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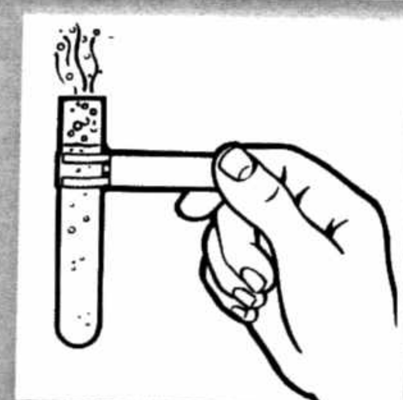
IDEAL®

CHEMCRAFT®

Chemistry Set

400 EXPERIMENTS



WARNING: THIS SET CONTAINS CHEMICALS THAT MAY BE HARMFUL IF MISUSED. READ CAUTIONS ON INDIVIDUAL CONTAINERS CAREFULLY. NOT TO BE USED BY CHILDREN EXCEPT UNDER ADULT SUPERVISION.

NOTES TO PARENTS

This Ideal® CHEMCRAFT Chemistry Set has been designed to provide your children with hours upon hours of fun, stimulation and enrichment when used in the proper manner. It is intended for use by those who are able to read, understand and follow directions. As such, every effort has been made to ensure that instructions are clear and easy to follow.

To ensure maximum enjoyment and safety, it is vital that you understand and adhere to the simple guidelines pointed out in this manual and, where appropriate, explain them to your children before beginning experimentation.

We suggest that you carefully read the introductory sections of the manual and the overviews of each chapter, and acquaint yourself with the procedures used. Because of the nature of these experiments, this set is to be used with adult supervision.

SAFETY FIRST

As with all scientific experimentation, safety in all procedures is of paramount importance:

- In carrying out your experiments, do not use or combine any chemicals, substances or materials not contained in this chemistry set unless specifically instructed to do so.
- When using this set, only those experiments included in this manual should be attempted.
- Chemicals should only be used in the quantities and mixed in the proportions mentioned in this manual.
- All used chemicals or any chemicals spilled or contaminated should be disposed of quickly and properly.
- Chemicals are carefully labeled. If an accident or mishap occurs, follow the indications printed on the labels. Contact a physician or seek appropriate medical aid immediately.
- All equipment should be kept clean and well maintained at all times, even when not in use.
- **CAUTION:** As you carry out your experiments you will be creating many observable chemical changes. Color, texture and smells will change. Always observe these changes from a safe distance. **Do not put your eyes, nose or mouth near the spoon or the opening of a test tube.** Holding your test tube or spoon at a normal distance—half an arm's length away from you—should be close enough for all observation or smelling required.
- Whenever an experiment calls for blowing air into a solution, use an ordinary drinking straw. Before putting your lips to the straw, take in a deep breath then blow gently with the opposite end of the straw immersed in the solution. **CAUTION: Never inhale with straw in mouth.**

Note: Do not, under any circumstances, use chemicals other than those contained in this set or specifically called for in an experiment, nor in quantities other than those specified.

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PART I: THE BASICS OF CHEMISTRY

CHAPTER 1 - BEFORE YOU START

Proper Laboratory Procedures

What is a chemistry set? Why, it's your own mini-laboratory, a place to perform experiments and learn while you have fun. **But remember, a chemistry set is not a toy.** Just like actual scientists, you're working with real lab equipment and real chemicals. To gain the most enjoyment from your experiments, take some time now to familiarize yourself with the components of your CHEMCRAFT set and be sure to observe these important laboratory procedures:

A. Prepare a work area. Set up a table where you will not be in the way of other members of your family. Spread old newspapers or cloth over your work surface to prevent stains.

B. Be organized. Before starting an experiment, set aside the chemicals and equipment you will need so that they are within easy reach.

C. Protect yourself. Wear an apron or smock while performing your experiments. And be careful not to let jewelry or hair get in the way. Safety glasses are recommended to protect your eyes.

D. Read first. Read through the entire experiment before starting and be sure to follow instructions carefully.

E. Be considerate. Some experiments call for the use of household objects like spoons, glasses and jars. Always ask permission and try to use objects that are no longer needed by other members of your family. Also, keep these and all chemicals and equipment out of the reach of younger children and pets.

F. Be careful. Try not to allow chemicals to touch your skin. Never put your fingers in your mouth or rub your eyes after handling chemicals. Wash your hands immediately after each experiment.

G. Neatness counts. Clean up your work area as you go. Put caps back on chemical containers as you use them. Also, dispose of chemicals immediately after each experiment unless instructed by the manual to save your results for a future experiment. Chemicals should be disposed of in a toilet and flushed immediately.

H. Wash your glassware. Test tubes should be washed with a detergent and rinsed several times in hot and cold water after each use. A test tube brush may be used if available. Allow glassware to air-dry. **Never** wipe it dry with a cloth or paper towel.

Laboratory Equipment

Knowing how to properly use and care for your laboratory equipment is the first step to hours of chemistry fun!

Test Tubes

Test tubes are made of hard, thin glass specially prepared to withstand heating. When heating test tubes, **always use your test tube holder** and **never** let a hot test tube come into contact with cold water. Otherwise, shattering may result.

Any cracked or chipped test tubes (or glassware) should be discarded immediately. Glass that has been cracked even slightly could be the cause of a serious accident.

Glassware

Where other types of glassware are called for, you may often use the tumblers included in this set or ask your parents for old drinking glasses or glass jars. Glassware used for experiments **should never** be used for eating or drinking.

Test Papers

Litmus paper is a chemical indicator used to test for an acid or a base (Chapter 2). Blue litmus paper turns red in the presence of an acid, but remains blue in a neutral solution. Red litmus turns blue with a base and stays red when exposed to a neutral solution.

Cut your test papers into small strips before starting your experiments.

Measuring Liquids

Use an eyedropper or your glass tube to measure liquids. Place the tube into a liquid. When liquid fills the tube, place your index finger over the top of the tube and take the tube out of the liquid. To drop the liquid, release your finger just long enough to let a drop of liquid fall. Practice filling a test tube with water drop by drop to various levels and record your results here to aid in your experiments.

Test tube is 1/5 full with _____ drops.   Test tube is 1/3 full with _____ drops.
Test tube is 1/4 full with _____ drops.   Test tube is 1/2 full with _____ drops.

Measuring Solids

Included in your set is a special spoon called a **measure.** The instruction "Add 1 measure of a chemical" means just a little bit more than full, as shown.

not like this...

Heat Sources: The Alcohol Lamp and Candle

Many experiments call for the addition of heat. You may do so with either a candle or alcohol lamp. Adult supervision is recommended when using any heat source and care should be taken to avoid loose fitting clothing when working with flame.

Always use **safety matches** when experiments call for lighting a heat source. Wooden household matches are recommended.

If you use a candle, light it and drip some wax into a shallow metal pan and, before the wax hardens, place the base of the candle into the wax to make it stand securely. Then add a little water to the pan.

If you use an alcohol lamp, refer to the following illustrations to assemble your lamp.

Slide down the casing of the wick and cut the wick fibers with a scissor (see fig. 1). Pull the casing up again and twist it to a point. Then pull the pointed end up through the hole of the cap, as shown.

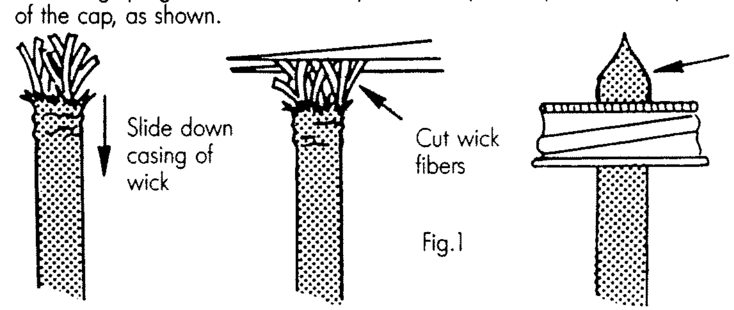


Fig. 1

Trim the wick to a dome shape and remove all frayed and ragged strands. Keep the tip trimmed and at a height of about 1/4" for an even flame.

Fill the lamp using only **denatured ethyl alcohol** (grain alcohol) for fuel. **Read all directions and cautions on its container and handle carefully—it is highly flammable. Do not drink.**

Never use methyl alcohol—it is highly toxic. Also, rubbing alcohol (isopropyl alcohol) does not work well and is not recommended.

Do not fill the lamp near an open flame.

Fill the lamp with alcohol to just below the bottle neck (see fig. 2) and screw cap on tightly. Be sure to close supply container and store it in a safe place away from your work area.

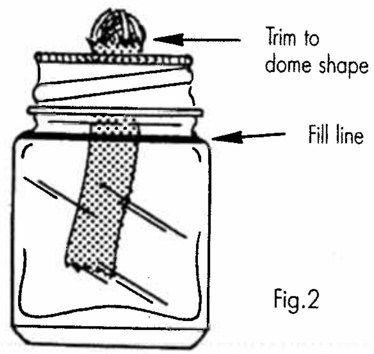


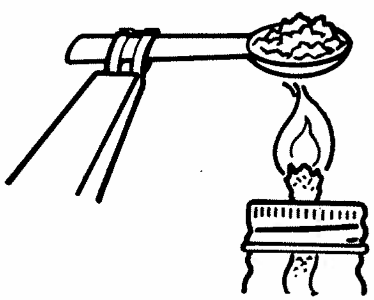
Fig. 2

After filling the lamp, wash your hands thoroughly to remove any alcohol. Before lighting, place the lamp in a shallow metal pan filled with water.

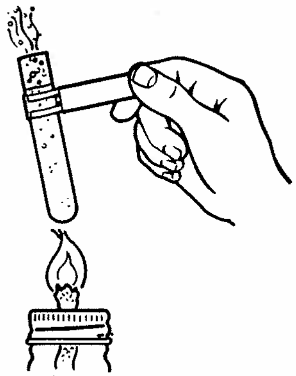
Never leave the lighted flame unattended and put out the flame as soon as you are finished using it. Before putting your chemistry set away, allow the lamp to cool to room temperature. For added safety, always pour the remaining contents of the lamp back into the original container after each use.

Heating Solids & Liquids

Solids are heated over a flame in your spoon. Use your test tube holder to hold the spoon in the flame.



Liquids are heated in test tubes held with a test tube holder over either a lit candle or alcohol lamp.



Always heat liquids carefully, not too deep into the flame and with the mouth of the test tube **pointing away** from you and everyone else in the room. Liquids sometimes spurt when heated. Also, gently shake the tube in a circular motion as you heat it.

Caution: Never put a cork **without a hole** in a test tube while heating it or while performing an experiment which produces a gas.

Follow heating instructions carefully. The very tip of the flame is the coolest part, so if an experiment calls for slow heating, you should place the bottom of the test tube or spoon at the tip of the flame. If you require intense heat, place the bottom of the tube or spoon further into the flame until you have achieved the result indicated in the experiment directions.

Stirring Solutions

To stir solutions use a glass tube.

Caution: When mixing chemicals over a flame, **never** use anything that can melt, such as a plastic straw, to stir your solution.

The Component Rack

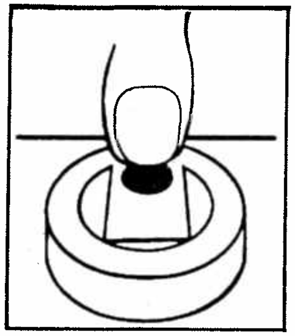
The component rack included in your set is perfect for temporary storage of test tubes as you are performing experiments, especially when you have to wait a while for precipitates to form, colors to change or for other signs of reactions taking place to appear. The larger center hole is where to store an **unlit** candle.

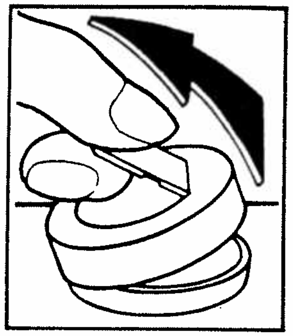
To prevent accidental melting, **never** put very hot test tubes in your component rack. Hold the test tube with your test tube holder until it cools. This takes only a few minutes.

Chemical Containers

Little brothers and sisters are curious and love to explore anything they can get their hands on. One of the first steps in setting up your laboratory should be to keep all chemicals and supplies organized by cleaning up and putting away all of your equipment after experiments are completed for the day.

However, youngsters have a way of getting into things. That's why all of the carefully-labeled Chemcraft containers feature safety-sealed caps. These caps provide extra protection against "unauthorized experiments" by little ones. Follow these instructions to make certain the caps are securely replaced on all chemical containers **immediately** after every use.





TO OPEN:
1. PRESS DOT WITH FINGERNAIL OR TIP OF PEN TO "POP" LOCK.

2. FIRMLY PULL TAB UP TO LIFT CAP.

TO CLOSE:
1. SECURELY SNAP CAP ON CONTAINER.
2. FIRMLY PUSH DOWN TAB TO LOCK.

Common Chemicals and Their Household Substitutes

(If an experiment should call for the use of one of these chemicals, you may substitute the household item listed.)

Acetic Acid	White Vinegar
Acetone	Nail Polish Remover
Ammonium Hydroxide	Household Ammonia
Calcium Carbonate	Chalk or Limestone
Calcium Hydroxide Solution	Limewater
Calcium Sulfate	Gypsum or Plaster of Paris
Carbon	Charcoal or Graphite
Copper Sulfate	Blue Vitriol
Ethyl Alcohol	Grain Alcohol
Fructose	Sugar
Glucose	Table Syrup or Sugar
Magnesium Hydroxide	Milk of Magnesia
Magnesium Sulfate	Epsom Salts
Naphthalene	Mothballs
Potassium Aluminum Sulfate	Alum
Potassium Carbonate	Potash
Silicon Dioxide	Quartz or Sand
Sodium Bicarbonate	Baking Soda
Sodium Borate	Borax
Sodium Carbonate	Washing Soda
Sodium Chloride	Table Salt
Sodium Silicate Solution	Water Glass
Sucrose	Sugar
Tannic Acid	Found in Instant Tea
Trisodium Phosphate (TSP)	Found in Water Softener

Sources of Materials to be Used in Experiments

Grocery Store

Acetic Acid (White Vinegar)
Ammonium Hydroxide (Ammonia)
Bean Seeds
Bleach
Borax
Candles
Coffee Filters
Cornstarch
Cream of Tartar
Distilled Water
Food Coloring
Instant Tea
Paraffin
Plastic Wrap
Safety Matches
Soda Straws
Sodium Bicarbonate (Baking Soda)
Sodium Carbonate (Washing Soda)
Sodium Chloride (Salt)
Steel Wool
Yeast

Drugstore

Alcohol (Denatured and Rubbing)
Antacid Tablets
Baby Powder
Boric Acid
Camphor
Castor Oil
Cotton
Dye
Emery Board
Hydrogen Peroxide
Mineral Oil
Mothballs
Nail Polish Remover
Oil of Wintergreen
Petroleum Jelly
Powdered Lycopodium
Safety Matches
Sodium Thiosulfate ("Hypo")
Talcum Powder
Thermometer
Tincture of Iodine

Hardware Store

Batteries
Candles
Charcoal
Fertilizer
Funnel
Glass Tube
Spray Bottle
Insulating Tape
Lubricating Oil
Magnets
Microscope Slides
Nails
Paint Thinner
Panes of Glass
Paste Wax
Plaster of Paris
Plastic Tubing
Quartz
Sandpaper
Steel Wool
Wire Screen

Florist or Garden Shop

Flowers
Flowerpots
Liquid Plant Food
Potting Soil
Plant Bed
Plastic Tubing
Sand

Stationery or Art Supply Store

Brushes
Cellophane Tape
Chalk
Clay
Colored Filters
Crepe Paper
Glue
Gum Arabic
Ink
Mucilage
Paper
Paper Clips
Rubber Bands
Watercolors

CHAPTER 2 - WHAT ARE ACIDS, BASES & SALTS?

Three of the most common compounds used by chemists and formed in chemical experiments are acids, bases and salts. Each compound has its own unique "properties," or ways of reacting with other chemicals.

In general, an acid is a compound that contains more hydrogen ions (positively charged hydrogen atoms) than hydroxide ions (negatively charged hydroxide molecules); a base is a compound that contains more hydroxide ions than hydrogen ions.

In foods, acids are responsible for sour taste, while bases are responsible for bitter, or alkaline, taste. When equal numbers of acid and base molecules react, water and salt are formed. The type of salt formed depends on the particular acid and base.

Experiments 1-55

Objective: To test for the presence of acids and bases by using common acid-base indicators
Materials: Test Tubes ■ Measure ■ Eyedropper ■ Red Litmus Paper ■ Blue Litmus Paper
Chemicals: Phenolphthalein Solution ■ Water ■ Ammonium Hydroxide (household ammonia) ■ Calcium Hydroxide ■ Acetic Acid (vinegar) ■ Sodium Bisulfate ■ Ammonium Chloride ■ Sodium Carbonate ■ Sodium Borate (borax)
Procedure: Litmus paper is a common acid-base indicator. Red litmus paper turns blue with a base and remains red with an acid or neutral chemical. Blue litmus paper turns red with an acid and stays blue with a base or neutral chemical. Therefore, when testing an unknown chemical it is best to use both red and blue litmus paper.

For each experiment, fill a test tube 1/4 full of water and mix in a few drops or a measure of the listed material. Then test with red litmus paper and record the results.

Experiment	Chemical	Color Change	Acid/Base?
1	ammonium hydroxide (ammonia)		
2	calcium hydroxide		
3	water		

For the following experiments, use blue litmus paper instead of red.

Experiment	Chemical	Color Change	Acid/Base?
4	acetic acid (vinegar)		
5	water		

Phenolphthalein is a chemical that turns pink with a base. For each of the following experiments, fill a test tube 1/2 full of water and mix in a few drops or a measure of the listed material. Then test with two drops of phenolphthalein solution and record the results.

Experiment	Chemical	Color Change
6	ammonium hydroxide (ammonia)	
7	sodium carbonate	
8	calcium hydroxide	
9	sodium borate (borax)	

You can test many items around the house to see if they are acids or bases. Try each of these experiments with a solution of the listed material and test with red and blue litmus paper.

Experiment	Item	Litmus	Acid/Base?
10	detergent		
11	soap flakes		
12	tooth paste		
13	milk		

Experiment	Item	Litmus	Acid/Base?
14	cottage cheese		
15	sour cream		
16	orange juice		
17	lime juice		
18	grapefruit juice		
19	tomato juice		
20	lemon juice		
21	apple juice		
22	grape juice		
23	salad dresssing		
24	soft drink		
25	cranberry juice		
26	mustard		
27	ketchup		
28	barbecue sauce		
29	ice cream		
30	mouthwash		
31	yogurt		
32	after-shave		

Now fill a test tube 1/3 full of water, mix in a few drops or a measure of the listed material and test with phenolphthalein solution.

Experiment	Item	Phenolphthalein	Acid/Base?
33	detergent		
34	soap flakes		
35	tooth paste		
36	milk		
37	cottage cheese		
38	sour cream		
39	orange juice		
40	lime juice		
41	grapefruit juice		
42	tomato juice		
43	lemon juice		
44	apple juice		
45	grape juice		
46	salad dressing		
47	soft drink		
48	cranberry juice		
49	mustard		
50	ketchup		
51	barbecue sauce		
52	ice cream		
53	mouthwash		
54	yogurt		
55	after-shave		

Experiments 56-62

Objective: To test common items found around the house for the presence of ammonia
Materials: Test Tubes ■ Test Tube Holder ■ Measure ■ Alcohol Lamp or Candle ■ Red Litmus Paper ■ Glass Tube or Eyedropper ■ All Materials Listed
Chemicals: Water ■ Calcium Hydroxide

Procedure: Ammonia is a very common base found in many items around the house. In its purest form, it has a very characteristic smell. We will use red litmus paper to test for the presence of ammonia.

For each of the following, heat a mixture of two measures of the substance with two measures of calcium hydroxide and five drops of water. Smell the test tube from a distance for ammonia and see if a wet piece of red litmus paper turns blue when placed in each test tube.

Experiment	Material	Ammonia Smell?	Litmus Color?
56	toothpaste		
57	silver polish		
58	mouthwash		
59	dishwashing liquid		
60	shaving cream		
61	shoe polish		
62	shampoo		

Experiments 63-69

Objective: To demonstrate the acidity or alkalinity of certain salts when mixed with water

Materials: Test Tubes ■ Measure ■ Glass Tube or Eyedropper ■ Red Litmus Paper ■ Blue Litmus Paper

Chemicals: Water ■ All Salts Listed Below

Procedure: Salts are formed when acids are added to bases. However, if the acid is stronger than the base, the resulting salt will have acidic properties. Conversely, if the base is stronger than the acid, a basic salt is formed. Such salts are said to be **hydrolyzed** when dissolved in water and **hydrolysis** is the name given to that chemical reaction.

For each experiment, mix 4 to 5 drops or a measure of the listed material in a test tube 1/2 full of water. Then test with red and blue litmus paper. No color change in litmus indicates a neutral solution.

Experiment	Salt	Color Change	Acid/Base?
63	sodium carbonate		
64	sodium borate (borax)		
65	ferric ammonium sulfate		
66	sodium chloride (table salt)		
67	sugar		
68	sodium bicarbonate (baking soda)		
69	sodium ferrocyanide		

Experiments 70-81

Objective: To extract natural acid-base indicators from plant sources

Materials: Test Tubes ■ Glasses ■ Teaspoon ■ Tablespoon ■ Clean White Cloth or Filter Paper (coffee filters) ■ Plant Materials Listed Below

Chemicals: Water ■ Acetic Acid (vinegar) ■ Calcium Hydroxide

Procedure: Many plants and fruits contain pigments of color that will react with acids and bases in very much the same way as litmus paper or phenolphthalein solution. In the following experiments you will extract these color pigments from a variety of natural sources. For each of the following experiments, crush a half glass of the fruit or plant indicated and add an equal amount of hot water to the juice. You may have to let the material soak for at least an hour. Stir each mixture now and then.

Experiment	Material
70	blackberries
71	blueberries
72	black cherries
73	raspberries
74	strawberries
75	red cabbage leaves

Strain each liquid through a clean white cloth or filter paper into a clean glass. Then fill two test tubes 1/2 full with each colored solution. Add a few drops of acetic acid to one and a few drops of calcium hydroxide to the other. Save your indicator liquids to make indicator papers in the following experiemts.

Experiment	Mixture	Acetic Acid Color	Calcium Hydroxide Color
76	blackberries		
77	blueberries		
78	black cherries		
79	raspberries		
80	strawberries		
81	red cabbage leaves		

Experiment 82

Objective: To make acid-base indicator papers from natural sources

Materials: Blotting Paper ■ Envelopes

Chemicals: Natural Indicators (from Ch. 2, Exper. 70-81) ■ Basic and Acidic Solutions (from Ch. 2, Exper. 63-69)

Procedure: Moisten small pieces of thin, white blotting paper with the indicator solutions you have made from previous experiments. Test them after they dry with a drop of a basic solution, then an acidic solution. Put the indicator papers in an envelope with the name of the indicator and the results.

CHAPTER 3 - EVERYDAY USES OF CHEMISTRY

As the following assortment of experiments will show, chemistry can have many practical uses around the house and can be used to learn exciting new things about yourself and the world around you.

During some of these experiments, you will be making chemical solutions to use later on. Be sure to have plenty of clean, dry jars or bottles on hand to save these solutions for future use.

Experiment 1

Objective: To remove ink or rust spots from material
Materials: Lemon Juice ■ Stained Material
Procedure: The acids in lemon juice are very effective stain removers when it comes to ink or iron rust.

Rub some lemon juice onto the spots. If the stains do not disappear quickly, direct sunlight will help.

Experiment 2

Objective: To remove grass stains from material
Materials: Rubbing Alcohol ■ Stained Material
Procedure: Grass stains are considered very difficult to wash out of clothing, especially white jeans. Here's an easy way to get rid of them **before** washing.

Rub some alcohol across the grass stains. Of course, the longer the stain sets, the harder it may be to get out.

Experiment 3

Objective: To make a household window cleaner
Materials: Water ■ Tablespoon ■ 2-Quart Container or Bucket
Chemicals: Sodium Borate (borax)
Procedure: A very effective window cleaner can be made at home with ingredients you probably already have: water and household borax.

Just dissolve 1 tablespoon of borax in 2 quarts of water. Add a wash cloth and you're on your way!

Experiment 4

Objective: To use egg whites to make glue
Materials: Egg White ■ Spoon ■ Paper Cup ■ Measure
Chemicals: Calcium Hydroxide
Procedure: A very good cement to mend broken chinaware can be made from egg white and calcium hydroxide.

In a paper cup, mix 1/2 spoonful of egg white with 6 measures of calcium hydroxide and stir to make a paste. Use the cement as soon as possible as it will begin to harden immediately. Brush the glue on the china pieces and press them together. Allow the pieces to dry for a day or two.

Experiment 5

Objective: To make sweet smelling floral fragrance soap
Materials: Paper Cup ■ Spoon ■ Butter Knife ■ Bar of Plain White Soap ■ Perfume
Procedure: This formula will make a small sample of sweet smelling soap. If you make more, you can press it into any shape you want and let it harden or "set".

With a butter knife, carefully shave a spoonful of soapshavings from a bar of plain white soap. **Be sure to shave the soap in a direction away from you.**

Put the shavings in a paper cup, add three drops of perfume and mix well by kneading with your hand.

Experiment 6

Objective: To make carbon paper from soap
Materials: Test Tubes ■ Paper Cup ■ Bar of Plain White Soap ■ Butter Knife ■ Small Brush or Cotton Ball ■ Sheet of Clean, Unlined Writing Paper ■ Measure
Chemicals: Sodium Ferrocyanide ■ Ferric Ammonium Sulfate
Procedure: Carbon paper is special paper that is used to make copies of what you write—as you write it. It is placed between two sheets of plain paper and copies onto the bottom sheet whatever you write on the top sheet.

To start, use your butter knife to carefully scrape off about 15 measures of soapshavings from a bar of plain white soap. Put the shavings in a paper cup.

Fill a test tube 1/3 full of water. Add a measure of sodium ferrocyanide and a measure of ferric ammonium sulfate and shake.

Pour this blue solution into the paper cup with the soapshavings. Mix to make a smooth paste.

With a small brush or ball of cotton, spread the paste smoothly on one side of a sheet of clean, unlined writing paper. Let the paper dry for a day before using.

When you are ready to use your carbon paper, be sure the blue side is against the paper on which you want to make your copy (the bottom sheet of paper). For best results, use a pencil or ballpoint pen to write.

Experiments 7-9

Objective: To use scientific knowledge and chemical know-how to determine the freshness of eggs
Materials: Light Source (flashlight or candle) ■ 6 to 12 Eggs ■ Measure ■ Measuring Cup ■ Bowl
Chemicals: Water ■ Sodium Chloride (table salt)
Procedure: A number of different methods can be used to determine the freshness of an egg at home. The first method—"candling"—is used on many farms before the eggs are packed in cartons.

Experiment 7

In a darkened room, hold an egg between your eye and an artificial light source, like a flashlight or candle. A fresh egg should appear unclouded, smooth and almost translucent. If dark spots are found, the egg is stale. A rotten egg will appear dark throughout.

Sometimes reddish spots will be seen when "candling" in this manner. These are called "blood spots". While a blood spot does not affect the freshness of an egg, it is not very appealing and eggs that contain them are usually rejected or "culled".

Against the larger end of a fresh egg, between the shell and the inner membrane, a small air cell should be distinctly visible. In an egg which is not perfectly fresh, this space would be filled with egg substance, unless the egg has been stored with the large end up.

Experiment 8

An egg's freshness may also be determined by placing it in salt water or "brine".

Prepare a salt water solution by dissolving 12 spoonfuls of sodium chloride in 2 cups of water. Immerse the egg in the solution. A perfectly fresh egg will sink. If several days old, the egg will swim just below the surface of the water. If the egg is stale, it will float on top of the surface.

Experiment 9

You can also tell if an egg is fresh by shaking it. Hold an egg close to your ear and shake it. The contents of a fresh egg will not move. If the slightest movement can be detected, the egg is somewhat stale. If it rattles, the egg is spoiled.

Open the egg and observe the odor and color. If the egg white and the yolk are not distinct, that is, if there is a tendency for the two to run together, either the egg is not fresh or the hen that laid it has not been properly fed.

Experiment 10

Objective: To see if the baking powder you use contains starch
Materials: Test Tubes ■ Test Tube Holder ■ Alcohol Lamp or Candle ■ Glass Tube or Eyedropper ■ Measure
Chemicals: Water ■ Baking Powder ■ Tincture of Iodine
Procedure: Put a measure of baking powder in a test tube 1/2 full of water and heat the solution to boiling. Allow it to cool and then test with one drop of iodine. A blue color indicates that the baking powder contains starch.

Experiment 11

Objective: To simulate the magnifying power of a lens
Materials: Glass of Water ■ Pencil
Procedure: Dip a pencil or your finger into a glass of water and observe from all sides. Notice that the farther the object is from your eye, the larger it looks. The same phenomenon can be observed when looking at a goldfish in a fish bowl from the top and bottom of the bowl.

Experiment 12

Objective: To use a potato to clean your hands
Materials: A Piece of Raw, Peeled Potato ■ Dirty Hands
Procedure: Hands stained with dirt or vegetable material may be cleaned with a piece of raw, peeled potato. Rub the potato between your hands in very much the same way you would a bar of soap.

Experiment 13

Objective: To make flour paste
Materials: Flour ■ Test Tube Holder ■ Test Tube ■ Measure ■ Candle or Alcohol Lamp ■ Oil of Wintergreen
Chemicals: Water ■ Calcium Chloride
Procedure: Put 8 measures of flour and 2 measures of calcium chloride in a test tube 1/2 full of water. Boil the mixture carefully until it becomes thick and paste-like. Then allow the paste to cool. You can keep this paste from spoiling by adding a drop or two of oil of wintergreen.

Experiment 14

Objective: To make a waterproof glue for mending wood, porcelain and glass
Materials: Test Tube ■ Cup ■ Milk ■ Drinking Glass
Chemicals: Water ■ Sodium Borate (borax)
Procedure: Let a glass 1/2 full of milk stand for a few days until it curdles. Then dissolve as much borax as you can in a test tube 1/4 full of water. Pour the borax solution in a cup and add enough curdled milk to make a thick glue.

CHAPTER 4 - UNDERSTANDING SURFACE TENSION & DIFFUSION

Everything is made up of **atoms**—liquids, solids, gases; living things, non-living things; substances found in nature, man-made substances—everything, including each and every one of us!

Different atoms make up substances we call **elements.** Hydrogen, oxygen, calcium and iron are all different kinds of elements. When atoms of different elements combine to form a new substance, this is called a **compound.** Water is a compound made up of atoms of hydrogen and oxygen. The smallest particle of any compound or element that exhibits all the characteristics of that compound or element is called a **molecule.** A molecule of water consists of two atoms of hydrogen and one atom of oxygen.

The difference between the liquid, solid or gaseous form of any compound (for example, water) is the amount of space that exists between the compound's molecules that makes it react in certain ways. In general, the molecules of a gas (water vapor) are farther apart and move faster than the molecules of a liquid (water), which are farther apart and move faster than the molecules of a solid (ice).

Experiment 1

Objective: To illustrate the property of liquids known as surface tension
Materials: Small Bowl ■ Sewing Needle
Chemicals: Water
Procedure: Because of the amount of space between the molecules of a liquid, liquids exhibit a property called **surface tension.** You can illustrate this property by filling a small bowl 1/2 full of clear water. Carefully wash and dry your fingers and place a clean sewing needle on the surface of the water. The needle should float. Why? Because the attraction downward and sidewards on the molecules of the water surface creates an elastic surface. If you look carefully, you can see how the surface of the water bends under the weight of the needle.

Experiment 2

Objective: To use the principle of surface tension to create a floating compass
Materials: Magnet ■ Sewing Needle ■ Small Bowl
Chemicals: Water
Procedure: Magnetize a sewing needle by pulling it across one side of a magnet several times, each time the same way. Float the needle in a bowl of water as you did in Ch. 4, Exper. 1. One end of the needle will always turn toward the north pole no matter which way you turn the bowl.

Experiment 3-6

Objective: To illustrate how impurities in a liquid decrease surface tension
Materials: Small Bowl ■ Long Rubber Band ■ Toothpick ■ Baby Lotion ■ Milk
Chemicals: Water ■ Lubricating or Mineral Oil ■ Rubbing Alcohol
Procedure:

Experiment 3

Fill a small bowl 1/2 full of clear water. Carefully wash and dry your fingers and place a long rubber band on the surface of the water. The rubber band should float, retaining its normal oval shape.

Now wet the end of a toothpick with lubricating or mineral oil and touch the surface of the water inside the rubber band. Repeat if necessary. You will see the band take a circular shape. This occurs because the presence of oil weakens the surface tension of the water inside the band, whereas outside it is unaffected. The stronger tension outside, therefore, pulls the rubber band equally in all directions so that it assumes the circular shape.

Repeat the above experiment with each of the following materials instead of oil and see how they affect the surface tension of water.

Experiment	Material	Observations
4	milk	
5	rubbing alcohol	
6	baby lotion	

Experiment 7

Objective: To illustrate the difference in surface tension across a single liquid surface
Materials: Drinking Glass ■ Small Cork
Chemicals: Water
Procedure: Fill a drinking glass with water nearly to the top. Drop a small cork in the water. It will move towards the side of the glass. This is due to the difference in the surface tension forces acting upon the cork, resulting in movement from an area of greater tension to an area of less tension.

Experiment 8

Objective: To make a floating object sink in liquid
Materials: Liquid Soap ■ Saucer ■ Needle ■ Glass Tube or Eyedropper ■ Rubber Band
Chemicals: Water
Procedure: Gently add soap solution drop by drop to a saucer of water containing a floating needle. After several drops, the needle will sink due to lower surface tension. Try this experiment with a rubber band.

Experiment 9

Objective: To observe the differences in surface tension exhibited by plain water and soapy water
Materials: Test Tubes ■ Piece of Soap ■ Soap Flakes ■ Measure ■ Glass Tube or Eyedropper ■ Wax Paper
Chemicals: Water
Procedure: Fill two test tubes 1/2 full of water. In one put a tiny piece of soap. In the other put two measures of powdered soap flakes. Shake the two test tubes. Put a drop of each soap solution on a piece of wax paper. Does either soap solution "wet" the paper better than plain water?

Experiment 10

Objective: To use the properties of liquids to create water that will not spill
Materials: Piece of Stiff Cardboard ■ Glass Bottle (with smooth rim)
Chemicals: Water
Procedure: Carry out this experiment over a sink. Fill a glass bottle to the very top with water. Obtain a piece of stiff cardboard large enough to cover the mouth of the bottle. Slide the cardboard over the mouth of the bottle. Hold the cardboard in position and turn the bottle upside down.

You will discover that the cardboard no longer needs to be held in place; the atmosphere presses upon every square inch of it and holds it tightly against the mouth of the bottle. This prevents the water from falling out.

Experiment 11

Objective: To make a heavy object float on top of water
Materials: Spice Jar Lid ■ Pan
Chemicals: Water
Procedure: Obtain the lid of a spice jar; one that has a number of holes already punched in it. Gently lay the top of the lid on the surface of a pan of water. Even though the lid is heavier than water, it will float due to the force being exerted upon it by surface tension.

Experiment 12

Objective: To show molecular motion in the different states of matter
Materials: Test Tubes ■ Test Tube Holder ■ Alcohol Lamp or Candle
Chemicals: Ice
Procedure: Put some small pieces of ice in a test tube and heat the test tube. The ice melts and becomes water. What happened chemically was that the molecules in the solid state, where they were fixed in position, acquired enough motion to break free to the liquid state. As a liquid, the molecules no longer stay more or less fixed in one place, but now move about, though still attracted to one another.

Heat the water until it comes to a boil. Here the water turns to vapor, or steam. The liquid state molecules acquired enough motion to break free of one another. In a gas state, the molecules travel so rapidly that the attraction between them is negligible.

As a further experiment, hold a drinking glass over the test tube so that as the steam rises out of it, the steam hits the glass. Watch the gas become liquid again as water droplets form on the glass.

Experiment 13

Objective: To show that air has weight
Materials: One-Gallon Metal Can with Screw Cap ■ Stove
Chemicals: Water
Procedure: Find a clean, empty one-gallon metal can with a screw cap. Before continuing, make sure that nobody else needs the can. **Do not use a container made of glass or any other material.**

Put enough water into the can to cover the bottom to a depth of about one inch. **After asking your parents for permission**, heat the can over a burner on a stove until the water boils. Turn off the burner and screw the cap on tight, making sure not to burn yourself. Put the can under a cold water tap and run the cold water over it.

The can will collapse! Why? Because the water vapor in the can condenses back to water, leaving a partial vacuum. Since there is less pressure inside, the weight of air on the outside bends in the sides. The sides are not strong enough to support the added weight.

Experiment 14

Objective: To use the surface tension properties of liquid to make a wooden boat move
Materials: Balsa Wood ■ Piece of Soap
Chemicals: Water
Procedure: Shape a small boat about two inches long out of a piece of balsa wood. Cut a V-shaped notch in the back (or stem) of the boat and put a piece of soap in this notch.

Carefully set the boat on the surface of some very still water, like a lake. It will move forward under its own power.

Experiment 15

Objective: To demonstrate molecular motion in a gas
Materials: Can of Fresh Paint, Bottle of Perfume or Container of Any Odorous Substance
Procedure: In one corner of the room, open the container of the substance to be used. Go to the opposite corner and see how long it takes for you to smell the substance at the other side. In other words, how long does it take for the gaseous molecules of the substance to travel to your nose? This process of travel is called **diffusion.**

CHAPTER 5 - THE MAGIC OF CRYSTALLIZATION

Atoms and molecules of solid substances that come together in regularly repeating three-dimensional patterns are called **crystals.** Compare, for example, the appearance of individual grains of table salt to individual grains of flour and you will immediately notice the physical difference between a crystalline substance and a powdery substance. The process of crystal formation is called **crystallization** and that is the primary focus of this chapter.

Experiments 1-5

Objective: To examine and record the characteristics of various crystalline substances
Materials: Test Tubes ■ Spoon ■ Glass Tube or Eyedropper ■ Magnifying Glass ■ Paper ■ Alcohol Lamp or Candle
Chemicals: Water ■ All Materials Listed Below
Procedure: For each experiment, put 1 spoon of each material in a test tube with 20 drops of water and heat until the material dissolves. Let the test tube cool and watch the crystals form. Spill out the crystals on a piece of clean paper, examine them with the magnifying glass and record the color or each set of crystals.

Experiment	Material	Color of Crystal
1	sodium borate (borax)	
2	sodium chloride (table salt)	
3	sugar	
4	~~sodium bicarbonate~~ (baking soda)	
5	sodium carbonate	

Experiment 6

Objective: To grow crystals from a borax solution
Materials: Test Tube ■ Test Tube Holder ■ Spoon ■ White Thread ■ Metal Nut ■ Toothpick ■ Magnifying Glass ■ Alcohol Lamp or Candle
Chemicals: Water ■ Sodium Borate (borax)
Procedure: Crystals can actually be grown by slowly evaporating a saturated solution of a substance over time and by providing a place where crystals can grow. In this experiment and the ones that follow, you will grow crystals over a period of three to four days.

Carefully add 3 spoonfuls of borax to a test tube filled with 30 drops of water. Use 10 more drops of water to wash down the sides after shaking the test tube. Heat the tube gently to dissolve the chemical. Start heating the test tube at the top first, holding it two or three inches above the flame so the liquid does not spurt out of the tube. Let the solution cool until it is just warm to your touch. Pour off the warm, clear liquid into another clean test tube.

Tie a few inches of white thread around a metal nut and carefully lower the thread into the liquid. To keep the thread in place in the liquid, attach the other end of the thread to a toothpick and lay it across the mouth of the test tube.

Put the test tube in a place where it will not be disturbed. In the next day or two borax crystals will have grown on the thread. They will look like ice.

Carefully remove the thread from the test tube, examine it with your magnifying glass and compare the appearance of the crystals to your findings in Ch. 5, Exper. 1.

Experiment 7

Objective: To examine sodium carbonate crystals made from a sodium carbonate solution
Materials: Alcohol Lamp or Candle ■ Test Tube ■ Spoon ■ White Thread ■ Metal Nut ■ Toothpick ■ Test Tube Holder ■ Magnifying Glass
Chemicals: Water ■ Sodium Carbonate

Procedure: Repeat the previous experiment using sodium carbonate in place of borax.

Experiment 8

Objective: To grow cubes of salt
Materials: Test Tube ■ Measure ■ White Thread ■ Small Button ■ Magnifying Glass ■ Toothpick
Chemicals: Water ■ Sodium Chloride (table salt)
Procedure: Prepare a piece of thread as you did in the previous experiment, only use a small button instead of a metal nut. Add 5 measures of sodium chloride and 40 drops of water in a test tube. Heat to dissolve the salt and put in the thread. Salt crystals will grow overnight and look like cubes.

Experiment 9

Objective: To grow crystals from a saturated sugar solution
Materials: Test Tube ■ Measure ■ White Thread ■ Small Button ■ Toothpick ■ Magnifying Glass
Chemicals: Water ■ Sugar
Procedure: Repeat the previous experiment using sugar in place of salt.

Experiments 10-14

Objective: To grow crystals by cooling a hot water solution
Materials: Test Tubes ■ Measure ■ Glass Tube or Eyedropper ■ White Thread ■ Small Buttons ■ Toothpicks ■ Magnifying Glass ■ Small Bottles
Chemicals: Water ■ All Materials Listed Below
Procedure: For each experiment, place the specified amount of material in a test tube and add 40 drops of hot water. Then drop in a button and thread in the same manner as in the last two experiments. If crystals do not form, boil the water in the test tube for five minutes. If crystals still do not form, add a little more chemical. Let the solutions stand overnight or until crystals start to grow - a week may be necessary. Save the crystals by keeping them in small, dry bottles.

Experiment	Material	Add this much	Color of Crystal
10	ferric ammonium sulfate	2 spoons	violet
11	sodium carbonate	1 spoon	white
12	sugar	5 spoons	clear
13	sodium ferrocyanide	1 spoon	yellow
14	sodium borate (borax)	10 measures	white

Experiment 15

Objective: To use crystallization to produce borax
Materials: Test Tube ■ Test Tube Holder ■ Measure ■ Alcohol Lamp or Candle
Chemicals: Boric Acid (crystalline) ■ Sodium Carbonate ■ Water
Procedure: Fill a test tube 1/4 full of water. Mix in three measures of boric acid and four measures of sodium carbonate. Heat the mixture in a flame, gently at first and then rapidly to a boil. Continue boiling until at least half the water has boiled away. Allow the test tube to cool for a few minutes and then finish the cooling by holding the test tube in cold water. The crystals that will form are sodium borate, better known as borax.

If you will examine all the borax crystals that you have produced during this and other experiments, you will notice the characteristic flat faces and straight edges of each crystal. These are formed because the atoms of the compound "line up" perfectly and grow in these orderly configurations.

Experiment 16

Objective: To use salt crystals as the basis of a magic trick
Materials: Salt Crystals (from Ch. 5, Exp. 8) ■ Tweezers
Procedure: Back in Exper. 8 you learned how to make salt crystals on a piece of thread. Here's a way to use these crystals to amaze your friends.

Hold one end of the thread of crystals with your tweezers so that the button hangs down at the other end. Have somebody light the thread from the bottom with a match. As it burns up, the button will still be supported in the air by the mysterious "thread of ashes"—your salt crystals.

Experiments 17-20

Objective: To isolate and examine the water molecules present in salt crystals
Materials: Test Tubes ■ Measure ■ Test Tube Holder ■ Alcohol Lamp or Candle ■ Safety Glasses
Chemicals: All Salts Listed Below
Procedure: Many salts are prepared in such a way that the crystals contain a definite amount of water per molecule of salt. This "water of crystallization" can be removed in most cases by gentle heating and such a loss is often accompanied by a change in the color of the salt.

For each experiment, place one measure of the indicated salt in the bottom of a clean, dry test tube. Using the test tube holder, hold the tube nearly horizontal and heat it gently at the bottom only, over a flame. This will keep the top of the tube cool enough so that any water driven out of the crystals can be seen as it condenses in the cool upper portion of the tube. Record your observations below.

Caution: If water appears at the mouth of the tube, do not stand the tube upright. If you do, the water running down onto the dry hot glass at the bottom will crack the tube. It is recommended that safety glasses be worn when conducting these experiments.

Experiment	Salt	Water Present?	Color Change
17	ferric ammonium sulfate		
18	sodium ferrocyanide		
19	sodium borate (borax)		
20	sodium carbonate		

CHAPTER 6 - REACTIONS I: PHYSICAL CHANGES

Professional chemists need pure substances to carry out the work they do. Many times, however, they must start with mixtures or solutions of several substances and separate out one compound from another. They often use **physical means** to accomplish this separation. Putting a substance into a solution is one way, but there are other ways that you will have a chance to learn about and explore in this chapter.

Experiment 1-4

Objective: To understand what a solution is
Materials: Drinking Glass ■ Spoon
Chemicals: Water ■ Sodium Chloride (table salt) ■ All Other Chemicals Listed
Procedure: Crush a little table salt with a spoon. Grind it up really fine and examine the salt powder. The pieces are very small, but you can still see them. You can't grind chemicals so small that you can't see them. Now take a little more salt and put it in the glass of water. Stir the water and watch the salt. What happens?

The salt disappeared as you stirred the water. The salt, however, is still there. You can taste it if you want to. But it is now in tiny pieces too small to see. This is called a solution.
Note: Never taste anything in an experiment unless specifically instructed to do so.

Repeat this experiment for each of the materials listed and save these solutions for future experiments.

Experiment	Material
2	sugar
3	sodium borate (borax)
4	sodium bicarbonate (baking soda)

Experiments 5-8

Objective: To show that a chemical in a solution can be recovered
Materials: Test Tubes ■ Alcohol Lamp or Candle ■ Test Tube Holder
Chemicals: Solutions from previous experiments
Procedure: Fill a test tube 1/2 full of solution. Boil the solution gently by heating until all the water is gone.

Experiment	Solution	Anything Left?	Appearance?
5	salt		
6	sugar		
7	sodium borate (borax)		
8	sodium bicarbonate (baking soda)		

Experiments 9-16

Objective: To see if water will dissolve various substances, thereby putting them into solution
Materials: Drinking Glasses ■ Measure
Chemicals: Water ■ All Materials Listed
Procedure: Water is called a mineral solvent which means that it dissolves more things than any other solvent. Place one measure of the following materials in a test tube 3/4 full of water.

Experiment	Material	Dissolve?
9	sodium bicarbonate (baking soda)	
10	flour	
11	sand	
12	salad oil	

Experiment	Material	Dissolve?
13	acetic acid (vinegar)	
14	coffee	
15	tea leaves	
16	pepper	

Experiments 17-23

Objective: To determine how soluble certain materials are in hot and cold water
Materials: Test Tubes ■ Test Tube Holder ■ Measure ■ Alcohol Lamp or Candle
Chemicals: Water ■ All Materials Listed Below
Procedure: In each of the following experiments, add one measure at a time of the listed material to a test tube 1/3 full of water at room temperature and shake vigorously after each addition. Record the number of measures added when no more material dissolves and some settles to the bottom of the tube. When you have reached this stage, you have a **saturated solution** of the material.

The saturated solution of each material will be in equilibrium with the solid material that settles out. Heat the solution gently over a flame and stir. Record whether heating the solution causes more material to dissolve.

Experiment	Material	# of Measures for Saturation	Effect of Heating
17	sodium chloride (table salt)		
18	sugar		
19	sodium bicarbonate (baking soda)		
20	ferric ammonium sulfate		
21	sodium carbonate		
22	sodium ferrocyanide		
23	sodium borate (borax)		

Experiment 24

Objective: To understand what a mixture is
Materials: Test Tube ■ Piece of Paper ■ Measure ■ Pepper
Chemicals: Water ■ Sodium Chloride (table salt)
Procedure: Put a measure each of sodium chloride and pepper in a test tube and shake well. What do you see?

Pour out the contents of the test tube onto the paper and separate the salt from the pepper. When you mixed the two materials in the test tube they still looked like two materials and when you poured them out, they were easy to separate.

A **mixture** is a combination of two or more substances in which the substances retain their own identity.

Experiment 25

Objective: To demonstrate how borax removes iron from water
Materials: Test Tube ■ Measure
Chemicals: Water ■ Ferric Ammonium Sulfate ■ Sodium Borate (borax)
Procedure: Fill a test tube 1/2 full of water and mix in two measures of ferric ammonium sulfate. Notice that the water gains a little color but remains clear. Add two measures of borax and shake the test tube again. Let the orange solids that form settle for a minute or two. The orange color of the solid material that settled out indicates the presence of iron. The borax removed the iron from the solution!

CHAPTER 7 - REACTIONS II: CHEMICAL CHANGES

Chemical changes involve the formation of brand new materials through a variety of chemical reactions. In this chapter, you will have the opportunity to create materials that did not exist at the outset of your experiments. You will also learn more about the variety of scientific tests used by professionals to identify unknown compounds and materials.

Experiment 1-10

Objective: To observe reactions of one chemical with another
Materials: Test Tubes ■ Measure ■ Glass Tube or Eyedropper ■ Filter Paper (coffee filters) ■ Funnel
Chemicals: Water ■ Ferric Ammonium Sulfate ■ All Other Chemicals Listed
Procedure: One of the most exciting parts of chemistry is using materials on hand to create things that didn't exist before. In general, this sort of process is called a **chemical reaction.**

For each experiment, dissolve 1/2 measure of the compound listed under Solution A in a test tube 1/4 full of water, and one measure or 10 drops of the compound listed under Solution B in another test tube 1/2 full of water.

Add Solution B drop by drop to Solution A, shaking the tube after each drop. Continue adding until there is no further reaction. Note the formation of any **precipitate.** This is classified as a **double decomposition** or exchange.

Experiment	Solution A	Solution B	Precipitate?
1	ferric ammonium sulfate	sodium ferrocyanide	
2	ferric ammonium sulfate	sodium carbonate	
3	ferric ammonium sulfate	sodium borate (borax)	
4	ferric ammonium sulfate	ammonium hydroxide (ammonia)	
5	ferric ammonium sulfate	tannic acid	

Shake the test tube holding the precipitate and filter it through a funnel and filter paper into a clean test tube. The precipitate remains on the filter paper. The other product of the reaction is in the filtrate. Note the color of the filtrate.

Note: Save these precipitates and filtrates for future experiments in this chapter.

Experiment	Solution A	Solution B	Filtrate Color
6	ferric ammonium sulfate	sodium ferrocyanide	
7	ferric ammonium sulfate	sodium carbonate	
8	ferric ammonium sulfate	sodium borate (borax)	
9	ferric ammonium sulfate	ammonium hydroxide (ammonia)	
10	ferric ammonium sulfate	tannic acid	

Experiments 11-15

Objective: To learn how to name precipitates of reactions
Chemicals: Precipitates from Ch. 7, Exper. 1-5
Procedure: In general, it is fairly simple to name the precipitates of chemical reactions. Here you will be naming the precipitates of the double composition reactions you just carried out.

In all cases you formed salt in the solution. The precipitate is what remained after the salt was removed during filtration. To identify the precipitate, combine the metallic non-chloride component of Solution A with the non-sodium component of Solution B. The first experiment has already been done to serve as your example.

Experiment	Solution A	Solution B	Precipitate Name
11	ferric ammonium sulfate	sodium ferrocyanide	ferric ferrocyanide
12	ferric ammonium sulfate	sodium carbonate	
13	ferric ammonium sulfate	sodium borate (borax)	
14	ferric ammonium sulfate	ammonium hydroxide (ammonia)	
15	ferric ammonium sulfate	tannic acid	

Note: Check your answers below.

Answers
12. ferric carbonate
13. ferric borate
14. ferric hydroxide
15. ferric tannate

Experiment 16

Objective: To demonstrate that matches contain sulfur
Materials: Test Tube ■ Measure ■ Silver Spoon ■ Safety Matches ■ Cloth
Chemicals: Water
Procedure: Scrape the heads off several matches and place them in a test tube. Add a few drops of water and mix to a paste-like consistency. Put a measure of this paste on a silver spoon and wrap the spoon with a cloth. After a day or so you should find black spots of silver sulfide on the spoon.

Experiment 17

Objective: To visibly determine the chemicals that make up fire
Materials: Small Pan ■ Wax Candle ■ Safety Matches
Procedure: Prepare and light the candle as explained in Chapter 1. Darken the room a little so that you can examine the candle flame for evidence of chemical changes.

Look at these things as you see them: melted wax on top of the candle; wet part of the wick below the flame; the three parts of the flame-blue flame at the bottom, colorless unburned gases around the wick, yellow outside layer of the flame; the slow burning of the wick from the wet part in the melted wax to the black, partly burned up tip.

Fire is a chemical change. The small blue flame is hydrogen. The yellow layer of flame is where hot gases and oxygen in the air meet and burn.

The yellow color is caused by a great many carbon molecules that were heated to their burning temperature. To start the candle burning, the match heated the wick to its burning temperature. After burning began, the heat of the fire kept itself going. A fire will last as long as there is something to burn and oxygen to feed it.

This same flame pattern will be observed when anything made of carbon and hydrogen, such as a match, paper or wood, is burned.

Experiment 18

Objective: To improve our understanding of the burning process as it relates to oxygen in the air
Materials: Small Pan ■ 2"-3" Wax Candle ■ Tall Drinking Glass ■ Safety Matches ■ Ruler
Chemicals: Water
Procedure: Prepare the candle in the pan as you did in the previous experiment. This time, add water to the pan about 1/2" deep.

Lower the glass over the burning candle so that it rests upside down in the pan. Do this quickly and smoothly so that you do not disturb the flame. Watch what happens.

When the water stops rising, measure the height of the water in the glass and fill in the following information:

The water in the glass was ______ inches high.

The glass itself was ______ inches high.

Divide the first number into the second number and record your answer here: ______

When hydrogen burns, it mixes with oxygen to create water vapor. If cooled enough, you can see it forming on the inside of the glass. Some of the oxygen trapped in the glass mixed with carbon from the wax and produced carbon dioxide, a gas that mixes easily with water. As the oxygen was burned, the water moved up into the glass to fill the space vacated by the burned oxygen.

When you measured the height of the water and the glass, you were comparing the quantities of oxygen in the glass before and after burning. Your answer should have been around five, since approximately 1/5 of the air is oxygen. Most of the space left in the glass was taken up by nitrogen.

Experiment 19

Objective: To demonstrate how some chemicals put out fire
Materials: 2" Square Piece of Paper ■ Measure ■ Small Pan ■ Safety Matches
Chemicals: Sodium Bicarbonate (baking soda) ■ Sodium Carbonate ■ Calcium Hydroxide
Procedure: Spread two measures of sodium bicarbonate all over the piece of paper. Carefully wad the paper into a ball, place it in the pan and light it with a match. The flame will quickly go out by itself.

The heat of the fire freed the carbon dioxide from the sodium bicarbonate and it was this carbon dioxide that put out the fire. Try this same experiment with sodium carbonate and calcium hydroxide.

Experiment 20

Objective: To prepare a solution of limewater to use to test for the presence of carbon dioxide
Materials: Test Tube ■ Measure ■ Drinking Glasses ■ Funnel ■ Filter Paper (coffee filters)
Chemicals: Water ■ Calcium Hydroxide
Procedure: Start by filling a drinking glass or cup 1/2 full of water. Add two measures of calcium hydroxide, stir and set the glass aside for two minutes. You will notice that some of the calcium hydroxide has settled out on the bottom of the glass. Now cover the glass and let it sit for an hour or two so that all the excess calcium hydroxide settles out. Then carefully pour off the clear liquid into another container.

Now use a funnel and filter paper to filter the liquid into another clean drinking glass. This filtrate is your clear limewater.

Store the limewater in a clean bottle with a tight cork or cover. Be sure to label the bottle so you know what is in it.

Experiment 21

Objective: To use limewater to test for the presence of carbon dioxide in your breath
Materials: Test Tube ■ Straw
Chemicals: Limewater from Previous Experiment
Procedure: Fill the test tube 1/2 full of clear limewater. Hold the straw so that one end is about 1/2" into the limewater. Blow gently into the tube several times.

The limewater will become cloudy due to the addition of carbon dioxide from your breath. The precipitate formed is calcium carbonate.

Experiment 22

Objective: To use limewater to test for the presence of carbon dioxide in the air
Materials: Test Tube ■ Dish
Chemicals: Limewater (from Ch. 7, Exper. 20)

Procedure: Pour half a test tube of limewater into a dish and leave it overnight or for about 10 hours. Then, without touching the dish, examine it. Notice the thin white crust on top of the limewater. The carbon dioxide in the air reacted with the limewater to form the calcium carbonate, just as before. Only this time it formed on the surface of the water, where the air touched it.

Experiment 23

Objective: To use acid to break down a carbonate into carbon dioxide
Materials: Test Tube ■ Measure ■ Glass Tube or Eyedropper ■ Drinking Glass
Chemicals: Sodium Bicarbonate (baking soda) ■ Acetic Acid (vinegar) ■ Limewater (from Ch. 7, Exper. 20) ■ Sodium Carbonate
Procedure: Pour half a test tube of limewater into the glass. Put four measures of sodium bicarbonate into a test tube and add 20 drops of acetic acid. As the mixture fizzes, hold the open end of the test tube over the edge of the glass of limewater, being careful not to pour any liquid into the glass.

Swish the limewater in the glass a little and you will observe the limewater becoming milky again. This was due to carbon dioxide overflowing from the test tube into the glass. The carbon dioxide was set free from the sodium bicarbonate by the acetic acid. Acetic acid therefore breaks down sodium bicarbonate. Repeat the experiment using sodium carbonate and record similarities and differences.

Experiment 24

Objective: To make soap
Materials: 2 Test Tubes ■ Test Tube Holder ■ Butter ■ Measure ■ Alcohol Lamp or Candle
Chemicals: Sodium Carbonate ■ Calcium Hydroxide ■ Sodium Chloride (table salt)
Procedure: Put two measures of sodium carbonate and three measures of calcium hydroxide in a test tube. Now, fill the test tube 1/3 full of water. Warm the test tube over a flame for a few minutes, then set the tube aside and let the precipitates settle out.

When the liquid is clear, pour it into the other test tube and add a small piece of butter to the clear liquid. Heat again for four minutes. The butter will first melt, then dissolve into the water. When this happens, add six measures of sodium chloride and shake. The soap will float to the top of the test tube and, when it cools, you can separate it from the liquid.

Feel the soap. Put a little in a test tube with some water and shake it. What happened?

The sodium carbonate, calcium hydroxide and water made sodium hydroxide. Hot sodium hydroxide causes fat to separate into a fatty acid and an alcohol called **glycerine**. Then the sodium and the fatty acid joined to make the sodium salt of the acid. That's exactly what soap is, the sodium salt of a fatty acid...the glycerine dissolved in the water. The soap you buy is made in just about the same way as the soap you created in this experiment.

CHAPTER 8 - WATER, WATER, EVERYWHERE

Water (H_2O) is one of the basic materials that is necessary for all life. It makes up a large part of all living things and of the world around us. In fact, over 70% of the earth is covered with water.
Chemists also recognize its value in chemical reactions and as a solvent.

Experiment 1

Objective: To observe the formation of water from fire
Materials: Test Tube ■ Test Tube Holder ■ Candle ■ Alcohol Lamp
Chemicals: Water
Procedure: Fill a test tube 1/3 full with water. Wipe the outside of the tube dry and hold it a few inches above a candle flame. Note that water will appear on the outside of the test tube.

Experiments 2-3

Objective: To observe how water acts toward fat
Materials: Drinking Glasses ■ Vegetable Oil ■ Liquid Detergent
Chemicals: Water
Procedure:

Experiment 2

Fill a tall drinking glass 1/2 full of warm water. Add some vegetable oil to a depth of about 1/4 inch. Stir the mixture vigorously.

Observe how the fat (the oil) is broken up into tiny droplets. Allow this mixture to stand and observe that all the droplets eventually come together and collect on the surface.

Experiment 3

Fill another tall drinking glass 1/2 full of warm water and add some vegetable oil. Add half a cup of liquid detergent and stir the mixture.

Allow the glass to stand and compare it to the one from the previous experiment. Notice that the soap has broken up the droplets of fat and that they are now evenly distributed throughout the mixture.

Experiments 4-11

Objective: To determine the relative hardness of a variety of water types
Materials: Test Tubes ■ Spoon ■ Glass Tube or Eyedropper ■ Plain Soap
Chemicals: Samples of Water Types Listed
Procedure: Dissolve one spoonful of soap flakes in a test tube full of hot water. Make sure the solution is well dissolved.

For each experiment, fill a test tube 1/3 full of the indicated water sample and add one drop of the soap solution. Shake the test tube well. Compare each sample to the one using distilled water. The harder the water the less it will suds. Rank the water types from the hardest to the softest.

Experiment	Water Sample	Rank
4	distilled	
5	tap	
6	rain	
7	well	
8	pond	
9	puddle	
10	river	
11	ocean	

Experiments 12-27

Objective: To test a variety of water types for the presence of iron
Materials: Test Tubes ■ Measure
Chemicals: Sodium Ferrocyanide ■ Ferric Ammonium Sulfate ■ Samples of Water Types Listed
Procedure: For each experiment, fill a test tube full of the indicated water sample. Add 1 measure of sodium ferrocyanide and shake the test tube until the chemical is dissolved.

Any trace of blue in the water indicates the presence of iron.

Experiment	Water Sample	Presence of Iron?
12	distilled	
13	tap	
14	rain	
15	well	
16	pond	
17	puddle	
18	river	
19	ocean	

Repeat the experiments using Ferric Ammonium Sulfate in place of Sodium Ferrocyanide.

Experiment	Water Sample	Presence of Iron?
20	distilled	
21	tap	
22	rain	
23	well	
24	pond	
25	puddle	
26	river	
27	ocean	

Experiments 28-29

Objective: To test a variety of chemicals and minerals for the presence of water
Materials: Test Tubes ■ Test Tube Holder ■ Alcohol Lamp or Candle
Chemicals: All Materials Listed
Procedure: The water in a chemical or mineral will be released when the material is heated. For each experiment, gently heat two measures of the indicated material in a clean, dry test tube. Look for little droplets of water on the cooler parts of the test tube as a sign of water being present in the material.

Experiment	Material	Presence of Water?
28	sodium borate (borax)	
29	sodium carbonate	

Experiment 30

Objective: To observe the expansion of gas in water
Materials: Dish ■ Small Empty Medicine Bottle ■ Dishwashing Liquid
Chemicals: Water
Procedure: Mix a small quantity of dishwashing liquid with some water in a shallow dish until you are able to form bubbles by simply blowing air at the solution.

Turn the empty medicine bottle upside down in the dish so that a soap bubble is stretched over the neck of the bottle. Place your warm hands around the bottle. As the air inside the bottle gets warm and expands, the bubble will grow.

Experiment 31

Objective: To observe the tendency of water molecules to stick together
Materials: Wax Paper
Chemicals: Water
Procedure: Sprinkle a few drops of water on a sheet of wax paper. Notice that the water forms beads. This is because water molecules have a tendency to stick together.

Experiment 32

Objective: To show that water is necessary for life
Materials: Drinking Glass ■ Toothpicks ■ 2 Sweet Potatoes
Procedure: Put some toothpicks around the center of a sweet potato to hold the potato up in a glass. Fill the glass with water. Take a second potato and just leave it out, in the open air. Which potato continues to grow?

CHAPTER 9 - THE IMPORTANCE OF OXYGEN

Oxygen is one of the most useful, as well as unusual, elements in existence. It is colorless, tasteless and odorless. It is found as one of the gases in the air as well as in water, most rocks and minerals and in many other organic compounds.

In this chapter we will delve into some of the mysteries of oxygen.

Experiment 1

Objective: To observe that oxygen is necessary for fire
Materials: Candle ■ Small Pan ■ Tall Drinking Glass
Chemicals: Water
Procedure: Light the candle and stand it in the center of a small pan, as explained in Chapter 1. Fill the pan 1/2 full of water.

Lower the glass over the candle so that the rim of the glass is underwater, forming a seal. The flame will get dimmer and eventually go out as the oxygen in the jar is used up.

Experiment 2

Objective: To oxidize iron
Materials: Drinking Glass ■ Test Tube ■ Steel Wool
Chemicals: Water
Procedure: Take a small handful of steel wool and stuff a few small strips down into the bottom of a wet test tube. Turn the test tube upside down in a glass 1/2 full of water.

Let a few days go by. If you look at the glass, you will notice a powdery rust forming as the iron present in the steel wool oxidizes. **Oxidation** is the process by which iron reacts with oxygen and water to form rust. Water rises in the tube as the oxygen in the air is used up.

Experiment 3

Objective: To show the action of light on plants to produce oxygen
Materials: Shallow Pan ■ Grass ■ Glass Jar ■ 3″x4″ Piece of Cardboard
Chemicals: Water
Procedure: Fill the shallow pan about 3/4 full of water. Put a bunch of green leaves or grass in the glass jar and fill it with water to the brim. Slide the cardboard across the top and place the fingers of one hand on it to hold it in place. With the other hand turn the container upside-down in the pan with the mouth under water. Pull out the cardboard. Place the apparatus in the sunlight. In time you will see oxygen gas collecting at the bottom of the container.

Experiment 4

Objective: To prove that air takes up space
Materials: Drinking Glass ■ Paper Towel
Procedure: Here's a way to prove a scientific principle while amazing your friends.

Tell your friends that you can put a paper towel in a glass and then plunge the glass into water without getting the paper wet.

Stuff the paper towel into the bottom of the glass, making sure that it is in there tight enough so that it won't fall out when you turn the glass upside down. Fill a sink with water. Hold the glass straight upside down as you plunge it into the water. Slowly count to ten and then carefully lift the glass up out of the water. Make sure you keep it perfectly straight at all times. Pull out the paper towel; it's completely dry!

Water could not get into the glass because the glass was full of air. And the air could not get out of the glass because air is lighter than water and could not escape under the rim of the glass.

Experiment 5

Objective: To illustrate why we do not live in an atmosphere of pure oxygen
Materials: 2 Test Tubes ■ Test Tube Holder ■ Measure ■ Glass Tube or Eyedropper ■ Cork (without hole) ■ Wooden Toothpick ■ Safety Match ■ Component Rack
Chemicals: Water ■ Hydrogen Peroxide ■ Cobalt Chloride Solution ■ Sodium Carbonate
Procedure: Fill a test tube 1/3 full of hydrogen peroxide and set it in your component rack. In another test tube, mix one measure of sodium carbonate in a test tube 1/4 full of cobalt chloride solution. Shake well.

Add several drops of this blue solution to the test tube containing hydrogen peroxide. The foaming action you will observe is due to the rapid release of oxygen from the hydrogen peroxide. Continue adding the solution until the foaming stops. Then cap the tube with a cork (without a hole).

Light the toothpick with a match and blow out the flame, leaving a glow. Quickly, uncap the test tube and thrust the glowing tip of the toothpick into it, being careful not to immerse it in the liquid. The toothpick should burst into flame and burn quite vigorously for a moment. Now you can see why it would be dangerous to live in an atmosphere of pure oxygen.

Experiment 6

Objective: To show how to change sugar into caramel
Materials: Test Tube ■ Test Tube Holder ■ Measure ■ Alcohol Lamp or Candle
Chemicals: Water ■ Sugar
Procedure: Add ten measures of sugar to a test tube and heat the test tube. Watch what happens and then smell the test tube.

You will notice that when the sugar melts it gives off steam. It then becomes brown and thick, turning into caramel. Caramel is brown because it has carbon in it. In the reaction, hydrogen and oxygen were given off as water vapor (steam), leaving carbon behind.

Caramel is used to make candy and as a flavoring and coloring material in foods and soft drinks. **Do not eat this caramel!**

PART II: THE WORLD AROUND YOU

CHAPTER 10 - THE COLORS OF CHEMISTRY: INKS, PAINTS & DYES

One of the most important fields of chemistry is in the development of processes and techniques for producing color.

In this chapter you will use chemical compounds and processes to create a variety of colors in different media. You may want to wear old clothes as you perform these experiments.

Experiment 1

Objective: To make a blue-black ink
Materials: Test Tubes ■ Measure ■ Small Storage Bottles ■ Fountain Pen
Chemicals: Water ■ Ferric Ammonium Sulfate ■ Sodium Ferrocyanide ■ Tannic Acid
Procedure: Put 1 measure of ferric ammonium sulfate and 1 measure of tannic acid in a test tube 1/3 full of water. Shake well. In another test tube, 1/4 full of water, put 1 measure of sodium ferrocyanide and 1 measure of ferric ammonium sulfate. Shake well. Mix the two solutions together. Use a clean pen to write with this ink. At first the writing will be blue. In a few days it will turn black. Find some small, clean bottles in which to keep your ink. Put labels on your bottles so you will know what is inside.

Experiments 2-9

Objective: To make a variety of invisible inks
Materials: Test Tubes ■ Test Tube Holder ■ Measure ■ Clean Fountain Pen ■ Electric Light Bulb ■ Cotton Swab ■ Onion ■ Cotton Ball
Chemicals: Water ■ Sodium Ferrocyanide ■ Ferric Ammonium Sulfate ■ Tannic Acid ■ Sodium Carbonate ■ Cobalt Chloride Solution ■ Lemon Juice ■ Grapefruit Juice ■ Acetic Acid (vinegar) ■ Milk
Procedure: Scientists call invisible inks **sympathetic inks** because they respond to warmth by turning darker. Although their practical value is limited, these inks can be used to send secret messages to your friends.

Note: In the following experiments you will be heating your "secret messages" near an electric light bulb. As always, be very careful when working with heat.

Experiment 2

Dissolve four measures of ferric ammonium sulfate in a test tube 1/4 full of water. You may now write with the solution on a sheet of paper. To make the writing appear, dissolve four measures of sodium carbonate in a test tube 1/4 full of water and carefully spread this solution over your writing, using a soft brush or ball of cotton. The writing will appear red-brown as if written with rust.

Experiment 3

Using a clean fountain pen or cotton swab, write with the juice of a lemon, making sure your lines are heavy. The writing will remain invisible until brought out by heating.

Experiment 4

Using a clean fountain pen or cotton swab, write with the juice of a grapefruit, making sure to make your lines heavy. The writing will remain invisible until brought out by heating.

Experiment 5

Using a clean fountain pen or cotton swab, write with acetic acid. The writing will remain invisible until brought out by heating and it will not fade away upon cooling.

Experiment 6

Using a clean fountain pen or cotton swab, write with milk, making sure to make your lines heavy. The writing will remain invisible until brought out by heating.

Experiment 7

Dissolve two measures of ferric ammonium sulfate in a test tube 1/4 full of water. When writing with this solution, the writing will appear brown when brought out by heating.

Experiment 8

Extract the juice of an onion and, using a clean fountain pen or cotton swab, write with it. The writing will remain invisible until brought out by heating, when it will turn brown and not fade away. This is a very stable "sympathetic" ink.

Experiment 9

Using a clean fountain pen or cotton swab, write on white paper with cobalt chloride solution. When the writing is dry, warm the paper gently, being careful not to scorch it, and the letters will appear in blue. If you breathe on the writing for a minute or two, it will disappear again. You can make this writing appear and disappear in this manner as often as you wish.

Experiment 10-14

Objective: To observe how household dye affects different kinds of cloth
Materials: All Fabrics Listed ■ Small Pan
Chemicals: Dye
Procedure: Ask your parents for some samples of the following types of cloth. Also, ask them to help you prepare some dye by following the directions printed on the package.

Cut each piece of the following cloths into a 2" square and change its color with the dye. Then record your observations.

Experiment	Type of Cloth	Observations
10	cotton	
11	silk	
12	wool	
13	rayon	
14	nylon	

Experiment 15

Objective: To make blue dye from tree bark
Materials: Test Tube ■ Test Tube Holder ■ Glass Tube or Eyedropper ■ Chips of Chestnut Tree Bark ■ Alcohol Lamp or Candle
Chemicals: Water ■ Ammonium Hydroxide (ammonia)
Procedure: Put several chips of bark from a chestnut tree into a test tube 1/2 full of water and boil for five minutes. Add several drops of ammonium hydroxide and boil for three more minutes. You may now use this blue solution to dye small pieces of different types of cloth.

Experiment 16

Objective: To dye a piece of cloth royal blue
Materials: 2 Test Tubes ■ Measure ■ Strip of White Cotton Cloth
Chemicals: Water ■ Sodium Ferrocyanide ■ Ferric Ammonium Sulfate
Procedure: Dissolve two measures of sodium ferrocyanide in a test tube 1/3 full of water. Wet a piece of cloth in this solution, squeeze out the excess liquid and let the cloth dry. Add two measures of ferric ammonium sulfate to another test tube 1/3 full of water. Shake

to dissolve. Add the piece of dry cloth and shake again. Remove the cloth and let it dry.

Experiment 17

Objective: To illustrate the importance of paint beyond simply changing the color of an object
Materials: 2 Pieces of Clean Steel ■ 1 Piece of Rusty Steel ■ Sandpaper ■ Paint Brush
Chemicals: Paint
Procedure: Sandpaper the two pieces of clean steel so that they are truly clean and rust free. Paint only one of these pieces and also paint the rusty piece.

Hang all three pieces outdoors and compare the looks of the pieces every week for several months. Notice that the only piece that still looks good is the clean painted piece. The unpainted piece has rusted and the paint has done nothing to stop the spread of rust on the already rusted piece. This test illustrates the importance of not only painting, but of cleaning the material before you paint.

Experiment 18

Objective: To make blue watercolor paint
Materials: Test Tubes ■ Measure ■ Glue
Chemicals: Water ■ Ferric Ammonium Sulfate ■ Sodium Ferrocyanide
Procedure: Dissolve 3 measures of sodium ferrocyanide in a test tube 1/3 full of water. In another test tube 1/3 full of water, dissolve 3 measures of ferric ammonium sulfate. Mix the two solutions. Let the solids settle and pour off the liquid, or filter the solids. You can make a water color paint by adding glue to the solids.

Experiment 19

Objective: To make brown watercolor paint
Materials: Test Tubes ■ Measure ■ Glue
Chemicals: Water ■ Sodium Carbonate ■ Ferric Ammonium Sulfate
Procedure: Dissolve 1 measure of sodium carbonate in a test tube 1/4 full of water. In another test tube 1/4 full of water, dissolve 1 measure of ferric ammonium sulfate. Mix the two solutions. Let the solids settle and carefully pour off the liquid, or filter them. You can make a water color paint by adding glue to the solids.

CHAPTER 11 - CHEMISTRY & FOOD

Every living thing, be it plant or animal, requires food to produce energy. And food, just like everything else around us, is composed of chemicals. In this chapter we will examine the particular characteristics of specific food groups.

Experiments 1

Objective: To create a solution to test for the presence of starch
Materials: Test Tube ■ Glass Tube or Eyedropper ■ Small Storage Bottle with Cap
Chemicals: Water ■ Tincture of Iodine
Procedure: Add six drops of iodine to a test tube 1/2 full of water. Pour this solution into a small bottle, label it "Starch Test Solution" and cap it tightly.

Experiment 2-23

Objective: To test a variety of foods for the presence of starch
Materials: Test Tubes ■ Test Tube Holder ■ Spoon ■ Glass Tube or Eyedropper ■ Alcohol Lamp or Candle ■ All Materials Listed
Chemicals: Water ■ Starch Test Solution (from previous experiment)
Procedure: Starch is found in many foods and is an example of compounds known as **carbohydrates**. Starch can actually be removed from foods and used for things like glues, cosmetics, medicines and clothing care.

For each of the following experiments, place a small piece of the indicated food in a test tube 1/2 full of water. Heat the mixture over a flame, bring it to a boil and then let it cool for a few minutes. Add two drops of starch test solution to the solution. A blue or purple color indicates the presence of starch, and the intensity of the color indicates the amount of starch present.

Experiment	Material	Observations
2	potato	
3	breakfast cereal	
4	pasta	
5	whole milk	
6	kidney beans	
7	soybean	
8	rice	
9	white bread	
10	peanuts	
11	ground meat	
12	cracker	
13	butter	
14	cottage cheese	
15	rye bread	
16	orange	
17	chicken	
18	margarine	
19	sugar	
20	cornstarch	
21	flour	
22	doughnut	
23	pancakes	

Experiments 24-35

Objective: To test a variety of foods for the presence of acid
Materials: Test Tubes ■ Dishes ■ Blue Litmus Paper ■ All Materials Listed
Chemicals: Water
Procedure: Many common foods are high in acid content. Lemons and most other citrus fruits contain acid; it's what causes that characteristic tart or sour taste.

For each of the following experiments, put a small amount of the indicated solid material in a test tube with a few drops of water. When using a fruit, simply squeeze some juice directly into a clean, dry dish. You may also use ready-made juices.

Test each food by placing a drop from each test tube or dish on a strip of blue litmus paper. If it turns red, acid is present.

Experiment	Material	Observations
24	orange	
25	grapefruit	
26	tomato	
27	lemon	
28	sour cream	
29	tea	
30	milk	
31	baking soda	
32	lime	
33	cranberry	
34	banana	
35	tangerine	

Experiments 36-52

Objective: To test a variety of foods for the presence of iron
Materials: Test Tubes ■ Test Tube Holder ■ Measure ■ Alcohol Lamp or Candle ■ All Materials Listed
Chemicals: Water ■ Sodium Ferrocyanide
Procedure: For each of the following experiments, heat two measures of the indicated material (cut into chunks, if necessary) in a test tube 1/3 full of water. Add one measure of sodium ferrocyanide. A blue color indicates iron is present in reasonable amounts.

Experiment	Material	Observations
36	liver	
37	egg yolk	
38	bran flakes	
39	cashews	
40	kidney beans	
41	bean sprouts	
42	spinach	
43	castor oil	
44	banana	
45	lima beans	
46	dried apricots	
47	shrimp	
48	tuna	
49	apple	
50	bread	
51	lettuce	
52	ground meat	

Experiments 53-68

Objective: To test a variety of foods for the presence of fat
Materials: Spoon ■ White Paper ■ Alcohol Lamp or Candle ■ All Materials Listed
Procedure: **Fats** can be found in many foods. These substances are composed of other substances called **glycerides** and **fatty acids**. An easy way to test for the presence of fat is to see if the material forms a greasy spot when put on white paper.

For each of the following experiments, use a spoon to mash a small portion of the indicated food on a piece of white paper. Warm the sample by holding the paper several inches above a flame for a few minutes. **Be careful not to burn the paper.**

Foods high in fat will cause a grease spot to appear on the paper.

Experiment	Material	Observations
53	peanut butter	
54	cashews	
55	egg white (hard boiled)	
56	mayonnaise	
57	bacon	
58	potato chips	
59	doughnuts	
60	almonds	
61	butter	
62	chocolate	
63	ground meat	
64	whole milk	
65	cheese	
66	salad dressing	
67	ripe olives	
68	steak	

Experiments 69-89

Objective: To test a variety of foods for the presence of proteins
Materials: Test Tubes ■ Test Tube Holder ■ Measure ■ Glass Tube or Eyedropper ■ Red Litmus Paper ■ Alcohol Lamp or Candle ■ All Materials Listed
Chemicals: Water ■ Calcium Hydroxide
Procedure: **Proteins** are essential to the diet of all animals, including human beings. A protein is a complex network of substances called **amino acids** and always contain carbon, hydrogen, nitrogen and oxygen. Many proteins also contain other elements like sulfur, phosphorous, iron or iodine.

For each of the following experiments, heat three measures or 4 to 5 drops of the indicated material in a test tube of two measures of calcium hydroxide dissolved in 2 to 3 drops of water. Moisten a piece of red litmus paper and hold it at the mouth of the tube. If the food contains a large amount of protein, you will smell ammonia at the mouth of the tube. The red litmus paper will also turn blue.

Experiment	Material	Observations
69	whole milk	
70	egg yolk	
71	ground beef	
72	chicken	
73	turkey	
74	lima beans	
75	salmon	

Experiment	Material	Observations
76	tuna	
77	lentils	
78	soybeans	
79	cottage cheese	
80	yogurt	
81	bread	
82	almonds	
83	peanuts	
84	butter	
85	chocolate	
86	ketchup	
87	mustard	
88	dried apricots	
89	bran flakes	

Experiment 90

Objective: To demonstrate that sugar burns like wood
Materials: Spoon ■ Alcohol Lamp or Candle ■ Test Tube Holder
Chemicals: Sugar
Procedure: Hold 1/2 spoonful of sugar over a flame and watch what happens. The sugar melts, turns brown and burns very easily. Notice that black carbon is left in the spoon. Sugar is comprised of carbon, hydrogen and oxygen.

Experiment 91

Objective: To create alcohol from the fermentation of sugar
Materials: Drinking Glass ■ Glass Tube or Eyedropper ■ Dish ■ Spoon
Chemicals: Water ■ Sugar ■ Yeast
Procedure: Put a spoonful of sugar in a glass 1/2 full of water. Put 1/4 of a cake of yeast in a dish and add a few drops of water to make a paste.

Put the paste into the sugar solution. In a few hours, you will notice bubbles of gas forming. The yeast **enzymes** (proteins) act to break the sugar down, first to simpler sugars and then to alcohol and carbon dioxide gas. The sugar is said to **ferment. Do not use or drink this alcohol!**

Experiment 92

Objective: To make vinegar from sugar
Materials: Glass Tube or Eyedropper
Chemicals: Fermented Sugar from Previous Experiment ■ Acetic Acid (vinegar)
Procedure: Let the solution you created in the previous experiment stand for about a week, or until the fermentation stops. (The gas stops bubbling.) Add a drop or two of vinegar to start the reaction. Cover it and let the solution stand for another week. It will then be vinegar. **Do not use or drink this vinegar!**

Experiment 93

Objective: To make vinegar from cider
Materials: Drinking Glass ■ Glass Tube or Eyedropper ■ Cider
Chemicals: Yeast ■ Acetic Acid (vinegar)
Procedure: Add a bit of yeast to a glass full of cider. Cover the glass and let it stand for about a week. When the fermentation has stopped, add a drop or two of vinegar to start the reaction. Let the solution stand for a few days more under a cover. It will then be vinegar. **Do not use or drink this vinegar!**

Experiment 94

Objective: To illustrate the fermentation of milk, which produces casein
Materials: Drinking Glass ■ Milk
Procedure: Let a glass 1/2 full of milk stand outside the refrigerator for a few days and observe it from time to time. The fermentation process produces **lactic acid** which curdles the milk. Milk curd is also called **casein**, a compound used in paints and other commercial products.

Experiment 95

Objective: To illustrate how baking powder fluffs up flour dough
Materials: Drinking Cup ■ Measure ■ Spoon ■ Alcohol Lamp or Candle ■ Test Tube Holder ■ Flour
Chemicals: Water ■ Sodium Bicarbonate (baking soda)
Procedure: Put a spoonful of flour in a cup and add four measures of sodium bicarbonate. Put in 1/2 spoon of water and stir to make a dough. Take a piece of dough about the size of a marble and put it on your spoon. Heat the spoon over a flame. Due to the production of carbon dioxide gas from the heating of the sodium bicarbonate, the dough will puff up. **Do not use or eat this dough!**

Experiment 96

Objective: To test for the presence of tannin in tea
Materials: Test Tubes ■ Test Tube Holder ■ Measure ■ Alcohol Lamp or Candle ■ Tea Leaves (from a tea bag)
Chemicals: Water ■ Ferric Ammonium Sulfate
Procedure: Boil a few tea leaves in a test tube 1/2 full of water. Cool the tube and pour off the liquid into another test tube. Add one measure of ferric ammonium sulfate to the solution and shake the tube. The solution will turn black, indicating the presence of tannin, or tannic acid in foods.

Repeat this experiment using instant tea, coffee and instant coffee. **Do not drink these liquids!**

Experiment 97

Objective: To test butter for freshness
Materials: Spoon ■ Alcohol Lamp or Candle ■ Butter
Procedure: Put one measure of butter in a spoon and heat it over a flame. The butter is fresh if it foams up when heated.

Experiment 98

Objective: To see if rye flour contains wheat flour
Materials: Flat Pieces of Glass ■ Measure ■ Rye Flour
Chemicals: Water
Procedure: Put a small quantity of water on a flat piece of glass, enough to cover a space about 1/2 inch square. Put two measures of the flour in the water. Spread this mixture around and press another flat piece of glass down upon it. If wheat flour is present, white spots will be seen on the glass.

Experiment 99

Objective: To detect the addition of starch to ground meat
Materials: Test Tube ■ Test Tube Holder ■ Glass Tube or Eyedropper ■ Alcohol Lamp or Candle ■ Ground Meat
Chemicals: Water ■ Tincture of Iodine
Procedure: Boil a small quantity of meat in a test tube 1/2 full of water. When the liquid has cooled, add one drop of iodine. A blue color indicates the presence of starch. In meats, a very small amount of starch may be present in the form of added spices. If a strong col-

oration is obtained, however, it is safe to assume that bread or cracker crumbs have been added. This is a very common practice in sausage and deviled meat products to add bulk and weight.

Experiment 100-103

Objective: To detect the presence of iron in canned foods
Materials: Test Tubes ■ Measure ■ Canned Fruit Listed
Chemicals: Water ■ Sodium Ferrocyanide
Procedure: Canned fruit is often very acidic. This may be due to the natural acid of the fruit or some acid added to preserve the fruit. When fruits are canned, sometimes a defect in the coating on the inside of the can causes the acid in the fruit to attack the iron in the can and dissolve a little of it.

Pour a little juice from a can of fruit into a test tube and add a few drops of solution prepared by dissolving one measure of sodium ferrocyanide in a test tube 1/4 full of water. A blue color indicates the presence of iron.

Experiment	Fruit	Iron?
100	Pineapple	
101	Pears	
102	Peaches	
103	Cranberries	

Experiment 104

Objective: To detect the presence of additives in mustard
Materials: Test Tube ■ Test Tube Holder ■ Measure ■ Teaspoon ■ Glass Tube or Eyedropper ■ Alcohol Lamp or Candle ■ Mustard Powder or Prepared Mustard
Chemicals: Water ■ Tincture of Iodine
Procedure: Mustard is sometimes altered with mustard seed hulls, rice or wheat flour, and when any light colored flour is used, a yellow coloring matter is generally added to hide the additives.

Put four or five measures of mustard powder or 1/2 teaspoon of prepared mustard in a test tube. Fill the tube 1/2 full of water and boil the mixture for about ten minutes. When the liquid has cooled, add one drop of iodine. A blue color indicates the presence of a starchy substance, such as rice, flour, etc.

Experiment 105

Objective: To detect the presence of additives in cloves and cayenne pepper
Materials: Test Tube ■ Test Tube Holder ■ Measure ■ Cloves ■ Cayenne Pepper ■ Alcohol Lamp or Candle
Chemicals: Water ■ Starch Test Solution (from Ch. 13, Exper. 1)
Procedure: Most spices are of a starchy nature making it very difficult to detect the presence of starchy additives. Cloves and cayenne pepper, however, contain no starch, and so the presence of starch in these spices is proof of additives.

Place two or three measures of either spice in a test tube 1/2 full of water. Boil the solution for a few minutes. When it cools, add one drop of starch test solution. A blue color indicates the presence of a starchy substance, such as flour.

Experiment 106-108

Objective: To test vegetable skins for the presence of protein
Materials: Test Tube ■ Test Tube Holder ■ Measure ■ Glass Tube or Eydropper ■ Alcohol Lamp or Candle ■ Potato Skins ■ Onion Skins ■ Turnip Skins ■ Lime Juice
Chemicals: Water
Procedure: For each of the following experiments, put a small piece of the indicated vegetable skin in a test tube together with one drop of lime juice and two or three drops of water. Heat the mixture and see if you can detect the presence of protein by smelling for ammonia.

Experiment	Material	Ammonia Smell?
106	potato skins	
107	onion skins	
108	turnip skins	

Experiments 109-112

Objective: to extract the oils found in most citrus fruits
Materials: Test Tubes ■ Test Tube Holder ■ Tablespoon ■ Tissue Paper ■ Alcohol Lamp or Candle ■ All Materials Listed
Chemicals: Water
Procedure: For each of the following experiments, mix and crush two tablespoons of the indicated citrus fruit peel with small pieces of tissue paper. Separate the paper from the peels and place the paper in a test tube 1/4 full of water. Heat the test tube over a low flame and observe the oils forming in the water. You will smell a strong citrus odor from the oil. It smells just like the particular fruit you are using.

Experiment	Fruit Peels	Observations
109	orange	
110	grapefruit	
111	lemon	
112	lime	

CHAPTER 12 - EXAMINING FABRICS

Some fabrics are made from natural fibers, like cotton, silk and wool. Man-made fibers are called **synthetic** and include materials like nylon, rayon, and polyester.

In this chapter, you will perform experiments to tell them apart from each other.

Experiments 1-7

Objective: To distinguish between different fabrics
Materials: Shallow Pan ■ Tweezers ■ Safety Match ■ Small Samples of All Fibers Listed
Chemicals: Water
Procedure: Before beginning, ask your parents for samples of the fabrics listed below. Also you will be using a flame in these experiments, so be extra careful, especially with synthetics.

For each of the following experiments, you will take a piece of the fabric with a pair of tweezers and light it. Hold the fabric over a shallow pan of water.

Before the entire fabric sample is burned, blow the flame out. Notice the smell and appearance of the material and try to make comparisons between natural fibers and man-made (synthetic) fibers.

Experiment	Textile	Type	Observations
1	wool	natural	
2	silk	natural	
3	cotton	natural	
4	linen	natural	
5	nylon	synthetic	
6	rayon	synthetic	
7	acetate	synthetic	

Experiments 8-11

Objective: To determine whether sample fibers come from either plant or animal sources
Materials: Shallow Pan ■ Tweezers ■ Safety Match ■ Small Samples of All Fibers Listed
Chemicals: Water
Procedure: For each of the following experiments, repeat the procedures above. Animal products, which are high in protein, will smell like burned hair. The ends of burned threads are little balls of carbon. The plant fabrics will have very little smell but will smell something like burned paper.

Experiment	Textile	Smell	Source
8	wool		
9	silk		
10	cotton		
11	linen		

Experiments 12

Objective: To create a cotton-iron buff
Materials: Test Tubes ■ Strip of Cotton Cloth
Chemicals: Water ■ Ferric Ammonium Sulfate ■ Sodium Carbonate
Procedure: Dissolve two measures of ferric ammonium sulfate in a test tube 1/3 full of water. Add a small strip of cotton cloth and shake. Remove the cloth and dry it. Now dissolve two measures of sodium carbonate in another test tube 1/3 full of water. Soak the cloth in this solution, remove the cloth, wash it and let it dry. What do you observe?

PART III: FUN WITH CHEMISTRY

CHAPTER 13 - YOUR CHEMICAL MAGIC SHOW

The following experiments might best be described as "magic" tricks that you can perform to astound your friends, parents and teachers. But there's more to a magic show than just tricks.

Like any magician, chemical or otherwise, the best way to ensure a successful performance and a fun time for your friends is to practice your craft. The tricks in this chapter are easy to learn. To really mystify your audience, you'll want to learn how to do them without having to look at this manual. Even great magicians rehearse and rehearse their tricks and illusions until they're just right. And remember, a good magician never reveals the secrets of his or her magic!

Experiments 1-2

Objective: To make writing mysteriously appear
Materials: Test Tube ■ Measure ■ Blank Writing Paper ■ Toothpick ■ Strong Tea ■ Small Sponge ■ Small Bottles
Chemicals: Water ■ Ferric Ammonium Sulfate ■ Sodium Chloride (table salt)
Procedure:

Experiment 1

Dissolve one measure of ferric ammonium sulfate in a test tube 3/4 full of water. Using a toothpick, write a message with this solution on a blank sheet of paper. Carefully blot the writing dry.

Wet a small sponge or napkin with strong tea and rub it gently over the writing. The writing will turn black and become easy to read. If you like, you may make up small bottles of your "mystery ink" to give to your friends and tell them how to make the writing appear.

Experiment 2

A different kind of "secret writing" trick can be performed using ordinary table salt. Mix 4 measures of table salt in a test tube 1/2 full of water. When the writing is dry, rub over it lightly with a soft lead pencil and the writing will stand out.

Experiment 3

Objective: To create "orange-red" invisible ink
Materials: Test Tube ■ Measure ■ Blank Writing Paper ■ Toothpick ■ Small Sponge
Chemicals: Water ■ Ferric Ammonium Sulfate ■ Sodium Carbonate
Procedure: Dissolve four measures of ferric ammonium sulfate in a test tube 1/4 full of water. Using a toothpick, write a message with this solution on a blank sheet of paper. Carefully blot it dry.

Make another solution by dissolving four measures of sodium carbonate in a test tube 1/4 full of water. Sponge this solution over the ferric ammonium sulfate writing. Your invisible ink will appear orange-red.

Experiment 4

Objective: To create invisible "blue" ink
Materials: Test Tube ■ Measure ■ Blank Writing Paper ■ Toothpick ■ Blotting Paper
Chemicals: Water ■ Ferric Ammonium Sulfate ■ Sodium Ferrocyanide

Procedure: Dissolve one measure of sodium ferrocyanide in a test tube 1/2 full of water. Using a toothpick, write a message with this solution on a blank sheet of paper.

Make another solution by dissolving one measure of ferric ammonium sulfate in a test tube 1/2 full of water. Dampen a piece of blotting paper with this solution and press it on the first sheet of paper. Your writing will turn blue.

Experiment 5

Objective: To create a mothball submarine
Materials: Wide-Mouthed Jelly Jar ■ Mothball ■ Measure
Chemicals: Acetic Acid (vinegar) ■ Sodium Carbonate
Procedure: Fill a wide-mouthed jelly jar 3/4 full of acetic acid. Drop a mothball into the jar and it will float!

Now add approximately 8 to 10 measures of sodium carbonate. The mothball will act like a submarine by sinking and rising in the acetic acid.

Experiment 6

Objective: To amaze your friends by creating blue from pink and red
Materials: Glass or Cup ■ Measure ■ Red Litmus Paper
Chemicals: Water ■ Phenolphthalein Solution ■ Sodium Carbonate
Procedure: In a glass 1/2 full of water, add 4 drops of phenolphthalein solution and 4 measures of sodium carbonate. Stir well to make a clear red solution.

Now dip in a piece of red litmus paper. (Be sure not to tell your audience that this is litmus paper. Let them think it is just a plain strip of red paper.) Surprise—the paper turns blue!

Experiment 7

Objective: To make a color appear and disappear
Materials: Glass Tube or Eydropper ■ Test Tube ■ Measure ■ Alcohol Lamp or Candle ■ Test Tube Holder
Chemicals: Water ■ Cornstarch ■ Tincture of Iodine
Procedure: Mix 1/2 measure of cornstarch in a test tube 1/2 full of water. Heat to boiling. Add 1 drop of tincture of iodine. A bright blue color will appear. Heat the entire mixture again and the blue will now magically disappear.

Experiment 8

Objective: To make a color turn colorless
Materials: Drinking Glass ■ Glass Tube or Eyedropper ■ Measure ■ Drinking Straw
Chemicals: Water ■ Phenolphthalein Solution ■ Sodium Carbonate
Procedure: Fill a glass 1/4 full of water. Add 2 drops of phenolphthalein solution and 1/4 measure of sodium carbonate. Stir until the liquid turns red throughout.

Insert a drinking straw into the solution and blow through it. **Do not inhale!** After a little while it will become colorless and will look like ordinary water.

Experiment 9

Objective: To create the illusion of water turning into blood
Materials: Glass or Cup ■ Measure ■ Glass Tube or Eyedropper
Chemicals: Water ■ Phenolphthalein Solution ■ Sodium Carbonate
Procedure: Warn your audience that anyone who cannot stand the sight of blood should leave. Wait a few moments as though you expect somebody to actually get up and go.

Put 5 measures of sodium carbonate into an empty glass. Fill another glass 1/2 full of water and add 10 drops of phenolphthalein solution to it. Pour the contents of the second glass into the first one and stir with your "magic wand". The water will turn red.

Now tell your audience that you can't stand the sight of blood, so you'll have to get rid of it. Insert a drinking straw into the solution and blow out through it. The water will turn clear again.

Experiment 10

Objective: To turn clear water green
Materials: Test Tube ■ Measure ■ Glass Tube or Eyedropper
Chemicals: Water ■ Cobalt Chloride Solution ■ Ammonium Hydroxide (household ammonia) ■ Sodium Ferrocyanide
Procedure: Drop by drop, add about 30 drops of ammonium hydroxide to a test tube 1/4 full of cobalt chloride solution. Your solution will turn green.

Another way of making green is to mix two measures of sodium ferrocyanide in a test tube 1/3 full of cobalt chloride solution.

Experiment 11

Objective: To create magic writing paper
Materials: Measure ■ Blank White Paper ■ Toothpick
Chemicals: Water ■ Ferric Ammonium Sulfate ■ Sodium Ferrocyanide
Procedure: Put one measure of sodium ferrocyanide and one measure of ferric ammonium sulfate on a sheet of blank white paper. Mix the two dry chemicals and rub the powder over the paper. Shake off any excess powder and discard. Using just plain water and a toothpick, write a message on the paper. The writing will appear blue.

Experiment 12

Objective: To create magic blueprint paper
Materials: Test Tubes ■ Measure ■ Blank White Paper ■ Toothpick ■ Small Brush
Chemicals: Water ■ Ferric Ammonium Sulfate ■ Sodium Ferrocyanide ■ Sodium Carbonate
Procedure: Blueprints are drawings used to help people build things. They are called "blueprints" because the drawings appear as white lines on blue paper. You can use the blueprint paper from this experiment to prepare drawings of things you may want to build someday.

Dissolve one measure of ferric ammonium sulfate in a test tube 1/3 full of water. Add one measure of sodium ferrocyanide and shake well. With a small, clean brush, paint a piece of blank white paper with this blue ink. Allow the paper to dry.

Dissolve 2 measures of sodium carbonate in another test tube 1/4 full of water. With a toothpick, write a message with the sodium carbonate solution on the blue paper. The lines will turn white on your magic blueprint.

Experiment 13

Objective: To make pink ink magically appear on blue paper
Materials: Test Tube ■ Glass Tube or Eyedropper ■ Measure ■ Blue Litmus Paper ■ Red Litmus Paper ■ Toothpick
Chemicals: Water ■ Acetic Acid (vinegar) ■ Sodium Carbonate
Procedure: Put 10 drops of acetic acid in a test tube 1/2 full of water. Take a piece of blue litmus paper and announce to your audience that you are holding an ordinary blue sheet of paper. As you write on the paper with the acetic acid solution, a pink message will appear.

You can also make blue writing appear on red litmus paper by writing with a mixture of 3 measures of sodium carbonate in a test tube 1/3 full of water.

Experiment 14

Objective: To test a member of the audience for "chemical power"
Materials: Glass or Cup ■ Measure ■ Glass Tube or Eyedropper ■ Drinking Straw
Chemicals: Water ■ Phenolphthalein Solution ■ Sodium Carbonate

Procedure: Before starting, prepare a solution made up of 1/2 glassful of water, about 1/10 of a measure of sodium carbonate and 2 drops of phenolphthalein solution.

Ask for a volunteer from your audience (someone you know can take a joke) and announce to the rest of the crowd that you have discovered a way to test for a person's "chemical power" level. Hold up the pink test solution you have already prepared and say that when your volunteer blows into the magic liquid, a gold color will indicate he or she has the most power, a silver color the next level, then green, yellow and purple.

Insert a straw into the solution and have the volunteer blow through it into the water. **Do not inhale!** When the liquid turns colorless, shake your head sadly, apologize and announce that the person obviously has no chemical power whatsoever.

Experiment 15

Objective: To make the color pink appear, disappear and appear again
Materials: Glasses or Cups ■ Measure ■ Glass Tube or Eyedropper ■ Spoon
Chemicals: Water ■ Phenolphthalein Solution ■ Sodium Carbonate ■ Acetic Acid (vinegar)
Procedure: Add 2 measures of sodium carbonate to a glass 1/2 full of water. Add 5 drops of phenolphthalein solution to turn the water pink.

In another glass mix one spoonful of acetic acid with 2 spoonfuls of water. **Slowly** pour the pink solution into the second glass. The acetic acid will render the pink water colorless at first, but as you keep pouring, the pink color will return.

Experiment 16

Objective: To turn the color purple into the color green
Materials: Glasses or Cups ■ Red Cabbage Leaves ■ Eyedropper ■ Pot
Chemicals: Water ■ Ammonium Hydroxide (household ammonia)
Procedure: Before starting your show, ask your parents for permission to use the stove or burner. Then make a solution of purple liquid by boiling some red cabbage leaves for about half an hour. Fill one glass 3/4 full of this purple solution.

In another glass, place 6 drops of ammonia. Announce to your audience that you will create green from purple. Pour the purple water into the other glass and it will turn green.

Experiment 17

Objective: To turn a clear liquid amber and then blue
Materials: Glass or Cup ■ Measure ■ Glass Tube or Eyedropper
Chemicals: Tincture of Iodine ■ Water ■ Cornstarch
Procedure: Before starting, prepare a magic glass by putting 3 drops of tincture of iodine into a clean, dry glass. Your audience will think the glass is empty.

Say a few magic words as you pour clear water into the glass. The solution will appear amber. If you then add three measures of cornstarch and stir, the solution will turn blue.

Experiment 18

Objective: To make clear water red and clear again
Materials: Pitcher ■ 5 Drinking Glasses ■ Measure ■ Glass Tube or Eyedropper
Chemicals: Water ■ Sodium Carbonate ■ Phenolphthalein Solution ■ Acetic Acid (vinegar)
Procedure: Prepare for this trick by filling a pitcher with water and setting it on the center of a table. Place five empty glasses around the pitcher. In one glass put one measure of sodium carbonate. In another glass put 6 drops of phenolphthalein solution. In a third glass put 21 drops of acetic acid. The other two glasses are for effect. Finally, add a few drops of water to the first two glasses to dissolve the chemicals and you are ready to begin.

Let the audience see the water in the pitcher. Fill each of the glasses with water from the pitcher. Pour the water back into the pitcher from all the glasses except the acetic acid.

Now pour water back into the four empty glasses from the pitcher. The water will be red. Pour all five glasses back into the pitcher. Now when you fill the glasses again, the liquid will be colorless.

Experiment 19

Objective: To turn clear water red, then blue
Materials: Pitcher ■ 4 Drinking Glasses ■ Measure ■ Glass Tube or Eyedropper
Chemicals: Water ■ Sodium Ferrocyanide ■ Ferric Ammonium Sulfate ■ Sodium Carbonate ■ Phenolphthalein Solution
Procedure: Prepare for this trick by filling a pitcher with two glassfuls of water and setting it on the center of a table. Place four empty glasses in front of the pitcher.

In one glass put two measures of sodium ferrocyanide. In another glass put two measures of ferric ammonium sulfate. In a third glass put one measure of sodium carbonate. In the last glass put 6 drops of phenolphthalein solution. Now you are ready to begin.

Let the audience see the water in the pitcher. Fill each of the glasses 1/2 full of water from the pitcher. Pour the last two glasses back into the pitcher, then pour the liquid back into the glasses. The liquid in these glasses will be red. Pour the first two glasses back into the pitcher. When you refill these glasses, the liquid will be blue.

Experiment 20

Objective: To suspend a ring in the air while the string that holds it burns to ashes
Materials: Cotton String ■ Glass or Cup ■ Spoon ■ Test Tube Holder ■ Light Ring ■ Safety Matches
Chemicals: Water ■ Sodium Chloride (table salt)
Procedure: Before you begin your show, prepare for this trick by soaking a 6 inch string in a glass 1/2 full of water with 2 spoons of table salt. Let the string soak for at least an hour. Then take it out of the solution and dry it before starting your show.

Show the "ordinary" string to your audience. Tie a light ring to one end of the string and hold the other end with the aid of a test tube holder. Light the string from the top with a safety match. The ring will still be held in the air by the ashes of the burned string.

Experiment 21

Objective: To bring forth the scent of fresh flowers from beyond the great unknown
Materials: Test Tube ■ Test Tube Holder ■ Measure ■ Glass Tube or Eyedropper ■ Alcohol Lamp or Candle
Chemicals: Sodium Carbonate ■ Castor Oil
Procedure: Announce to your audience that you will call upon your friends "on the other side" to deliver flowers—ghost flowers—to everyone in the room.

Heat one measure of sodium carbonate in a clean, dry test tube with three drops of castor oil. Stop the heating process when a cloud of white vapor rises in the test tube. Walk around the audience and wave the test tube around so everybody can smell the scent of violets.

Experiment 22

Objective: To use magic to create national flags
Materials: Test Tubes ■ Measure ■ Glass Tube or Eyedropper ■ Blank Drawing Paper ■ Sponge or Cotton Ball ■ Pencil ■ Small Brushes
Chemicals: Water ■ Sodium Carbonate ■ Sodium Ferrocyanide ■ Ferric Ammonium Sulfate ■ Phenolphthalein Solution
Procedure: Draw a flag of the United States **lightly** in pencil on a piece of drawing paper. Paint the blue section of the flag with a mixture of one measure of sodium ferrocyanide and 1/2 a test tube of water. Put two measures of sodium carbonate in a test tube 1/2 full of water and paint the red stripes with the solution. Leave the white stripes and stars unpainted and let the paper dry.

Make a mixture of one measure of ferric ammonium sulfate and 5 drops of phenolphthalein solution in a test tube 1/2 full of water. Wet a sponge or cotton ball with this solution and quickly wipe it over the paper. The American flag will suddenly appear.

Using these same solutions, you can make the flags of other nations, as well.

Experiment 23

Objective: To insert a glass of cotton into a full glass of water without spilling a drop
Materials: Glasses or Cups ■ Cotton
Chemicals: Water
Procedure: Tell your audience that water is made of tiny little molecules and that you will prove it by filling up the spaces between these molecules.

Fill a glass to the very top with water. Fill another glass with cotton or cotton balls and place it next to the first glass. Now take the cotton out of the glass in one piece and **slowly** put the cotton into the glass of water. To everyone's surprise, you can put the cotton all the way into the water without spilling a drop.

Experiment 24

Objective: To create an egg submarine
Materials: Tall Drinking Glass ■ Egg ■ Spoon
Chemicals: Water ■ Sodium Chloride (table salt)
Procedure: Fill a tall glass 1/2 full of water and stir in 8 spoonfuls of table salt.

Now fill the glass almost full with plain water by very, very carefully pouring the plain water down the side of the glass so it does not mix with the salt water.

If you carefully put an egg into this glass it will sink in the plain water but float on the salt water, halfway to the bottom. As the egg sinks, say your magic words and it will surprise your audience when the egg stops in the middle of the glass.

Experiment 25

Objective: To use the properties of frozen solids to amaze your friends
Materials: Dish ■ String
Chemicals: Ice Cubes ■ Sodium Chloride (table salt)
Procedure: Put an ice cube in a dish and invite your friends to try to lift it out with a string. After they have tried, sprinkle some table salt on the cube. Lay the string across the top of the cube and in a short while the string will freeze to the ice cube. Now you can lift the cube out using the string.

Experiment 26

Objective: To create an unlightable candle
Materials: Short Wax Candle ■ Drinking Glass ■ Glass Tube or Eyedropper ■ Teaspoon
Chemicals: Sodium Bicarbonate (baking soda) ■ Acetic Acid (vinegar)
Procedure: Stick a short candle in the bottom of a drinking glass and light it. The wick must be at least an inch below the rim of the glass. Put a teaspoonful of sodium bicarbonate at the bottom of the glass and add a few drops of acetic acid. Soon the candle will go out. If you try to light it again, the match will go out.

Experiment 27

Objective: To make apple seeds move at your command
Materials: Apple Seeds ■ Drinking Glass ■ Clear Soda (club soda or lemon-lime soda)
Procedure: Fill a glass with clear soda and drop in an apple seed. Tell your audience that you are going to command the seed to rise and fall. When you see the bubbles gathering on the seed, tell it to rise. Just before it hits the surface tell it to fall. It will sink as the bubbles burst at the surface.

Experiment 28

Objective: To magically and safely brand your hand
Materials: Piece of Soap ■ Piece of Paper ■ Metal Pie Plate ■ Alcohol Lamp or Candle ■ Pencil
Procedure: Before starting this trick, write your initials on the back of your hand with a piece of sharpened soft soap.

Tell your audience that you have discovered a magic way to transfer writing. Write your initials with a pencil on a small piece of paper and show it to the audience. Then carefully burn the paper (in a metal pie plate), crush the ashes and rub them gently over the back of your hand. The ashes will stick to the soap and you can show the audience that you have been magically and safely branded.

Experiment 29

Objective: To soften a fresh egg just enough to make it appear elastic
Materials: Drinking Glass ■ Fresh Egg
Chemicals: Acetic Acid (vinegar)
Procedure: Fill a drinking glass with acetic acid and place a fresh egg in it. Allow the glass to stand undisturbed for 24 hours. At the end of this time carefully feel the egg with your fingers.

If the egg is soft and elastic, remove it from the glass and examine it carefully. If the egg is not soft, pour out the acetic acid, replace it with fresh acetic acid and let the egg sit in it for another 24 hours.

When the egg has become elastic, it may be squeezed into a bottle through which it would not ordinarily pass without breaking. But be careful. The egg shell may still crack if too much pressure is applied.

Experiment 30

Objective: To make magical streamers appear in water
Materials: Clear Glass Quart Jar ■ Dye Wafer
Chemicals: Water
Procedure: Fill a clear glass quart jar with water. Wait a few moments until no movement appears on the surface of the water. Carefully drop a small piece of dye wafer on the surface of the water. Watch what happens.

Experiment 31

Objective: To waterproof your hand
Materials: Basin ■ Ring
Chemicals: Water ■ Powdered lycopodium
Procedure: Prepare for this trick by filling a basin with water and sprinkling some powdered lycopodium on top of the water. Powdered lycopodium will waterproof your hand.

Put a ring or some other easily identifiable object in your basin of water. Say your magic words as you put your hand into the water to retrieve the ring. When you take your hand out, you will be holding the ring but your hand will not be wet.

Experiment 32

Objective: To make a homemade weather forecaster
Materials: White Crepe Paper ■ Spoon ■ Glass or Cup
Chemicals: Water ■ Cobalt Chloride Solution
Procedure: Here's a souvenir you can give to your audience at the end of your show. Soak a strip of white crepe paper in cobalt chloride solution. If this paper is hung out-of-doors, it will help forecast the weather. Pink means rain and blue means the weather is dry.

Experiment 33

Objective: To soften a chicken bone just enough to make it appear rubber.
Materials: Drinking Glass ■ Small Chicken bone (wishbone)
Chemicals: Acetic Acid (vinegar)
Procedure: Obtain a small chicken bone such as a wishbone, clean it thoroughly and let it sit completely immersed in a glass full of acetic acid for 24 hours. At the end of this time remove the bone from the acetic acid and notice how rubbery it is. You will probably be able to tie it in knots without breaking it. Then, if you let it dry, just think about what an interesting conversation piece you'll have.

CHAPTER 14 - BE A CHEMICAL DETECTIVE

Chemistry plays an important role in the fields of crime detection and security. In this chapter, you will learn more about the processes used in fingerprinting and fingerprint detection.

Experiment 1

Objective: To make a record of your own fingerprints
Materials: Rubber Roller (from art supply store) ■ Flat Board (like a plastic cheese board) ■ 8" Square White Card ■ Printer's Ink
Procedure: Making a record of your own fingerprints is more than fun. It is a very valuable piece of information to have on record, much like your birth certificate and other pieces of information that tell a lot about you.

To make fingerprints with ink, pour the ink onto a flat board and roll it out evenly with a rubber roller. Divide your card into ten squares, each about two inches high and 1-1/2" wide.

In order, press your finger into the ink and then gently **roll**—do not press—your inky finger on the card in the appropriately labeled square. When you are finished, give the card to your parents for safekeeping.

Experiment 2

Objective: To make a record of your own fingerprints using chemicals
Materials: Test Tubes ■ Measure ■ Cotton Ball ■ Pen ■ 8" Square White Card ■ Alcohol Lamp or Candle ■ Flat Board ■ Instant Tea
Chemicals: Water ■ Ferric Ammonium Sulfate
Procedure: Fill two test tubes 1/2 full of water. Add two measures of ferric ammonium sulfate to one and shake. Add 4 measures of instant tea to the other and heat until the liquid is deep brown. Then let it cool.

Pour the ferric ammonium sulfate solution into the instant tea solution and mix. This will be your fingerprint ink. Prepare your card as you did in the last experiment.

Dampen the cotton ball with your new ink and dab some on the flat board. Then gently roll your finger tip on the ink coated board. Next make an impression on the card in the appropriate square. When you are finished, give the card to your parents for safekeeping.

Experiment 3

Objective: To bring out fingerprints on paper
Materials: Aluminum Foil ■ Measure ■ Talcum Powder, Baby Powder or Face Powder ■ Candle ■ Wax Paper ■ White Paper
Procedure: Light the candle and hold some aluminum foil at a slant over the flame so that soot collects on it. Scrape off the soot from time to time and spread it out on a sheet of wax paper. When you have collected about a measure's worth of soot, add one measure of powder to it and mix the two ingredients.

Breathe on your pinkie finger several times and then press it down onto a sheet of white paper. Shake out the soot-powder mixture over the spot where you made the impression. Shake it over the area several times, each time returning the excess to the wax paper. You will soon see a clear impression of your fingerprint.

Repeat this procedure with prints you make on other kinds of paper.

Note: Save this "soot" for future experiments.

Experiments 4-6

Objective: To bring out fingerprints on hard surfaces
Materials: Dark Glass Bowl ■ Talcum Powder or Baby Powder ■ Hard Plastic Object ■ Dark Polished Wood ■ Alcohol Lamp or Candle ■ Glass Slide
Procedure:

Experiment 4

Press your fingers on a dark glass surface and then sprinkle a bit of powder onto where you just pressed. Blow off the extra powder (or use a small brush) and you will be able to see your fingerprints.

Experiment 5

Repeat the above procedure using a glass slide, except use candle soot (from Ch. 14, Exper. 3) in place of the powder, and heat the glass over a low flame to make the impression come clear.

Experiment 6

Repeat the above procedure on hard plastic. Be extra careful when warming the material over the low flame.

Experiment 7

Objective: To "lift" fingerprints from a surface
Materials: Sticky Transparent Tape ■ Shiny Black Paper ■ All Materials Listed for Ch. 14, Exper. 4-6
Procedure: To examine a fingerprint more easily, or to keep it, you can "lift" it.

"Dust" for fingerprints as you did in Ch. 14, Exper. 4-6. Then press a piece of sticky, transparent tape over each print or collection of prints and peel the tape away with the powder pattern on it. Stick the tape on shiny black paper and the print will show up very clearly.

CHAPTER 15 - THE GLASS WORKS

Glassmaking is one of the oldest and most fascinating crafts still being practiced today. At any one of hundreds of craft fairs around the country you can see glassmakers practicing their art: blowing, stretching and shaping glass into sparkling scupltures, vases and other useful objects.

But glassworking also has practical value to the modern chemist, not only in understanding how different types of glass are made, but in using the characteristics of glass to fashion equipment necessary for experimentation.

Caution: Working with glass is serious work. For best results as well as your own protection, follow directions closely and be extra careful in carrying out experiments.

Experiment 1

Objective: To make a sheet of safety glass
Materials: 2 Small Pieces of Glass (e.g. glass slides) ■ Modeling Cement ■ Sheet of Celluloid or Clear Plastic ■ Clamp or Vise ■ Cloth ■ Hammer
Procedure: Safety glass is made by cementing a sheet of celluloid or other clear plastic between two sheets of glass. Cover one side of each piece of glass with modeling cement. Then cut a piece of celluloid to the same size and place this between the cemented sides of the glass. Press this assembly together firmly and place it in a clamp or vise for two or three days. At the end of this time, you will notice that you can see through the two pieces of glass and the plastic just as if they were a single piece of glass. Now wrap the safety glass in a couple of thicknesses of cloth and break it with a hammer. Notice that it does not shatter, but holds together and merely cracks.

Experiment 2

Objective: To make a sheet of wire glass
Materials: Thin Strip of Wire Screen ■ Glass Tube ■ Alcohol Lamp or Candle
Procedure: Obtain a thin strip of screen door wire just large enough to be placed inside the end of a glass tube. Heat the end of the tube until the glass fuses together around and over the screen wire. A close examination will reveal your wire firmly embedded in the glass. This is the type of glass commonly used in skylights, where injury might result to somebody if the glass were shattered. The wire acts as a supporting material and does not allow the glass to fall apart, even if it should become cracked.

Experiment 3

Objective: To cut a glass tube
Materials: Glass Tube ■ Triangular File ■ Cloth
Procedure: Measure the desired length of the tube and then make a scratch with a triangular file at the location in which you wish to break the tube. Now wrap the entire tube in cloth and grasp the tube firmly in both hands. Hold it with your thumbs pressing upon the tube directly underneath the scratch. Apply pressure outward with your hands and break the tube just as you would a stick or pencil. With a little practice, a clean and even fracture can be obtained. **Careful**—The edges will be sharp!

Experiment 4

Objective: To smooth newly cut glass tubing via fire polishing
Materials: Newly Cut Glass Tubing (from previous experiment) ■ Alcohol Lamp
Procedure: It is always a good idea to fire polish the sharp edges of a glass tube to make it safer to handle and use. Hold the ends of the tube which have been broken in the flame of your alcohol lamp for a few minutes. The heat will round off the sharp edges and make

them smooth. When fire polishing the ends of a glass tube always rotate the tube by rolling it between your thumb and forefinger to distribute the heat evenly.

Experiment 5

Objective: To etch glass
Materials: Drinking Glass ■ Glue (high quality) ■ Brush
Procedure: Obtain some high quality glue and, using a brush, paint a thick coat over the outside and inside of a drinking glass. Let the glass sit for about a day until the glue dries and then put it in a warm place over a heater or near a stove. Keep the glass there for another day.

Now remove the glass from the warm place and put it someplace cool. About this time the glue will start to crack and, in doing so, will break off small chips of glass from the surface of the glass. After the glass has remained in the cool place for a little while, carefully wash it with warm water to remove all traces of glue. Now examine the glass. You will find very peculiar designs etched on the surface.

If this experiment does not work properly with one coating of glue, apply two more coats before putting it in a warm place.

Experiment 6

Objective: To make ground glass
Materials: Flat Glass (e.g. glass slide) ■ No. 2 Sandpaper
Procedure: Working on a flat table, carefully rub over the surface of a sheet flat glass with some No. 2 sandpaper. (Sandpaper is commonly numbered to indicate relative coarseness.) After two or three minutes of rubbing you will find that you have thoroughly ground or scratched the glass. Try writing on this ground glass with an ordinary pencil. You can grind a spot on a bottle in this manner, thus enabling you to write on it.

Experiment 7

Objective: To bend a glass tube
Materials: Glass Tube ■ Alcohol Lamp
Procedure: A glass tube can be bent and shaped to make things like right angle glass tubes and drinking straws.

Fire polish both ends of a glass tube as outlined in Ch. 15, Exper. 4. Select the spot on the tube where you want it to bend. Hold this spot in the flame and rotate the tube slowly. After a short time, you will feel the tube getting softer. Quickly remove the tube from the flame and slowly bend it by pulling the ends down. Lay it aside to cool.

Experiment 8

Objective: To dose off a glass tube
Materials: Glass Tube ■ Alcohol Lamp
Procedure: Hold one end of a glass tube in a flame and rotate it slowly until the end melts closed.

NOTES