Notice the black precipitate of copper sulphide which is formed, showing that proteins contain sulphur.

EXPERIMENT 385

Repeat experiment 384 using a piece of the finger of an old leather glove.

EXPERIMENT 386

Repeat experiment 384 using a piece of dried cheese.

EXPERIMENT 387

Repeat experiment 384 using a piece of rubber tubing.

EXPERIMENT 388

Repeat experiment 384 using a piece of woolen yarn. Also test the piece of woolen yarn for protein.

EXPERIMENT 389

Repeat experiment 384 using ground mustard seed.

EXPERIMENT 390—Testing canned goods for copper

This test may be applied on a great variety of food articles such as canned peas, beans, ordinary spinach, apricots, pears, pickles, sauerkraut, etc. Grind together a selected sample of the food to be tested with two or three measures of sodium bisulphate and several spoonfuls of water. Heat this mixture for several minutes below the boiling temperature of water (212° F.) in a sauce pan and finally let stand on the back of a warm stove. Finally drop into this hot solution a polished wire nail and let

it remain there for about one-half to one hour. It is well to stir the contents of the pan occasionally. If the wire nail takes on a red color due to copper plating this will be evidence that the sample of food product you have tested will contain traces of copper.

EXPERIMENT 391—Copper in oysters

Repeat experiment 390 using the pulp of an oyster.

EXPERIMENT 392—Copper in scallops

Repeat experiment 390 using the meat of a scallop.

EXPERIMENT 393—Copper in a round clam

Repeat experiment 390 using the meat of a round clam.

Sea food is frequently contaminated with traces of copper. This is carried often times to the sea water by sewage drainage, especially in areas where certain industrial operations are carried on extensively. Oysters are often found contaminated with copper.

EXPERIMENT 394—Testing coffee

Coffee does not contain starch. It is often contaminated, however, with starchy materials. Some of these are ground beans, peas and chicory. The microscope will serve many times to detect such adulterations. A test for starch may be used, therefore, to show the presence of these adulterants. Digest the coffee with hot water to make a strong solution. Treat with a spoonful of absorbent charcoal to remove the color, and finally dilute with a little water to obtain a light colored solution. Then apply your starch-iodine reaction to test for starch. A blue coloration will be formed if starch is present.

EXPERIMENT 395—Decolorizing hamburger steak

Meat turns a deep red color on long exposure to the air. This is due to changes in the blood content. To bleach out meat put a small quantity of chopped meat in a test tube and add some hydrogen peroxide solution. Warm the solution gently and let stand. The chopped meat will be bleached and lose all its color.

EXPERIMENT 396—Hydrogen peroxide and liver

Grind a piece of chicken liver and suspend in some hydrogen peroxide solution. Note the change in the appearance of the liver.

EXPERIMENT 397—Hydrogen peroxide and a lamb's kidney

Grind a piece of lamb's kidney and suspend in some hydrogen peroxide solution. Note the change in appearance of the kidney. Hydrogen peroxide is an excellent preservative for animal matter and will prevent such material from putrefying.

EXPERIMENT 398—Chicken feathers

Test chicken feathers for both protein and sulphur. The feather should be cut into fine pieces before applying the fusion test with calcium oxide. Burn some feathers and note the odor produced.

EXPERIMENT 399—Honey comb

Secure some natural honey comb from a hive and cut out a small piece and clean it thoroughly. Then apply to this material the regular procedure, as described above, for testing for protein and sulphur, by fusing with calcium oxide.

EXPERIMENT 400—Iron in honey comb

Incinerate a piece of honey comb in a porcelain crucible, and test the residue or ash for iron.

EXPERIMENT 401—Bees' wax

Test some refined bees' wax for protein, iron and sulphur. Determine what happens when a small piece of bees' wax is warmed in a test tube with some (a) turpentine, (b) carbon tetrachloride, (c) benzol, and (d) denatured alcohol.

EXPERIMENT 402—A wasp's nest

Detach from the roof of your mother's attic an old wasp's nest. Incinerate this and examine the ash for silica and iron.

EXPERIMENT 403—Composition of a wasp's nest

Apply a regular test for protein and sulphur. A wasp's nest is a combination of cellulose similar to artificial paper.

EXPERIMENT 404—House flies

Kill 12 or 15 large house flies and incinerate in a crucible. Test the ash of the flies for iron.

EXPERIMENT 405—The house wasp

Kill two or three large house wasps and grind them to a pulp in one-third test tube of water. After thorough digestion then filter and test the water extract with blue litmus solution. The color will be turned to red due to the presence of formic acid. The wasp excretes formic acid in its sting.

EXPERIMENT 406—Tannin in tea

Make a very strong water solution of hot tea. Cool and pour off the clear liquid and add about one measure of ferric ammonium sulphate. Shake well. On standing a black color will develop due to the formation of iron tannate.

EXPERIMENT 407—Sanka coffee

Repeat experiment 406 using some strong Sanka coffee solution.

EXPERIMENT 408—Potato sprouts

Secure some clean colorless common potato sprouts and make the following tests: (a) incinerate and test for iron; (b) test for protein; (c) test for sulphur; (d) test for starch.

SOME PRACTICAL CHEMICAL EXPERIMENTS

EXPERIMENT 409—Making a low temperature bath

Follow the technique of the ice cream manufacturer and mix some crushed ice with pulverized salt. Read the temperature with your thermometer.

EXPERIMENT 410—A sugar bath

Repeat the preceding experiment, using some household granulated sugar in place of pulverized salt. Do the sugar and salt produce the same results? Explain.

EXPERIMENT 411—Iron in your tonic

Pour one-quarter of a test tube of your spring tonic mixture into a test tube and add to it one-third a test tube of sodium ferrocyanide solution. The production of a blue color will prove that iron is present.

EXPERIMENT 412—Iron in blood

Repeat experiment 411, using a few drops of animal blood. Mix with water and then add the sodium ferrocyanide solution.

EXPERIMENT 413—Decolorizing tincture of iodine

To a little tincture of iodine add a solution of sodium thiosulphate (hypo solution). Shake well and observe that the iodine color is lost. This reagent is useful for removing iodine stains from clothing. Try the experiment using a corner of your handkerchief.

EXPERIMENT 414—Stains on your fingers

Fingers stained with juices of fruits may be cleaned by washing with sulphur dioxide water.

EXPERIMENT 415—Cleaning a straw hat

Mix two measures of sodium bisulphite with one measure of tartaric acid and one measure of borax. Dissolve the three reagents in hot water and scrub your straw hat with the solution. After thorough rubbing with a brush then wash with pure water and dry the hat in the sunlight.

EXPERIMENT 416—Removing paint from cloth

Lay a pad of blotting paper on the side of the fabric which has a paint spot on it. Then rub the other side of the fabric with a piece of flannel moistened with carbon tetrachloride. This chemical will dissolve paint and carry it into the blotting paper. The success of this method depends on the use of some absorbent material to take up the organic solvent when it dissolves the paint.

EXPERIMENT 417—Preparation of a good gum for labels

Dissolve one teaspoonful of gum arabic in two and one-half test tubes of water by warming. Then add four teaspoons of common sugar and one teaspoon of starch and finally boil the solution for a few minutes. If the gum solution is too thick, on cooling, add more water. If you wish to preserve the gum from fermentation and action of mould, add about one teaspoon of boric acid. Hydrogen peroxide solution may also be used to keep it sweet.

EXPERIMENT 418—Rubber cement

Place one ounce of latex rubber in a salt mouth bottle and pour over it some carbon tetrachloride. Cork and let stand until the rubber latex dissolves completely. Use as needed.

EXPERIMENT 419—Cleaning marble

Use a mixture of one part of pumice stone, two parts of sodium carbonate, and one part of powdered chalk. Mix well and rub with a little water. Then use the mixture for rubbing the marble surface. Wash well with water after the treatment.

EXPERIMENT 420—Vegetable stains on the hands

Rub with a fresh cut slice of raw potato.

TESTING FOODS**TESTING FOR STARCH****EXPERIMENT 421—How to make a solution for testing starch**

Put one-half measure of tartaric acid and one-half measure of bleaching powder (calcium hypochlorite) in a test tube two-thirds full of water. Shake the contents of the tube until the solids are dissolved. Then add 10 or 12 drops of sodium iodide solution and shake again. Notice the brown solution which is formed. This is free iodine in solution and was formed by the action of chlorine gas on the sodium iodide solution. The chlorine gas was liberated by the action of the tartaric acid on the bleaching powder or calcium hypochlorite.

Save this solution and use it in the following experiments for testing for starch in foods and other substances.

EXPERIMENT 422—Testing for starch in rice

Put three or four grains of rice in a test tube half full of water and boil the water for three or four minutes. Allow the test tube to cool and then add one or two drops of the iodine solution prepared in the preceding experiment. Notice the blue color which is formed. This is the test for starch.

EXPERIMENT 423—Testing for starch in potatoes

Boil a small piece of potato about the size of a pea in a test tube half full of water for three or four minutes. Allow the test tube to cool, then add one or two drops of iodine solution. Notice the formation of a blue color, showing that potatoes contain starch.

EXPERIMENT 424—Testing for starch in flour

Put one measure of flour in a test tube half full of water and boil the solution for one or two minutes. Allow the solution to cool and then add one or two drops of iodine solution. Notice the blue color which is formed, showing that flour contains starch.

EXPERIMENT 425—Testing for starch in corn

Break one or two kernels of corn into small pieces and boil them in a test tube half full of water for three or four minutes. Allow the solution to cool and add one or two drops of iodine solution. Notice the formation of a blue color, showing that corn also contains starch.

EXPERIMENT 426—Testing for starch in apples

Green fruit contains starch, which is converted into sugar when the fruit becomes ripe. Satisfy yourself that this is true by boiling a small piece of a green apple and of a ripe apple in separate test tubes half full of water for one or two minutes and adding one or two drops of iodine solution to the cool solutions. Notice that the blue color was formed only in the case of the green apple, showing that starch is present in green fruit.

THE FOOD CHEMIST—JACK HORNER

"Little Jack Horner, he sat in a corner,
Eating a piece of Mother's Thanksgiving pie,
He stuck in his finger and pulled out a raisin
And applied Gilbert's iron test to satisfy his imagination."

EXPERIMENT 427—Testing a raisin for iron

Select a raisin and wash it with water. Then incinerate the raisin in a porcelain crucible by heating the crucible over your alcohol lamp until the raisin is reduced to an ash. This ash contains only inorganic matter. Digest the ash in diluted boiling hydrochloric acid solution and filter. The insoluble residue will be silica. The iron content of the ash will be dissolved, forming iron chloride. Apply the characteristic test for iron by adding some of the iron solution to the reagent sodium thiocyanate. If iron is present red iron thiocyanate will be formed. Also add some of the iron solution to a mixture of potassium ferro- and potassium ferricyanide solutions. A blue color will be formed if iron is present.

EXPERIMENT 428—Testing raisin seeds

Take a clean raisin and remove all of the seeds from the pulp. Then incinerate the washed seeds, and the pulp separately in porcelain crucibles. Test the ash in each crucible for iron. Which contains the most iron, the seeds or the pulp?

EXPERIMENT 429—Apple seeds

Apply the iron test to the ash of apple seeds.

EXPERIMENT 430—Quince seeds

Apply the iron test to the ash of quince seeds.

EXPERIMENT 431—Turnip seeds

Apply the iron test to the ash of turnip seeds.

EXPERIMENT 432—Cabbage seeds

Apply the iron test to the ash of cabbage seeds.

EXPERIMENT 433—Beans

Incinerate a bean after grinding to a powder and test the ash for iron.

EXPERIMENT 434—Sunflower seeds

Apply the iron test to the ash of sunflower seeds.

EXPERIMENT 435—Lettuce seeds

Apply the iron test to the ash of lettuce seeds.

EXPERIMENT 436—Wheat kernel

Apply the iron test to the ash of kernels of wheat.

EXPERIMENT 437—"Tums for your Tummy"

Procure in the drug store a small package of "Tums." Incinerate one of the "tums" and test the ash for iron. Dissolve some of the ash from "tums" in water and determine whether the water solution is alkaline or acid by testing with indicators. Test a "tum" for the presence of sugar.

EXPERIMENT 438—Pop corn

Apply an iron test to the ash of incinerated popcorn.

EXPERIMENT 439—Popcorn balls

Pop some dry popcorn in a corn popper. Then separate some of the white fluffy material and incinerate. Test the resulting ash for iron.

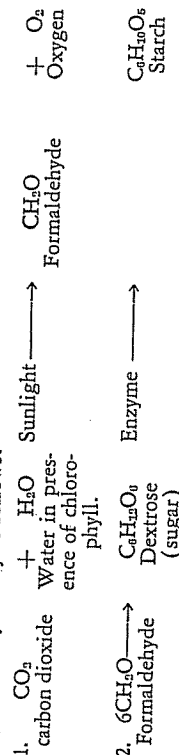
EXPERIMENT 440—Grape seeds

Apply an iron test to the ash of some grape seeds.

STARCH AND SUGAR INDUSTRY

Before we say anything about this industry, we will discuss briefly how starch and sugar are being made every day by nature in plant life and the changes these substances undergo in animal life.

The carbon dioxide which is always found in the air is made by the heat of the sun to combine with water in the plant tissues to produce a compound formaldehyde. Formaldehyde in turn undergoes what is known as polymerization in the plant to form sugars. By polymerization we mean several molecules of the substances combining to form a more complex compound. The sugar is changed to starch by plant ferments or enzymes. In the process of converting carbon dioxide and water by the plants into sugar and starch, oxygen is liberated and given off into the air. This process may be expressed very clearly as follows:



Man is dependent upon plants for starches and sugar. When these foods are taken into the body they are changed back again with the aid of the oxygen which we breathe into the lungs from the air into water and carbon dioxide. The carbon dioxide is constantly being passed out of the body when we breathe the air out of our lungs.

To summarize, then, we can say that carbon dioxide of the air is taken up by plants and oxygen given off. In animal life oxygen is removed from the air and carbon dioxide given off. In other words, carbon dioxide sustains plant life but destroys animal life.

Nearly all plant and vegetable matter contains starch—potatoes, corn, wheat and rice containing a large percentage of this substance. Sugar cane and beets on the other hand are the chief sources of sugar and contain large amounts of this substance.

Starch and sugar come under the class of compounds known as carbohydrates. That is, they are compounds of carbon with hydrogen and oxygen. In the United States starch is obtained chiefly from corn, while in Europe potatoes are the chief source. Starch consists of minute granules. These granules are composed of a substance known as granulose, which is surrounded by a membrane composed principally of cellulose. Starch does not dissolve in cold water because the granulose which is soluble in water is protected from the action of water by insoluble cellulose membrane. When heated with water the granules burst and the granulose dissolves, forming the well-known starch paste.

Besides its commercial use in the laundry, starch is manufactured for the purpose of making the commercial products known as glucose, grape sugar, malt glucose, dextrin, British gums and soluble starch. These compounds are all formed from starch

by hydrolysis with suitable reagents. They are all important compounds and are widely used. Corn syrup is nothing more than glucose which originally came from starch.

Cane sugar or ordinary household granulated sugar is obtained from the sugar cane through a process of refining. It is the sweetest of all natural sugars and is called sucrose. It has the formula $C_{12}H_{22}O_{11}$. On hydrolysis with acids this sucrose may be broken down into two other sugars, dextrose and levulose, having the same formula $C_6H_{12}O_6$, but differing in physical properties. Levulose is sweeter than dextrose and is the chief component of honey. Dextrose is found in commercial glucose or corn syrup. Maltose is the sugar that is formed by the action of enzymes, such as diastase on starch. It has the same formula as dextrose and levulose and is the sugar from which alcohol and most of the alcoholic liquors are prepared.

EXPERIMENT 441—How to make potato starch

Peel a fresh potato and after washing it with water cut a piece of it up into very small slices. Place these slices in a mortar, or cup, add a little water, about a test tube full and grind the pieces into a fine pulp by means of a pestle or spoon. Now add a little more water and after stirring a little with a stirring rod strain the mixture through a coarse cloth, catching the liquid in a glass. Fill the glass half full of water, stir a few times and allow the liquid to stand quietly for several minutes. Notice that a white sediment settles out in the bottom of the glass. This sediment is the starch originally contained in the potato. The liquid contains a little of the fibrous material which passed through the cloth on straining.

The principle involved in the manufacture of starch from potatoes in Europe is similar to this, although complicated machinery is used in the manufacture of large quantities and in the purification and separation of starch.

EXPERIMENT 442—How to make cornstarch

Place about 15 kernels of corn in a mortar, or cup, add a test tube full of water and allow the corn to soften somewhat in the water for several hours. Then grind the kernels up into a pulp by means of a pestle or spoon.

Add a little more water and after stirring a few times, strain the mixture through a coarse cloth into a glass. Fill the glass half full of water, stir the mixture a few times and allow the liquid to stand quietly for a few minutes. Notice the sediment in the bottom of the glass. This is starch originally contained in the corn.

Cornstarch is manufactured extensively in the United States by a method similar to this.

EXPERIMENT 443—How to make starch from flour

Besides starch, flour contains an organic compound called gluten. In order to separate the starch from gluten proceed as follows:

Put two tablespoonsfuls of flour in a cup and add just enough water to make the flour into a stiff dough. This can be done by working the moist flour with the fingers until it is kneaded into a round ball the same as your mother does when she prepares bread dough for making bread. Now take this ball of dough and holding it in a glass half full of water work it with the fingers so that all portions of it will come in contact with the water. Notice that the starch separates from the dough and settles in the water, leaving a very sticky mass of gluten in the fingers.

EXPERIMENT 444—Changing starch into glucose (sugar)

Put 12 measures of starch and three measures of sodium bisulphate in a test tube half full of water and boil the mixture for 10 or 15 minutes. The starch has now been hydrolyzed by the acid to form glucose.

In order to tell whether the starch has been completely changed over into glucose pour 4 or 5 drops of the above solution into another test tube, add 2 or 3 drops of sodium iodide solution and 1 measure of bleaching powder. If the mixture turns blue, there is still some starch present, and it will be necessary to heat the starch and sodium bisulphate solution a little longer, adding a little more sodium bisulphate. If no color is produced when a portion of this solution is tested with sodium iodide and bleaching powder, all the starch is converted over into glucose.

When bleaching powder is added to some of the acid solution containing starch and sodium bisulphate, chlorine gas is liberated which, in turn, reacts with the sodium iodide, liberating iodine. Iodine in the presence of starch gives a blue color.

In order to obtain solid glucose from the above solution of starch and sodium bisulphate, pour the solution into a saucer and allow it to evaporate slowly. Solid glucose will soon separate out.

EXPERIMENT 445—Making starch from Bantam sweet corn

Obtain a good ear of Golden Bantam corn. Use a grater to make a pulp and do not use the cobs. Put an equal amount of water with this pulp. Put the solution in a fine cotton cloth (a linen cloth will do) and squeeze the juice into another pan. Allow this to set for 12 hours and pour the water off. A white paste will be left. Dry this in the sun and you will have a good grade of corn starch.

EXPERIMENT 446—Manufacture of potato starch

Obtain quite a large potato and by scraping reduce it to pulp. Mix this pulp with an equal amount of water and then squeeze through a cotton cloth (linen is also good). Repeat the squeezing operation several times until the pulp is quite free of all water. The pulp (which we can now call cellulose) remains on the cloth and the starch and water goes through into a container. Allow the solution of water-starch to set for some time and then pour the water off. The white compound in the bottom of the container is potato starch. By drying this starch of all water a good quality dry starch will be obtained.

EXPERIMENT 447—Changing starch into sugar in the body

The starch in foods we eat is converted into sugars in the body during digestion by the action of acids contained in the stomach and in the saliva.

Make a little starch paste by mixing one measure of starch in a test tube with eight or 10 drops of water. Fill the test tube half full of hot water and boil the mixture for several minutes. Now to the warm starch paste add a test tube one-quarter full of saliva from the mouth. Shake the contents of the tube and allow the test tube to stand in a warm place, preferably on the back of the stove for a half hour.

Test a few drops of this mixture from time to time in a test tube by adding one measure of tartaric acid and one measure of bleaching powder and two or three drops of sodium iodide solution. When you fail to get the blue color, the starch is all converted into glucose.

In the United States most of the granulated sugar or sucrose is obtained from the sugar cane which is imported into this country from Cuba. Most of the sugar in Europe, on the other hand, is obtained from the sugar beet.

The process of refining or obtaining sugar from these substances is rather simple. These substances are first cut up and moistened with water. They are then passed through heavy rollers which squeeze out all the soluble juice. These juices are then filtered to remove any fibrous material, after which they are treated with dry slaked lime which neutralizes the acids contained in the juices and precipitates impurities such as albumens. The mixture is then filtered and the juice concentrated or evaporated

in large vacuum evaporators to a heavy syrup. It is then allowed to stand until the sugar crystallizes out. This is removed and after further purification is ready for the market. The liquid remaining contains much sugar in solution and is usually very dark. This is sold on the market as molasses.

EXPERIMENT 448—Sugar as a reducing agent

Put two measures of sodium carbonate and two measures of calcium oxide in a test tube one-third full of water. Shake thoroughly and warm for a few minutes over a flame. Now filter off the precipitate of calcium carbonate which is formed in the reaction, catching the sodium hydroxide solution in another test tube.

Now to the test tube containing the sodium hydroxide solution add one-half measure of copper sulphate and shake thoroughly. This gives a green precipitate of copper hydroxide.

To this test tube containing copper hydroxide and sodium hydroxide add eight or ten drops of corn syrup or honey and heat the solution nearly to boiling. Notice that the solution turns brown and a red precipitate forms on the bottom of the test tube. This precipitate is cuprous oxide.

The corn syrup contains a sugar dextrose which reduces the copper hydroxide to cuprous oxide and water. Several of the sugars have this property of reduction and this is due to the aldehyde group (CHO) contained in the sugar molecule.

TESTING FOR PROTEINS

Proteins of which we already have spoken is the class of substances containing nitrogen, such as lean meat, the whites or albumen of eggs, the albumen and casein of milk and that part of dry vegetables which is not carbohydrate, oil or mineral matter. Let us examine a few of these substances for proteins. When proteins are treated with a base, or alkali, the nitrogen is given off in the form of ammonia.

EXPERIMENT 449—How to test for proteins in eggs

Put half a spoonful of the white of an egg in a test tube, add 2 measures of calcium oxide and 3 or 4 drops of water. Warm the test tube over a flame for a few minutes then remove the test tube from the flame and smell at the mouth of the tube. Do you recognize the odor of ammonia? Hold a piece of moistened red litmus paper over the mouth of the tube and notice that it turns blue.

EXPERIMENT 450—How to test for proteins in milk

Put five or six drops of milk in a test tube, add one measure of calcium oxide and warm the test tube over a flame. Remove the test tube from the flame and smell at the mouth of the tube. Notice the odor of ammonia.

EXPERIMENT 451—How to test for proteins in meat

Put a piece of lean meat about the size of a pea in a test tube, add one measure of calcium oxide and 3 or four drops of water. Warm the test tube over a flame for a few moments. Remove the test tube from the flame and smell at the mouth of the tube. Do you recognize the odor of ammonia? Potato, although a vegetable, contains a certain amount of protein.

EXPERIMENT 452—How to test for proteins in beans

Crush two beans in small pieces and place them in a test tube. Add one measure of calcium oxide and four or five drops of water. Warm the test tube over a flame for a few moments. Remove the test tube from the flame and smell at the mouth of the tube. Do you recognize the odor of ammonia?

Beans contain about 22 per cent protein material.

EXPERIMENT 453—Testing for sulphur in proteins

Put a half spoonful of the white of an egg into a test tube and add one measure of copper sulphate and two measures of calcium oxide. Heat the test tube over a flame and allow the mixture to boil for two or three minutes. Notice the black precipitate of copper sulphide which is formed, showing that proteins contain sulphur.

BREAD MAKING AND BAKING POWDER

In making bread, baking powder is thoroughly mixed with the dry flour. Water is then added, the flour is kneaded into a dough and put in a warm place to rise. Heat nearly always hastens a chemical reaction; that is why dough rises quicker in a warm place than in a cool place.

The moisture plus the tartaric acid act upon the sodium bicarbonate and start the formation of carbon dioxide. Soon the dough begins to rise, due to the gas being liberated. The powder has been distributed through the mass, so that a million gas bubbles are formed which puff out the dough, making it porous. During the process of baking, the gas and the remaining constituents of the baking powder are converted into harmless substances. Most of the carbonates are insoluble compounds and can therefore be precipitated from solutions of their soluble salts by carbon dioxide or a soluble carbonate. Some of these insoluble carbonates are beautifully colored and make very interesting experiments.

EXPERIMENT 454—How to make baking powder

Put two measures of sodium bicarbonate and two measures of tartaric acid into a test tube. Mix thoroughly by closing the mouth of the tube with your thumb and shaking back and forth. Notice that nothing happens. Now add a half test tube full of water and notice the sudden reaction. These are the two active constituents of baking powder. The gas liberated is carbon dioxide.

Baking powder is composed of two or sometimes more chemicals which, when dry, are not active. When water or moisture is applied the tartaric acid and sodium bicarbonate are put into forms whereby they react readily upon each other, the sodium bicarbonate giving up its carbon dioxide. This gas is the same as that formed in the lungs or in soda water.

Baking powders found on the market are of three kinds, named from the kind of acid salt used. For example, tartrate powders have tartaric acid or acid potassium tartrate (cream of tartar); phosphate powders have an acid phosphate such as lime- or potassium; and alum powders have as an acid aluminum sulphate.

The reactions which take place in these different baking powders may be expressed as follows:

1. Acid potassium tartrate + sodium bicarbonate = carbon dioxide + sodium potassium tartrate (Rochelle Salts).
2. Acid potassium phosphate + sodium bicarbonate = carbon dioxide + sodium potassium phosphate.
3. Aluminum sulphate + sodium bicarbonate = carbon dioxide + aluminum hydroxide + sodium sulphate (Glauber's Salt).

EXPERIMENT 455—How to test for starch in baking powder

Put one measure of baking powder in a test tube one-half full of water and heat the solution to boiling. Allow the solution to cool, then add one or two drops of iodine solution. Notice the formation of a blue color, showing that baking powder contains starch.

Starch is put into baking powder for the purpose of taking up moisture, thereby preventing the acid salt in the baking powder from reacting with the sodium bicarbonate.

EXPERIMENT 456—How to test for alum in baking powder

Make a solution of logwood by putting one measure of logwood in a test tube half full of water and heating the solution to boiling. Allow the liquid to cool, then pour the clear red liquid into another test tube.

Put three measures of baking powder in a test tube half full of water and add one-half measure of tartaric acid. Notice the violent effervescence due to the liberation of carbon dioxide gas. When the reaction has stopped add two or three drops of the red logwood solution. If the solution turns reddish-blue, alum is present in the baking powder. Apply this same test for detection of alum in bread, biscuits, doughnuts and loaf cake.

EXPERIMENT 457—How to test for copper sulphate in bread

Dissolve one-third measure of tartaric acid and one measure of sodium ferrocyanide in a test tube half full of water. Then put into the test tube three or four pieces of bread to be tested and allow the bread to stand in this solution for one or two hours. If the solution becomes reddish-brown the bread contains copper sulphate.

Copper sulphate is very seldom used as an adulterant in bread.

TESTING MILK

EXPERIMENT 458—How to test for coloring matter in milk

Put one measure of sodium bicarbonate in a test tube one-third full of milk, and, putting the thumb over the mouth of the test tube, shake the contents of the tube thoroughly.

Now place a piece of filter paper in this solution and allow the paper to remain in this solution for 10 to 12 hours. At the end of this time remove the paper and examine it. If it is colored a reddish yellow the milk contains some artificial coloring matter.

EXPERIMENT 459—How to test for starch in milk

Heat a half test tube full of milk to boiling and allow the test tube to cool. Then add one or two drops of iodine solution. If the milk turns blue, it contains starch.

EXPERIMENT 460—How to test butter

Place a small piece of butter about the size of a pea in your spoon and heat it slowly over a flame. If the butter foams and froths on boiling the butter is fresh. On the other hand, if it sputters or pops it is either oleomargarine or renovated butter.

Another test that may be applied to butter to show whether it is adulterated is as follows:

Heat a half cupful of milk until it is very hot. Then put into the milk a piece of butter about a half inch square to be tested and stir until it is all melted. Now place the cup in a pan of cold water containing a little ice and stir the milk continually until the milk becomes cold and the butter solidifies. If the butter is pure or renovated it will solidify into small particles throughout the milk. If it is oleomargarine it will solidify into one solid cake.

Pure fresh butter contains water and butter fat. Butter fat consists principally of the fats olein, palmitin and stearin. The flavor of the butter is due to the presence of a small amount of butyric acid and glycerine.

Oleomargarine is made from the fat of cattle and hogs, together with small amounts of cotton seed oil and milk or butter. The milk or butter is added to furnish enough butyric to give the butter flavor.

Renovated butter is stale or rancid butter made over by chemical treatment.

EXPERIMENT 461—How to make casein

Put three measures of sodium bisulphate in a test tube one-third full of water and shake until it dissolves. Now add a few drops at a time with constant shaking some of this solution to a half test tube full of milk. Notice that suddenly a white curdy precipitate is formed. This precipitate is casein. This is the same precipitate that is formed when milk turns sour or curdles. The souring of milk is brought about by the formation of lactic acid, due to the fermentation of the milk.

Casein besides being used as a food in cheese has many other important uses today. It is used in the manufacture of adhesives, paints, in dyeing, in medicine, as electrical insulators and in making plastic masses as in stoneware, toys, etc. In the manufacture of these things the casein is put through a certain chemical treatment.

SOAP

Most of us are familiar with soap and its cleansing properties, but how few of us understand the chemistry of soap making and the part soap plays in cleansing. Soap was made in early history by treating fat with the lye obtained by extracting wood ashes with water and lime. What really happens when ashes are treated in this way is that potassium carbonate which occurs in wood ashes is dissolved by the water. This water solution of potassium carbonate then reacts with the lime or calcium oxide to form an insoluble compound of calcium carbonate and a soluble compound of caustic potash, potassium hydroxide or lye as it is commonly called. Fats or grease, which are compounds of glycerine with fatty acids, are then boiled with the proper proportion of lye. During the reaction the glycerine of the fat is set free and a compound of the fatty acid with the lye is formed, which is the soap.

If too much alkali is used in making a soap, the soap will contain free alkali which is bad. If not enough alkali is used the soap will be greasy which is also bad. It is up to the chemist in the soap factory to determine exactly what the suitable proportions are for every sample of soap to be made. In making fine soaps, such as Castile soap and the high grade toilet soaps, olive oil is used instead of common fats and in the manufacture of many soaps, perfumes and coloring matters are mixed with the other materials. Ordinary white soaps are made from cotton seed oil. Cheap laundry soaps are made from impure fats obtained from kitchen grease, bones, etc. Glycerine soaps are made by melting hard soap and adding an equal amount of glycerine.

The difference between hard and soft soaps is due to the materials contained in them. Soaps made from caustic potash, or potassium soaps, are soft, while those made from caustic soda, or sodium soaps, are hard.

In making hard soap, caustic soda and fat are boiled together and when the contents of the vessel are thoroughly united a strong solution of sodium chloride or common salt is added and the mixture heated again. The heating is then stopped and the contents allowed to stand for several hours. During this time the contents of the vessel separate into two portions, the lower one consisting of glycerine, salt and all impurities and the upper one of soap. The glycerine is separated from the water and is used in medicine and in the manufacture of high explosives such as nitroglycerine and dynamite.

Did you ever stop to think what happens when you wash your hands with soap?

The soap removes grease or oil from your hands by breaking it up into tiny droplets that are washed away by the water. In other words, when you produce a lather on the hands with soap you emulsify the oil or grease and in this condition it is easily removed.

EXPERIMENT 462—Making soap

Make a solution of caustic soda or lye by putting three measures of sodium carbonate and four measures of calcium oxide into a test tube half full of water and boil for two or three minutes. Allow the tube to cool and when the liquid has settled pour the clear liquid into another test tube. Now add a piece of lard or butter about the size of a marble and boil the liquid again for a few minutes, being careful that the liquid does not bump out of the test tube. You can prevent this by shaking the tube in the flame while heating. Notice that the lard or butter dissolves very readily in the hot alkali. Now add three measures of common salt and heat the mixture again for two or three minutes. Allow the contents of the tube to cool and notice that the soap separates out as the upper layer. The liquid layer below contains glycerine, salt and impurities. Try washing your hands with the soap you have made.

EXPERIMENT 463—Why soap cleanses

Put a little kerosene oil into a test tube one-third full of water and shake the contents of the tube. Notice that the oil has been broken up into minute droplets. Allow the tube to stand and now notice that the oil runs together and rises to the top of the water.

Repeat this experiment, using the white of an egg in place of the water. Notice that this time the oil is broken up into minute droplets as before, but remains in this condition and does not run together and rise to the top of the water. This forms what is called an emulsion, the oil being emulsified.

Repeat this experiment, using a soap solution in place of the white of an egg and convince yourself that the soap forms a true emulsion with the oil. It is due to this fact that oil, grease and dirt are easily removed from the hands when washed with soap.

EXPERIMENT 464—Making liquid soap

Put a piece of toilet soap about the size of a marble in a test tube and add twice the amount of glycerine. Heat the test tube over a flame until the mixture is all melted together. When this mixture is melted together pour the contents of the test tube into a small bottle and fill the bottle with water. This will give you a liquid soap which can be used on the hands the same as ordinary soap.

EXPERIMENT 465—Chemical films and bubbles

Many times you will have the occasion to use films or bubbles in your laboratory. You may desire to fill a soap bubble with hydrogen gas. You may wish to use films of soap for refraction experiments. The common soap bubble will not stand up well, so below we are giving a formula of a soap that will give a good bubble and that will stand up well.

Pure Castile Soap	1 oz.
(Palm-Oil soap is also good)	
Distilled Water	8 oz.
Pure Glycerine	4 oz.

Cut the soap into thin shavings. Dissolve in the water. When the solution is complete as possible, add the glycerine and stir well. On standing, the mixture becomes clear at the bottom. The clear portion is removed and used.

DETERGENTS

Ordinary soap is a detergent and is made by the action of alkali on fats. During the World War several of the countries of Europe, especially Germany, were cut off from the outside world and as a result, fats became so scarce that they could not be used for making soap. This shortage stimulated a search for other kinds of detergent agents. This led to the discovery of a new type of valuable washing agents. These are designated by the class name "Hymolal Salts," and are alkali salts of sulfated alcohols of high molecular weight. The organic chemist prepares his higher alcohols by application of catalytic hydrogenation to higher fatty acids which are widely distributed in nature. Lauric acid, for example, which is obtained commercially from coconut oil, gives on reduction lauryl alcohol. Sulfation of this alcohol gives lauryl sulphuric acid, and when this last acid is neutralized with alkali a practical detergent is formed (sodium lauryl sulphate.) These salts are more powerful sudsing agents than the ordinary soaps, they are not affected by hard water, and can be used in both acid and alkaline solutions. The hymolal salts are manufactured in the form of powders, flakes, bars and liquids. These detergents are being introduced to the trade in this country by the Proctor and Gamble Company of Cincinnati, Ohio. The greatest advantage for these detergents over soaps is that they are affected very little by the hardness of water.

SOLVING THE HARD WATER PROBLEM IN THE KITCHEN, LAUNDRY AND BATHROOM

EXPERIMENT 466—Action of ordinary soap on hard water

Place some very hard water in a basin and try to make a good washing solution by sudsing with some of your mother's kitchen soap. Note that a large portion of your dissolved soap is used up by the hard water and is turned into insoluble calcium and magnesium soap. These insoluble metallic soaps are sticky and heavy and settle on clothes, your face and hands, in your hair, and on the surface of your wash bowl and bathtub. They cannot be removed by rinsing.

EXPERIMENT 467—Action of ordinary soap on sea water

Secure a bottle of salt water at the sea shore and shake with some ordinary soap. Note the result.

EXPERIMENT 468—Soap in acid solutions

Prepare a dilute solution of hydrochloric acid as directed in a previous experiment and treat this acid solution with some ordinary soap. Note the result.

EXPERIMENT 469—Treating hard water with a hymolal salt

Repeat experiment 468 and treat your hard water with a hymolal salt detergent.

EXPERIMENT 470—Treating sea water with a hymolal salt

Repeat experiment 468 and treat sea water with a hymolal salt detergent. Note the difference in behavior.

EXPERIMENT 471—Action of hydrochloric acid solution on soap

Mix a hymolal salt detergent solution with dilute hydrochloric acid solution. Compare with the results obtained with soap under the same conditions.

EXPERIMENT 472—Action of calcium chloride solution on soap

Dissolve some calcium chloride in water and then try to dissolve some common soap in the solution. Note the formation of an insoluble calcium soap.

EXPERIMENT 473—Action of calcium chloride on a hymolal salt

Repeat the previous experiment, but instead of using soap, stir into the calcium chloride solution a hymolal salt. Note the difference in behavior.

EXPERIMENT 474—Action of barium chloride on a hymolal salt

Repeat experiment 473 using barium chloride.

EXPERIMENT 475—Action of strontium chloride on a hymolal salt

Repeat experiment 473 using strontium chloride.

ALKALINE DETERGENTS AND THEIR BEHAVIOR TOWARDS METALS

Alkaline detergents are used commercially for cleaning metal surfaces. Chemicals which find wide use for this purpose are sodium hydroxide, sodium carbonate, trisodium phosphate, sodium stearate and sodium metasilicate. A very interesting and instructive series of experiments can be carried out with these salts as follows: Perform a series of immersion treatment tests with the following metals in sheet form, namely, tin, aluminum, zinc and copper.

IMMERSION TESTS

EXPERIMENTAL PROCEDURE 476—Immersion test with metal strip

Suspend a small sheet of the metal strip in a one to two per cent solution of the different detergents mentioned above and let the metal remain in contact with the detergent solution for four to five hours at ordinary temperature. The strip of metal should be weighed before and after immersion. These experiments will offer an opportunity of using your gravimetric balance and weights. Note the loss or increase in weight of each strip.

EXPERIMENT 477—Tin and sodium hydroxide

Tin and sodium hydroxide.

EXPERIMENT 478—Tin and sodium carbonate

Tin and sodium carbonate.

EXPERIMENT 479—Tin and trisodium phosphate

Tin and trisodium phosphate.

EXPERIMENT 480—Tin and sodium silicate

Tin and sodium silicate. Strips of tin may be cut from a clean tomato can. Strips of metal two inches by one-half inch are large enough for experimental purposes.

EXPERIMENT 481—Copper sheet

Apply the same series of four experiments using thin copper sheet.

EXPERIMENT 482—Zinc sheet

Apply the same series of four experiments using zinc sheet.

EXPERIMENT 483—Sheet aluminum

Apply the same series of four experiments using sheet aluminum. Observe which one of the different metals dissolves in any of the detergent solutions. Also observe whether gas bubbles are generated. If gas is generated try to identify it.

GUMS, ADHESIVES AND GLUES

Gum arabic, a natural occurring substance, is the essential constituent in the manufacture of gums and adhesive for envelopes and stamps. However, a very good substitute known as dextrin or British gum is now made in large quantities both in this country and in Europe by heating starch and subjecting it to the proper treatment.

Glues are manufactured by boiling with water properly prepared animal matter, such as skins, bones and fish stock, and drying the solution.

A very good household cement for mending crockery, glass, etc., can be made by using water glass or sodium silicate as the binding agent.

EXPERIMENT 484—How to cement broken glass

By means of a small camel's hair brush, paint the broken surfaces of the glass with water glass. After the water glass starts to harden, which will require a few minutes, press the two broken surfaces together and allow the glass to remain this way for a day or two. If on pressing the two surfaces together a little of the water glass squeezes out, rub this off with a damp cloth. Notice after a day or two that the pieces are held very firmly together. Glass mended with water glass will not hold together in contact with water, since water glass is soluble in water.

EXPERIMENT 485—How to mend broken china or porcelain

Make a paste by putting a half spoonful of water glass and six measures of calcium carbonate in a mortar or cup and mixing with a pestle or spoon. Now mend the pieces of china or porcelain by painting with a brush the broken surfaces with this paste. This paste when dry is white and resembles exactly the color of the china or porcelain.

EXPERIMENT 486—How to mend black crockery

To cement together pieces of black chinaware or porcelain make a paste, using a half spoonful of water glass and six measures of manganese dioxide. Then mend the broken pieces together, using this cement the same way as described in the previous experiment.

EXPERIMENT 487—How to mend blue chinaware

To mend broken pieces of blue chinaware make a paste, using one-half teaspoonful of water glass, four measures of sodium ferrocyanide and two measures of ferric ammonium sulphate. Then proceed exactly as before in applying the cement. The blue color is formed by the action of sodium ferrocyanide on ferric ammonium sulphate.

How could you make a red cement, a brown cement, or a green cement?

EXPERIMENT 488—Another household cement

A very good cement for mending chinaware may be made by making a paste, using a half teaspoonful of the white of a fresh egg and six measures of calcium carbonate. To mend pieces of broken china with this paste brush some of it on the broken surfaces of the china and quickly press the broken edges together and allow the mended pieces to stand for a day or two.