

Volume 13, Number 6

American Chemical Society
American Institute of Physics
American Mathematical Society
Spring 1999

WONDERS SCIENCE

Hands-on Science Activities
for Elementary School
Teachers and Students

Hands-on Math too!

Chemistry &

COLOR

International Chemistry Celebration 1999!
You, and your students can join in a
World-Wide Chemistry & Color Activity!
See back for details.

Colors *on the* Mooooove

Color is used all the time and in many different ways in chemistry. Color can help us figure out what a substance is, can help us tell when a substance has changed, and can be used to help tell us how strong or weak a substance is. Try the activity below and see that chemistry and color can be an exciting combination!

1 Use your masking tape and pen to label your three bowls **skim milk**, **whole milk**, and **half & half** as shown. Add about 1/4 cup of skim milk, whole milk, and half & half, each to its labeled bowl. Look at the milks closely. What differences do you notice about them? What do you think might cause these differences?

2 Gently add one drop of food coloring to the center of the milk in each bowl. **DO NOT STIR OR DISTURB THE BOWLS.** What do you observe about the way the food coloring looks in each bowl? Does this observation make sense with what you observed about the milks before you put in the food coloring?

3 Dip a cotton swab in your detergent. Carefully touch the center of each food coloring drop in each bowl. Do not stir. Use a different cotton swab tip for each bowl. What do you observe? Do you notice a difference in the way the color looks in each of the bowls? What do you think might cause these differences?*

* For an explanation of the color movement in the milk, see the *Teacher's Guide*.

YOU WILL NEED:

milk (skim, whole, and half & half)

3 shallow bowls

liquid dish detergent

food coloring

cotton swabs

masking tape

pen

small paper cup



Show your true Colors

YOU WILL NEED:

coffee filters
food coloring droppers (red, blue, green, and yellow)
cotton swab
metric ruler
pencil
tape
small cup (3 oz)
big clear plastic cup (8 oz)
water

Sometimes chemists need to know what is in a mixture of chemicals. If different colors are mixed together and you need to figure out what the colors are, you can use a method like the one that chemists use. The colors can be separated using chromatography. (kro-ma-tah-gruh-fee). Try it and see!

1 Cut a strip from a coffee filter that is about the same height as your tall clear plastic cup and about 2 cm wide.

2 Place one drop each of two different food colors together in your small 3-oz cup so that they mix. Even though the colors are mixed, a little chemistry can make them come apart again!

3 Use your cotton swab to soak up the food color from the cup. Touch your coffee filter strip with the cotton swab to make a dot of color about 2 cm from the bottom of the strip. Allow the strip to dry for 3–5 minutes.

4 Place a little water in the bottom of your large clear plastic cup. Wrap the top of the strip around a pencil and tape it down as shown. Place the pencil on the cup but be sure that only the very bottom of the paper strip touches the water. **Do not allow the dot to go into the water.**

5 Watch the color dot as water moves up the strip. What do you notice? How many colors do you see? If you see more than two colors, what do you think could cause that?

6 If you mixed three or four colors, do you think you could see them *all* as they moved up the strip? Try it and see! How about trying just one color. There may be more to that one color than you think!



Go for the

A color change can tell us that a chemical reaction has occurred. It can also give us some hints about the type of chemicals that are causing the color change reaction. Check out these activities using a special gold-colored paper to see chemistry and color go for the gold!

TEACHER PREPARATION:

Cut gold paper into pieces about 4×8 cm long. (An 8.5×11 in sheet should make 18–20 pieces.) Each group of students should get two pieces.

YOU WILL NEED:

gold paper (insert)	serrated plastic knife
4 small disposable plastic or paper cups	cotton swabs
measuring spoons	dropper
powdered laundry detergent	vinegar
baking soda	pen
Ivory® soap bar	masking tape
	paper
	water

1 Use your masking tape and pen to label your four cups **water**, **soap**, **baking soda**, and **detergent**. On a sheet of paper, use your plastic knife to scrape up and down on the edge of the soap to make some soap flakes.

2 Place $\frac{1}{2}$ teaspoon of each powder into its labeled cup. Add 2 tablespoons of water to each cup and swirl to mix. Put only water in the cup labeled water.

3 Use your pen to divide the piece of gold paper into four sections. Label the sections **water**, **soap**, **baking soda**, and **detergent**.

4 Dip one end of a cotton swab into the water. Rub the water in its area on the gold paper to make a dot a bit smaller than a dime. Repeat for each solution with a clean end of a cotton swab. Do you notice any difference between the dots? Describe what you see. Put the paper aside to dry.

5 After about 5 minutes, put one drop of vinegar on each dot. What do you notice?



Wash your hands when you are done experimenting.

Welcome to your *WonderScience* on chemistry and color. Paints, dyes, inks, and natural pigments all depend on chemicals to give them their wide variety of colors. But aside from the role that chemicals play in coloring our natural and human-made environment, color itself often plays a very important part in chemistry experimentation. The

color of a substance can help scientists determine what the substance might be. Color changes also give scientists important information about whether a particular chemical reaction may have taken place and what the reactants and products might be. In this issue of *WonderScience*, students will focus on this role that color plays in chemical investigations.

This Issue:

Chemistry & Color

Page 2

Colors on the Mooove

You could explain to students that sometimes scientists need to be able to tell the difference between substances that are very similar. Sometimes adding a test chemical to the substances can help scientists tell them apart. In this activity, food coloring is the test chemical. It is used to help tell the difference between skim milk, whole milk, and half & half.

Results:

The drop of food coloring should spread out the most in skim milk, the least in half & half, and somewhere in between in whole milk.

The investigation is taken one step further when another test chemical (dish washing detergent) is added to each color dot. The detergent should cause the color to move and spread quickly away from the center and toward the edge of the bowl. There may also be some swirling of the colors. The reason for the movement of the food color in the milks is not well understood. One possible explanation has to do with the way detergent molecules surround the tiny fat globules in milk. Detergent molecules are long. They have a charged end and a neutral end. The neutral ends of many detergent molecules surround the fat globules. All the charged

ends stick out and repel each other causing the spreading action. The food coloring is just pushed along.

Page 3

Show Your True Colors

This simple process of chromatography should separate the different-colored food dyes in the food coloring drops. There are several chemical principles involved in separating substances based on chromatography. The degree to which a substance attaches to water or to the filter paper will play a part in determining how far it travels up the paper. The size, weight, and shape of the color molecule also help determine how it moves on the filter paper and where along the paper it attaches. These factors usually cause enough separation that you can tell which colors were combined to make the original mixture.

Pages 4–5

Go for the Gold!

Page 4

Included in your *WonderScience* issue is an 11 x 17 piece of gold paper. This is not just any goldenrod paper. Students will see in the activity on page 4 that the paper changes color from gold to red when a base such as baking soda, laundry detergent, or soap is applied to it. It will also change back from red to gold when an acid such as vinegar or lemon juice is applied to it.

National Science Education Standards

The following National Science Education Standards relate to the activities and information in this issue:

Science as Inquiry

Conduct a scientific investigation. Develop the ability to make systematic observations and identify control variables. *Investigate the use of color in chemistry by observing a variety of physical and chemical reactions. (All activities)*

Use appropriate tools and techniques to gather, analyze and interpret data. *Investigate the use of color in chemistry by using various tools, including paper chromatography, acid–base indicators, and other color-changing chemical reactions. (All activities)*

Develop descriptions, explanations, predictions, and models using evidence. *Use observations of various chemical reactions to make predictions and explain other chemical reactions. (All activities)*

Think critically and logically to make the relationships between evidence and explanations. Review and summarize data, and form a logical argument about the cause and effect relationships in the

continued on last page

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STUDENT ACTIVITY SHEET

NAME _____

DATE _____

Pages 4–5: Go for the Gold!

Page 4

Record your observations after placing water, and the solutions of soap, baking soda, and detergent on the gold paper. Include as many details as you can about what happened with each solution. Also point out the similarities and differences between the results for the solutions.

Water _____

Soap _____

Baking soda _____

Laundry detergent _____

What did you notice when you put vinegar on each sample? _____

Page 5

Record your observations after placing one drop each of baking soda solution and one drop of laundry detergent solution into their separate cups of yellow solution. Record the color of these solutions compared with the color of the control. Also note how the colors compare with each other.

Baking soda _____

Laundry detergent _____

What happens when you add a drop of vinegar to the baking soda and the laundry detergent test cups? _____

Baking soda and laundry detergent solutions can change the color of the test solution back to the color of the control. Make a prediction about which solution can do it in the fewest number of drops. Explain why you picked the one you did.

After adding drops of baking soda and laundry detergent to their cups, which one changed back to the color of the control in the fewest number of drops? Was your prediction correct?

STUDENT ACTIVITY SHEET

NAME _____

DATE _____

Pages 6–7: Vitamin C Testing—Chemistry's the Clear Solution!

1. After dissolving the starch pellets in water and then filtering the water, what color is your final filtered starch solution?

2. After adding one drop of iodine solution to each cup of starch solution, what is the color of the solutions?

3. How many drops of vitamin C solution did it take to change the color of the starch/iodine solution from blue to clear?

The more vitamin C a solution has, the fewer drops it takes to turn the starch/iodine solution from blue to clear. Does this mean that the vitamin C solution has a lot of vitamin C or a little? _____

4. Would you expect Tang to have more or less vitamin C than the vitamin C solution you have tested?

5. Do you think it will take more or fewer drops of Tang than it did of vitamin C solution to change the starch/iodine solution from blue to clear? _____
6. How many drops of Tang did it take to change the test solution from blue to clear? _____
7. Does Tang have more or less vitamin C than the vitamin C solution? _____
8. Would you expect orange juice to have more or less vitamin C than the vitamin C solution and the Tang you have tested?

9. Do you think it will take more or fewer drops of orange juice than it did of vitamin C solution or Tang to change the starch/iodine solution from blue to clear? _____
10. How many drops of orange juice did it take to change the test solution from blue to clear? _____
11. Does orange juice have more or less vitamin C than the vitamin C solution and the Tang?

continued from first page

Results:

Step 4: When water, baking soda, soap, and laundry detergent solutions are rubbed on separate sections of the paper, everything except water turns the paper red. Students should realize that since these substances cause a similar color change, they may have something in common. They should also see that the red color was not the same intensity for all samples. This should suggest that the samples have both similarities and differences. This is a way that chemists can begin to categorize substances.

Step 5: The vinegar turned the red back to gold.

Page 5

Here, the gold paper is used to make a solution.

Results:

Step 4: Both the laundry detergent solution and the baking soda solution turn the yellow test liquid red, but the detergent turns it a darker red. Students should conclude that there is something "stronger" about the detergent than the baking soda.

Step 5: The one drop of vinegar turns both solutions yellow, but even more yellow than the original test solution (control).

Step 6: If the detergent solution is in some way stronger than the baking soda solution, students should predict that it will take fewer drops of the detergent solution than it does of the baking soda solution to turn the test solution back to its original color.

Step 7: That is indeed what happens. This means that there is either a stronger base in the laundry detergent than in the baking soda or that the base itself is about the same strength, but is higher in concentration.

Pages 6–7

Vitamin C Testing— Chemistry's Clear Solution

This activity calls for using biodegradable starch pellets used as packing material. The use of this material has become very common as an alternative to Styrofoam "peanuts." If you or your students do not have any starch pellets from a recently opened box, try a mailing supply store.

After making the starch solution and adding the diluted tincture of iodine, the starch and iodine solutions in all cups should be blue. To these three samples of blue solution, students add drops of vitamin C, Tang, and orange juice. When the amount of vitamin C reaches a certain level, the solution changes from blue to clear. The key to the test is for students to understand that the *more* drops of Tang or orange juice needed to turn the blue solution clear, the *less* vitamin C the Tang or orange juice has. The converse is also true. The *fewer* drops it takes to turn the blue solution clear, the *more* vitamin C the Tang or orange juice has.

Results:

Page 6

Step 5: The vitamin C solution should turn the blue solution clear in the fewest number of drops. It has the highest concentration of vitamin C.

Page 7

Step 2: The Tang solution should turn the blue solution clear in fewer drops than it takes the orange juice. It has a higher concentration of vitamin C than orange juice.

Step 3: The orange juice requires the most drops to turn the solution clear. It has a lower concentration of vitamin C than the Tang solution.

National Science Education Standards

continued from first page

experiment. Analyze observations from a simple experiment and use that data to develop explanations of how the sense of smell and taste function. (All activities)

Physical Science

Substances react chemically in characteristic ways with other substances to form new substances with different characteristics. Substances are often placed in categories or groups if they react in similar ways. Observe and compare chemical reactions of acids and bases on a special paper that contains an indicator pigment. (Go for the Gold!, Color & Chemistry—An Artful Solution!)

Page 8

Color & Chemistry—An Artful Solution!

This activity gives students an opportunity to have some more fun with the color-changing paper. In addition to the activities suggested, you could have students write on the dry paper with a white candle and then use a cotton swab to rub the paper with a baking soda solution. This will reveal the hidden writing.

We want to hear from you!

Please e-mail us with suggestions, comments, and ideas for future issues!

wonderscience@acs.org

Gold

This gold paper is pretty amazing. In the last activity, you saw that some substances produce a darker colored red when they react with chemicals in the paper. You also saw that vinegar could make the color go back to gold. Here's another way to use the gold paper to learn more about your baking soda and detergent solutions.

1 Cut up three pieces of gold paper into very thin strips. Place the strips into a zip-closing plastic bag. Add about 1/4 cup warm water. Push the air out of the bag and seal it tightly. Squish the paper and the water for 3 or 4 minutes until the water is very yellow. Open a corner of the bag and pour all the yellow solution into your large cup. Do not drink any solutions.

2 Use the masking tape and pen to label two small cups **baking soda** and **detergent**. Place 1/2 teaspoon of baking soda and 1/2 teaspoon of laundry detergent into their labeled cups. Add 1 tablespoon of water to each cup. Swirl to mix.

3 Now label your three remaining small cups **control**, **baking soda test**, and **detergent test**. Divide the yellow solution evenly among these three cups.

4 Add one drop of baking soda solution to the baking soda test cup and swirl. Using a clean dropper, now add one drop of the detergent solution to the detergent test cup and swirl. Do not add anything to the control cup. What do you observe? How do the colors in the two cups compare to the color in the control? Does one solution make a darker color than the other?

5 Using a clean dropper again, add one drop of vinegar each to the baking soda test cup and to the detergent test cup. Swirl each cup. What happens?

6 You can add drops of baking soda solution and detergent solution to their test cups to turn them back to the color of the control. Which do you think would take more drops to change back to color of the control? Why?

7 Try it by adding one drop at a time of baking soda solution to its test cup and swirling after each drop. Count the drops as you go. Stop adding solution when the color stays the same as in the control. Now try the same thing by adding drops of detergent solution in its test cup. Which took more drops to reach the color of the control? Was that what you predicted?

YOU WILL NEED:

gold paper (insert)	measuring spoons
scissors	zip-closing plastic bag
5 small plastic cups	3 droppers
1 plastic cup (8 oz)	warm water
baking soda	vinegar
laundry deter- gent	masking tape
	pen

TEACHER PREPARATION:

Cut gold paper into pieces about 4 × 8 cm long. Each group of students should get three pieces.



YOU WILL NEED:

4 starch pellets (biodegradable starch "packing peanuts" available at mailing supply stores)

water

coffee filter

Tang® breakfast drink

vitamin C tablet

tincture of iodine solution

plastic cups (two 8-oz and five 3-oz)

measuring spoons

3 droppers

orange juice

masking tape

pen

Vitamin C Testing—

Which has more vitamin C: Tang® drink mix or orange juice? Chemistry and color can help you find the answer!

TEACHER PREPARATION:

Make a solution by adding 1 teaspoon of tincture of iodine to 1 tablespoon water. Place about 1/4 teaspoon of this iodine solution into labeled cups so that each group gets one.

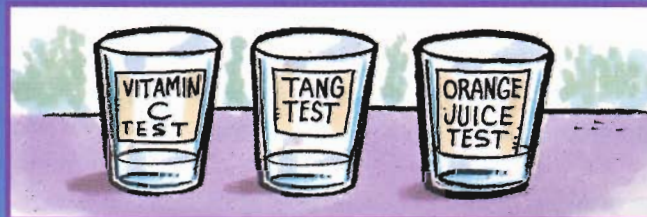
Do not drink any solutions.

1 Use the two 8-ounce cups to make your *starch solution*: Dissolve 4 starch pellets in 1/2 cup of water. Set up a coffee filter in the other cup as shown. Pour the starch solution through the filter. Label this cup **starch solution**.

2 Label three of the small plastic cups **vitamin C test**, **Tang test**, and **orange juice test** as shown below. Add 1 tablespoon of starch solution to each cup.

3 Now add 1 drop of iodine solution to each labeled test cup.

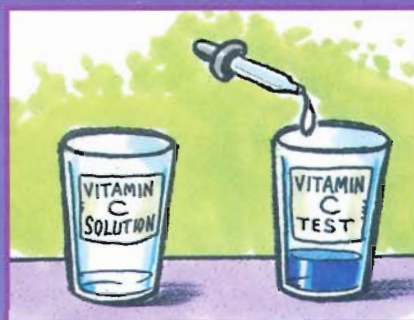
4 Label your fourth cup **vitamin C solution**. Crush your vitamin C tablet and add it to 2 tablespoons water in this cup. Stir.



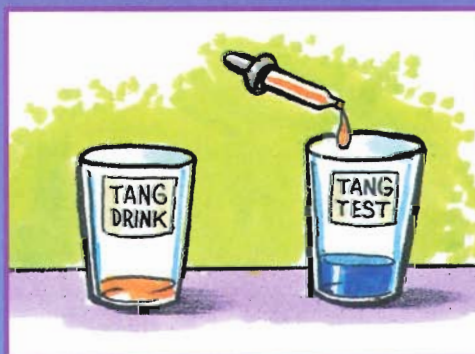
Chemistry's Clear Solution!

The more vitamin C a solution has, the fewer drops it takes to turn the starch/iodine solution clear. So the fewer drops it takes, the more vitamin C the solution must have. Let's see whether Tang or orange juice has more vitamin C.

5 Now place 1 drop of the **vitamin C solution** in the **vitamin C test** cup and swirl. What do you observe? If nothing happens, try adding another drop.

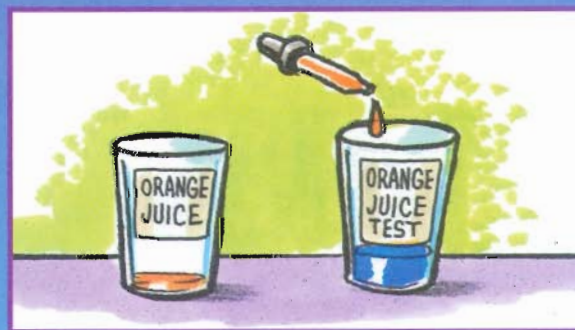


6 Mix up some Tang® by adding 3/4 teaspoon of Tang® powder to 2 tablespoons of water in your fifth cup. Label this cup **Tang Drink**.



7 Try adding 1 drop of Tang® drink to the **Tang test** cup. If it takes more than 1 drop to clear the solution, that means there is less vitamin C in 1 drop of Tang® than there is in 1 drop of your vitamin C solution. How many drops does it take?

8 Now try adding 1 drop of orange juice to its test cup. What do you observe? How many drops of orange juice does it take for the solution to become clear? Which has more vitamin C, Tang® or orange juice?



CHALLENGE:

Try testing some other drinks for vitamin C, such as orange soda pop, lemon-lime soda pop, cranberry juice, or apple juice.

Color & Chemistry

An Artful Solution!

Chemistry and color can make for some interesting art work. Try these next three activities to express yourself as a *WonderScience* chemistry and color artist!

1 Place 1/2 teaspoon of laundry detergent in one tablespoon of water. Swirl to mix.

2 Dip a piece of gold paper in water. Shake off any excess water and place the paper on the back of the index card.

3 Dip a cotton swab in the detergent solution and gently place one drop in the center of the gold paper. What do you observe?

4 Use a piece of Ivory® soap to draw a design on the wet paper.

5 Take a tiny bit of detergent between your thumb and index finger and sprinkle it from about 30 cm above the paper.

Experiment with these activities to make other *WonderScience* chemistry and color art!



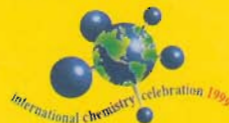
YOU WILL NEED:

gold paper (insert)
large index card (5 in x 8 in)
water
laundry detergent
Ivory® soap
small plastic cup
cotton swab
vinegar



Wash your hands when you are done experimenting.

International Chemistry
Celebration 1999!



Join in the celebration of the importance of chemistry by participating in an international Chemistry & Color Experiment!

Search for natural dyes and experiment with ways to change their colors using activities in *The World of Color* booklet. For a free single copy call 1-800-227-5558 x6097

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WonderScience publishes 4 issues in September and 4 issues in January as a joint effort of the American Chemical Society, 1155 Sixteenth Street, N.W., Washington, DC 20036, and the American Institute of Physics, One Physics Ellipse, College Park, MD 20740; in cooperation with the American Mathematical Society, 201 Charles St., P.O. Box 6248, Providence, RI 02940.

The subscription price is \$12.00/ eight issues and eight teacher's guides. For additional subscription information, call toll-free 1-800-209-0423 or write to *WonderScience* at the ACS address. Canadian GST Reg. No. 127571347.

The activities described in this booklet are intended for elementary school children under the direct supervision of adults. The American Chemical Society and the American Institute of Physics cannot be responsible for any accidents or injuries that may result from conducting the activities without proper supervision, from not specifically following directions, or from ignoring the cautions contained in the text.

All activities in *WonderScience* have been reviewed for safety by Dr. Jay Young, Chemical Health and Safety Consultant, Silver Spring, MD; Herb Bryce, Seattle Central Community College, Seattle, WA; Ruth Hathaway, Chemical Health and Safety Consultant, Cape Girardeau, MO.



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