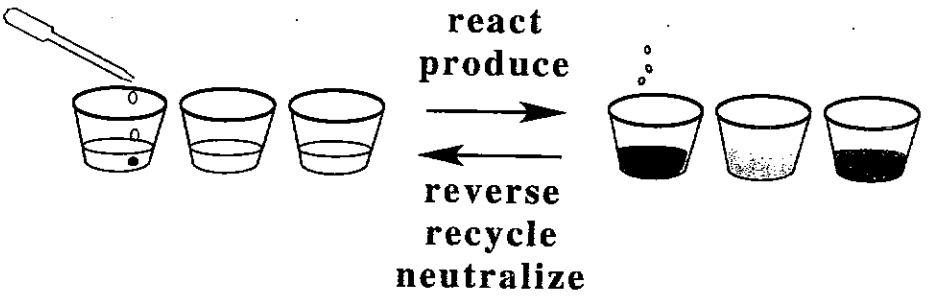
Patriotic Colors Chemistry Experiment Kit

Make Red, White and Blue Appear, Disappear and Reappear!

Turn 3 colorless solutions into America's patriotic colors.
Add a crystal and make the colors disappear.
Add another crystal and make the colors reappear.
Learn about chemical solutions, solubility, crystals,
pH, indicators and acid-base reactions.
Analyze and identify chemicals in your environment.
Do Disappearing Ink tricks and make "magic" test papers.
Great for teachers and science projects.



WARNING!
This kit contains chemicals that may be harmful if misused.
Read all labels carefully.
For ages 9 and up with adult supervision.

Caution !

The Patriotic Colors Chemistry Experiment Kit is a safe experiment kit when used as directed. However, anything can be dangerous when used in the wrong way. Always use any chemical, including household chemicals, with care.

Phenolphthalein is a chemical that has been shown to cause cancer in rats and mice in very large dosages. However, the Phenolphthalein Solution in this kit is very dilute (less than 0.1 %) and will not be harmful when used as directed.

Keep the chemicals in this kit away from infants and young children.
Do not drink or taste the chemicals in this kit.

Wear safety glasses when using the chemicals in this kit.

If any chemical in this kit or any household chemical gets on the skin or in the eyes or mouth, the best first aid is to wash with lots of water.

Always ask permission to use any household materials.
Work on a newspaper or paper towel to make clean up easier.
Read the directions carefully. Read the labels on the bottles carefully.
Never experiment with something you know nothing about.
Experiment with small amounts of materials. It will be less dangerous, easier to control and you will conserve your resources.
Keep the caps on the bottles when not in use.
When finished with an experiment, pour any liquids down the sink and run the water for about 1/2 minute. Wash any cups and spoons that you used.
Wash your hands and put away your materials.

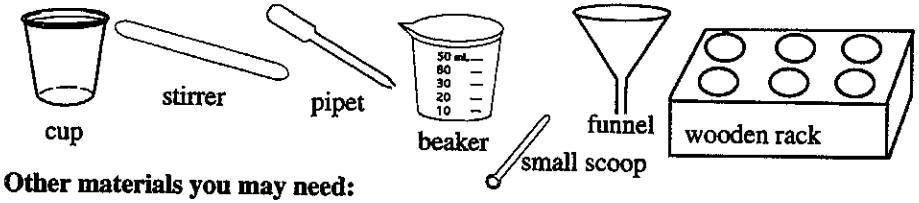
The Patriotic Colors Chemistry Experiment Kit contains:

1 ounce Calcium Chloride = $CaCl_2$

1 ounce Citric Acid = $C_6H_8O_7$

1 ounce Sodium Carbonate = Na_2CO_3

1 ounce Disappearing Ink = Thymolphthalein Solution
1 ounce Phenolphthalein Solution
wood bottle rack, 5 plastic cups, 5 wooden stirring sticks, 2 pipets (droppers), beaker, 2 small scoops, funnel, paper towels and this instruction booklet.



Other materials you may need:

paper towels or newspapers to work on, old plastic containers or cups, white paper, vinegar, ammonia, laundry detergent, ashes, ice water.

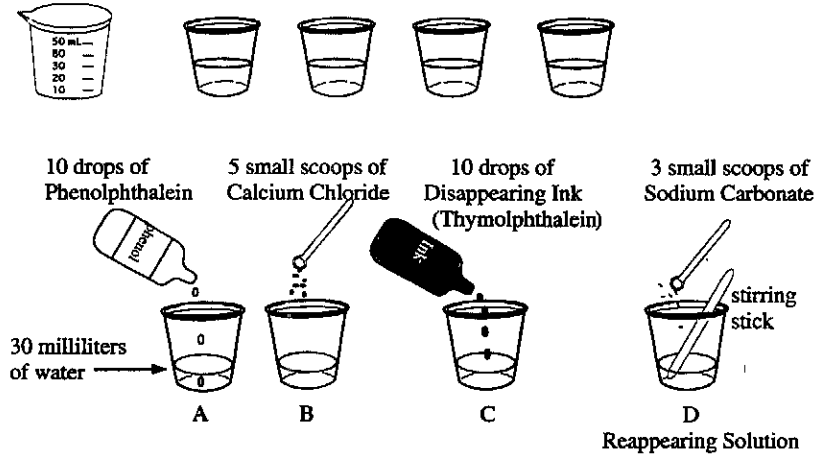
Chemistry is fun, but always experiment carefully!
Now let's get ready to make some red, white and blue experiments and tricks. And discover the chemistry behind it.

Solutions

Chemists call a mixture of something dissolved in something else a **solution.**
A solution also means an answer to a problem. In chemistry, you may be able to find a solution in the solution. Words can be confusing, so it is a good idea to use a dictionary.

Experiment 1 Red, White and Blue

You will make 4 colorless solutions, then use one solution to turn the other 3 different colors.
Take four plastic cups and using the beaker, put about 30 milliliters of water into each (about half full). You will add a different chemical to each and make four different colorless solutions. You may want to label each, so the mixtures will not get mixed up.



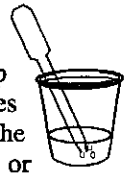
A. Squirt about 10 drops of **Phenolphthalein Solution** in the first cup of water. Phenolphthalein is pronounced fe-nol-thal-en.

B. Add 5 small scoops of **Calcium Chloride** to the second cup of water. Stir, with the stick, until the crystals dissolve. **Dissolve** means to break apart and go into solution. Watch the crystals. When they mix with the water and dissolve they will not be visible. It looks like plain water, but it is not. The calcium chloride crystals dissolve in the water and form a calcium chloride solution. Feel the cup. You may have noticed that it became warmer. Heat is given off when calcium chloride dissolves.

C. Squirt about 10 drops of the **Disappearing Ink (Thymolphthalein Solution)** into the third cup of water and stir. Thymolphthalein is pronounced thy-mol-thal-en. The blue color should disappear when it is put in the water. If it does not, add one citric acid crystal and stir. Water from different locations may have different amounts of acidic substances that react with the Disappearing Ink. If necessary, add another citric acid crystal to make the Disappearing Ink in cup C colorless.

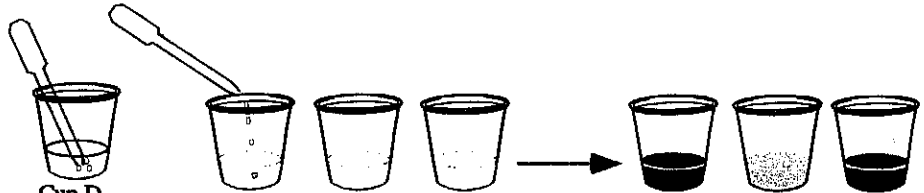
D. Add 3 small scoops of the **sodium carbonate** to the fourth cup of water. Stir to completely dissolve the crystals. This will be the **Reappearing Solution.** You will use this to make the other solutions turn colors in the next experiment.
Keep the caps on the bottles when you are not using them.

Experiment 1 Continued Red, White and Blue Appear



Take cup D (sodium carbonate Reappearing Solution) and the plastic dropper. The dropper is called a **pipet** (pronounced pie-pet). The word pipet comes from a French word meaning "little pipe". Put the dropper tip in the Reappearing Solution and squeeze slightly. Notice that air bubbles come out. Keep the dropper in the liquid and release the bulb. Look at the liquid move up the dropper. Squeezing the air out creates a **vacuum**, or empty space. Releasing the bulb allows the liquid to move into the empty space and fill the dropper. Lift the dropper with the liquid in it and practice squeezing it, so that one drop comes out at a time back into the solution.

Now squeeze a few drops of the Reappearing solution into each of the other 3 cups. You should get Red, White and Blue. If the colors are too light, then try adding a little more. Experiment using more or less of each to get the best colors. Water from different places may have different acidities and hardness that may affect how much is needed to make the colors appear.



The sodium carbonate solution reacted with and changed the composition and the structure of each of the chemicals that you put in cups A, B and C. These changes are chemical reactions.

The arrow is used to show that the starting materials on the left are changed to the products on the right. The arrow can be read as **"yield", "produce", "go to" or "change to".**

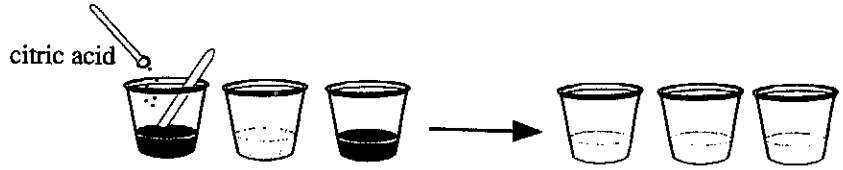
Starting Materials ⟶ Products

Look closely at cup B, you will see that the white color is actually a white solid that was formed from the sodium carbonate and calcium chloride. The name of the white product is calcium carbonate. **Save these solutions for the next experiment.**

Experiment 2 Red, White and Blue Disappear

To make the Red, White and Blue colors disappear, use a clean small scoop and shake just a few of citric acid crystals into each of the red, white and blue cups and stir or swirl the cup. The colors should disappear and the white solid will dissolve. If the colors do not disappear, add a few more citric acid crystals.

When experimenting, add a small amount of the material at first and stir to give it a chance to react. It is always easier to add more than to remove some.



Save the colorless solutions for the next experiment.

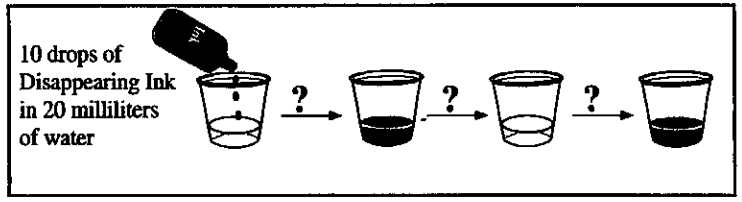
The citric acid crystals are reacting with each colored substance to form the colorless substances that you started with in experiment 1. Look carefully as the citric acid reacts. You may see it turn into bubbles. The citric acid crystals are reacting with and **neutralizing** sodium carbonate and carbon dioxide gas bubbles are produced. When the fizzing and bubbling is finished, the reaction is complete and neutralized.

But, even though the chemicals have been neutralized, changed and are not visible, they are not gone.

Experiment 3 Red, White and Blue Reappear

In the last reaction, you made the colors disappear. The colors became colorless when their chemical structure was changed. You can make the colors reappear. Use the plastic dropper and add a little more of the sodium carbonate Reappearing Solution (Cup D), one drop at a time to each of the 3 colorless solutions from experiment 3, until the red, white and blue reappear. Watch the reaction as the drops hit the solutions.

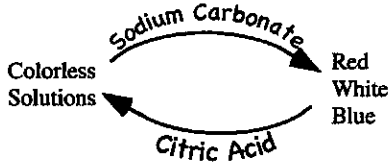
Experiment 4 Disappear--Reappear--Disappear-Reappear
What is needed to make each of the following changes?



Disappearing Ink turns colorless in the water. Add sodium carbonate to make it blue, followed by citric acid to make it colorless and then sodium carbonate to make it blue again.

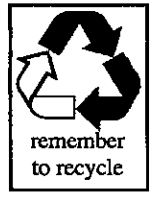
Reverse and Recycle

Reverse means to go in the opposite direction. The reactions that you are doing are **reversible.** We can make a reaction go back to the starting material if we have the right chemicals.



Reversible reactions are very important in nature. For example, every time we move a muscle, chemicals called enzymes react. To move the muscle again, other chemicals must undo, reverse or put back the first reaction.

Recycle means "to put back" so that it can be used again. We can recycle our chemicals and things in our environment if we have the right reactions. Nature works in cycles and recycles all materials including air, water and even the rocks in the earth.



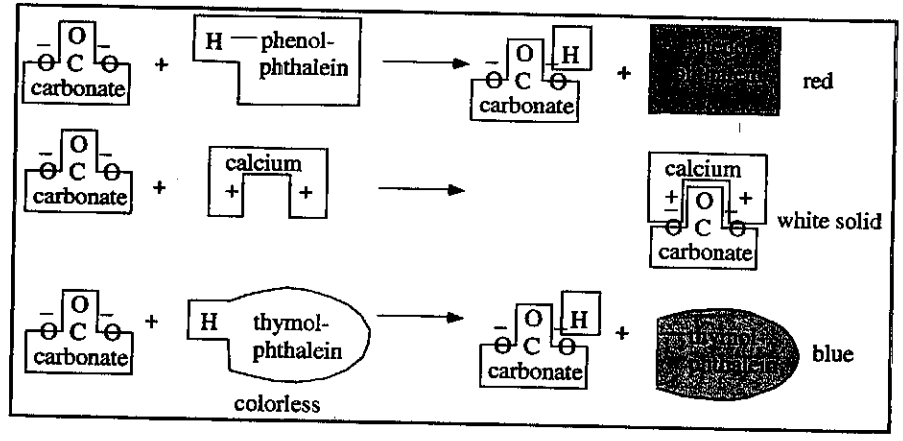
Sodium Carbonate

Sodium carbonate is a common chemical that is also called soda ash. It is in washing soda and you will see it on the labels of some laundry and dish washer detergents. It is used in water softeners, making glass and neutralizing acid spills. The chemical formula for sodium carbonate is Na_2CO_3. Sodium is Na^+ and Carbonate is $CO_3^=$. They are in the form of **ions** which are charged (positive or negative) atoms or groups of atoms. And there are 2 positive sodium ions to balance the negative 2 charged carbonate ion.

Model for the Red, White and Blue Reactions

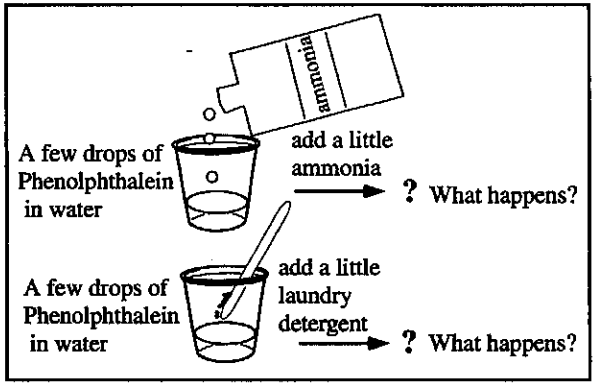
Scientists use **models** to help visualize or see what can not be seen directly. This model uses some chemical symbols for the elements and some shapes to let us see how the reactive parts are being lost and gained to formed the products.

Carbonate acts as a base to change the color of phenolphthalein to red and the color of the thymolphthalein (Disappearing Ink) to blue. Bases react by taking H (hydrogen) away from acids. Carbonate can also combine with calcium in calcium chloride to form the white solid precipitate calcium carbonate.



Experiment 5 Kitchen Chemistry

Most household cleaning solutions are bases. Let's try to find some household chemicals that will work like the sodium carbonate and the Reappearing Solution. First, always ask permission to use any household items.



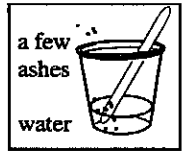
Make up more of the colorless phenolphthalein solution (cup A in experiment 1). Pour a little of it into several cups. Try adding a little ammonia to one cup. Add a little laundry detergent to another. Did either turn the phenolphthalein red?

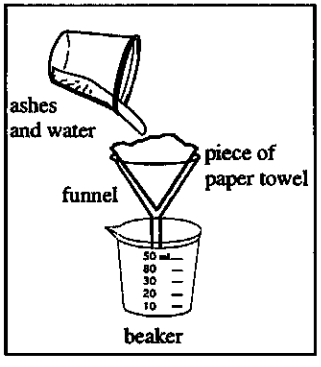
Ammonia reacts like the Reappearing Solution. It turns phenolphthalein red. It is a base. Ammonia is a good substitute if you run out of sodium carbonate.

Experiment 6 Soda Ash

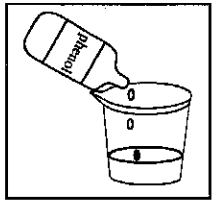
Sodium carbonate is called soda ash because it was **extracted** or taken out of wood ashes by early chemists and pioneers who used it to make soap.

Find a small amount of ashes from a cigarette or from a wood fireplace or charcoal grill. Ask for help and permission from a responsible adult. Put the ashes in a cup, half filled with water, and stir.





Now take the funnel, the beaker and a piece of paper towel, about 3 or 4 inches wide, and put the paper in the funnel and set the funnel in the beaker. Pour the mixture of water and ashes into the paper and funnel and collect the solution in the beaker. That solution that comes through the filter is called the **filtrate.**



Add a few drops of Phenolphthalein Solution to that solution. Surprise, it will turn red.

The ashes contain a strong base that dissolved in water and that part passed through the paper and the insoluble part of the ashes collected on the paper.
The paper with the ashes can be discard in the trash. You can make more of the soda ash solution and use it as the Reappearing Solution in the other experiments.

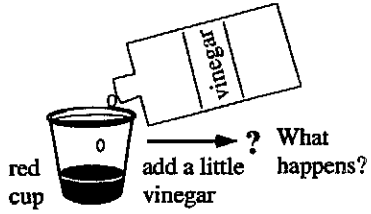
This process of separating a solid from a solution is called **filtration.** You can use the funnel and a paper towel, or a coffee filter paper, to filter other solids from liquids.

Citric Acid

Citric acid is found in citrus fruit such as lemons and oranges. Citric acid is used in preserving jelly and giving some foods and beverages a tart or sour taste. The molecular formula is $C_6H_8O_7$. Citric acid is a weak acid that reacts with and neutralizes bases. It reacts like an acid when it turns the red and blue solutions colorless and dissolves the white solid.

Experiment 7 More Kitchen Chemistry

Try and experiment to find household chemicals that will work like the citric acid. Try lemon juice, vinegar or drinks like "7-UP or Sprite" to see if they can turn the red, white and blue solutions colorless.

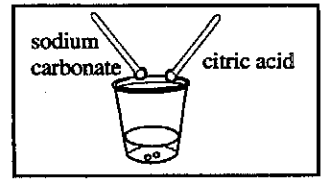


Lemon juice and vinegar react like the citric acid. They are acids. They turn phenolphthalein colorless. Use vinegar or lemon juice, if you run out of the citric acid crystals.

Experiment 8 Neutralize

Neutralize means to counteract or to destroy the activity of something. Chemical forces do this by reacting with and changing other chemicals. This is often amazing and may look like magic.

Add a few sodium carbonate and citric acid crystals to a half cup of water. Watch closely and you will see bubbles of carbon dioxide.



You may have seen advertisements about neutralizing stomach acidity. Stomach acid is neutralized by antacids and is an acid-base reaction very similar to the this reaction. The acid and base are changed into less reactive or neutral compounds. Water is one of the other neutral products formed.

Save this solution for experiment 9.

Acids and Bases

An **acid** is a substance that gives hydrogen ions (H^+) when it reacts.
A **base** is a substance that accepts hydrogen ions. Carbonates can act as bases. Carbonates neutralize acids and produce water, a salt and carbon dioxide gas. The balanced chemical equation for the neutralization reaction in Experiment 8 is:

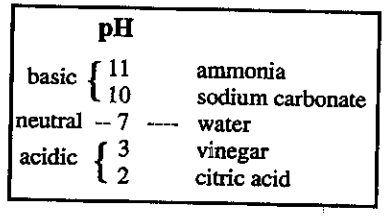
$$2\,H_3C_6H_5O_7 + 3\,Na_2CO_3 \longrightarrow 3\,H_2O + 2\,Na_3C_6H_5O_7 + 3\,CO_2$$

citric acid — sodium carbonate — water — sodium citrate — carbon dioxide

Formulas for acids generally start with H so we can follow where the hydrogen goes in a reaction. Three of the H's in the citric acid are acidic and combine with an O (oxygen) in the carbonate to form water (H_2O). The carbonate breaks down to carbon dioxide, CO_2. Sodium citrate is a salt formed from the other parts of the acid and base.

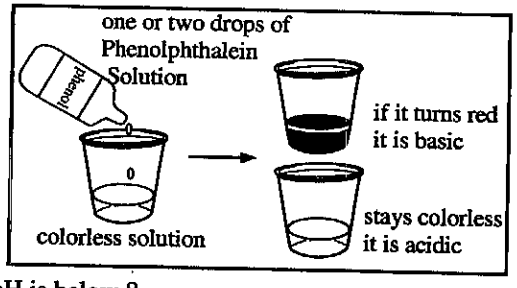
Acids, Bases and pH

Chemists use the term **pH** to tell how acidic something is. **Acids** have a pH less than 7. **Bases** have a pH greater than 7. Pure water is neutral and has a pH = 7. Here are the pH values for some of the substances you have used.



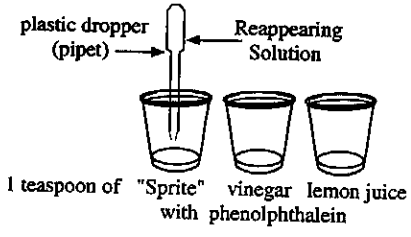
Experiment 9 Indicators

Put a few drops of phenolphthalein in the cup from the last neutralization reaction (experiment 8). If it turns red then the solution has more base than acid and is basic. If it is colorless, then it is acidic. **Indicators** can help identify or tell what other chemicals are by the way they change color. Phenolphthalein is an acid-base indicator. It turns red when the pH is greater than 8 and is colorless when the pH is below 8. Chemists use indicators to measure pH.



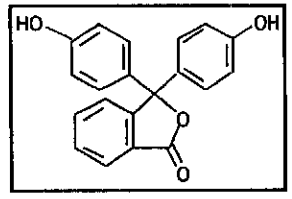
Experiment 10 Acid Analyzer

Chemists analyze to find out what something is and how much there is. An indicator and a pipet will help us do a **titration** (pronounced ti-tray-shun) to find out which has more acid in it: soda pop, vinegar or lemon juice. The pipet will let us accurately measure and the indicator will tell us when the reaction is complete. Place exactly one teaspoon of each liquid to be tested, in separate cups. Use a clear soda such as "Sprite" or "7-Up". Add two drops of Phenolphthalein Solution to each. Using the pipet, add sodium carbonate solution, counting the drops that it takes to turn each red. Swirl the cup to make sure it all reacts. The more acidic one needs more base to neutralize it.



Phenolphthalein

Phenolphthalein turns red or pink with chemicals called bases. Sodium carbonate and ammonia are both bases and they turn the phenolphthalein red. Acids turn phenolphthalein colorless. Phenolphthalein is used in laboratories to identify acids and bases.

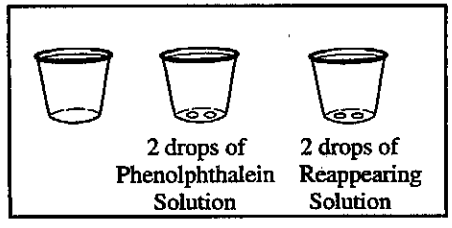


The molecular structure of phenolphthalein is shown to the right. The formula is $C_{20}H_{14}O_4$. It is complicated, but amazingly, when one of the hydrogens (H) is removed by a base, the molecule turns red. Acids can put the H back and turn it colorless.

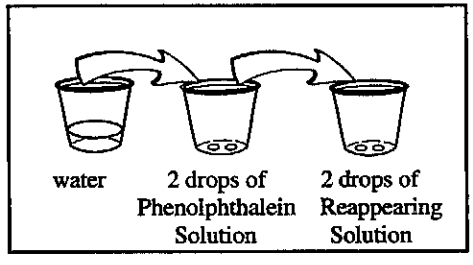
Things are colored because of the way they absorb and reflect light waves. Something that is colorless will not absorb any light. The red form of phenolphthalein reflects red wavelengths of light and absorbs all the other colors. Something that is black, absorbs all colors of the visible light spectrum.

Experiment 11 The Famous Water into "Wine" Trick

Take 3 cups. Place a few drops of Phenolphthalein Solution in one and a few drops of sodium carbonate Reappearing Solution in another. Place the cups so no one will notice the drops.



Now when you are ready to do the trick, ask a volunteer to get some water in the third cup. Pour the water into the cup containing the phenolphthalein. Give it a slight swirl to mix. Then pour that into the other cup containing the Reappearing Solution. The water will turn red.



Disappearing Ink

Disappearing Ink is also an acid-base indicator. Its chemical name is **thymolphthalein** (pronounced thy-mol-thal-en) and its molecular formula is $C_{28}H_{30}O_4$.

It reacts very similar to phenolphthalein, except that thymolphthalein turns blue when the pH is greater than 10 and is colorless when the pH is below 10. Acids such as citric acid turn thymolphthalein colorless and bases such as sodium carbonate turn it blue. When the blue Disappearing Ink is put in water, the pH is lowered and it turns colorless.

Experiment 12 The Famous Disappearing Ink Trick

Put a drop of the blue Disappearing Ink on a paper towel and watch it. It will turn colorless in a minute or two. What made the blue color disappear?

We could guess or **hypothesize** that it evaporated into the air, or perhaps something acidic reacted with the ink and turned it colorless. Put a drop of Reappearing Solution on the spot that had disappeared. The blue should reappear. The ink is still on the paper. The first hypothesis does not appear to be correct.

Put another drop of Disappearing Ink on two pieces of paper. Blow on one piece. Leave the other piece alone; this will be a control. A **control** allows you to observe how changing one thing affects the experiment. Blowing should cause the blue color to disappear faster.

Scientists have discovered that carbon dioxide (CO_2) in air and exhaled breath causes the color to disappear. You may have also noticed how the red and blue colors will fade after awhile. This is because they are **absorbing** or picking up carbon dioxide from the air.

Carbon dioxide reacts with water to form carbonic acid (H_2CO_3), a weak acid that is also in carbonated beverages. This acid is what makes the Disappearing Ink disappear. The chemical equation is: $CO_2 + H_2O \longrightarrow H_2CO_3$

Experiment 13 Breath Analyzer

Analyze means to examine. In this experiment, you can analyze exhaled air for the presence of carbon dioxide.

Put 5 drops of Disappearing Ink in a cup with water. Add 1 or 2 drops of Reappearing Solution to make it blue. Take a straw and blow into the blue solution until it becomes colorless. **Be careful. Do not drink it.**

Calcium chloride

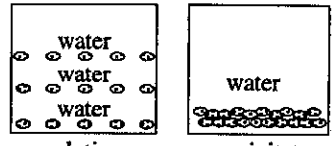
Calcium chloride has the formula $CaCl_2$. You dissolved it in water and reacted it with sodium carbonate (Na_2CO_3), to form the white solid calcium carbonate ($CaCO_3$). Solids that form like that are called **precipitates** (pronounced pre-sip-a-tate). This is a **double replacement reaction.** Can you find which parts are switching or replacing?

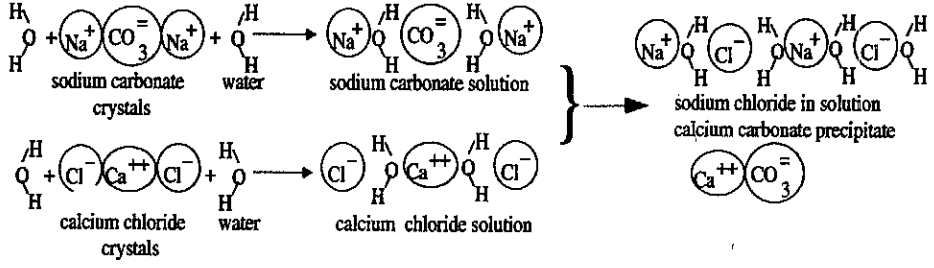
$CaCl_2$ (solution) + Na_2CO_3 (solution) $\longrightarrow$ $CaCO_3$ (solid) + 2 NaCl (solution)

calcium chloride plus sodium carbonate yields calcium carbonate plus sodium chloride

Solutions and Precipitates

Why do some compounds such as Na_2CO_3 and $CaCl_2$ dissolve completely and form solutions, and why do some such as $CaCO_3$ form precipitates and do not dissolve?





Solubility or how much dissolves, depends on how strong the parts of the compound bond to each other and to water. If they bond stronger to water, they will dissolve. Water will separates the parts of sodium carbonate and calcium chloride into positive (+) and negative particles called ions. When the solutions are mixed, Ca^{++} attracts $CO_3^{=}$ and they form a strong bond that does not dissolve in water. The $CaCO_3$ appears as the white solid precipitate. Sodium ion, Na^+, and chloride ion, Cl^-, bond stronger to water than to each other and sodium chloride will stay dissolved in solution

Experiment 14 Dissolving the White Solid Calcium Carbonate

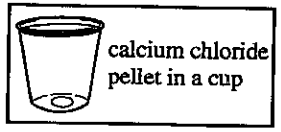
Calcium carbonate is a very common substance in nature. It is in chalk, limestone, marble, the mineral calcite, stalactites in caves, pearls, sea shells and egg shells. Caves are formed when limestone reacts with acid in groundwater. A similar reaction happened in experiment 2 when citric acid was added to the cup with the white solid. Citric acid reacted with and dissolved the calcium carbonate.

Acids can dissolve carbonates. This can be a very useful reaction. You can clean the white solid left in your experiment cup by dissolving it with vinegar. However, the reaction is a very serious problem in our environment when acid rain dissolves marble and limestone buildings. The chemical reaction is:

$CaCO_3$ (solid) + 2 H^+ (any acid) $\longrightarrow$ Ca^{++} (solution) + CO_2 (gas) + H_2O

Experiment 15 A Drying Agent

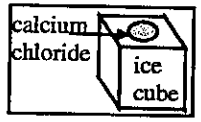
Calcium chloride is a very useful chemical. It can absorb or soak up water from the air. Put one crystal or pellet of calcium chloride in a dry cup or on an old saucer. Watch it for several minutes. It will become wet by taking moisture from the air around it. The air will become drier.



The amount of moisture that you see will depend on the season and your location. Winter is generally a drier time. Areas near river and lakes are generally more humid. Look up in a dictionary the following words that mean "to remove water": dehumidify, dehydrate, deliquesce and desiccate. **Make sure to keep the cap on the calcium chloride container so that it does not pick up moisture.**

Experiment 16 A De-icing Agent

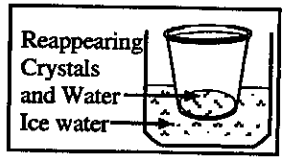
Calcium chloride can also make ice melt faster. Put one crystal of calcium chloride on a piece of ice. Watch the ice around it melt. It lowers the freezing point of ice. It also gives off heat when it dissolves in water. This is used to melt ice on sidewalks and roads in the winter.



Experiment 17 Crystals

You will need hot water and ice water for this experiment. Run a hot water faucet until the water comes out as hot as possible and put some in a cup. Take one cap full of the sodium carbonate and put it in another cup. Use the pipet and add, with stirring, the smallest amount of hot water to the cup that will dissolve the crystals. This will be a **concentrated** and **saturated** solution. Saturated means that it is holding as much as it can hold.

Now put the cup with the solution in another cup with a few ice cubes and water. Wait several minutes until the cup cools. You should see crystals begin to grow.



Temperature is a factor in how many crystals will dissolve in water. Generally, the hotter the water, the more solid that can dissolve. As the solution is cooled, the solid is less soluble and the crystals separate. This is similar to rain or snow precipitating in the air. You dissolved the crystals in hot water and recrystallized them by making the solution colder. That did not change the chemical composition. The crystals are still sodium carbonate (Na_2CO_3). Save these crystals to make more Reappearing Solution for the red, white and blue experiments (see experiment 1).

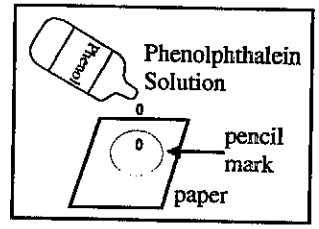
Experiment 18 Solids and Solubility

There is one more way for crystals to appear. Take any of the solutions that you have and let the water evaporate for a few days. You will reclaim or get back any solid that was dissolved in the solution. You may find some interesting crystals.

Experiment 19 Chemical Test Paper

Chemists use **indicator** test papers to help **identify** substances quickly and easily by the color change of the paper when the right substance is put on it. You can make your own **acid-base test paper**.

Cut out several strips of white paper. Draw a circle with a pencil (not a pen) on a piece of the paper and then squirt one or two drops of Phenolphthalein Solution on the circle and let it dry. Put a drop of the liquid that you want to test on the circle where the solution was put. If the test paper turns red, then the liquid is basic and has a pH greater than 8. Test your test paper with the Reappearing Solution. What is the pH of the Reappearing Solution?



Try to make a test paper using the Disappearing Ink instead of phenolphthalein. What color will it turn with bases? If something turns the Disappearing Ink test paper blue, then it must have a pH greater than 10.

The red and blue colors from the test papers will fade after a while. Do you know why? Go back to the Disappearing Ink trick in experiment 12 to find out. Can you make the colors reappear?

Experiment 20 Ammonia Detector

Try this "magic" trick with your test papers from experiment 19. Hold a piece of the test paper over an open bottle of household ammonia. The ammonia vapors will turn the phenolphthalein test paper red and the thymolphthalein test paper blue. If you wet the test paper first with tap water, then hold it over the open bottle of ammonia, the color change will be more dramatic.

The **vapors** or fumes of ammonia are an invisible gas, but the test paper can **detect** them. Detect means to discover or notice the presence of something. Our nose is also a chemical detector and we can smell the ammonia. Always use caution when smelling anything.

Patriotic Colors "Magic" Chemistry Test
This "magic" test is really a test of chemical knowledge using a chemical test paper. The Reappearing Solution will let you check your answers. See experiment 1 to make more Reappearing Solution. Can you figure out how this chemistry test works?

Dip a stick in the sodium carbonate Reappearing Solution and touch it on the circle above your answer.
If your choice is correct you will see a color change.

1. Bases turn phenolphthalein what color?

O	O	O	O
red	white	blue	colorless

2. Acids turn phenolphthalein and Disappearing Ink what color?

O	O	O	O
red	white	blue	colorless

3. What does citric acid do to the white solid, calcium carbonate?

O	O	O	O
turns it red	turns it blue	dissolves it	precipitates it

4. Acids can neutralize

O	O	O	O
acids	water	bases	everything

5. Reactions that can go back to the original substance are

O	O	O	O
reversible	blue	red	not very useful

6. Which reacts like sodium carbonate to make the colors reappear?

O	O	O	O
vinegar	ammonia	water	citric acid

7. Which of the following reacts like citric acid to make the colors disappear?

O	O	O	O
vinegar	ammonia	water	sodium carbonate

Experiment 21 One More Chemical Magic Trick
Dip a stick in the sodium carbonate solution and then touch the stick on the stars on the front cover of this booklet.
What happens?
How did it happen?

Science is fun, fundamental and amazing, but always experiment carefully!