In-Touch Science: Chemistry & Environment

A Cornell Cooperative Extension Publication

Acknowledgments

In-Touch Science: Chemistry and Environment was developed as an interdisciplinary Cornell Cooperative Extension education program for children in grades 3 to 5. The project was funded by the National Science Foundation and Cornell University.

The project team included Louis Albright, Sofia Betancourt, Dan Brown, Charlotte Coffman, Marcia Eames-Sheavly, Doreen Greenstein, Ann Lemley, Raylene Ludgate, Jane Mt. Pleasant, Tatiana Stanton, Dan Tennessen, John Terry, and Nancy Trautmann.

Appreciation is extended to the Advisory Committee: Julie Chapin, Jennifer Greene, Karen Hollweg, Richard Ponzio, E. J. Sarton, and Deborah Trumbull. We also thank Jennifer Birckmayer for her guidance in the area of child development and Judy Taylor for her insights into working with elementary school–age children. Kathleen Hunt and Bonnie Hill provided valuable advice on planning workshops.

The In-Touch Science team wishes to thank national collaborators: 4-H, Girls Inc., American Indian Science and Engineering Society, National School-Age Childcare Alliance, and Wellesley School-Age Child Care Project.

We owe particular thanks to the dedicated individuals who provided insights after pilot testing draft activities through the following organizations: the Sciencenter; Finger Lakes United Cerebral Palsy; Girls Inc.; the Tuscarora Indian School; and 4-H programs in New York, Pennsylvania, and Maryland. Thanks also to Jean Bonhotal for generously sharing her stash of science-related storybooks for children.

Gratitude is expressed to all adults and agencies who implement these materials. We salute their commitment to involving children in inquiry-based science and in improving educational opportunities for diverse audiences.

A special thank you is extended to the young people whose curiosity, enthusiasm, and sense of adventure convinced the authors that this program works.

Illustrated by Marcia Eames-Sheavly
Designed by Sofia Betancourt
Edited by Susan E. Pohl

This project was supported, in part, by the
National Science Foundation
Opinions expressed are those of the authors and not necessarily those of the Foundation

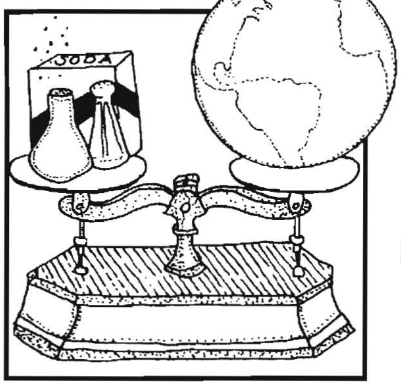
Cornell Cooperative Extension
Helping You Put Knowledge to Work

This publication is issued to further Cooperative Extension work mandated by acts of Congress of May 8 and June 30, 1914. It was produced with the cooperation of the U.S. Department of Agriculture; Cornell Cooperative Extension; and College of Agriculture and Life Sciences, College of Human Ecology, and College of Veterinary Medicine at Cornell University. Cornell Cooperative Extension provides equal program and employment opportunities. D. Merrill Ewert, Director.

Alternative formats of this publication are available on request to persons with disabilities who cannot use the printed format. For information call or write the Office of the Director, Cornell Cooperative Extension, 365 Roberts Hall, Ithaca, NY 14853 (607-255-2237).

Additional copies of this publication may be purchased from Cornell University, Media and Technology Services Resource Center, 7 Cornell Business & Technology Park, Ithaca, NY 14850.
Phone: 607-255-2080
Fax: 607-255-9946
E-mail: Dist_Center@cce.cornell.edu
A free catalog of Cornell Cooperative Extension publications and audiovisuals is available from the same address, or from any Cornell Cooperative Extension office. The catalog also can be accessed at the following World Wide Web site: http://www.cce.cornell.edu/publications/catalog.html

ISBN 1-57753-265-1
332LM3 722/1200 10/99 2M CR MTS80416



In-Touch Science: Chemistry & Environment

Contents

Introducing the Program

In-Touch Science is a hands-on science program developed by Cornell Cooperative Extension for children in grades 3 to 5 (aged eight to eleven). The program helps children

- communicate what they are observing and learning.
- understand the science connection between two fields of study.
- recognize those science concepts in daily experiences.

In-Touch Science emphasizes giving each child an opportunity to manipulate materials and equipment, test ideas, and explore what interests them in a relaxed learning environment. This works best with groups of five to ten children. A ratio of one adult to six children is ideal.

The ten activities in *In-Touch Science: Chemistry and Environment* let children observe how one science concept relates to both chemistry and the environment. This unit encourages youngsters to be more curious about their everyday encounters with chemicals and environmental issues or news stories.

The teaching style emphasizes interaction and communication among the children and between the children and the adult leader. Both adults and children are active participants. Together they experience the fun of discovery and share "I wonder..." statements that could lead to further science exploration.

In-Touch Science: Chemistry and Environment was field-tested with more than 200 children from diverse socioeconomic backgrounds in 4-H clubs, school-age child care programs, scout groups, school fairs, and science clubs. It is also appropriate for use in summer camps, the Expanded Food and Nutrition Education Program (EFNEP), science and nature centers, and other community programs serving children and families. Although this program is intended to promote greater opportunities for children in nonclassroom settings, it has also been used successfully in school science classes.

Welcoming All Children

In-Touch Science welcomes all children. To that end, adult facilitators are encouraged to adapt materials and settings whenever those changes make sense for their audience. For example, if eyedroppers are too expensive you may want to teach the children to drop water by using their forefinger over the end of a plastic straw. If you don't have enough measuring cups to go around, you can have the children make their own by using a marker to draw lines on clear plastic cups.

You may have little choice of location. If possible, however, choose a setting that is comfortable for the children and is conducive to conversation. Do not allow the need for a water source or table space to dictate the site. Sometimes you can move everything outdoors and simply bring along a thermos of water and a plastic bag to cover your "table" on the ground. The goal is to provide a relaxed atmosphere that promotes exploration and interaction. You and the children in your group are the best judges of whether the *In-Touch Science* laboratory should be a cozy kitchen, your backyard, the local park, or the school gymnasium.

These activities are also designed to be within the capability of children who have special needs. Sometimes, the term "special needs" is equated with wheelchair accessibility, but in doing science activities such everyday things as allergies must also be considered. Specific information and handy hints are included with each activity to alert you to some of the special needs you may encounter. Please remember, however, that a comprehensive how-to list to address all situations is not possible.

Your common sense and your experience with children will often be the best guide. Many times you can ask the individual child what would be helpful, or ask the child's parent or teacher. Many of the hints will be applicable for several activities, so browsing through the manual may provide the answer you need.

Finally, a caution: Although the information and recommendations contained in this publication have been developed by rehabilitation specialists, we make no guarantee as to, and assume no responsibility for, the correctness, sufficiency, or effectiveness of any of these modifications in solving a particular problem.

What's in Each Session

The ten activities in *In-Touch Science: Chemistry and Environment* are organized into five sessions of one to two hours each. Although the sessions are numbered 1 to 5, they do not need to be carried out in order. Feel free to change the sequence to fit the needs of your group.

Each session includes the same segments and flow of delivery:

Segment:	Focus (Chemistry)	Activity A	Transition	Focus (Environment)	Activity B	Closure
Time (min.)	5	20	5	5	20	5

Ideally, each pair of activities should be carried out during a single session. Alternatively, each session can be broken into two sessions. In that case, remember to review at the second meeting what was done during the first so that the connecting science theme is still clear.

As you read through each session, you will encounter these sections:

Mini-Poster. A one-page poster on colored card stock names the two activities and states the connecting science theme. Leaders should refer to this as needed to help the children understand how the two activities are linked.

Introduction. This page describes the chemistry and environment activities and explains the common science concept.

Leader's Guide.
What's the point? explains what is expected of the participants, restates the main idea, and defines terms.
What's the plan? reminds you to become familiar with the activity and materials.
What's my role? emphasizes that you are a facilitator, a partner, a helper but *not* a lecturer. You set the tone and direction, then allow the children to wonder and try things at their own pace.

Plan Ahead. This section alerts you to advance preparation needs.

Special Hints. This box suggests adaptations that make the program more inclusive.

Science: Behind the Scenes. This section provides more detail about the underlying science concept. This extra dose of information may help you relax and enjoy the science experience. Please do not use this material as a lecture, and avoid trying to convey everything you know to the children. Your genuine curiosity and a willingness to explore will inspire them far more than an armload of facts. If you want more background, browse your public or elementary school library or refer to the references (page 111).

Supplies and Preparation. Materials and equipment are listed along with suggestions for alternate supplies. Information is included about collecting supplies, preparing materials, and organizing workstations.

Focus. The Focus directs the group's attention to the general theme of the activity. This helps children relate what they know to what they will observe. Substitute other props or questions, but avoid telling the children too much about what you will be doing.

Activities. Each session has two activities: Activity A about chemistry and Activity B showing the connection to an environmental theme. The activity pages include step-by-step directions, sample questions to help stimulate conversation, safety precautions ***(in bold italics)***, and a reminder to listen for "I wonder..." statements (page 10).

Each child and adult should have his or her own workstation with enough materials and space to work comfortably. Some materials and equipment will be shared and helping companions is encouraged, but each person should also be able to chase an idea or ponder an interesting thought. That may mean a step back, a fast move forward, or a long detour from what the group is doing.

Transition. Review aloud the "I wonder..." statements. This not only helps the children remember and share some of the great ideas that were expressed during the activity, but it also stimulates new ideas and projects. Ideally, the children will design a follow-up activity to answer an unresolved question.

If you are doing only one activity in a session, ask the children to clean up their workstations. If you are doing both activities, clean up from the first and create workstations for the second.

Closure. This is the time to think about how the two activities are linked. Compare the "I wonder..." statements from the two activities, looking for common elements. Refer to the poster to make certain the children understand how the two activities are related.

A Step Beyond. Questions that children expressed when these activities were tested have been developed into additional activities that expand or extend the experience. This activity-question-activity-question cycle demonstrates how the

Learning Cycle (below) works and fosters an open-minded approach to learning and teaching. Ideas for more science activities and children's books related to this topic are included in the references (page 111).

A Way of Teaching and Learning

In-Touch Science uses the Learning Cycle, a teaching method that engages children in active investigative science. The Learning Cycle follows a sequence of exploration, concept introduction, and concept application as outlined in the box below. During concept application, new questions arise and the cycle starts again. Children are asked to look for many possible answers, not just one "correct" answer. An example of how it applies to *In-Touch Science: Chemistry and Environment*, Activity 1A, "Swirling Colors," is given in the second box at the top of page 8.

Learning Cycle Checklist

Exploration Phase

- Exploration is engaging.
- Ample time is provided for exploration.
- Exploration provides child-child and child-adult interaction.

Concept Introduction Phase

- The concept(s) introduced are an outgrowth of observation in the exploration phase.
- The concept(s) are named, and appropriate vocabulary is developed.

Concept Application Phase

- Children are given time to repeat observations with new materials.
- Children extend concept(s) to a new situation.
- Children are encouraged to wonder more about the experience, generating ideas for continued exploration and repetition of the cycle.

Adapted from Barman, C. R., and M. Kotar. "The Learning Cycle." *Science and Children* 27(7): 30–32. 1989.

Learning Cycle in "Swirling Colors"

Exploration Phase

- Children compare what happens when they dip a toothpick into colored spots in a bowl of milk, first with a plain toothpick and then with a toothpick that has been dipped in dish detergent. They observe the swirling colors and have fun dipping over and over again.

Concept Introduction Phase

- Children talk about what is happening ("I wonder..." statements). The leader asks questions and makes observations. The process of dispersion is discussed in simple terms, related to the idea of using soap to wash something greasy off your hands like they saw in the focus activity.

Concept Application Phase

- Children repeat the activity on their own, dipping their toothpicks into a variety of substances and observing which are effective at making the milk colors swirl. They might wonder what would happen if they used a bowl of some liquid other than milk. They relate this activity to something they have done in the past or an item they have at home. They review "I wonder..." statements and suggest ideas they would like to test or they try A Step Beyond.

Encouraging Conversation

Conversation between adults and children, and among children, is important in each phase of the Learning Cycle. The adult is both a participant and facilitator throughout the cycle.

Listen to the child's way of describing phenomena before introducing scientific language. One strategy is to focus your attention on what the children are doing. Help them communicate what they see, hear, smell, taste, and feel. Challenge them to make relationships among observations. Stating relationships indicates real understanding—in contrast to repeating memorized facts.

Each activity contains a shaded box, "Questions You Might Ask." The questions are intended as a guide, not a script. Take your cues from what the children say. Encourage them to talk to each other and not just to you. Avoid asking too many questions. Until they are comfortable following the procedures and manipulating supplies, some children will consider conversation a disruption rather than a natural part of the process. Respect each child's abilities, interests, and way of learning.

The sample questions promote conversation by using phrases that focus on the child's experience. Ask what the children saw, not why something happened. Ask how their results compared with their neighbor's, not which one was correct. Ask questions that can be answered with descriptions and comparisons, not "yes" or "no."

The following chart relates the wording of questions to specific science processes. Use it as an aid in designing child-centered questions. *In-Touch Science* units rely heavily on basic science processes; additional activities would lead to greater use of complex science processes.

Developing Science Process Skills by Experimenting and Talking with Children

Basic Science Processes	*Experimenting and Talking*
Observing	How would you describe...?
Using the senses to gather information	Tell me about...
Classifying	Which ones contain...?
Ordering or grouping observations	How are these alike? Different?
Communicating	Any expression of ideas or answers to questions
Exchanging information	
Questioning	I wonder why...?
Raising uncertainty	
Predicting	What do you think will happen?
Stating future cause-effect relationships	What if...?
Using Numbers	How many...?
Expressing with numbers rather than words	How long did it take to...?
Measuring	Make a layer $^1/_2$ inch deep
Using instruments to quantify observations	Measure $^1/_2$ cup water

Complex Science Processes	*Experimenting and Talking*
Interpreting Data	What happened before...? After?
Finding patterns or meaning among sets of data	Compare the samples.
Controlling Variables	What's our time limit?
Manipulating factors that could influence results	
Designing Experiments	Try testing "What would happen if...?"
Planning data-gathering procedures to test ideas	
Inferring	Try explaining, "Why?" by reasoning from gathered evidence
Proving explanations for events based on limited facts	Try answering, "This happens because..."

Twinkle, twinkle, little star,
How **I wonder** what you are.
—*Rhymes for the Nursery,* 1806
The Star, st. 1

Child of the pure, unclouded brow
And dreaming eyes of **wonder**!
—*Through the Looking-Glass,* 1872
Introduction, st. 1

For all knowledge and **wonder**
(which is the seed of knowledge)
is an impression of pleasure in itself.
—*The Advancement of Learning,* 1605

An "I wonder..." statement may

- be a simple observation about the materials: "This looks really cool."
- relate the activity to the child's prior experience: "We spilled cooking oil on the kitchen floor, and it took forever to clean it all up."
- express discovery: "I didn't know that soap could do that."
- show growth: "I thought that cleaning up an oil spill would be easy, but it's impossible to get it all out!"
- relate the activity to another situation: "This is like my brother's lava lamp, but its colors don't swirl so fast."

"I Wonder..." Statements

Because questioning and curiosity are key elements of the *In-Touch Science* program, the authors have adopted the phrase "I wonder..." to describe children's responses. These responses are used by the adult to direct, reinforce, and evaluate learning.

An "I wonder..." statement does not have to begin with the words "I wonder." It does not even have to be a statement. "I wonder..." statements are comments, ideas, questions, descriptions, concerns, theories, doubts—any expression that demonstrates that the children are thinking about what they are doing.

Throughout the sessions, children and leaders share, discuss, and collect "I wonder..." statements. These statements are important evidence that the children understand what they are doing, that they can see the connection between activities A and B, and that they can relate the science concepts to similar situations in their daily lives.

Most children have plenty to say, but it is not easy for a busy leader to hear or remember all of their ideas. With practice, most leaders can follow the children's conversation enough to redirect them when they stray from the topic and to help them summarize what they learned by referring to overheard "I wonder..." statements. Some leaders invite a helper to record "I wonder..." comments and read them back at the end of the activity or session. Others ask the children to write statements on cards, newsprint, or a chalkboard for review. Some groups have enjoyed tape-recording their ideas while others express in drawings what they learned or wondered about.

Organizing Supplies

The science experience will be more enjoyable if you have a plan for collecting, cleaning, storing, and restocking supplies. Each activity has a "Supplies and Preparation" page that lists the items needed, explains any preparation procedures, and suggests alternate materials. Supplies are easier to manage if they are assembled into a kit.

Supplies

The supplies recommended in this book have been used with many children and are known to work. Most can be found in your kitchen. All can be purchased at local food, drug, discount, garden, or pet supply stores. For a few that are hard to find locally, mail order suppliers are included in the "Guide to Ordering Supplies" (page 101).

Reusable supplies are tools that can be used several times. Examples are measuring cups and eyedroppers. Sturdy plastic spoons, knives, and cups that might be considered disposable are intended to be reused.

Consumable supplies include perishable and nonperishable items that are used only once. Examples are foods, paper, and paper towels. If you have storage space, you may want to buy nonperishable products in quantity.

Supply Kits

Because the self-discovery nature of this program is most effective with small groups, instructions for assembling supply kits are based on ten participants. The "Checklist for Assembling Supply Kits" on page 97 lists all of the supplies needed for doing the ten experiments with ten participants.

The "Checklist for Assembling Supply Kits to Loan" on page 99 excludes perishable items and groups other supplies so that you can quickly assemble a "basic" kit with only tools and reusable supplies or a "made-to-order" kit that fits your specific needs.

Hints for the Successful Use and Maintenance of Supply Kits:

- Identify one key person, such as a child who offers to help, teen, parent, or other volunteer, to monitor your kits.
- Purchase in quantity.
- Label items with name and quantity.
- Keep small items together with rubber bands or in bags or small boxes.
- Allow time to wash and dry reusable tools before they are repacked in the kit. If possible, include the children in the cleanup tasks.
- Choose a durable storage container with a tight-fitting lid such as the cardboard boxes used for packing reams of office paper.
- Tape a copy of the appropriate checklist inside the lid of the kit.

Monitoring Success

Adults who use the *In-Touch Science: Chemistry and Environment* program will be giving children an opportunity to explore the science of chemicals and environmental issues through experimentation. This may be a new experience for you, and you may never have considered teaching children about these two disciplines together.

The aim of this program is for children to gain a greater appreciation for science and its role in their everyday encounters with chemistry and environmental issues. The ten activities introduce several concepts, any one of which probably needs to be explored more fully for children to achieve understanding. Yet children can begin to appreciate how similar science concepts relate.

Two indicators of program success are the degree of the child's communication and the complexity of the child's "I wonder..." statements. If the children are engaged by the activities, they should express their enthusiasm by talking, drawing, pantomiming, or in some way sharing what they are doing. The children's expressions should progress from "I wonder if this yucky oil will wash off my hands" to "I wonder if you could wash ducks with soap if they got stuck in an oil spill." Participants may also make comments about personal experiences or future plans such as "Oh, yeah, this is like what I saw on TV" or "I'm going to show my dad what happened."

The evaluation form on pages 107 and 108 is designed to collect both quantitative and qualitative data. Copy as needed, using a separate form for each session.

A Preprogram Activity

If you decide to use all the material sequentially with a group of children, you may want to introduce the program to them, especially if you haven't done many science experiences together. Before you start, it might be interesting to collect their ideas about science and their experiences with chemistry and environmental science.

You could play a word game by saying, "If I say 'science,' what do you think of? Tell me about a time that you've experienced science. What did you do? Why do you think that's science?"

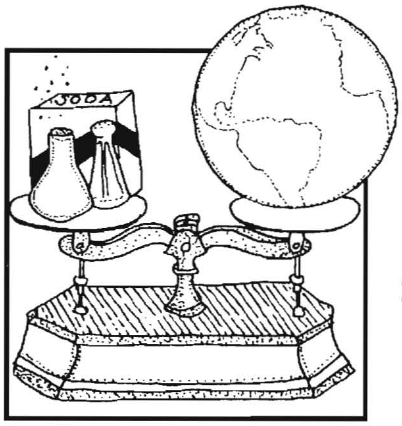
Or you might have the children draw a picture or collect magazine pictures of people doing science. The pictures could include people, objects, or activities. What are the children's perceptions of science?

You could conclude an introductory activity by saying, "Chemistry is part of almost everything we do. Believe it or not, everything is made of chemicals. The water we drink, the food we eat, the air we breathe, even the clothes we wear—they are all made of chemicals. Some of these chemicals are meant to be there, and others cause pollution or other environmental problems. We will be doing a series of ten activities to find out more about the science of chemistry and the environment."

Swirling Colors

Cleaning Up an Oil Spill

Dispersion

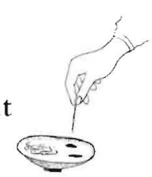


Session 1

Dispersion

These two activities introduce the idea of dispersion. When you shake oil and vinegar to make salad dressing, the oil and vinegar disperse; each liquid temporarily scatters, causing them to mix together rather than remain in separate layers. But given a chance to settle, the layers of oil and vinegar will quickly reappear. Children are encouraged to think about how dispersion occurs and whether it is helpful in environmental cleanup operations.

In Activity 1A, *Swirling Colors*, children observe dispersion by adding detergent to milk, which causes fat droplets and other tiny particles to disperse, or scatter.

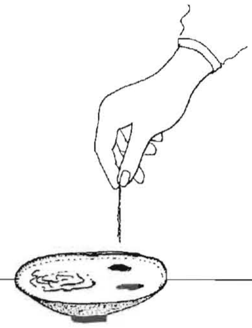


In Activity 1B, *Cleaning Up an Oil Spill*, they try cleaning up a miniature oil spill and decide under what circumstances we might want dispersion to occur.

Session at a Glance

Activity 1A

Swirling Colors



Leader's Guide

What's the point?

Children observe dispersion in colorful milk solutions and experiment to see what household chemicals cause such dispersion to occur. They find that detergents and soaps make the milk colors swirl and also help you to wash oil off your hands. Washing with soap causes oils and fats to break into small droplets that become dispersed in water like the colors do in the milk solutions. *For additional information, read Science: Behind the Scenes (page 19).*

What's the plan?

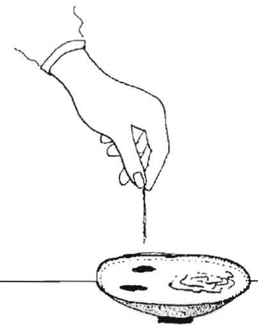
1. Read the activity (page 21).
2. Gather the supplies (page 20).
3. Try the activity.
4. Note special hint (below).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Special Hint

If children are likely to put their fingers in their mouths, provide reminders and adequate supervision and ask them to wash their hands after the activity.



Activity 1A

Swirling Colors

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

In this activity, you will see that soaps, detergents, and similar cleaning products cause swirling action in milk, whereas other types of liquids do not. In Activity 1B, you will observe that oil and water do not mix well—if you stop shaking a jar containing these two liquids, they quickly settle into distinct layers. But when you add just a few drops of detergent, the oil and water will stay mixed.

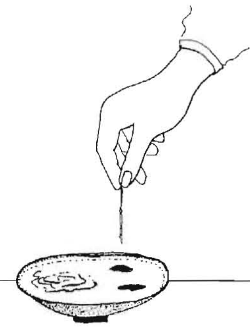
How does detergent make milk swirl or cause layers of oil and water to mix? Soaps and detergents have chemical properties that cause other compounds to disperse, or spread out. When you place a drop of detergent into a spot of color in the milk, it causes the surrounding solution to spread in all directions. When you add a few drops of detergent to the oil and water in a jar, the detergent helps to break the oil into small droplets that spread throughout the water.

These same chemical properties make soaps and detergents very useful for cleaning. These products help to dislodge the oil on your skin or the grease on your dishes or clothing. They cause the oil or grease to break into droplets, which spread out, mix with water, and get washed away.

When cleaning up oil spills in the environment, sometimes we want the oil to remain in one place where it can be collected. Under other circumstances, we want the oil to disperse. These concepts will be explored further in Activity 1B, *Cleaning Up an Oil Spill.*

Activity 1A

Swirling Colors



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

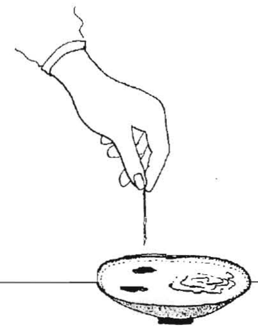
- ❑ small amount of shortening or cooking oil
- ❑ hand soap or a few drops of dish detergent
- ❑ bucket of water or wet washcloth

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ smocks, old shirts, or aprons
- ❑ 2 bowls or pie plates
- ❑ 2 cups whole milk[1]
- ❑ liquid food colorings in 2 or more colors
- ❑ several toothpicks
- ❑ 1 tablespoon or more of liquid dish detergent, poured into a bowl (for the group to share)
- ❑ 1 tablespoon or more of a variety of other household liquids, in bowls (for the group to share)[2]

[1]Try to use whole milk instead of 1% or 2% milk. The lowfat milks will swirl, but not as well.
[2]Use some liquids that are soaps or detergents and others that are not (e.g., honey, cooking oil, molasses, shampoo, liquid hand soap, vinegar, fruit juice, or liquid cleaning solutions).



Activity 1A

Swirling Colors

Focus

Rub your hands with cooking oil or shortening and show them to the children. Tell them you would like to remove the oil. Using a bucket of water or a wet washcloth, demonstrate that water alone will not do the job. Ask the children how you could do better. Chances are they will suggest using soap, and you can demonstrate that with soap the oil can be removed much more thoroughly. You could conclude by suggesting that in the following activity we will see this same effect of soap in a different way.

I wonder...

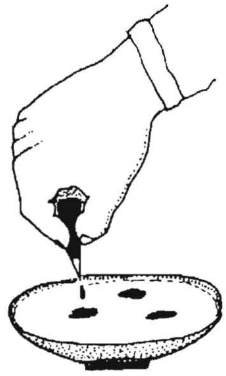
Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

why water won't wash the oil off.

what soap does to the oil.

Activity

1. Cover the tables with newspaper and have the children put on their smocks.
2. Pour enough milk into a bowl to make a layer about 1/2-inch deep.
3. Once the milk has settled, add a drop of two or three different colors of food coloring at different locations on the surface of the milk. Do this gently, being careful not to stir the mixture.



4. Ask the children to predict what will happen if they gently dip a toothpick into one of the colored dots. Then let them try dipping, being careful not to stir, and watch for any changes in the food coloring and milk as they do so.

Conversation

Questions You Might Ask

What does dish detergent do to the color spots?

What do you think makes the colors swirl?

What do you think would happen if you used something besides dish detergent on the toothpicks?

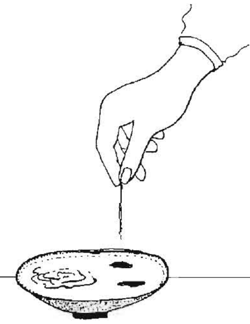
What happens if you put honey on your toothpick? How about a bit of oil?

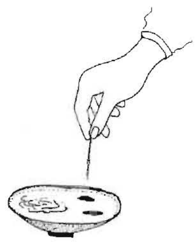
Can you think of another chemical that might work? How about a different kind of soap or detergent?

Do you think the same kind of swirling would happen if water were used instead of milk?

Activity 1A

Swirling Colors





5. Now pass around the bowl of dish detergent and have the children dip their toothpicks into detergent. Ask what they think will happen when they use these toothpicks to touch the spots of color. Let them try dipping, and give them time to play with their mixtures, watching the colors swirl wherever they dip the coated toothpicks.

6. Starting with a fresh bowl of milk and colored spots, encourage each child to dip toothpicks into substances other than dish detergent, predicting and then testing their effects on the milk spots. You could let them choose from a variety of common substances that will stick to a toothpick, such as honey, cooking oil, shampoo, or liquid hand soap. You could also include liquids that are less sticky but will soak into a toothpick, such as vinegar, fruit juice, or liquid cleaning solutions.

7. Discuss any observations the children have made about what substances caused mixing in the milk.

Transition or Closure

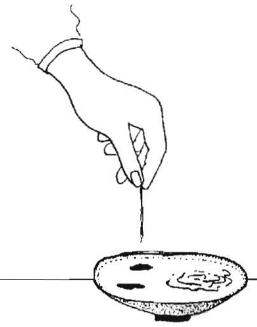
If you are doing only Activity 1A, review the "I wonder..." statements. If you are doing Activities 1A and 1B together, help the children clean up their work areas. Then shift their attention to the oil spill activity.

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

why soap makes the color spread out.

why honey doesn't do the same thing.



Activity 1A

Swirling Colors

A Step Beyond

I wonder whether this would work in water instead of milk.

Try it! The children might want to try the same activity in a variety of liquids such as water, fruit juice, skim milk, or tea. You are likely to see the same effect in any of these other liquids, but it will be much more dramatic in some than others. In water, most of the food coloring tends to sink, and only the small amount left at the surface will react to the toothpick tests. Liquids that contain tiny suspended particles do a better job of keeping the color in dots at the surface. These include any variety of milk or cream and fruit juices such as orange juice or cider.

Activity 1B

Cleaning Up an Oil Spill

Leader's Guide

What's the point?

Children learn that environmental oil spills are difficult to clean up. For some steps of the cleanup process, it is useful to contain the oil, and for other steps it is desirable to have it spread out or disperse. A detergent is an example of a chemical that helps oil disperse in water, just as it caused the colored spots to spread in milk in Activity 1A.

For additional information, read Science: Behind the Scenes (page 25).

What's the plan?

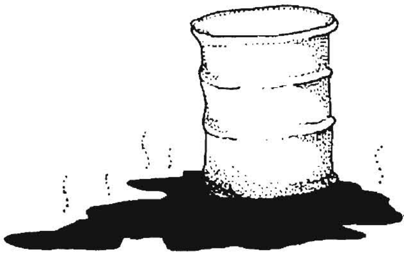
1. Read the activity (page 27).
2. Gather the supplies (page 26).
3. Try the activity.
4. Note special hint (below).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Special Hint

If a child has problems holding a regular spoon handle, make the handle "fatter" by folding a washcloth in quarters lengthwise and wrapping the folded cloth snugly around the handle, fastening it with rubber bands.



Activity 1B

Cleaning Up an Oil Spill

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

Oil and water do not mix—when you stop shaking them together, they quickly separate into distinct layers. Adding a few drops of dishwashing liquid causes the oil to break up into small drops that tend to remain mixed with the water rather than settling out. This is how dishwashing liquid removes grease from pots and pans, and it can also be useful in cleaning up oil spills in the environment.

When oil is spilled in a lake or ocean, it forms a floating layer called an oil slick that is very difficult to clean up. Exxon spent more than two billion dollars on cleanup operations following the Valdez spill in Alaska! Usually the first strategy in cleanup operations is to try to surround the oil slick so that it will not be able to spread. Then efforts are made to pump or soak it up. In the case of smaller spills, or the residues left after removing as much as possible of larger ones, the next line of attack is to apply dispersants. These are chemicals that act in the same way that dish detergent does in our experiment—they break the oil into small droplets that disperse in the environment.

When an oil tanker crashes, it creates an ecological disaster and big headlines in the news. You may be surprised to learn, though, that much of the oil that ends up in lakes and oceans comes not from these huge accidents but from much smaller leaks and spills. One significant source is used motor oil that people pour into storm drains rather than recycling it or disposing of it safely. Most storm drains lead directly to a river, lake, or ocean. Another significant source is the oil and gas that leaks or gets dumped from motorboats. It's important to remember that it is much easier to keep oil out of water than to try to clean it up once a leak or spill occurs.

Activity 1B

Cleaning Up an Oil Spill

Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 2 jars containing several inches of water, a couple of drops of blue food coloring, and a thin layer of vegetable oil. Make sure that the jars don't leak because the children will be shaking them vigorously.
- ❑ a few drops of dish detergent

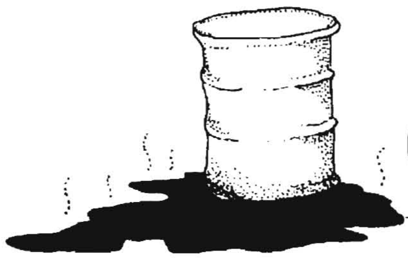
Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ smocks, old shirts, or aprons
- ❑ pie tin or flat bowl
- ❑ water
- ❑ vegetable oil, several tablespoons
- ❑ materials for making small animals or boats[1]
- ❑ oil cleanup supplies such as cotton balls or paper towels[2]
- ❑ optional: 1 cup of gravel or sand
- ❑ liquid dish detergent
- ❑ eyedropper
- ❑ spoon

[1] Pipe cleaners, foam trays, feathers, and fuzzy fabrics

[2] Sponges, string, pipe cleaners, cotton balls, paper towels, cotton swabs, pieces of hay or straw, a spoon, etc.



Activity 1B

Cleaning Up an Oil Spill

Focus

Ask whether anyone has seen pictures of an oil spill in an ocean or lake. What does it look like? Does the oil float or sink? As you hold this discussion, pass around a bottle containing water and oil. Ask the children to shake it up and observe what happens when they stop shaking it.

Put a few drops of dish detergent into a second jar containing water and oil. Pass this jar around as well, again asking the children to shake it up and observe what happens.

Activity

1. Cover the table with newspaper and have the children put on their smocks unless already in place from the previous activity.

2. Fill a pie tin or flat bowl with one inch of water. Add several tablespoons of vegetable oil to the water surface in each bowl.

3. Using pipe cleaners, bits of fuzzy fabrics, feathers, or other scrap materials, ask the children to design small animals to float on or swim in the water.

4. Optional: Allow the children to add sand or gravel on one side to make a beach or shoreline area.

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

why water and oil don't stay mixed.

why oil floats on water.

Conversation

Questions You Might Ask

Suppose that an oil tanker crashed, causing a large oil spill in the ocean. How do you think you might clean it up so that it wouldn't kill too many birds, fish, whales, or other living things?

What materials seem to work best for gathering all the oil into one place?

What materials work best for soaking up the oil?

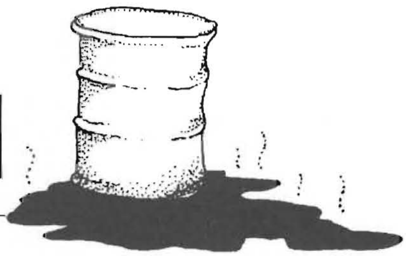
Which materials spread out the oil?

If you mix the oil into the water, can you make the oil slick go away? Does it stay away? If you add a bit of dish detergent, does this help or make it worse?

Is it possible to clean up all the oil?

Activity 1B

Cleaning Up an Oil Spill



5. Provide a variety of supplies such as cotton balls, string, sponges, bits of hay or straw, cotton swabs, and a spoon. Challenge the children to collect as much of the oil as possible and remove it from the water and beach (if they built one in step 4). Encourage them to try various collection techniques.

6. Discuss whether it is possible to remove all the oil and ask whether the children have ideas for additional ways to clean it up. If they don't mention soap, you could remind them to think about when you were trying to get oil off your hands.

7. Now provide dish detergent and eyedroppers and ask the children to figure out whether detergent helps to clean up what's left of their oil spills.

8. Ask what effect the oil has on the toy animals in their bowls and have the children experiment with how this oil might best be removed.

Closure: Connecting Chemistry and Environment

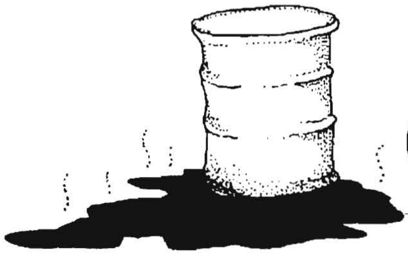
If you are doing only Activity 1B, review the "I wonder..." statements. If you are doing Activities 1A and 1B in one session, talk with the children about how the activities helped them to think about how to disperse an oil spill. Discuss which technique worked better at cleaning up the oil spill. Did adding detergent make the oil easier or more difficult to remove? Did it help when you wanted to mix the oil into the water rather than remove it?

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

how ducks get the oil off their feathers.

how many cotton balls it would take to clean up an oil spill in the ocean.



Activity 1B

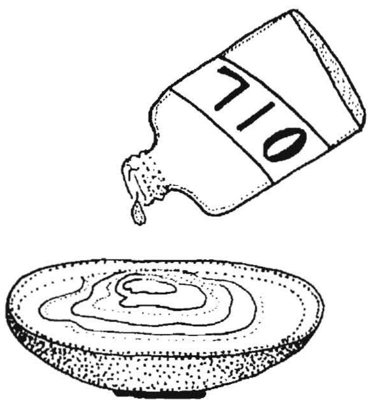
Cleaning Up an Oil Spill

A Step Beyond

I wonder how real oil spills get cleaned up—it would take millions of cotton balls to clean up the ocean! I wonder whether people use detergents to clean up real oil spills.

Looking into questions such as these would make a good library project. *Oil Spill!*, by Melvin Berger, is an excellent book on this topic for young children (see References). Children may also be interested in looking in encyclopedias or books about the ocean, then coming back and sharing ideas they have found about environmental cleanup operations.

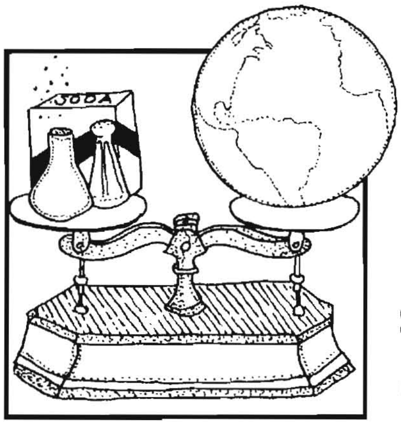
Although cotton balls certainly would not be practical on an environmental scale, other absorbent materials are used to soak up oil spills, and chemicals similar to detergents are used to disperse what is left. For more information, see *Science: Behind the Scenes*.



What's the Strength?

How Polluted Is It?

Chemical Concentrations

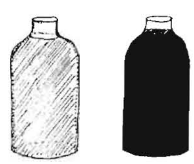


Session 2
Chemical Concentrations

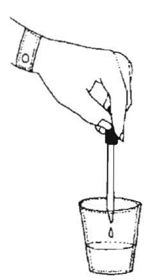
These two activities introduce the idea that chemical solutions exist in a wide range of concentrations. The concentration can sometimes be estimated by color, sometimes by taste, and sometimes through more sophisticated chemical methods. Not all chemical solutions are the same. Some are dilute and others are more concentrated. Scientists measure the strength of solutions using a variety of methods, a few of which are tried in these activities.

Session at a Glance

In Activity 2A, *What's the Strength?*, the children make solutions of various concentrations and explore the effects of solution strength on chemical properties such as color and taste.

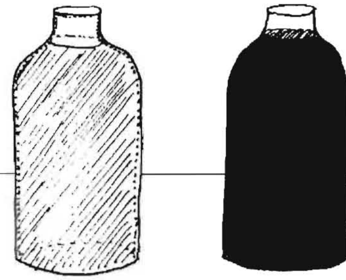


In Activity 2B, *How Polluted Is It?*, they mix up a range of concentrations of a mystery pollutant and then try to predict which of their solutions is most "polluted." They then test their prediction using a simple chemical test based on a reaction involving a color change.



Activity 2A

What's the Strength?



Leader's Guide

What's the point?

Children make solutions of various concentrations and learn that some chemical solutions are dilute and others are more concentrated. The concentration of a solution affects its properties, including some we can easily observe such as color or taste.

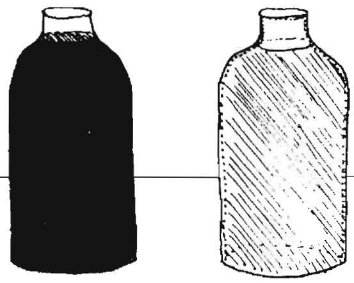
For additional information, read Science: Behind the Scenes (page 35).

What's the plan?

1. Read the activity (page 37).
2. Gather the supplies (page 36).
3. Make the solutions and try the activity.
4. Note safety measures (in ***bold italics***).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.



Activity 2A

What's the Strength?

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

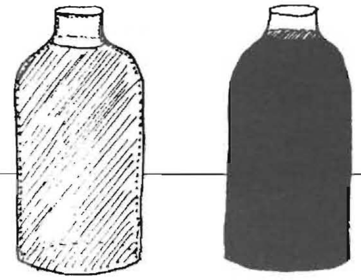
The concentration of a solution is a key concept in environmental chemistry. The water, land, and air in our environment are made up of countless chemicals, some natural and others added by humans. Some of these compounds are beneficial at low levels but toxic at higher concentrations.

Environmental laws and regulations such as pollution discharge standards are designed to keep the concentrations of selected chemicals within the ranges that are known to be safe for humans, wildlife, and other concerns. Public drinking water, for example, must meet a long list of water quality standards. What does this mean? Believe it or not, it means that our drinking water is allowed to contain many chemicals, including some pesticides, solvents, and other compounds that we wouldn't normally think of drinking. Does this mean we should buy bottled spring water and avoid drinking public supplies? No—even bottled water contains these same impurities. Unless you drink distilled water, your water is not "pure." Although drinking water standards allow our water to contain many chemical compounds, the concentrations are required to be far lower than those that are known to cause health problems in humans.

In this exercise, we use color and taste to detect differences in solution concentrations. Only a few of the many chemicals found in drinking water can be detected with these methods. Salt, sulfur, and chlorine are examples of chemicals that affect the taste of drinking water. Iron, manganese, and copper are examples of chemicals that affect its color. For most other compounds found in water, more sophisticated laboratory tests are required for analysis of solution concentrations. Water suppliers conduct these laboratory tests on a regular basis to ensure the safety of public water supplies.

Activity 2A

What's the Strength?



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 2 jars containing water and food coloring (add the same color to both jars, but make one of them noticeably darker)
- ❑ 2 jars containing water with dissolved salt (the amounts of salt don't matter, but make one solution more concentrated than the other—this difference will not be visible)

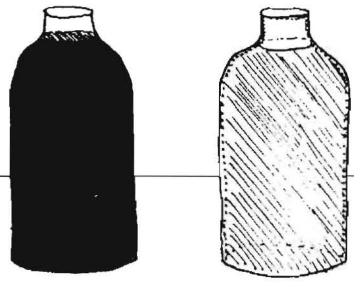
Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ smocks, old shirts, or aprons
- ❑ masking tape or sticky labels
- ❑ 4 clear plastic cups, 9-oz. size
- ❑ measuring cup
- ❑ water
- ❑ eyedropper or measuring spoon
- ❑ 9-oz. cup half-filled with colored water solution[1]
- ❑ marker or pen
- ❑ 9-oz. cup half-filled with salt or sugar solution[2]
- ❑ plastic spoon for stirring

[1] Colored water solution: mix about 20 drops of food coloring into a quart of water. For 10 children, make 2 quarts.

[2] Salt or sugar solution: mix 3 tablespoons of salt or sugar into a quart of water. This is for a tasting activity, and you can decide which to use. Sugar will be more fun for the children to taste, but salt makes it easier to relate to ocean water or environmental issues such as highway deicing. Two quarts will be enough for 10 children.



Activity 2A

What's the Strength?

Focus

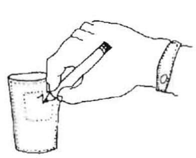
Pass around two jars, one containing lightly colored water and the other containing a darker solution. Ask if the children can tell which solution is more concentrated. Then pass around two more jars, one containing a weak salt solution and the other containing a stronger salt solution. Without giving the children any clues about what might be in the water, ask them if they can tell whether the two solutions are different from each other. Explain that solutions come in different strengths and that you can't always see the differences.

Chemists use a variety of techniques to measure the concentrations of solutions. Ask for ideas about what some of these techniques might be. (Save the jars and salt solutions to use again in the Focus for Activity 2B.)

Activity

1. Cover the table with newspaper and have children put on their smocks.

2. Attach a piece of masking tape or a sticky label to each of four clear plastic cups, then measure $\frac{1}{2}$ cup water into each cup.



3. Give each child a cup or other container holding about $\frac{1}{2}$ cup colored water solution. Invite them to use an eyedropper or measuring spoon to add different amounts of the colored solution to the water in each of their cups. Ask them to count how many squirts or spoons of solution they add to each cup and to write that number on the label for that cup.

4. After they have made four different colored solutions, ask the children to arrange their cups in order of increasing

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

why some solutions are colored and others are clear.

why sometimes you can't see different concentrations.

Conversation

Questions You Might Ask

What happens as you add more squirts of color?

How does the darkness of the solutions compare with the numbers you've written on their labels? Is this what you would expect?

What happens if you mix a light solution and a dark one? If you mix two dark solutions, do you get one that is twice as dark?

Can you estimate by looking at a solution how many squirts of color went into it?

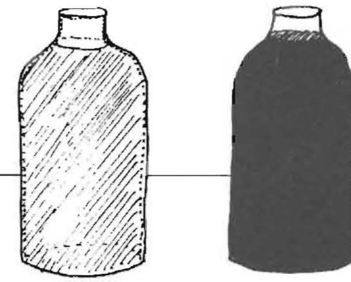
Can you tell by looking at your salt solutions which ones are most concentrated?

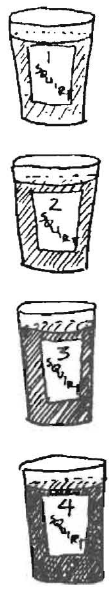
Can you make a salt solution that is so dilute you can't taste the salt?

Have you ever tasted ocean water? Can you make a solution that tastes as salty as that?

Activity 2A

What's the Strength?



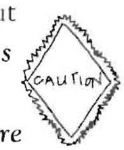


color. Then ask them to check the numbers they wrote on the labels. Are the darkest solutions the ones with the highest numbers? Is this what you would expect?

5. Give the children time to explore ideas about their solutions. Encourage them to ask a question and then figure out how to answer it. For example, "What happens if you mix a light solution and a dark one?" or "Will four squirts of color make a solution whose color is in between the ones I've made with two squirts and six squirts?"

6. Repeat the steps above using salt solution in place of colored water. (Make sure that all the cups and spoons are cleaned thoroughly so that the children will be able to taste the salt or sugar solutions that they make.)

7. This time the children will not be able to rank the solutions according to color, but they can try ranking them by taste. ***Explain that it would usually be dangerous to taste chemistry experiments, but we are making an exception for this experiment because the ingredients are just water and salt, both of which are safe to taste.***

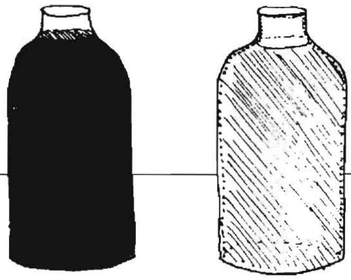


8. Ask the children to figure out which of the solutions they have made is the least salty and which is the strongest. How do these rankings compare with the number of squirts or spoonfuls of salt solution they contain?

Transition or Closure

If you are doing only Activity 2A, review the "I wonder..." statements. If you are doing Activities 2A and 2B together, help the children clean up their work areas. Then shift their attention to the pollution activity.

> **I wonder...**
>
> Keep listening for "I wonder..." statements after the activity. Children might wonder
>
> *how the sea gets so salty.*
>
> *why some solutions are colored and others are colorless.*



Activity 2A

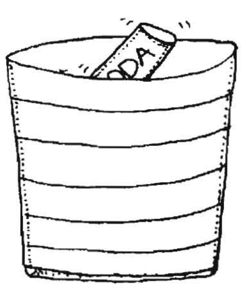
What's the Strength?

A Step Beyond

I wonder how else you can measure concentrations.

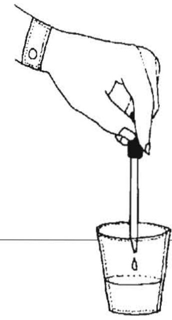
Color and taste are two simple ways to estimate the concentration of a solution, but you may have thought of others as you carried out this activity. How about smell? Can you think of a substance that has a strong odor, either pleasant or unpleasant? Mouthwash might be a good example. You could take a solution such as this and dilute it to various concentrations, then test whether your sense of smell can detect the differences in solution strength.

Another way to test concentration is using density. One way of illustrating this is to place an unopened can of nondiet soda in a bucket of water. The can of soda is denser than water, so it will sink. If you mix a chemical such as sugar into the water, the density of the water will increase. The more sugar you add, the denser the sugar/water solution becomes. By experimenting with the concentration of the sugar/water solution, you should be able to find a point at which the can of soda will hover in the middle rather than sinking to the bottom. Adding even more sugar to the water will cause the can to float. (This may seem like a pretty unscientific way to measure concentration, but actually it illustrates the principle behind the hydrometer, a device that scientists use to measure the salinity of ocean water or the sugar content of maple syrup.)



Activity 2B

How Polluted Is It?



Leader's Guide

What's the point?

Children mix up a "mystery pollutant." They are introduced to the idea that scientists carry out tests to determine what chemicals are present in water and to measure the concentration of these chemicals.

For additional information, read Science: Behind the Scenes (page 41).

What's the plan?

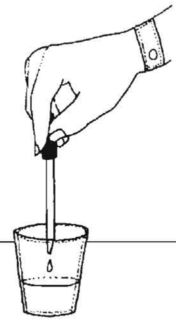
1. Read the activity (page 43).
2. Gather the supplies (page 42).
3. Make the solutions and try the activity.
4. Note safety measures (in ***bold italics***) and special hint (below).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Special Hint

If children are likely to put their fingers in their mouths, provide reminders and adequate supervision and ask them to wash their hands after the activity.



Activity 2B

How Polluted Is It?

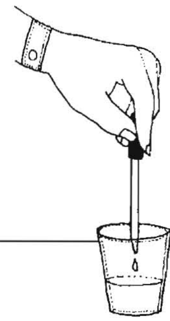
Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

This activity uses a "mystery pollutant" that is simply cornstarch and water. Although not a real environmental contaminant, this mixture provides a safe and easy illustration of how scientists can use indicator compounds to identify and measure concentrations of chemicals in the environment. In this case, tincture of iodine is used as the indicator chemical. If you apply tincture of iodine to a wound or observe it against a white background, you will notice that it is a dark yellow solution. Why does it make the cornstarch solutions turn purple? When iodine molecules combine with starch molecules, a chemical reaction occurs and a purple compound is formed. If you observe the reaction of iodine in the cornstarch solution for a few moments before stirring, you will see swirls of color as the yellow turns to purple. Tincture of iodine is an alcohol-based solution, and the swirling occurs as the alcohol gradually mixes with and dissolves in the water.

Activity 2B

How Polluted Is It?



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 2 jars containing water with dissolved salt (the amounts of salt don't matter, but make one solution more concentrated than the other; you can use the same ones used in the Focus for Activity 2A)

Activity Supplies

Activity supplies are listed for individuals; multiply as needed.

- ❑ newspaper
- ❑ smocks, old shirts, or aprons
- ❑ goggles or safety glasses
- ❑ masking tape or sticky labels
- ❑ 5 clear plastic cups, 9-oz. size
- ❑ measuring cup
- ❑ water
- ❑ 9-oz. cup about half-filled with mystery pollutant solution[1]
- ❑ measuring spoon (teaspoon size)
- ❑ marker or pen
- ❑ tincture of iodine[2]
- ❑ spoon for stirring
- ❑ Lysol or other disinfectant solution[3]

[1] Mystery pollutant solution: mix 1 tablespoon cornstarch into 1 quart of water. This will not dissolve completely. That's OK—there will still be enough in solution, and you can ignore the part that settles out. Two quarts will be enough for 10 children.

[2] Tincture of iodine is sold in pharmacies as a disinfectant for minor wounds. If you can't find it, brand name disinfectant products that contain iodine will probably work as well.

[3] Reminder: before reusing, disinfect goggles in a solution of 1 1/4 oz. Lysol in 1 gallon of water. Rinse well and air-dry.

Activity 2B

How Polluted Is It?

Focus

Pass around the two jars containing different concentrations of salt solution. Discuss the idea that sometimes substances we can't see are dissolved in water. Why does this matter? What if we need to decide whether the water is safe to drink or whether it contains chemicals that might harm fish or other living things? We certainly wouldn't want to taste it without knowing how safe it might be. Scientists have developed many ways of testing water to find out what chemicals it contains and how strong the concentrations are. In this activity, we'll make some solutions and try a simple chemical test to determine their concentrations.

Activity

1. Cover the table with newspaper and have the children put on their smocks.

2. ***Pass out goggles and make sure the children understand that in this exercise they should not taste the solutions they will be making.***

3. Attach a piece of masking tape or a sticky label to each of four clear plastic cups, then measure $^{1}/_{2}$ cup of water into each cup.

4. Give each child a cup or other container holding about $^{1}/_{2}$ cup of the mystery pollutant solution. Instruct them to use their measuring spoon to add different amounts of the pollutant solution to the water in each of their cups. Ask them to count how many spoonfuls of solution they add to each cup and to write that number on the label for that cup.

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

how you can tell what's in the water.

whether fish can taste chemicals in water.

Conversation

Questions You Might Ask

Can you tell by looking at your solutions which one is most polluted?

Would you want to taste them to find out? What other methods do you think you could use?

What happens when you add iodine? Now can you see any differences in concentration?

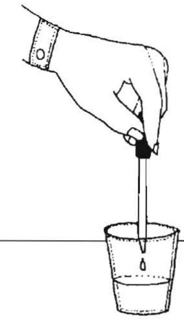
If we put two drops of iodine in each cup, why are some solutions darker than others?

If you line up your solutions from darkest to lightest, which ones do you think are most polluted?

How could you use these solutions to estimate the concentration of a mystery solution from your partner?

Activity 2B

How Polluted Is It?



5. After they have made four different concentrations of "polluted water," ask the children to arrange their cups in order of increasing pollution, based on the number of spoons of solution they added.

6. Add two drops of tincture of iodine to each cup. The children can watch the iodine swirl around and react with the "pollution" in their solutions, then stir the solutions with a spoon to get them well mixed.

7. Ask the children to look for color differences among the four solutions. Get them to think about questions such as, if we put two drops of iodine in all of the cups, why are some solutions darker than others? Is the darkest one the solution that you expected to be the most polluted? Are your solutions lined up from lightest to darkest? What does this indicate about the amount of pollution they contain? Make sure to save the four solutions to use in the next step.

8. Pick a partner and make a mystery solution for the partner to test. The partner should be able to estimate how many spoonfuls of pollutant were added to the mystery solution. Ask the children for ideas about how they could do this. Through discussion, they should come up with the idea that if they add iodine to the mystery solution, they will be able to compare its color to the four different shades in their samples of known concentrations.

Closure: Connecting Chemistry and Environment

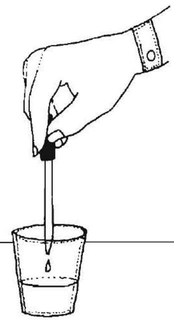
If you are doing only Activity 2B, review the "I wonder..." statements. If you are doing Activities 2A and 2B in one session, talk with the children about how the activities helped them to think about solutions and pollutants.

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

why the yellow iodine makes a purple solution.

if water doesn't turn purple, does that mean it isn't polluted.



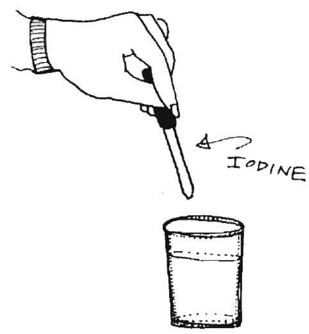
Activity 2B

How Polluted Is It?

A Step Beyond

I wonder whether the same test could be used for other types of "pollution."

There's no harm in trying! The children could mix up their own "pollution" solutions using safe household chemicals, then test to see whether iodine turns color in these mixtures.



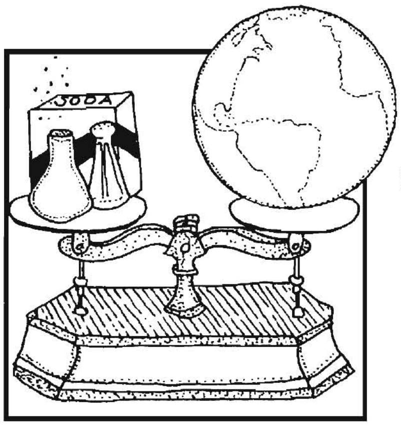
You may also have wondered whether adding iodine would be a useful test for real water pollutants. Iodine turns purple when it reacts with starch, so it is frequently used to indicate foods that contain starches. Because the chemicals that cause water pollution usually are not starches, iodine would not be a good indicator to detect real water pollution. The same concepts are used in real environmental sampling, though. If you have used a test kit to measure pH or nutrients in garden soils, you are familiar with the idea of adding an indicator chemical that causes a color change in the solution you are testing. By comparing the color of the solution to a chart that is supplied with the test kit, you get a number representing the concentration of nitrogen, potassium, or whatever substance you are testing.

Soil test kits are sold inexpensively at garden centers and would provide an opportunity for the children to collect and test environmental samples for nutrients or acidity. Testing for pollutants is not so easy and usually involves use of hazardous chemicals and laboratory equipment.

Making Gloop

Polymers—How Can We Use Them?

Chemical Bonds and Physical Properties

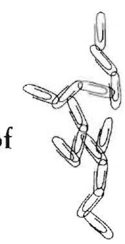


Session 3

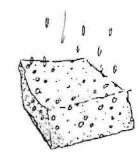
Chemical Bonds and Physical Properties

These two activities introduce the idea of chemical bonds and how they determine the properties of substances. Children are encouraged to learn about the wide range of properties of chemical polymers and to think about ways these properties affect their possible uses, both in environmental science and in everyday life.

In Activity 3A, *Making Gloop*, the children make a polymer, a chemical that is made up of a long chain of similar molecules, and explore its properties.



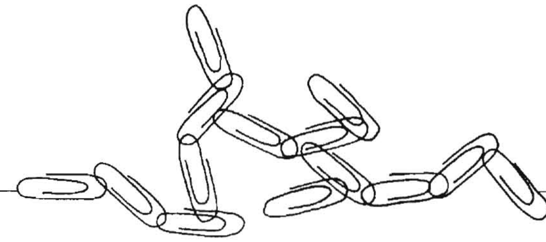
In Activity 3B, *Polymers—How Can We Use Them?*, they experiment with the properties of a water-absorbing polymer and brainstorm various ways in which it might be useful.



Session at a Glance

Activity 3A

Making Gloop



Leader's Guide

What's the point?

Children make "gloop," which is not only fun but demonstrates how the properties of a chemical compound can change when it combines with other compounds. Just as a chain of paper clips has different properties from a handful of individual ones, the chemical mixture we've named gloop has properties different from the compounds from which it is made.

For additional information, read Science: Behind the Scenes (page 51).

What's the plan?

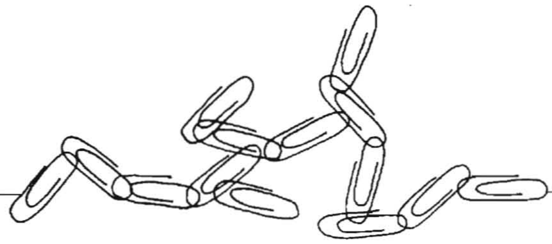
1. Read the activity (page 53).
2. Gather the supplies (page 52).
3. Try the activity.
4. Note safety measures (in ***bold italics***) and special hint (below).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Special Hint

If children are likely to put their fingers in their mouths, provide reminders and adequate supervision and ask them to wash their hands after the activity.



Activity 3A

Making Gloop

Science: Behind the Scenes

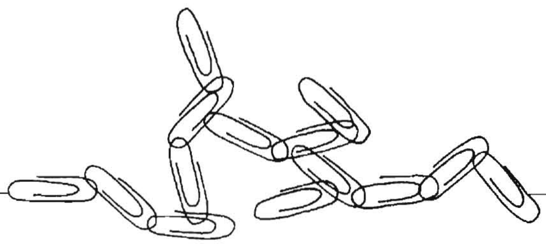
Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

Plastics and other synthetic polymers are part of our everyday life. Nylon, polyester, and Plexiglas are examples of synthetic polymers, meaning that they have been created by people and are composed of long chains of repeating molecules. There may be anywhere from 1,000 to 50,000 molecules in each of these chains!

Milk jugs, plastic bags, carpets, and ski jackets are all made of polymers. Obviously, different polymers can have very different properties. Some can be molded into rigid shapes, and others remain stretchy or flexible. This difference in properties results from their differing chemical composition. All polymers are composed of long chains, but they differ in the molecules that make up these chains and the ways in which the molecules are linked together.

Activity 3A

Making Gloop



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ enough paper clips for each child to have about 10

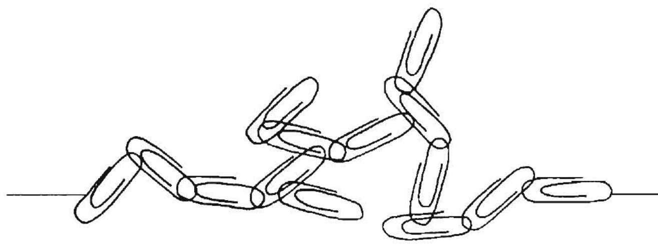
Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ smocks, aprons, or lab coats
- ❑ goggles or safety glasses[2]
- ❑ 9-oz. cup, either disposable or washable
- ❑ 1 tablespoon white glue (Elmer's or other liquid white glue)
- ❑ food coloring (optional)
- ❑ water
- ❑ 2 teaspoons Borax solution, in cup or other small container[1]
- ❑ spoon or tongue depressor
- ❑ disposable gloves (optional)
- ❑ Lysol or other disinfectant solution[2]

[1]Mix 2 tablespoons of Borax powder into 2 cups of warm tap water. You can find Borax powder in the laundry section of grocery or household stores.

[2]Reminder: before reusing, disinfect goggles in a solution of 1 $^1/_4$ oz. Lysol in 1 gallon of water. Rinse well and air-dry.



Activity 3A

Making Gloop

Focus

Have each child make a chain using 5 to 10 paper clips. While they are doing this, talk about how chemicals can also be made up of chains. Explain that chemical compounds are made up of tiny pieces called molecules. In plastics and other chemicals called polymers, the molecules are linked together to make long chains like the ones we're making with paper clips.

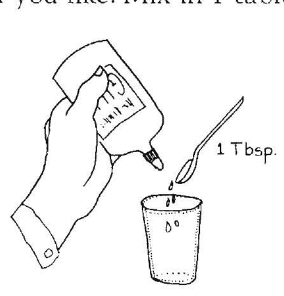
Ask the children for ideas about whether linking paper clips together changes any of their properties. For example, if we drop a handful of paper clips on the table, can we pick them up in the same way we can pick up our paper clip chains?

Activity

1. Cover the tables with newspaper and have the children put on their smocks.

2. ***Make sure each child is wearing goggles or safety glasses and instruct them not to taste any of the chemicals they will be using.***

3. Place 1 tablespoon of white glue in a cup. Add a few drops of food coloring if you like. Mix in 1 tablespoon of water.



4. Gradually stir in 2 teaspoons of Borax solution, a few drops at a time, while stirring constantly. Try to imagine long chains of molecules being built as you stir.

5. Continue to stir until the mixture no longer sticks to the sides of the cup.

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

what chemicals are made of chains.

what chemical chains would look like through a microscope.

Conversation

Questions You Might Ask

How did the two solutions look before they were mixed together?

What happens as you mix them together? What changes did you notice?

What do you think happens to the molecules in the glue as it gets thick?

Can you imagine molecules linking together to make chains like the ones we made with paper clips?

If we mixed the glue with something other than Borax, what might happen to it?

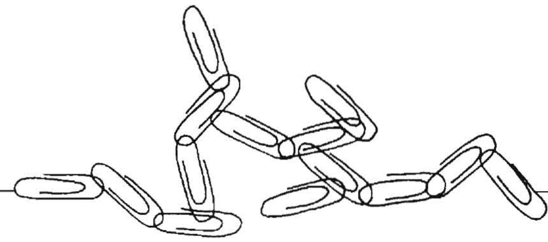
How do you think "superballs" were invented?

Does your gloop stick to things? Can you stretch it out slowly to make a long string? What happens if you stretch it quickly instead?

How does it compare to Silly Putty?

Has anyone tried making bread or pizza dough by hand? As you knead the dough, you can feel its consistency change—gradually it becomes more elastic and stretchy as the gluten in it binds molecules together to make long chains.

Making Gloop



6. Once the mixture holds together in a blob, remove it from your cup and work with it in your hands. (Some children may prefer to wear disposable gloves to handle this sticky mixture.) Ask the children to knead their gloop for a while and observe whether it goes through any changes in properties such as stickiness or stretchiness.

7. As the children play with their gloop, gradually it will begin to feel firmer and drier. Try forming it into a ball and see if it bounces. Test other properties. Will it float? Does it soak up water? Does it stretch? Can you break it? How does it compare with commercial products like Silly Putty or Gak?

8. If the children wish to save their gloop, they will need to store it in a tightly sealed plastic bag or airtight container so it will not dry out.

Transition or Closure

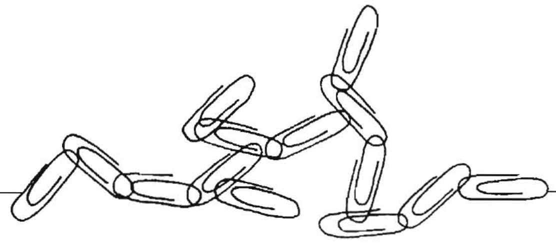
If you are doing only Activity 3A, review the "I wonder..." statements. If you are doing Activities 3A and 3B together, help the children clean up their work areas. Then shift their attention to the polymer activity.

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

if is this the way Silly Putty is made.

what happens to gloop if it dries out.



Activity 3A

Making Gloop

A Step Beyond

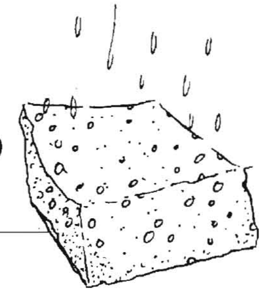
I wonder what those recycling symbols mean on the bottoms of most plastic containers.

The number in the middle of the symbol indicates the polymer that the container is made of. You might want to ask children to look at the recycling symbols on the bottoms of containers they use at school and at home and to bring in a few samples when the containers are empty. Then compare the properties of the polymers. Are some brittle and others stretchable? Some rigid and others flexible? Can you find products made of the same polymer but with very different characteristics? For example, polyethylene terephthalate, the polymer that is molded to form detergent bottles, can also be formed into thin threads that are used to insulate sleeping bags and jackets.

Number in Recycling Symbol	Polymer Name and Abbreviation	Examples of Products Labeled with the Recycling Symbol	Other Typical Products Made from This Polymer
1	polyethylene terephthalate (PETE)	soft drink bottles	carpets, fiberfill, scouring pads, photographic film
2	high-density polyethylene (HDPE)	milk jugs, detergent bottles	trash cans, plastic lumber, milk bottle caps
3	vinyl, or polyvinyl-chloride (V or PVC)	cooking oil bottles, peanut butter jars	credit cards, water pipes, wrapping for meats and other foods, siding for houses
4	low-density polyethylene (LDPE)	squeeze bottles	grocery bags, food wrap, plastic lids, candy wrappers
5	polypropylene (PP)	yogurt containers, margarine tubs	screw-on lids, carpets, rope, wrapping films, drinking straws
6	polystyrene (PS)	foam cups, egg cartons	meat trays, disposable utensils, foam "peanuts" and packaging
7	all other polymers	all other containers	toothpaste and cosmetic containers

Activity 3B

Polymers–How Can We Use Them?



Leader's Guide

What's the point?

Most long-chained chemicals called "polymers" repel water, but in this activity we use one that does an excellent job of soaking up water. This polymer is used in disposable diapers, fuel filters, and some potting soils.

For additional information, read Science: Behind the Scenes (page 57).

What's the plan?

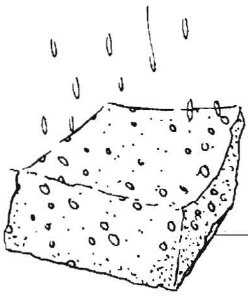
1. Read the activity (page 59).
2. Gather the supplies (page 58).
3. Try the activity.

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Plan Ahead

Purchase water-absorbing gel, either locally or by mail order (see Activity Supplies, page 58).



Activity 3B

Polymers–How Can We Use Them?

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

Most polymers made by humans do not absorb water. Think about milk jugs, soda bottles, and Styrofoam cups—all of them would be useless if they absorbed water rather than providing a leakproof container in which to hold it. Polyacrylamide, the gel used in this activity, is a polymer that does absorb water. In fact, it is a super-absorbent gel that will soak up hundreds of times its weight in water. It forms very large molecular chains, and water is held in the spaces between these chains.

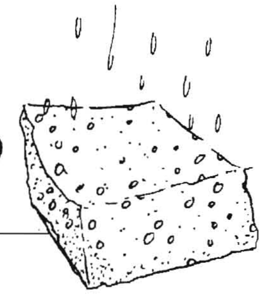
When you sprinkle salt into the gel/water mixture, the salt reduces the number of water molecules the gel can hold. The mixture becomes more watery because the water molecules are no longer bound so tightly by the molecules in the polymer chains.

If you cut apart a disposable diaper, you will find a fibrous filling that contains tiny crystals of water-absorbing gel. These gel crystals expand greatly when wet, and this provides most of the diaper's absorbency. This same polymer is used in some potting mixes to increase the amount of water held in the soil and in fuel filters to remove moisture from fuel used in automobile or jet engines. Water-absorbent gels are also added to some water beds to provide fluid movement without the danger that large amounts of water will leak out. Water-absorbent gels are even used in some shakes that are sold at fast food restaurants. Unlike a milkshake that is thickened with ice cream, these shakes are thickened with gel and will remain thick even as they warm up. If you want to experiment with your shake, stir in a teaspoon of salt and see if the mixture becomes watery as it does in Activity 3B.

Can you imagine using gels for environmental cleanup operations? How about a gel that absorbs oil rather than water? Gels of this sort exist, as well as others that are used to absorb toxic chemical spills before the liquid can spread or soak into the ground. Scientists are working on developing ways to cause gels to release the toxic chemicals they absorb, just as adding salt in our activity will cause the gel to release much of the water it had absorbed. Then the contaminated gels could be cleaned and reused rather than thrown away, and the chemicals released could be treated to make them less toxic.

Activity 3B

Polymers–How Can We Use Them?



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ cup of water
- ❑ plastic dish scrubber
- ❑ sponge

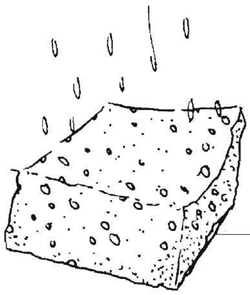
Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ 2 clear plastic cups, 9-oz. size
- ❑ 1/2 teaspoon water-absorbing powdered gel[1]
- ❑ measuring spoon, teaspoon-size
- ❑ 1 teaspoon table salt (NaCl)
- ❑ spoon
- ❑ dishpan or similar dump bucket
- ❑ distilled or deionized water (optional)[2] or tap water

[1] You may be able to find water-absorbing gel sold as root dip at local garden stores. Make sure that it looks like powder, not larger crystals, so that it will soak up water quickly enough to be effective for this activity. If you can't find powdered gel locally, you can order HydroSource Fine Grind from Castle International Resources (see "Guide to Ordering Supplies"). A less effective alternative is to cut apart a disposable diaper. If you put some of the filling material into a cup and add water, you will gradually be able to see gel particles as they soak up water and expand. This will not be as dramatic as using HydroSource or similar gel powder because the gel in diapers takes much longer to soak up water and to release it when salt is added.

[2] Distilled or deionized water is available in drugstores and some grocery stores. It is more dramatic than tap water for this activity because the gel will absorb more before becoming soupy.



Activity 3B

Polymers–How Can We Use Them?

Focus

Spill a small amount of water onto a table and try to clean it up with a plastic dish scrubber. This doesn't work very well because the plastic doesn't absorb water. Ask the children how you could do better. They may suggest using paper towels, newspaper, or a sponge. All of these materials absorb water by holding it in air spaces between their fibers.

Of all the plastics you can think of, would any help to soak up water? Synthetic sponges are one example, although the children may be surprised to learn that they are made of a plastic. Most plastics are made from polymers that repel water. Think of a vinyl raincoat—rather than soaking in, rain forms beads and runs off.

In this activity, we will use a polymer that is unusual because it has the opposite property—it attracts water molecules and holds them among its long chains. This polymer would make a terrible raincoat, but it does have a variety of other uses.

Activity

1. Cover the table with newspaper.

2. Place 1/4 teaspoon of water-absorbing powdered gel in a clear plastic cup and approximately 1/2 cup distilled or tap water in another cup.

3. Ask the children to look at the gel powder, describe it, and try to predict what will happen when they add water.

4. Using the measuring spoon, add a spoonful of water into the cup containing gel and watch what happens.

5. Add another spoonful of water and watch what happens. Ask the children to count how many spoonfuls they can add before they see any water that hasn't become absorbed. Have them write down this number.

I wonder...

Keep track of "I wonder...." statements you and the children express while doing the activity. Children might wonder

why some materials soak up water and others don't.

how a sponge works.

Conversation

Questions You Might Ask

Where does the water go when you add it to the cup containing gel powder?

Why can't you pour it back out?

Do you think it is possible to add more water than the gel can absorb?

Does everyone's gel hold the same number of spoonfuls of water?

Can you think of any reasons why yours might hold more or less than someone else's?

What do you think happens when you add the salt?

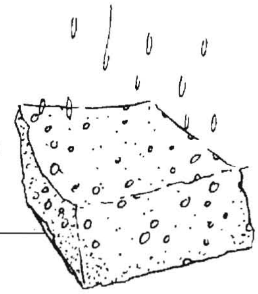
Can you think of a product you'd like to invent that would contain this gel?

Why do you think some materials absorb water better than others?

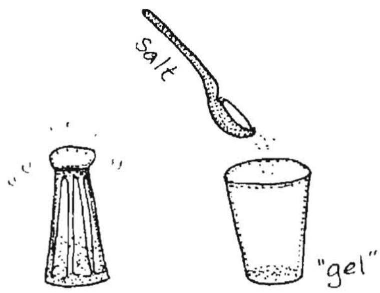
What would happen if your raincoat were absorbent?

Activity 3B

Polymers–How Can We Use Them?



6. Sprinkle 1/2 teaspoon of table salt onto the gel-water mixture and watch what happens.



7. Ask what they predict would happen if they started with a new batch of gel but this time mixed in a bit of salt before starting to add water. Try it, and compare the number of spoonfuls of water to the number they got for the gel with no salt added.

Closure: Connecting Chemistry and Environment

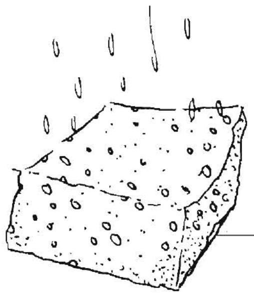
If you are doing only Activity 3B, review the "I wonder..." statements. If you are doing Activities 3A and 3B in one session, talk with the children about how the activities helped them to think about chemical compounds such as polymers. Ask, "What did you enjoy about these activities? What did you learn about polymers and their possible uses?"

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

how gel can hold so much water.

how much gel it would take to soak up all the water in the bathtub.



Activity 3B

Polymers–How Can We Use Them?

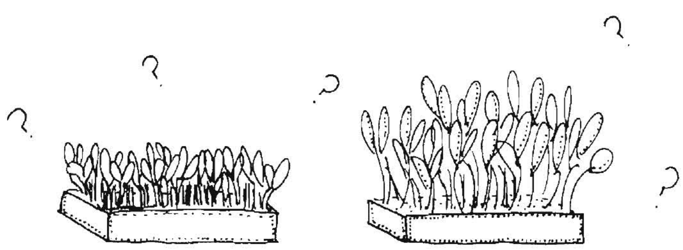
A Step Beyond

I wonder if other chemicals will work like salt in making the gel less able to absorb water.

You might want to experiment with ways of releasing water from the gel. Try using common household chemicals other than salt. The children might choose to try related substances like pepper or sugar. (As they will discover, neither of these will cause the gel to become liquid because they do not contain ions that interact with the polymer molecules in a way that causes them to release the water molecules.) Other chemicals that are more likely to work include salt substitutes or a few drops of acidic solutions such as lemon juice or vinegar.

I wonder if adding gel to soil would help plants to grow better.

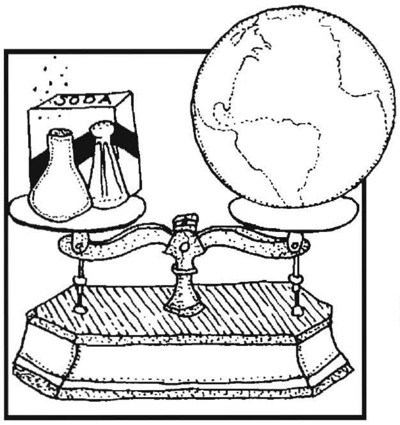
Try growing some seedlings in various potting mixtures, such as sand, sand mixed with gel, soil, and soil mixed with gel. How does addition of the gel affect the growth of the seedlings? Will plants grow in gel with no soil?



What Dissolves and What Doesn't?

Water Treatment—Cleaning It Up

Dissolving



Session 4

Dissolving

These two activities introduce children to the idea that some substances dissolve in water whereas others do not and that water treatment processes are designed to remove both kinds of substances.

In Activity 4A, *What Dissolves and What Doesn't?*, the children dissolve a variety of substances in water and try to figure out the difference between substances that truly dissolve and others that mix with water but then settle back out.

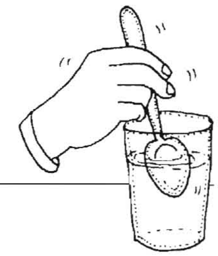
In Activity 4B, *Water Treatment—Cleaning It Up*, they experiment with techniques for water treatment, trying to remove both dissolved and suspended substances from the water.

Session at a Glance

- Leader's Guide, pages 66, 72
- Plan Ahead, page 72
- Special Hint, page 66
- Science: Behind the Scenes, pages 67, 73
- Supplies and Preparation, pages 68, 74
- Focus, pages 69, 75
- Activity, pages 69, 75
- Transition or Closure, pages 70, 76
- A Step Beyond, pages 71, 77

Activity 4A

What Dissolves and What Doesn't?



Leader's Guide

What's the point?

Children learn that some substances dissolve in water and become invisible as they mix into solution. Others dissolve in water but change its color or appearance. And some substances do not dissolve at all.

For additional information, read Science: Behind the Scenes (page 67).

What's the plan?

1. Read the activity (page 69).
2. Gather the supplies (page 68).
3. Try the activity.
4. Note special hint (below).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Special Hint

If children are likely to put their fingers in their mouths, provide reminders and adequate supervision and ask them to wash their hands after the activity.

Activity 4A

What Dissolves and What Doesn't?

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

When a substance dissolves, it becomes part of a liquid solution. Pure water (such as distilled water) contains only water molecules and no dissolved substances. The water we use in everyday life is far from pure—it may contain an assortment of dissolved minerals such as calcium, magnesium, and iron, as well as other chemicals such as dissolved organic compounds, salts, and chlorine, the latter of which is added as a disinfectant during water treatment.

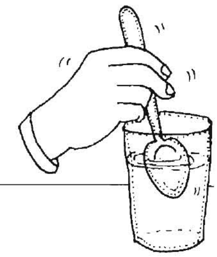
In this activity, some chemicals such as salt and sugar dissolve in water without changing the water's appearance. Others, such as powdered drink mix, change the color of the water when they dissolve. A third category of the substances tested does not fully dissolve—if you stir cornstarch or flour into water, you will notice that many particles quickly settle back out of solution. It may look as if all of the cornstarch and flour settle out, but some actually does dissolve. You can test this by adding a couple of drops of iodine as you did to indicate the "mystery pollutant" in Activity 2B. If the water turns purple, you will know that some of the starch from the flour or cornstarch has dissolved.

So, what does it mean to dissolve, and how can a white powder such as salt or sugar simply disappear into a clear solution? Salt and sugar are examples of chemical compounds that are white crystals when in solid form. When these substances dissolve, the crystals are broken into small, invisible particles, called molecules or ions, that mingle among the water molecules.

Solids are not the only substances that dissolve. See "A Step Beyond" for ideas about simple demonstrations of gases and liquids that dissolve in water.

Activity 4A

What Dissolves and What Doesn't?



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 2 jars, one containing only water and the other containing water and a bit of sand
- ❑ sugar

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ smocks, old shirts, or aprons
- ❑ measuring cup
- ❑ water
- ❑ clear plastic cup, 9-oz. size
- ❑ a variety of household substances, some of which will dissolve (sugar, salt, Kool-Aid or other colored drink mix, flour, cornstarch, baking soda, dried milk)
- ❑ teaspoon measure
- ❑ spoon

Activity 4A

What Dissolves and What Doesn't?

Focus

Pass around two jars, one containing only water and the other containing water and a bit of sand. Ask the children whether they think anything is in the bottles other than water. The sand doesn't dissolve, so it's easy to see that it is in one of the bottles. But if you added a bit of sugar or salt to the other bottle, the appearance of the water would not change. In fact, unless it has been distilled, all water contains dissolved substances, many of which we cannot see. Try mixing in a pinch of sugar and then ask if the water looks any different. Discuss the idea that some substances dissolve in water and others do not and that some of those that do dissolve become invisibly mixed with the water.

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

how you can tell if there's anything dissolved in water.

if something dissolves in water, whether it always disappears and becomes invisible.

Activity

1. Cover the table with newspaper and have the children put on their smocks.

2. Measure 1 cup of water into a plastic cup.

3. Put out a selection of common household substances such as sugar, salt, cornstarch, flour, baking soda, powdered drink mix, and dried milk powder.

4. Ask each child to select a substance he or she thinks will dissolve in water, then measure one teaspoonful of that substance and stir it into the cup of water.

Conversation

Questions You Might Ask

Do you think everything will dissolve in water? Can you think of anything that might not?

Does everything that dissolves look the same (for example, a white powder such as sugar or salt)?

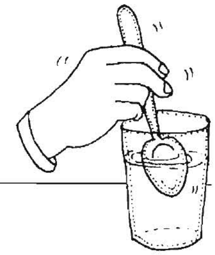
Where do you think things go when they dissolve? Why can we no longer see them?

If something dissolves in water, will the solution always remain clear?

Do some substances change the appearance of the water in which they dissolve, while others do not?

Activity 4A

What Dissolves and What Doesn't?



5. Compare what substances the children chose. Ask them whether they can see any particles that have settled out of solution or whether they think their substance has fully dissolved.

6. Give them time to experiment with other substances, either mixing them into the same solution or starting with fresh water as they see fit. Ask them to notice any differences in the appearance of the solution with each substance they stir in.

7. Discuss whether anyone has found a substance that did not dissolve. How could they tell?

Transition or Closure

If you are doing only Activity 4A, review the "I wonder..." statements. If you are doing Activities 4A and 4B together, help the children clean up their work areas. Then shift their attention to the water treatment activity.

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

why some things disappear when they dissolve.

whether dissolved chemicals can come back out of water.

Activity 4A

What Dissolves and What Doesn't?

A Step Beyond

I wonder what other things will dissolve in water.

As you know, many solids will dissolve in water and many others will not. The children may be surprised to learn that it is also possible for gases to dissolve in water. When you drink a glass of soda, it is the dissolved carbon dioxide that makes the soda taste bubbly.

If you vigorously stir or shake water, you are probably causing more air to dissolve in it, but you cannot see this. What you can observe is gases coming back out of solution. As a glass of cold water or soda warms up, you will see bubbles forming and rising to the surface. These are bubbles of gas that were dissolved but are coming back out of solution as the temperature rises.

Another idea that may be surprising is that some liquids dissolve in water. As you may notice when you shake a jar containing oil and water, those two liquids do not mix and neither dissolves in the other. If you try mixing water and rubbing alcohol, though, you will find that they stay mixed. In this case, the alcohol has dissolved in the water.

The children might wonder how much of a substance will dissolve in water. If you keep stirring more and more sugar into a glass of water, will you reach a point at which it will no longer dissolve? Yes, because at some point the solution will become so concentrated that any added sugar will remain in solid form rather than dissolving. At this point, though, you can warm the solution and find that once again more sugar crystals will disappear.

You can put this idea to practical use by making sugar candy. First you create a highly concentrated sugar solution in hot water, then you let it sit long enough for some of the water to evaporate. Because the sugar does not evaporate, the remaining solution becomes even more concentrated, and crystals will begin to form on the sides of the glass or on a string or stick suspended in the middle.

Activity 4B

Water Treatment–Cleaning It Up

Leader's Guide

What's the point?

Children try various techniques for removing dissolved and suspended substances from water. Many substances become dissolved or mixed into water as it flows in rivers or streams. Before we drink that water, it goes through treatment to purify it.

For additional information, read Science: Behind the Scenes (page 73).

What's the plan?

1. Read the activity (page 75).
2. Gather the supplies (page 74).
3. Try the activity.

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Plan Ahead

Purchase activated carbon, either locally or by mail order (see Activity Supplies, page 74).

Activity 4B

Water Treatment–Cleaning It Up

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

All of the water we use for drinking and cooking comes either from surface water such as lakes, rivers, or streams, or from groundwater that we obtain from wells or springs. Even water that is sold in bottles comes from these same sources. This water is clean but not pure. Pure water contains nothing but water molecules (H_2O), but the water we drink contains a variety of other substances such as minerals dissolved from rocks, organic compounds dissolved from leaves, and possibly also chlorine or some other chemical that has been added to disinfect it so that it will not carry disease germs. Some of the substances naturally found in water are harmless or even good for human health. Some other substances, however, need to be removed before we can safely use water. The purpose of water treatment plants is to accomplish this.

In this activity, you may find that filtering your muddy water makes it clear. Although this clear water may look clean enough for drinking, that would not be a good idea—it may still contain germs or microscopic organisms that could cause you to become sick. In water treatment plants, the final step is disinfection, which is designed to kill germs and disease-causing organisms and make the water suitable for human consumption.

The activated carbon used in this activity to remove color from water is used in real water treatment processes to remove substances that cause odor, color, or contamination. For example, many of the water purification units that people use in their homes are based on treatment with activated carbon, as are the filtration pumps used by campers and backpackers. Activated carbon particles soak up many undesirable compounds such as solvents and pesticides. Under the microscope, activated carbon particles look like tiny sponges with many holes and pores that can trap molecules and remove them from solution.

Activity 4B

Water Treatment–Cleaning It Up

Supplies and Preparation

Focus Supplies

The Focus item can be shared by the group.

- ❑ jar containing muddy water

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ smocks, old shirts, or aprons
- ❑ funnel[1]
- ❑ cup or jar in which funnel can be suspended
- ❑ 2 coffee filters
- ❑ assortment of sand, gravel, and soil, for use in filling the funnels, about 1 cup total (you may also choose to include other materials such as cotton balls or scraps of fabric)
- ❑ 1 cup muddy water[2]
- ❑ 1 cup lightly colored water[3]
- ❑ 1 tablespoon of activated carbon pellets[4]

[1] Make inexpensive funnels and cups by cutting 1-liter soda bottles about 4 inches from the bottom. Turned upside down, the top half fits into the bottom half to form a funnel and cup. Another way to make funnels is to use a paper clip to make many tiny holes in the bottom of foam cups.

[2] Make muddy water by mixing $^1/_2$ cup of soil or mud into 1 gallon tap water.

[3] Make colored water by adding three to four drops of food coloring per gallon of water.

[4] Activated carbon is like charcoal but has been treated at high temperature to "activate" it, or increase its ability to remove chemicals from solution. Activated carbon is used in aquarium filters, and you may be able to buy it at local pet or aquarium supply stores. (It is also sold in pharmacies for treatment of poisoning, but this form is too finely ground to work well for this activity.) If you can't find activated carbon locally, you can order it (see "Guide to Ordering Supplies").

Activity 4B

Water Treatment–Cleaning It Up

Focus

Pass around a jar containing muddy water and ask the children if they think they would like to drink it. Use this as the basis for a discussion about how there are many substances that become dissolved in or mixed with water as it flows in rivers or streams. Before we drink that water, we take steps to clean it up. The most obvious step is to remove mud and other solid particles, but the water may also contain invisible substances that would make it unsafe to drink without proper treatment. Even clear water in a fresh mountain stream may contain germs that make it unsafe to drink before being treated.

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

how you get mud out of muddy water.

how you can tell if water is clean enough to drink.

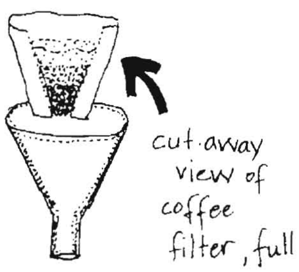
Activity

1. Cover the table with newspaper and have the children put on their smocks.

2. Suspend each funnel into a jar or cup, making sure to leave at least a couple of inches of drainage space below the funnel.

3. Line each funnel with a coffee filter.

4. Explain to the children that they will be using their funnels to create filters to clean up a cupful of muddy water. Provide a variety of materials and let each child choose what to try. Possibilities include sand, soil, gravel, cotton balls, or fabric scraps. Someone might decide to leave the funnel empty, using just the coffee filter to clean up the water.



Conversation

Questions You Might Ask

What substances do you think might be dissolved in our drinking water?

Can you think of some substances you definitely would *not* want in your water?

What are some others that would be OK?

Does the water look cleaner after you filter it?

Can you think of other ways you might be able to make it even cleaner?

Which filter makes water look the cleanest?

What happens if you add carbon pellets to your filter?

Can you remove dissolved substances through filtration? How can you tell?

Activity 4B

Water Treatment–Cleaning It Up

5. After all of the children have completed filters, have them each pour a cup of muddy water into the funnel and observe what happens as it drips out. Does it become clearer? Which filters seem to work the best?

So far, you have been experimenting with removing solid particles from water. The next part of the activity is to see whether you can also remove dissolved substances.

6. Ask the children whether they think colored water will become clear when poured through their funnels. Then have them try it. Does the solution lose its color?

7. Filtration through sand and activated carbon is a common method of treating water to remove colors and other dissolved chemicals. Try mixing 1 tablespoon of activated carbon pellets into the sand or other material in each funnel. (If the filters have become clogged with too much mud, it may work better to empty them out and start over with only clean sand and activated carbon in the funnel.)

8. Pour $^1/_2$ cup of colored water through this new filter, noticing whether there is any difference in appearance of the water that drains through.

Closure: Connecting Chemistry and Environment

If you are doing only Activity 4B, review the "I wonder" statements. If you are doing Activities 4A and 4B in one session, talk with the children about how the activities helped them to think about what substances may be found in water and how some of these can be removed by water treatment. Ask, "What did you enjoy about these activities? What did you learn about chemistry and the environment?"

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

where the color goes.

why carbon doesn't make the water turn black.

Activity 4B

Water Treatment–Cleaning It Up

A Step Beyond

I wonder if this is what happens to our water before we drink it.

Read *The Magic School Bus at the Waterworks* (see References). In the amusing and entertaining Magic School Bus style, this book explains the process of treating water and making it safe to drink. You might also want to call your local water treatment plant to ask what processes they use to clean the water. If you have the time, it would be even better to tour the facility.

One of the steps in water treatment is to remove suspended sediment, the fine particles of silt that stay suspended in water for a long time after you mix mud with water. These particles are not dissolved, but they are so small that it takes a long time for them to settle out of solution. Many water treatment plants add alum, a chemical compound that causes these tiny particles to clump together so that they will settle more quickly or can be more readily filtered out of solution.

If you'd like to try another hands-on activity, here's one that demonstrates why alum is used:

1. Pour $^1/_2$ cup of muddy water into each of two jars. Label one jar "with alum" and the other "no alum."
2. To the "with alum" jar, add 1 teaspoon of alum[1] and shake.
3. Let both jars sit undisturbed for about 10 minutes.
4. Try filtering your "alum" and "no alum" water samples through funnels lined with coffee filters. Does one filter faster than the other? After filtration, does one look less cloudy than the other? Alum is used in water treatment to cause small particles to clump together so that they will filter out more easily. Did this work for your samples?

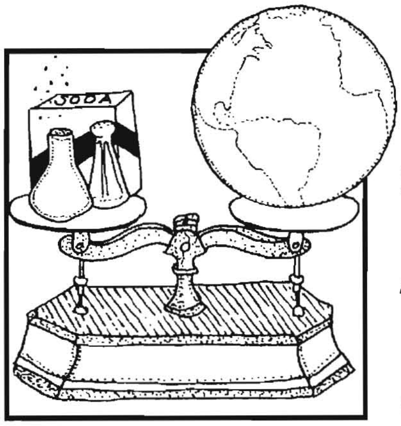
---

[1] Alum is sold in pharmacies and also in the spice section of grocery stores.

Pink? Green? Or In Between?

Forever Purple?

Acids, Bases, and Buffers



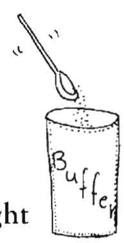
Session 5

Acids, Bases, and Buffers

These two activities introduce the idea that some solutions are acidic, others are neutral or basic, and they can change back and forth depending on what is added to them. Children learn about the concepts of acids, bases, and buffers and their influence on organisms living in lakes and streams.

In Activity 5A, *Pink? Green? Or in Between?*, the children use red cabbage juice to test several household solutions to determine which are acids and which are bases.

In Activity 5B, *Forever Purple?*, they experiment with changing a solution from an acid to a base or vice versa. They discover that changing the acidity of a solution is much harder if the solution contains something called a "buffer," and they think about what implications this might have for fish and other aquatic life.



Session at a Glance

- Leader's Guide, pages 82, 88
- Plan Ahead, page 82
- Science: Behind the Scenes, pages 83, 89
- Supplies and Preparation, pages 84, 90
- Focus, pages 85, 91
- Activity, pages 85, 91
- Transition or Closure, pages 86, 92
- A Step Beyond, pages 87, 93

Activity 5A

Pink? Green? Or in Between?

Leader's Guide

What's the point?

Children learn that chemicals can be classified as acids, bases, or neutral compounds. They use a colored solution to discover which common household chemicals fit into these classifications. Through exploration, children may discover that when acids and bases are mixed together, they tend to cancel each other out and produce a more neutral solution.

For additional information, read Science: Behind the Scenes (page 83).

What's the plan?

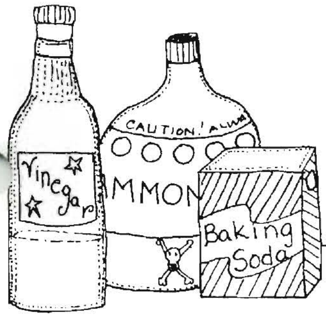
1. Read the activity (page 85).
2. Gather the supplies (page 84).
3. Make the solutions and try the activity.
4. Note safety measures (in ***bold italics***).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Plan Ahead

Purchase red cabbage and prepare the red cabbage solution (see "Supplies and Preparation"). Assemble common household chemicals indicated in the supply list or ask children to bring in samples from their own homes.



Activity 5A

Pink? Green? Or in Between?

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

In this activity, children will use red cabbage juice as a simple indicator of whether a solution is an acid or a base. This works because the cabbage juice contains a pigment that changes color depending on the acidity of the solution with which it is mixed.

Acidity of Solution:	acidic	neutral	basic
Color when mixed with cabbage juice indicator:	pink	purple	green

Many chemicals change color in this way. Litmus paper, which scientists use to determine the acidity of a solution, contains an indicator chemical like the one in cabbage juice. Other examples include juices made from purple grapes, blueberries, and cranberries (see *In-Touch Science: Foods and Fabrics*, Activity 4B).

If the children are curious about the chemistry of acids and bases you can explain that a water molecule can separate into two pieces: an H^+ and an OH^- ion. Because pure water contains equal numbers of H^+ and OH^- ions, it is neutral (neither an acid nor a base). In an acid such as vinegar or lemon juice, there are extra H^+ ions in solution. In a base, there are extra OH^- ions. When you mix an acid with a base, the resulting solution will be closer to neutral than either of the original solutions because extra H^+ ions from the acid will combine with OH^- ions from the base to form water.

Activity 5A

Pink? Green? Or in Between?

Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 1 cup fruit juice for each child (lemonade, cranberry, or grapefruit juice is best—you want a juice that will pucker up their mouths)

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ goggles or safety glasses
- ❑ smocks, old shirts, or aprons
- ❑ 6 clear plastic cups, 9-oz. size
- ❑ markers
- ❑ measuring spoon (tablespoon size)
- ❑ about 1/2 cup red cabbage juice[1]
- ❑ eyedropper
- ❑ several drops of white vinegar
- ❑ several drops of washing soda solution[2]
- ❑ small amounts of household substances such as lemon juice, clear soft drinks such as 7-Up or Sprite, tap water, laundry detergent, window cleaner, dishwashing liquid, shampoo, soap, salt, flour, or sugar. Do not use baking soda—it is a buffer and will be used in Activity 5B. ***(Avoid solutions containing chlorine or bleach and check product labels for safe handling instructions.)***
- ❑ Lysol or other disinfectant solution[3]

[1]To make red cabbage solution pour 2 cups of hot water over 1/2 cup of chopped red cabbage and let stand until cool. Strain and discard the cabbage pieces and refrigerate or freeze the juice until needed. You need about 1/2 cup of solution per child. Save extra for Activity 5B.

[2]To make washing soda solution mix 1 tablespoon of washing soda into 1 cup of water.

[3]Reminder: Before reusing, disinfect goggles in a solution of 1 1/4 oz. Lysol in 1 gallon of water. Rinse well and air-dry.

Activity 5A

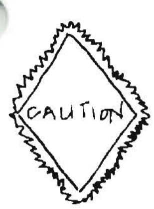
Pink? Green? Or in Between?

Focus

Give each child a glass of lemonade, cranberry juice, or grapefruit juice. As they drink it, discuss how it makes their tongues feel funny because it contains an acid.

Activity

1. Cover the table with newspaper and have the children put on their smocks.

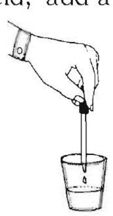


2. ***Make sure that each child is wearing goggles or safety glasses, and instruct them not to taste any of the chemicals they will be using. Although some of these are foods or drinks, others are cleaning products or other inedible compounds. To ensure safety, children shouldn't put any of these substances into their mouths.***

3. Label three clear plastic cups: "acid," "neutral," and "base."

4. Pour 1 tablespoon of red cabbage juice into each cup.

5. To the cup labeled "acid," add a couple of drops of vinegar, then mix.



6. To the cup labeled "base," add a couple of drops of washing soda solution, then mix.

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

if all juices are acids, or maybe only the ones that make your mouth pucker up.

whether other drinks, like milk, water, or tea are acids.

Conversation

Questions You Might Ask

What color does cabbage juice turn when you add an acid to it? What color does it turn when you add a base? Does the color change all at once or gradually?

Is the fruit juice an acid or a base?

What other solutions have you tested that are acids? Which ones are bases?

Have you found any that are neutral?

What does it mean if your test solution has a color that doesn't exactly match one of the solutions in the labeled cups?

What color do you think the solution might turn if you mix two acids together?

How about if you mix an acid with a base?

Activity 5A

Pink? Green? Or in Between?

7. Line up the cups, with the "neutral" cup in the middle, and compare their colors. Keep these solutions to refer to in the following steps.

8. Pour 1 tablespoon of red cabbage juice into three more cups.

9. Test the acidity of the juices you used for the focus activity. You can do this by adding a few drops to the cabbage juice solutions, then comparing their colors to those in your labeled cups. In the same way you can test other common household substances such as colorless soft drinks, laundry detergent, window cleaner, dishwashing liquid, and shampoo. You can also test solids such as soap, salt, flour, and sugar. Simply add a small amount to your indicator solution, stir it up, and observe the color.

10. Once you have tested other chemicals, you can experiment with your labeled solutions. Try mixing the acid with the base and compare the color of the mixture with the color of your "neutral" solution.

11. Pour your mixtures down the sink and rinse your cups for reuse.

Transition or Closure

If you are doing only Activity 5A, review the "I wonder..." statements. If you are doing Activities 5A and 5B together, help the children clean up their work areas. Then shift their attention to the buffer activity.

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

why the colors change.

if any drinks are bases.

Activity 5A

Pink? Green? Or in Between?

A Step Beyond

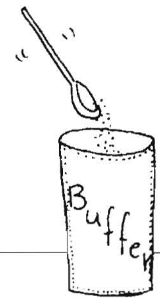
I wonder whether other solutions can be used like red cabbage juice to indicate acids or bases.

Several other household substances work in the same way. You might want to try other indicator solutions, such as juice from blueberries or cranberries, and compare their colors when they are mixed with various household chemicals. (Unlike red cabbage juice, these fruit juices are acidic, so they will not change color when acids are added. They will change color when mixed with a base, though, and then will change back to their original color when mixed with an acid.)

Another household chemical that can be used as an acid and base indicator is the spice called turmeric. If you mix $^1/_2$ teaspoon of turmeric into $^1/_2$ cup water, you will get a yellow mixture. This will turn reddish brown if you mix in a base such as a few drops of the washing soda solution. Then if you add an acid such as vinegar, the mixture will become yellow again.

Activity 5B

Forever Purple?



Leader's Guide

What's the point?

Children discover that a chemical called a "buffer" makes it much more difficult to change a neutral solution into an acid or a base. Lakes and streams that are well buffered are protected against acid rain and other pollutants that might otherwise make the water too acidic for fish and other living things.

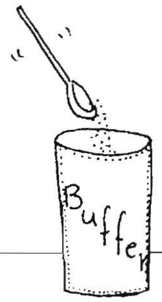
For additional information, read Science: Behind the Scenes (page 89).

What's the plan?

1. Read the activity (page 91).
2. Gather the supplies (page 90).
3. Make the solutions and try the activity.
4. Note safety measures (in ***bold italics***).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.



Activity 5B

Forever Purple?

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

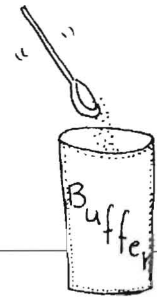
In this activity the children will probably discover that they cannot make their buffered solutions change from purple (neutral) to either green (basic) or pink (acidic). The colors will not change as readily as they did in Activity 5A because this time the solutions are buffered. This means that they contain a chemical compound that helps them to resist change in acidity.

Baking soda is a chemical compound called sodium bicarbonate ($NaHCO_3$). It creates a buffered solution by soaking up extra H^+ or OH^- ions, making it much harder to change the solution to either an acid or a base. In this activity, when you add vinegar to the buffered solution, you will notice fizzy bubbles. These are carbon dioxide (CO_2), which is formed by a chemical reaction between the acidic vinegar and the baking soda buffer. You're probably familiar with several other buffers. Bufferin is an aspirin that is buffered so that it won't make your stomach too acidic. Antacids are also buffers. They help prevent acid indigestion and heartburn by neutralizing excess stomach acids.

Fish die if the water in which they live becomes too acidic. Rainfall is naturally slightly acidic, and it may become more so by dissolving acids contained in air pollution. Some lakes, ponds, and streams are buffered by minerals similar to baking soda, so their water will remain close to neutral even if the rain and snowmelt entering them is acidic. In some areas, the minerals present in the rocks and soils do not provide good buffers, so the water bodies in these areas are much more susceptible to the effects of acid rain. Many lakes in New York State's Adirondack Mountains, and in countries such as Norway, Sweden, and Finland, have no fish because the water has become too acidic. Other nearby lakes still have healthy fish populations because the surrounding rock and soils have provided the right minerals to buffer the water and keep it from becoming too acidic.

Activity 5B

Forever Purple?



Supplies and Preparation

Focus Supplies

The Focus item can be shared by the group.

- ❑ picture of fish or other underwater life

Activity Supplies

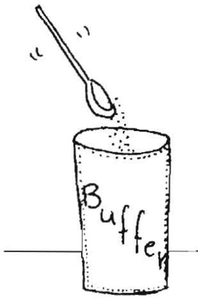
Activity supplies are listed for individuals unless otherwise noted; mutiply as needed.

- ❑ newspaper
- ❑ smocks, old shirts, or aprons
- ❑ goggles or safety glasses
- ❑ 2 clear plastic cups, 9-oz. size
- ❑ markers
- ❑ measuring spoon
- ❑ 2 tablespoons red cabbage juice[1]
- ❑ $^1/_8$ teaspoon baking soda
- ❑ eyedropper
- ❑ several drops white vinegar
- ❑ several drops washing soda solution[2]
- ❑ masking tape or sticky labels
- ❑ small amounts of household substances such as lemon juice, clear soft drinks such as 7-Up or Sprite, colorless liquid dish soap, tap water, laundry detergent, window cleaner, dishwashing liquid, shampoo, toothpaste, soap, antacid tablets, salt, flour, or sugar ***(Avoid solutions containing chlorine or bleach, and check product labels for safe handling instructions.)***
- ❑ Lysol or other disinfectant solution[3]

[1] To make red cabbage solution pour 2 cups of boiling water over $^1/_2$ cup of chopped red cabbage and let stand until cool. Strain and discard the cabbage pieces and refrigerate or freeze the juice until needed.

[2] To make washing soda solution mix 1 tablespoon of washing soda into 1 cup of water.

[3] Reminder: Before reusing, disinfect goggles in a solution of 1 $^1/_4$ oz. Lysol in 1 gallon of water. Rinse well and air-dry.



Activity 5B

Forever Purple?

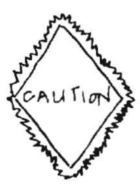
Focus

Look at an aquarium of fish, visit a lake or pond, or pass around pictures of fish swimming in water. Talk about how fish spend their lives surrounded by water, just as we live surrounded by air. We can drink some solutions that are acids (such as fruit juices or soft drinks) without any harm to our health, but fish cannot live in acidic water. Discuss the idea that in the last activity, we found that it was pretty easy to change the colors of the solutions by adding a few drops of an acid or a base. In this activity we will try adding a buffer to the water to see how this affects its changes in acidity.

> **I wonder...**
>
> Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder
>
> *why solutions change color.*
>
> *why we can drink some acids but fish can't swim in them.*

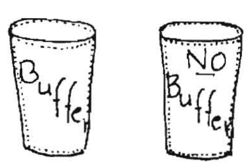
Activity

1. Cover the table with newspaper and have the children put on their smocks.



2. ***Make sure that each child is wearing goggles or safety glasses and instruct them not to taste any of the chemicals they will be using. Although some of these are foods or drinks, others are cleaning products or other inedible compounds. To ensure safety, children shouldn't put any of these substances into their mouths.***

3. Label two clear plastic cups "buffer" and "no buffer."



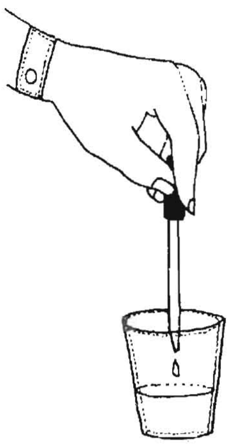
4. Pour 1 tablespoon of red cabbage juice into each of these cups.

5. To the cup labeled "buffer," add $^1/_8$ teaspoon of baking soda and stir.

> **Conversation**
>
> Questions You Might Ask
>
> Are the "buffer" and "no buffer" solutions the same color? What happens to their colors when you add washing soda solution?
>
> If an acid turns pink and a base turns green, can you tell if washing soda is an acid or a base?
>
> What happens to the colors when you add vinegar?
>
> Do you notice any differences between the "buffer" and "no buffer" solutions? Which solution doesn't change color as easily?
>
> Can you get the "no buffer" solution to turn pink?
>
> If you were a fish, which solution would you rather live in?

Activity 5B

Forever Purple?



6. Using an eyedropper, add a couple of drops of washing soda solution to both cups and observe the color changes.

7. Drop by drop, add vinegar to the solution in the "no buffer" cup, mixing after each drop. Notice what happens to the color. Keep adding drops until the solution becomes pink.

8. In the same manner, gradually add drops of vinegar to the mixture in the cup labeled "buffer," seeing if you can get the color to change to match the "no buffer" cup.

9. Try some of the household substances you used in Activity 5A, comparing the color changes when these substances are added to the buffered and unbuffered solutions.

Closure: Connecting Chemistry and Environment

If you are doing only Activity 5B, review the "I wonder..." statements. If you are doing Activities 5A and 5B in one session, talk with the children about how the activities helped them to think about acids, bases, and changing back and forth between the two. Ask, "What did you enjoy about these activities? What did you learn about chemistry and the environment?"

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

why it won't turn pink.

where the bubbles come from.

Activity 5B

Forever Purple?

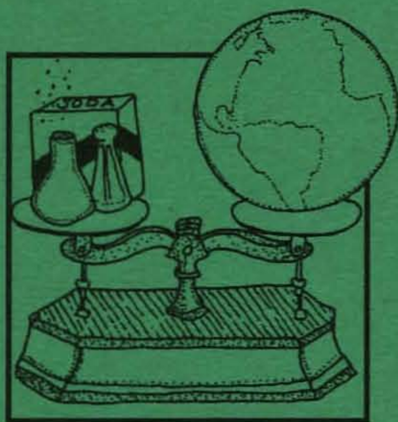
A Step Beyond

I wonder if the water in nearby streams or lakes is buffered or unbuffered.

To find out, you could collect water samples from local bodies of water and test to see how well buffered they are. Simply take each water sample, mix in enough cabbage juice indicator to give it color, and then test to see how easily you can change the color by adding a few drops of an acid such as vinegar or a base such as washing soda solution.

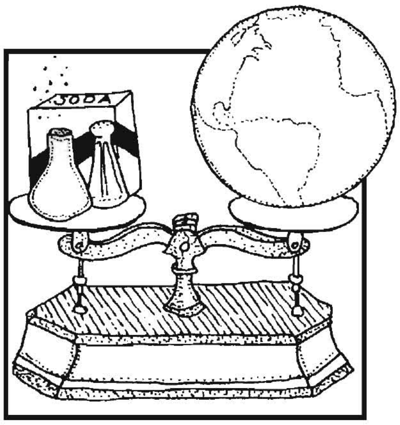
You might find it interesting to compare stream or lake water to water you collect from precipitation. If you live in a part of the country with limestone rock and soils, the water in rivers and lakes probably contains minerals that make it well buffered. Because the rain and snow have not filtered through rock and soil, they have not dissolved these minerals.

You will probably find that rainwater changes to an acid or a base when you add just a few drops of the test solutions, indicating that the rainwater is not well buffered. What happens if you take rainwater and shake it up in a jar with soil? After the soil settles out, can you figure out whether the water has dissolved any buffering minerals?



In-Touch Science: Chemistry & Environment

Resources and Management



In-Touch Science: Chemistry & Environment

Checklist for Assembling Supply Kits

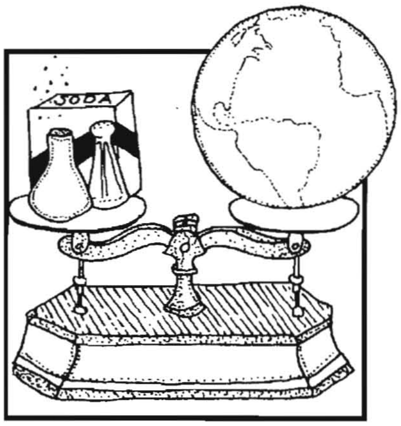
The supplies listed at right are needed to assemble one ten-person supply kit. Supplies are grouped as Tools, Consumable Supplies, and Perishable Food. The "quantity" column indicates amounts needed for ten participants to complete all ten activities. The "activities" column indicates when the items are used.

To keep small items organized, you may want to place them in resealable bags or envelopes labeled with item name, quantity, and activity number.

To make shopping easier, foods are listed together, but perishable items (such as milk, eggs, and plant materials) should be purchased when needed for the specific activity.

Item	*Quantity*	*Activities*
Tools		
❑ goggles or safety glasses (borrow if possible)	10	2B, 3A, 5A–B
❑ smocks, old shirts, or aprons	10	all
❑ bucket or dishpan	1	1A, 3B
❑ bowls or pie plates	20	1A–B
❑ bottles or jars with tight lids	4	1B, 2A–B, 4A–B
❑ spoons	10	1B, 2A–B, 3A–B, 4A
❑ eyedroppers	10	1B, 2A–B, 5A-B
❑ measuring cups	10	2A–B, 5A
❑ clear 9-oz. plastic cups	60	2A–B, 3A–B, 4A–B, 5A–B
❑ markers or pens	10	2A–B, 5A–B
❑ measuring spoons (tbsp. size)	10	2B, 3B, 5A
❑ measuring spoons (tsp. size)	10	4A, 3B
❑ paper clips	100	3A
❑ plastic dish scrubber	1	3B
❑ sponge	1	3B
❑ funnels (can be made from soda bottle)	10	4B
❑ picture of fish or underwater life	1	5B
Consumable Supplies		
❑ shortening or cooking oil	1 quart	1A–B
❑ liquid dish detergent	1 bottle	1A–B
❑ toothpicks	1 box	1A
❑ liquid food colorings	1 box	1A–B, 2A, 3A, 4B
❑ newspapers	as needed	all
❑ variety of liquids (such as honey, molasses, shampoo)	1 bottle each	1A–B
❑ cotton balls	10	1B
❑ paper towels	5	1B
❑ gravel or sand (optional)	10 cups	1B
❑ variety of cleanup supplies (such as sponges, pipe cleaners, cotton swabs)	10	1B

Item	*Quantity*	*Activities*
❑ table salt	1 container	2A–B, 3B
❑ masking tape or sticky labels	1 roll	2A–B
❑ tincture of iodine	1 bottle	2B
❑ cornstarch	4 tbsp.	2B
❑ white glue	1 bottle	3A
❑ disinfectant	1 bottle	2B, 3A
❑ Borax	2 tbsp.	3A
❑ disposable gloves (optional)	10 pairs	3A
❑ water-absorbing powdered gel	3 tbsp.	3B
❑ distilled water (optional)	1 gallon	3B
❑ variety of household substances some of which will dissolve	a few tbsp. of each	4A
❑ muddy water	1 gallon	4B
❑ coffee filters	10	4B
❑ assortment of sand, gravel, and soil	10–20 cups	4B
❑ activated charcoal	10 tbsp.	4B
❑ washing soda	1 tbsp.	5A–B
❑ vinegar	1 bottle	5A–B
❑ variety of household liquids (such as lemon juice, clear soft drinks, window cleaner)	small amounts	5A–B
❑ baking soda	3 tsp.	5B
❑ activated carbon pellets	1 box	4B
Perishable Food		
❑ whole milk	1 gallon	1A
❑ lemonade or other sour fruit juice	2 quarts	5A
❑ red cabbage	1/4 head	5A–B



In-Touch Science: Chemistry & Environment

Checklist for Assembling Supply Kits to Loan

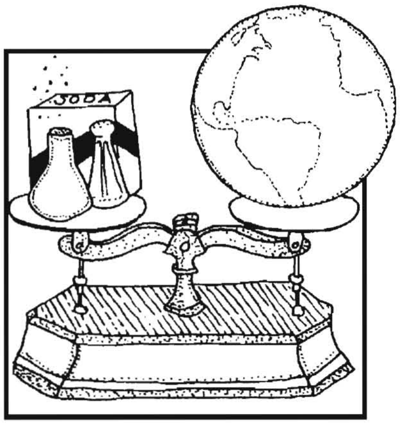
These are basic kits. Perishable goods or items usually found around the home or school are not included. Wash and repack.

Item labeled in bags or boxes	*Quantity*
Wash and Repack	
❑ goggles or safety glasses	10 pairs
❑ smocks, old shirts, or aprons	10
❑ clear plastic cups	60
❑ bowls or pie plates	20
❑ spoons	10
❑ eyedroppers	10
❑ measuring cups	10
❑ measuring spoons (tsp. size)	10
❑ measuring spoons (tbsp. size)	10
❑ funnels (can be made from soda bottles)	10
❑ markers or pens	10
❑ bottles or jars with tight lids	4
❑ sponge	1
❑ plastic dish scrubber	1
❑ picture of fish or underwater life	1
❑ bucket or dishpan	1
❑ box of paper clips	1
Replace as Consumed	
❑ food colorings	1 box
❑ cooking oil	1 quart
❑ liquid dish detergent	1 bottle
❑ salt	1 container
❑ cornstarch	4 tbsp.
❑ baking soda	3 tsp.
❑ variety of substances, some of which will dissolve (such as sugar, powdered drink mix, flour, dried milk)	few tbsp. each
❑ lemonade mix	2 quarts
❑ vinegar	1 bottle
❑ small amounts of liquids (such as honey, molasses, shampoo)	1 bottle each
❑ white glue	1 bottle
❑ Borax	2 tbsp.
❑ washing soda	1 tbsp.

Item	*Quantity*
❑ alum (optional)	1 bottle or box
❑ tincture of iodine	1 bottle
❑ activated charcoal	10 tbsp.
❑ water-absorbing gel	3 tbsp.
❑ Lysol or other disinfectant solution	1 bottle
❑ toothpicks	1 box
❑ cotton balls	10
❑ pipe cleaners	10
❑ cotton swabs	10
❑ masking tape or sticky labels	1 roll
❑ coffee filters	10

Supplies Not Provided

❑ paper towels
❑ distilled water (optional)
❑ disposable gloves (optional)
❑ newspapers
❑ sand, gravel, and soil



In-Touch Science: Chemistry & Environment

Guide to Ordering Supplies

Most of the supplies used in *In-Touch Science: Chemistry and Environment* can be purchased at food stores, drugstores, discount stores, and fabric stores. The following or similar mail order sources may be useful if you are assembling several supply kits or have difficulty finding supplies.

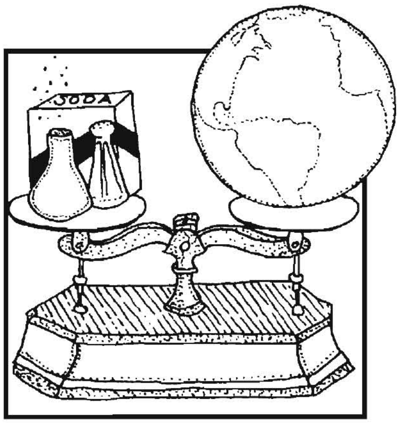
Carolina Biological Supply Company
K–6 Science Catalog
2700 York Road
Burlington, NC 27215
800-334-5551
Web site: http://www.carolina.com/
safety glasses, measuring cups and spoons, funnels, and other basic science equipment

Delta Education
Hands-On Science K–8 catalog
P.O. Box 3000
Nashua, NH 03061-3000
800-442-5444
Web site: http://www.delta-ed.com/
safety glasses, measuring cups and spoons, funnels, and other basic science equipment

Two items may need to be ordered in advance rather than bought locally: the water-absorbing gel used in Activity 3B and the activated charcoal used in Activity 4B.

Castle International Resources
2370 W. Highway 89A #11-300
Sedona, AZ 86336-5349
Telephone: (toll-free): 888-703-0222
E-mail: castle@sedona.net
Web site: http://www.hydrosource.com/prod01.htm
Order HydroSource Fine Grind [pulverized], 1 lb., for $4.95 plus $3.00 shipping.

InnerOceans
206 Millburn Avenue
Suite 6F
Millburn, NJ 07041
973-258-4074
Web site: http://inneroceans.com/
Order hobbyist-grade activated carbon, 14 oz. for $3.75 plus shipping.



In-Touch Science: Chemistry & Environment

Parent Letter

You may want to introduce *In-Touch Science* to the parents of the children in your group. This is especially helpful if your group has not previously worked on science projects or if you want to encourage parent volunteers. Complete the form below and duplicate as needed.

__________________ (Agency name)

__________________ (Agency address)

__________________ (Date of letter)

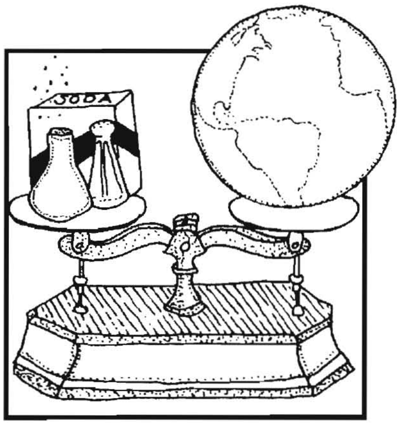
Dear Parent/Guardian:

The __________________________ (name of your group) will be exploring and having fun with *In-Touch Science* on _______________________ (program dates). *In-Touch Science* is a hands-on science program that encourages children to examine everyday items, to talk about their observations, and to connect what they learn to what they do in daily life. Your children will occasionally bring home something they made. More often, you will need to ask them to tell you what they did. The program was developed by Cornell University with funding from the National Science Foundation.

Signed:______________________

Position:______________________

Agency:______________________



In-Touch Science: Chemistry & Environment

Model Release

You may want to take photographs for local publicity or to share with Cornell University as part of the national *In-Touch Science* evaluation. In either case, you need to obtain permission to use these images. Adults can sign individual model release forms; parent/legal guardians should sign for children under 18 years of age. Complete the form below and reproduce as needed.

Model Release

Please check all that apply:

___ ____(your agency)

___ In-Touch Science Team and Cornell Media and Technology Services, Cornell University, 239 Martha Van Rensselaer Hall, Ithaca, NY 14853-4401

The agencies indicated above are hereby granted the right to record and use any images (including, but not limited to, videotape, photographs, film, and audiotape) in which I, my child or children have participated as part of *In-Touch Science*[1]. I further understand that this authorization shall extend to their grantees, lessees, or licensees in perpetuity.

Model's Name (please print):______________________________

Model's Signature (if model is adult):______________________________

Parent/Guardian Signature (if model is a minor):______________________

Home Address:______________________________________

Telephone:____

E-mail:____

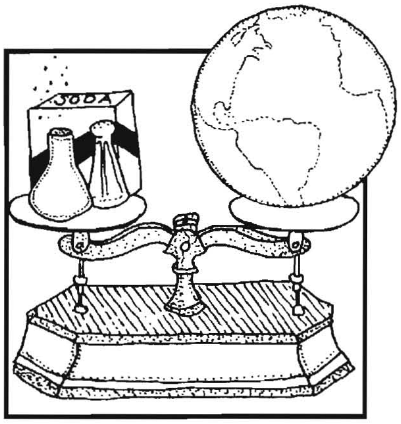
Date Signed:______________________________________

Location and Description of Event:__________________________

____

Date of Event:_____________________________________

[1]*In-Touch Science* is a hands-on science program for youth. Centered at Cornell University and funded by the National Science Foundation, it emphasizes exploration, conversation, and application to everyday experiences.



In-Touch Science: Chemistry & Environment

Evaluation Form

Copy as needed, using separate forms for each session.

Sessions and Activities

❑ 30-minute session with one activity
❑ 60-minute session with two activities
❑ Other ____________________
❑ Session 1 1A Swirling Colors • 1B Cleaning Up an Oil Spill
❑ Session 2 2A What's the Strength? • 2B How Polluted Is It?
❑ Session 3 3A Making Gloop • 3B Polymers–How Can We Use Them?
❑ Session 4 4A What Dissolves and What Doesn't? • 4B Water Treatment–Cleaning It Up
❑ Session 5 5A Pink? Green? Or in Between? • 5B Forever Purple?

Participation

Number of participants:

Children ________

Adults ________

Description of children:

Age(s) ________
Ethnic group(s) ____________________
Gender ____________________
Additional information ____________________

Description of adults:

Age(s) ________
Ethnic group(s) ____________________
Gender ____________________
Position ____________________
Education ____________________
Teaching Experience ____________________

Setting

School-age child care program
4-H club
EFNEP
Parenting program
Other ____________________
Community youth program
Camp
Museum

Children's Interest and Conversation

Level of interest	(low)	1	2	3	4	5	(high)
Amount of conversation among children	(low)	1	2	3	4	5	(high)
Amount of conversation with you	(low)	1	2	3	4	5	(high)

Children's Ideas and Comments

List sample "I wonder..." statements:

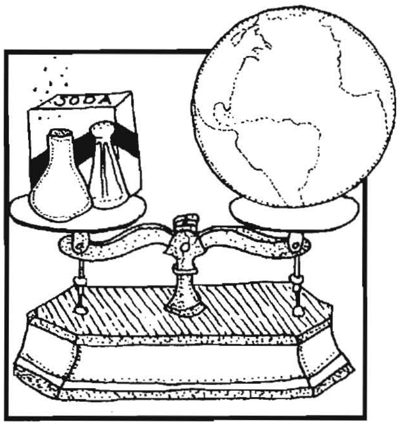
Other comments:

Adults' Ideas and Comments

Prior knowledge of this session's topic	(low)	1	2	3	4	5	(high)
Comfort level using this teaching approach	(low)	1	2	3	4	5	(high)
Age appropriateness of materials/procedures	(low)	1	2	3	4	5	(high)
Difficulty managing noise and disruptions	(low)	1	2	3	4	5	(high)
Level of support (site, parents, volunteers)	(low)	1	2	3	4	5	(high)
Amount of time for preparation/cleanup	(low)	1	2	3	4	5	(high)
Would you use this activity again?	Yes	No					

Other comments:

Return to
Extension Staff
Cornell University
Department of Textiles and Apparel
204 MVR Hall
Ithaca, NY 14853-4401



In-Touch Science: Chemistry & Environment

Glossary

absorbent
Capable of soaking up liquids

acid
A substance that produces hydrogen ions (H^+) when dissolved in water

acidity
The capacity of a substance to release hydrogen ions. The naturally occurring acids in fruits and some vegetables give them a high level of acid, which can cause a sour taste such as in lemons or grapefruit.

activated charcoal
Charcoal that has been treated at high temperature to increase its capacity to remove chemical substances from solution

atom
A particle of matter representing the smallest unit of a chemical element such as carbon or hydrogen

base
A substance that produces hydroxide ions (OH^-) when dissolved in water

buffer
A substance that makes a solution more resistant to change in acidity

chemical bond
The linkage between atoms in molecules and between molecules and ions in crystals

chemical reaction
The interaction of two chemicals to form different elements or compounds. Indicators of a chemical reaction include color change, release of gas, release of heat, formation of a precipitate, and formation of a new substance.

compound
A chemical substance made up of two or more elements that cannot be separated by physical means. For example, table salt (sodium chloride, NaCl) is a compound.

concentration
The measure of the quantity of a substance that is dissolved in a solution

contaminate
To introduce impurities, making the environment less clean or pure

density
The mass (commonly expressed as weight) per unit volume of a substance. A pound of sand is much more dense than a pound of feathers, so the pound of sand would fit into a much smaller space than the pound of feathers.

detergent
A cleansing substance derived from petroleum

dilute
The opposite of concentrated. A solution is dilute if there is not very much of a substance dissolved in it.

dispersion
Breaking up and scattering of molecules or particles in solution

dissolve
To enter or cause to enter into solution. For example, sugar dissolves in water.

element
A substance made up of only one kind of atom. For example, sodium (Na) is an element.

environment
The natural surroundings

gel
A semisolid material such as a jelly

indicator
A compound or solution that changes color to show a chemical property. A pH indicator shows whether a solution is an acid or a base.

ion
A positively or negatively charged atom or molecule

microscopic organism
A living being that is too small to be seen with the naked eye

mineral
An element, such as calcium or magnesium, or a mixture of inorganic compounds, such as granite or limestone

molecule
The smallest particle of a substance retaining the properties of the substance. A molecule is made up of two or more atoms that are held together with chemical bonds.

neutral
Neither acid nor base

pH
A scale that indicates the relative acidity or basicity of a solution

pigment
A substance that produces color

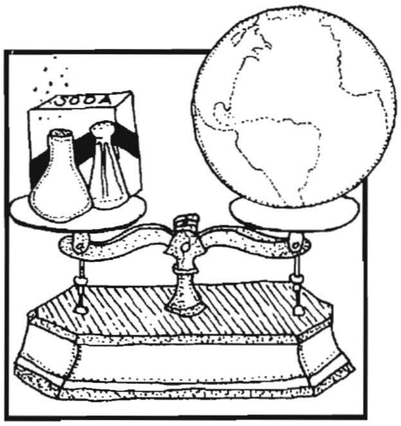
pollutant
A substance that degrades or fouls the environment, lowering the quality of land, water, or air

polymer
A large, chainlike molecule composed of many identical repeating units

solution
A liquid mixture of dissolved substances. In a solution it is impossible to see the separate parts.

suspended sediment
Substances that occur as such fine particles that they hover in solution rather than settling out. They are not dissolved.

toxic
Poisonous



In-Touch Science: Chemistry & Environment

References

Activities for Children

Chemistry

Cobb, V. 1990. *Chemically Active! Experiments You Can Do at Home*. New York: Harper Collins. ISBN 0064461017.

Gutnik, M. J. 1991. *Experiments That Explore Oil Spills (Investigate!)*. Brookfield, Conn.: Millbrook Press. ISBN 1562940139.

Gutnik, M. J. 1992. *Experiments That Explore Acid Rain (Investigate!)*. Brookfield, Conn.: Millbrook Press. ISBN 1562941151.

Petterson, K. 1997. *Icky Sticky Foamy Slimy Ooey Gooey Chemistry Set*. New York: Scholastic Trade. ISBN 0590360434.

Shalit, N. 1989. *Cup and Saucer Chemistry*. New York: Dover Publications. ISBN 0486259978.

Wellnitz, W. R. 1993. *Homemade Slime and Rubber Bones: Awesome Science Activities*. Blue Ridge Summit, Pa.: TAB Books, McGraw Hill. ISBN 0830640940.

Environment

Braus, J., ed. 1990. *Pollution: Problems & Solutions*. Ranger Rick's NatureScope. National Wildlife Federation. New York: McGraw-Hill. ISBN 0070471053.

Cooperative Extension Service, Michigan State University. 1991. *SPACES, SHARED SPACE: Our Common Earth* (Ecology and Relationships). 4-H Youth Programs. East Lansing, Mich.: Michigan State University.

Gartrell, J. E. Jr., J. Crowder, and J. C. Callister. 1992. *Earth: The Water Planet*. Arlington, Va.: National Science Teachers Association. ISBN 0873550838.

Hogan, K. 1994. *Eco-Inquiry: A Guide to Ecological Learning Experiences for the Upper Elementary/Middle Grades*. Dubuque, Iowa: Kendall/Hunt. ISBN 0840395841.

Ingram, M. 1993. *Bottle Biology*. Dubuque, Iowa: Kendall/Hunt. ISBN 084038601X.

National 4-H Council. 1995. *Cycling Back to Nature: Soils Alive*. Washington, D.C.: USDA, Cooperative State Research, Education, and Extension Service.

Storybooks

Berger, M. 1994. *Oil Spill!* New York: Harper Collins Let's Read-and-Find-Out Science. ISBN 0064451216.

Cherry, L. 1995. *A River Ran Wild: An Environmental History*. New York: Houghton Mifflin. ISBN 0395732409.

Cole, J. 1988. *The Magic School Bus at the Waterworks.* New York: Scholastic Trade. ISBN 0590403605.

Seuss, Dr. 1971. *The Lorax.* New York: Random House. ISBN 0394823370.

Warner, G. C. 1991. *Bus Station Mystery (Boxcar Children, No. 18).* Morton Grove, Ill.: Albert Whitman. ISBN 0807509760.

Information for Educators

Chemistry

Mullin, V. 1968. *Chemistry Experiments for Children.* Reprint Edition. New York: Dover. ISBN 0486220311.

Sarquis, M. 1995. *Chain Gang—The Chemistry of Polymers.* Middletown, Ohio: Terrific Science Press. ISBN 1883822130.

Environment

American Water Works Association. 1991. *Water Can Be Fun! How to Create a Successful Science Fair.* Denver, Colo.: AWWA. ISBN 0898675391.

U.S. Environmental Protection Agency. 1990. *Acid Rain: A Student's First Sourcebook.* EPA/600/9-90/027. Washington, D.C.: US EPA, Office of Environmental Processes and Effects Research.

Wright, R. G. 1995. *Oil Spill! An Event-Based Science Module.* Reading, Mass.: Dale Seymour. ISBN 0201490900.

Teaching Science

Blosser, P. E. 1991. *How to Ask the Right Questions.* Washington, D.C.: National Science Teachers Association. ISBN 0873551028.

Cothron, J. H., R. N. Giese, and R. J. Rezba. 1996. *Science Experiments by the Hundreds.* Dubuque, Iowa: Kendall/Hunt. ISBN 0787215740.

Paulu, N., and M. Martin. 1993. *Helping Your Child Learn Science.* Washington, D.C.: American Chemical Society.

Rezba, R. J., C. Sprague, R. L. Fiel, and J. H. Funk. 1995. *Learning and Assessing Science Process Skills,* 3d ed. Dubuque, Iowa: Kendall/Hunt. ISBN 0840384300.

The teaching style of the **In-Touch Science** program emphasizes the fun of engaging in the scientific process of discovery using simple and safe activities that give children the freedom to question and explore. Together, adults and children will share "I wonder. . ." statements that can lead to heightened interest in science and exploration.

In-Touch Science: Chemistry and Environment

The ten activities in this 112-page manual show children how each of five science concepts relates to chemistry and the environment. For example, Session 1 introduces the concept of dispersion. Children disperse fat droplets in milk to create swirling colors. They then consider whether dispersion is desirable when cleaning up an oil spill.

The **In-Touch Science** publications were developed by Cornell Cooperative Extension educators at Cornell University in response to the need for youth to develop science literacy emphasizing learning science by *doing* science. These hands-on projects and activities engage children at an early, and naturally inquisitive, age.

In-Touch Science is for children in grades 3 to 5 (aged 8 to 11). The program helps children

- communicate what they observe and learn.
- understand the science connection between two fields of study.
- recognize science concepts in daily experiences.

Each **In-Touch Science** unit has children manipulating materials and equipment, testing ideas, and exploring what interests them in a relaxed learning environment. It works best with groups of five to ten children.

In-Touch Science is useful to science centers, 4-H clubs, school-age child-care programs, summer camps, home schoolers, the Expanded Food and Nutrition Education program, scouts, and other community programs. It can be easily adapted for use in school science programs.

ISBN 1-57753-265-1