

Dedication	iii
Preface	v
Welcome!	ix
How to Use this Guidebook	x
How do I find an appropriate activity?.....	x
What's included with each activity?.....	x
Where can I purchase materials?.....	xii
Be Careful—And Have Fun!	xiii
ACS Minimum Safety Guidelines	xiv
Part 1—Introduction	1
Carbon Dioxide	2-A
1 The Blowing Contest.....	3
2 Carbon Dioxide Rocket Launch	9
3 A Balloon Full of Carbon Dioxide.....	13
4 Cylinders of Color	17
5 Fire Extinguishers	25
6 Carbon Dioxide from Minerals and Rocks.....	29
Chemistry with Foodstuffs	32-A
7 Cookies and Yeast.....	33
8 Corn Starch Putty.....	39
9 Hard-boiled or Raw, Fresh or Stale?.....	43
10 Ice on a String.....	47
11 Iron for Breakfast.....	49
12 Cabbage Patch Detective	53
13 Curdling of Milk	63
14 Heating a Raisin.....	67
15 The Popcorn Pop	71
16 Chromatography of Grape Drink	77
17 Surface Area and Dissolving Rate	83
Color Changes	86-A
18 Magic Signs.....	87
19 Disappearing Ink	91
20 Weather-or-Not Flowers	95
21 Mouth-to-Mouth Bottles.....	99
22 Color-Changing Bottle	105
23 Temperature-Induced Color Change	111

Density	114-A
24 Household Density Columns	115
25 Not on the Level	119
26 Colored Layers	123
27 Bobbing	129
28 Density Water Fountains	133
From the Five and Dime	138-A
29 Needle Through a Balloon	139
30 Crushing Bottles Reversibly	143
31 Chemistry in a Ziploc® Bag	147
32 Balloon Inside a Flask	155
33 Collapsing Aluminum Can	159
34 Chemiluminescence: Investigating Lightsticks	163
35 Rubber Band Stretch	167
36 Boiling Water in a Paper Pot	173
37 Flashing	177
Part 2 — Overview and Background	181
Part 2	182-A
38 A Two-Message Sign	183
39 Iodine Clock Reaction	189
40 The Great Balloon Race	195
41 Effects of Liquid Nitrogen	199
42 Ammonia Fountain	203
43 A Glowing Blue Reaction	209
44 Hydrogen Explosion in a Can	213
45 Nylon 6–10	217
46 Banging Balloons	221
47 Silver and Gold Pennies	225
48 Superheated Steam	229
49 Boiling Water with Ice	235
50 From Yellow to Purple	241
51 Non-Burning Towel	245
52 Chemical Genie in a Bottle	249
53 Reaction of Zinc and Iodine	253
Appendix A: Shopping List; Supplier Contact Information	257
Appendix B: Easy-to-Find Chemicals	263
Appendix C: Glossary of Terms	269
Appendix D: Activities: Indexed by Key Concept	275
Appendix E: Activities: Alphabetical List	283

Carbon Dioxide

Concept and Activity	Recommended Grade Levels					Page
	K-3	4-6	7-9	10-12	Gen	
1 The Blowing Contest	<input checked="" type="checkbox"/>	3				
<p>Does the breath that you exhale contain the same compound found in dry ice? Try this activity and find out that carbon dioxide {CO₂} and limewater react to produce the white solid calcium carbonate {CaCO₃}. Since calcium carbonate is only sparingly soluble in water, the limewater becomes cloudy. This reaction occurs regardless of the source of carbon dioxide. Some sources of CO₂ include your breath, dry ice, and Alka Seltzer®.</p>						
2 Carbon Dioxide Rocket Launch	<input checked="" type="checkbox"/>	9				
<p>What happens when you mix baking soda and vinegar in a corked bottle? In this activity, the pressure from the carbon dioxide {CO₂} produced by the reaction propels the cork across the room much like a small rocket.</p>						
3 A Balloon Full of Carbon Dioxide	<input checked="" type="checkbox"/>	13				
<p>Can you inflate a balloon by placing a solid in it? If the solid is dry ice (solid carbon dioxide), it will change to a gas (sublime) at room temperature. Because carbon dioxide occupies more space as a gas than as a solid, the balloon inflates.</p>						
4 Cylinders of Color	<input checked="" type="checkbox"/>	17				
<p>Can Alka-Seltzer® or dry ice change the color of a solution? They can if they are added to a basic solution which contains an acid-base indicator. Juices or extracts of foods and flowers containing natural acid-base indicators may be used for this activity.</p>						
5 Fire Extinguishers	<input checked="" type="checkbox"/>	25				
<p>How does a fire extinguisher work? In this activity, you will observe how carbon dioxide {CO₂}, found inside a carbon dioxide fire extinguisher, extinguishes the flame from a candle.</p>						
6 Carbon Dioxide from Minerals and Rocks	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	29
<p>Rocks and minerals that contain carbonate salts can be identified by testing them with acids. If carbonates are present, carbon dioxide is formed. Using an overhead projector enables an entire class to view the formation of bubbles of carbon dioxide to confirm the presence of carbonates.</p>						

Chemistry with Foodstuffs

Concept and Activity	Recommended Grade Levels					Page
	K-3	4-6	7-9	10-12	Gen	
7 Cookies and Yeast What makes yeast grow? In this activity, students conduct several tests to determine which ingredients in cookies are necessary for yeast to grow. The volume of gas produced is also determined.	<input checked="" type="checkbox"/>	33				
8 Corn Starch Putty What's sillier than Silly Putty®? Corn starch putty! This activity demonstrates the unusual properties of corn starch putty.	<input checked="" type="checkbox"/>	39				
9 Hard-boiled or Raw, Fresh or Stale? What a disappointment to pick the wrong egg out of the refrigerator! If only you could tell a hard-boiled egg from a raw egg, or a fresh egg from a stale egg without cracking the shell. This activity shows a way to distinguish between kinds of eggs.	<input checked="" type="checkbox"/>	43				
10 Ice on a String Can you lift an ice cube with a piece of string without tying it? In this activity, you will use a little salt, a piece of thread, and some practical chemistry.	<input checked="" type="checkbox"/>	47				
11 Iron for Breakfast Do you eat small pieces of iron metal for breakfast? You might if you eat cereal that is fortified to meet 100% of the minimum daily dietary requirement of iron. In this activity, you will extract the food-grade iron filings from a cereal and examine their properties.	<input checked="" type="checkbox"/>	49				
12 Cabbage Patch Detective Can you get the colors of the rainbow from cabbage juice? Well, almost. In this activity, you extract the juice from red cabbage to use as a universal acid–base indicator. The materials you test will give a range of colors that include red, pink, lavender, purple, blue, green, and yellow. Part 1 provides an easy and fun method for testing liquids at home by using paper that has been dyed with red cabbage juice. Part 2 is a more advanced method of determining the relative acidity or basicity of a solution; the color of a sample is compared to the colors of several buffer solutions of known pH.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	53
13 Curdling of Milk What causes milk to curdle? This activity demonstrates the coagulation of milk with rennin, allowing you to smell and touch the curds of milk.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	63
14 Heating a Raisin Does a dried fruit contain water? In this activity, you will heat a raisin to discover that water is still present even in dried fruit.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	67

Chemistry with Foodstuffs

Concept and Activity	Recommended Grade Levels					Page
	K-3	4-6	7-9	10-12	Gen	
15 The Popcorn Pop	<input type="checkbox"/>	71				
<p>Have you ever wondered why popcorn pops? This experiment examines the relationship between water content and the popping of corn kernels.</p>						
16 Chromatography of Grape Drink	<input type="checkbox"/>	77				
<p>How many components are in grape-flavored Kool-Aid®? By using a Sep-Pak® C18 cartridge, four components in grape-flavored Kool-Aid® can be separated: polar components (sugar and citric acid), red food coloring, blue food coloring, and nonpolar components (flavoring oils). (The Sep-Pak® is a small, reusable cartridge which is used in industry and research to separate liquid mixtures into their component parts.)</p>						
17 Surface Area and Dissolving Rate	<input type="checkbox"/>	83				
<p>How does surface area affect the rate of dissolving a solid? In this activity, students compare the dissolving rate of sugar cubes with that of smaller pieces and powdered sugar.</p>						

Color Changes

Concept and Activity	Recommended Grade Levels					Page
	K-3	4-6	7-9	10-12	Gen	
18 Magic Signs						87
<p>Do you want to begin the day by developing a secret message painted in invisible ink and then make that message disappear? This activity allows a two color message to be developed.</p>						
19 Disappearing Ink						91
<p>Will an “ink” stain on a white towel disappear? This activity shows how you can make ink that will disappear with the help of carbon dioxide in the atmosphere.</p>						
20 Weather-or-Not Flowers						95
<p>Can you use a “flower” to predict the weather? In this activity, you will make weather-or-not flowers that indicate humidity using a cobalt chloride solution.</p>						
21 Mouth-to-Mouth Bottles						99
<p>Students may find it difficult to believe their eyes—the clear, colorless liquid in one bottle inverted over another becomes pink (or blue) without any visible mixing of chemicals. Get them to speculate... Why?</p>						
22 Color Changing Bottle						105
<p>What makes a solution change color? This activity shows you how to change the color of a solution inside a bottle (from colorless to blue, or from colorless to red) using an oxidation–reduction reaction.</p>						
23 Temperature-Induced Color Change						111
<p>Can changing the temperature change the concentration of species in equilibrium? In this activity, a blue solution turns pink when cooled in an ice water bath, and the pink solution turns blue when it is warmed. You can repeat these color changes any number of times by simply warming or cooling the solution.</p>						

Density

Concept and Activity	Recommended Grade Levels					Page
	K-3	4-6	7-9	10-12	Gen	
24 Household Density Columns						115
What can you make with Karo [®] syrup, Dawn [®] detergent, vegetable oil, and rubbing alcohol? This activity shows you how to create a colorful density column from common items available from the supermarket.						
25 Not on the Level						119
How can the level of a liquid on one side of a U-shaped tube be different than the level on the other side? In this activity, you'll discover that the key to the not-on-the-level U-tube is using two liquids of different densities in the tube.						
26 Colored Layers						123
Can you place colored solutions in test tubes and straws without all the colors mixing together? This activity shows you how to layer colored solutions having different densities.						
27 Bobbing						129
Can you make spaghetti or raisins bob up and down in a liquid? This can be done by generating bubbles of carbon dioxide gas that cause spaghetti and raisins to rise when the bubbles are attached and sink when the bubbles escape at the surface.						
28 Density Water Fountains						133
Submerge a bottle of brightly colored hot water in a container of cold water and watch the colorful streams spiral up to the top like a fountain. Reverse the procedure by submerging a bottle of colored, cold water into a container of hot water—the colorful streams do not appear.						

From the Five and Dime

Concept and Activity	Recommended Grade Levels					Page
	K-3	4-6	7-9	10-12	Gen	
29 Needle Through a Balloon	<input checked="" type="checkbox"/>	139				
<p>Can you stick a needle into a balloon without popping it? If you lubricate the needle and pass it through the right spot, you might be surprised. This activity demonstrates how lubrication and location of the needle in the balloon can result in the unexpected. This experiment stimulates students to explain the unexpected with a rational, scientific reason.</p>						
30 Crushing Bottles Reversibly	<input checked="" type="checkbox"/>	143				
<p>Can gravity and air pressure work together to crush and then expand a plastic bottle? Try this dramatic activity to find the answer to this question.</p>						
31 Chemistry in a Ziploc® Bag	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	147
<p>Three substances are mixed in a sealed plastic bag; a reaction occurs that causes the bag to get warm and expand as the color of the contents is changing.</p>						
32 Balloon Inside a Flask	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	155
<p>Have you ever tried to blow up a balloon <i>inside</i> a flask? This demonstration illustrates how air pressure and a steam-to-water phase change can work together to accomplish this event. You can also vary this activity by using a chemical reaction to inflate the balloon into the flask.</p>						
33 Collapsing Aluminum Can	<input checked="" type="checkbox"/>	159				
<p>How can air cause an aluminum can to collapse? Try this activity and find out how atmospheric pressure can be used to crush an aluminum can.</p>						
34 Chemiluminescence: Investigating Lightsticks	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	163
<p>Is light an indication of a chemical reaction? Lightsticks are a convenient package for showing chemiluminescence, a reaction that produces light without heat.</p>						
35 Rubber Band Stretch	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	167
<p>What happens to a stretched rubber band when it is heated? It contracts! Try this demonstration and make the observation for yourself.</p>						
36 Boiling Water in a Paper Pot	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	173
<p>Can you boil water in a paper pot? Try this activity and see that you can, in fact, boil water without burning the paper.</p>						
37 Flashing	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	177
<p>Can you flash a flash bulb without using a conventional battery? This demonstration uses a chemical reaction to produce the electrical energy that causes a flash bulb to flash.</p>						

Part 2

Concept and Activity	Recommended Grade Levels					Page
	K-3	4-6	7-9	10-12	Gen	
38 A Two-Message Sign	<input checked="" type="checkbox"/>	183				
<p>Can one sign have two invisible messages? In this activity, one reagent reveals a hidden message; a second reagent erases the first message and develops a new one.</p>						
39 Iodine Clock Reaction	<input checked="" type="checkbox"/>	189				
<p>Turn on the music, mix the chemicals, and watch the solutions turn blue to the beat of the music. By changing the concentrations of the two colorless solutions, you can change the time it takes for the blue color to appear. The solutions can be prepared so that the color change in a series of flasks is sequential with the last one turning when the music just finishes.</p>						
40 The Great Balloon Race	<input checked="" type="checkbox"/>	195				
<p>Why do some balloons float? Why do some drop to the floor? Why do some fall gently to the floor? In this activity, you will “race” three balloons filled with three different gases and observe how their relative densities cause them to float, drop, or drift.</p>						
41 Effects of Liquid Nitrogen	<input checked="" type="checkbox"/>	199				
<p>Is it possible to shatter a racquet ball by dropping it on the floor or throwing it against a wall? Yes—if it is first cooled to a very low temperature. This activity demonstrates the effect of extremely low temperature on common objects cooled with liquid nitrogen.</p>						
42 Ammonia Fountain	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	203
<p>Can you push water up a long piece of glass tubing? In this activity, the exceptionally high solubility of ammonia gas in water allows you to accomplish this event in a dramatic demonstration.</p>						
43 A Glowing Blue Reaction	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	209
<p>Did you know that some chemical reactions produce energy in the form of light without producing heat? In this activity, you simultaneously pour a colorless solution and a blue solution through clear plastic tubing to observe the phenomenon of chemiluminescence.</p>						
44 Hydrogen Explosion in a Can	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	213
<p>How can you ripple the chips of a Pringle’s® can? This activity is a dramatic example of the reaction that occurs when an explosive mixture of oxygen and hydrogen is ignited.</p>						
45 Nylon 6–10	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	217
<p>Imagine a thin rope of nylon being pulled from the boundary between two liquids. Keep pulling—up to the top of a ladder, across the front of the room, or around and around a popsicle stick or test tube. It seems almost endless!</p>						

Part 2

Concept and Activity	Recommended Grade Levels					Page
	K-3	4-6	7-9	10-12	Gen	
46 Banging Balloons	<input type="checkbox"/>	221				
<p>Three balloons float in the air. One is filled with helium gas, a second with hydrogen gas, and a third with hydrogen and oxygen mixed together. Can you guess which will cause the loudest “bang”? This activity shows the explosive reaction of hydrogen and oxygen and the nonflammable nature of helium.</p>						
47 Silver and Gold Pennies	<input type="checkbox"/>	225				
<p>Alchemists tried to turn ordinary metals into gold. In this activity, a penny turns “gold” by forming a metal alloy. When pre-1982 pennies react with zinc in a hot zinc chloride solution, they turn a silver color. The silver color then changes to a gold color when you carefully heat the coin with a “cool” flame.</p>						
48 Superheated Steam	<input type="checkbox"/>	229				
<p>Water is a substance often used to put out a fire. Can it be used to start a fire? Yes. In fact, in this activity, you will ignite a match and scorch paper with steam that is much hotter than 100 °C.</p>						
49 Boiling Water with Ice	<input type="checkbox"/>	235				
<p>Can you really boil water by using ice? You can accomplish this feat by using the ice to reduce the pressure inside a flask containing water. This activity demonstrates this phenomenon in a dramatic fashion.</p>						
50 From Yellow to Purple	<input type="checkbox"/>	241				
<p>Is it possible to change an apple-juice-colored solution to a grape-juice-colored solution? In this activity, such a change occurs as a result of a chemical reaction.</p>						
51 Non-Burning Towel	<input type="checkbox"/>	245				
<p>How can a towel be engulfed in flames without catching fire itself? The towel is soaked in a 1:1 mixture of alcohol and water prior to being ignited. When ignited, it becomes engulfed in flames as the alcohol burns, but the towel itself doesn’t burn or char. Most of the heat produced by the burning alcohol is absorbed by the water, so the temperature of the towel remains below its ignition temperature.</p>						
52 Chemical Genie in a Bottle	<input type="checkbox"/>	249				
<p>Do genies really exist in bottles? Chemical genies do. This activity demonstrates the formation of a cloud of steam, a “chemical genie,” that results from the manganese dioxide {MnO₂} catalyzed decomposition of hydrogen peroxide {H₂O₂}.</p>						
53 Reaction of Zinc and Iodine	<input type="checkbox"/>	253				
<p>A mixture of iodine and zinc is placed in a test tube; no apparent reaction occurs. Upon the addition of water, a vigorous, exothermic reaction occurs accompanied by the production of a cloud of purple iodine vapor.</p>						