Science in a Box

Girl Guides of Canada

BC Program Committee 2003

(Revised October 2005)

Table of Contents

Introduction to Science in a Box

In the last couple of years there has been a move towards packaging program information into a box. The idea is a great one for leaders who are new to a specific topic or need a quick idea. The BC Program Committee put forth the idea of sending out Science in a Box to each District and to each Lone Guide/Guider. The idea integrates the need for more information on science and technology with hands-on equipment necessary to do the experiments.

There have been a lot of studies that show if girls become confident in science and math, there is no stopping them. Once they are more confident about themselves, they tend to answer more questions in the classroom and end up receiving more attention in the learning process. We can give girls the power of knowledge in our all-female environment, so that they are self-assured to explore all their options in the rest of their lives. This does not mean that every girl needs to become an engineer or chemist, but it opens more doors for the future.

What's in the Box?

So what can you expect in the Science in a Box? This booklet will provide you with information to carry out a number of experiments on different topics that relate to science and technology. On page 45 there is a list of references to books and websites that give even more information. Inside the box itself, some basic equipment and safety gear is provided for a number of experiments. It will be up to each District to determine how best to replenish the supplies. Feel free to photocopy the booklet.

Now if you are reading this booklet and you are saying to yourself, "what in the world is that?" or "I have no idea what pH is myself, how am I going to do an experiment about it?" don't worry. The booklet gives some background information with the experiment and more in the appendix. When going through this booklet, items that are included in the box will be checked off on the list like this: ☑.

Science in a Box can be used with any age group. Beside each experiment we have listed the suggested age group as S, B, G, or P. Senior Branches girls can do and teach all the activities! This is a guideline only. You may find that you can adapt many of the activities to other age groups.

We have also listed possible program connections at the end of each Experiment. For Sparks and Brownies we have included some hands-on activities that they can do with help. We also suggest bringing in older girls to put on a Science Show to demonstrate other activities. For Guides and Pathfinders, you will probably find that setting up stations works well. A Scavenger Hunt Checklist for the Guide Scientist Badge (see page 46) has been included as well. Information for most of the stations in the Scavenger Hunt is provided in this booklet, but you will need to prepare a few items on your own. For example, #3 requires objects representing various science and technology careers, #4 requires info on 2 female scientists for the girls to read, and #5 requires poster supplies.

Extensions for some experiments are also included, so if you find that the girls are interested in a specific experiment, there are often other activities to do on the same topic. For each section, background information is given first, then the experiment, extensions to the idea, and Program Connections. The appendix contains additional information on some topics.

We hope that these boxes provide fun activities and useful information on science and technology for both Guiders and girls. If you are not sure how to answer any of the girls' questions (or your own!) check out the "FAQs" (Frequently Asked Questions) for the Science in a Box on the BC Girl Guide website at www.bc-girlguides.org or email the Science and Technology Adviser c/o program@bc-girlguides.org. On page 52 there is a form that you can fax with your questions and they will be posted on the website.

Additional experiments that you can do using the Science in a Box equipment will be published in future editions of the *FunFinder* newsletter which is available from your Program Adviser or from the BC Girl Guide website.

Safety in the Laboratory, the Kitchen, or the Meeting Place

Accidents can be prevented if you think about what you are doing at all times, use good judgment, observe safety rules, and follow directions. Each experiment will include comments to alert you to possible hazards, including how to protect yourself and others against injury.

- Eye protection (safety glasses) must be worn when working on experiments. Make a habit of putting them on before the experiment begins and keeping them on until all clean-up is finished.
- Do not eat or drink while in the laboratory.
- Do not taste any chemical.
- Long-sleeved shirts and close-toed shoes are the suggested clothing to be worn.
- Long hair should be tied back so it will not fall into chemicals or flames.
- Do not work alone; work with an adult.
- Never perform any unauthorized experiment.
- It is best to stand while doing experiments so that you can move back quickly in case something spills.
- All equipment must be washed and cleaned. Wipe all counter surfaces and hands with soap and water.
- Never point the open end of the containers at yourself or another person.
- If you want to smell a substance, do not hold it directly to your nose. Instead, hold the container a few centimeters away and use your hand to fan vapors toward you (called wafting). 💣Ammonia, which is used in the pH experiment, should not be inhaled!

- When diluting acids, always add the acid to the water; never water to acid. Add the acid slowly.
- Flush with large quantities of water when disposing of liquid chemicals or solutions in the sink.
- If you spill any acid or base material on you, wash the exposed area with large amounts of cold water. If skin becomes irritated, see a physician.

Chemistry

Chemical Reactions

Let's start with the idea of a reaction. In chemistry, a reaction is when two or more molecules interact and something happens. That's it. What molecules are they? How do they interact? What happens? Those are some of the things you can learn about reactions. The possibilities are infinite.

Chemical reactions have the following characteristics:

1. A chemical change must occur. You start with one compound and turn it into another. One example of a chemical change is a steel garbage can rusting. Rust forms when the iron in the metal combines with oxygen in the atmosphere.
2. Reactions can happen with ions, molecules or pure atoms.
3. Single reactions often happen as part of a larger series of reactions. Take something as simple as moving your arm. A whole series of reactions (hundreds actually) are needed to make it happen.

Experiment 1. Ack, It's Gak! (S, B, G)

You'll need:

- ❑ 1/4 cup cornstarch
- ❑ 3-1/2 teaspoons water (add more if needed)
- ❑ a bowl
- ❑ food colouring (optional) 💣 Watch out for stains!

1. Add cornstarch to water in a bowl. Mix with hands (not spoon; needs warmth of hands).
2. When you touch the mixture gently, it should yield like a liquid. When you smack your hand down on it, it should resist like a solid. Add colouring if wanted. Play away!

What is Happening?

Substances can be solid, liquid or a gas (states of matter). This change between states can occur when there is a change of temperature or pressure. Gak is borderline between a solid and liquid.

Program Objectives Covered:

Sparks – Exploring And Experimenting Keeper

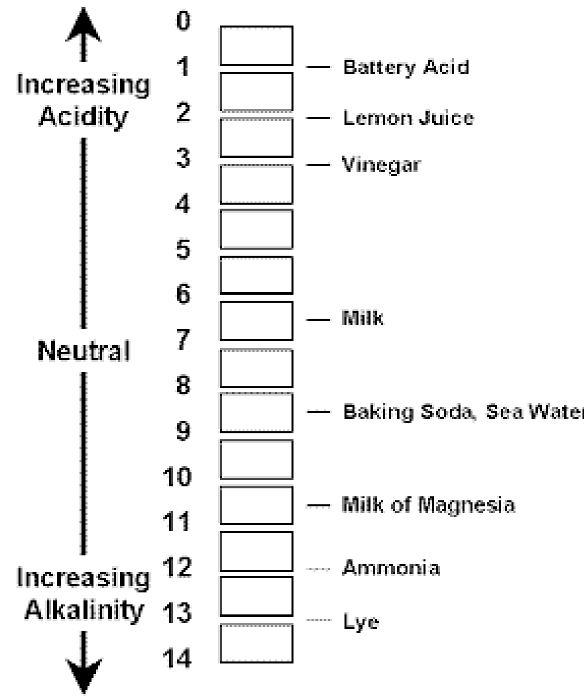
Brownies – Key To STEM – CABOOSH Part 3

Guides – Chemistry Badge Part 1, Science Badge Part 4

Acids, Bases, and pH

Acids and bases (bases are also called alkaline) are two extremes that describe chemicals, just like hot and cold are two extremes that describe temperature. Mixing acids and bases can cancel out their extreme effects, much like mixing hot and cold water can even out the water temperature.

The pH scale measures how acidic or basic a substance is. It ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic, and a pH greater than 7 is basic. For more information on pH see page 46.



Pure water is neutral. Vinegar and lemon juice are acidic substances, while laundry detergents and ammonia (found in glass cleaner) are basic. Chemicals that are very basic (lye, found in household drain cleaners) or very acidic (car battery acid) are called "reactive." These chemicals can cause severe burns.

Experiment 2. Mix 'n Match (G, P)

You'll need:

- ☑ pH kit
- ☑ vinegar, water, and ammonia
- ☑ 1 cup for clean water
- ☑ 1 cup for the waste liquid
- ☑ plastic syringe
- ❑ paper towel

1. Put your gloves and glasses on and spread the paper towel on the tabletop.
2. Take the red lid off the pH tester. The yellow side is for chlorine so we won't need it.
3. Use the syringe to take some of the liquid out of one of the containers labeled ammonia, water, or vinegar and place it in the pH tester. Fill up to the MAX line.
4. Add 5 drops of the phenol red dye, put the lid on tightly and shake it a bit.
5. The liquid will have changed colour. Look to the left and match the colour and the number.
6. Now look on the pH scale above to find out if the liquid is an acid or a base (alkaline).
7. Pour the used liquid into the waste cup.
8. Use some clean water to rinse out the kit with the syringe.
9. Now repeat with the other two liquids.

What is happening?

An indicator is a special type of compound that changes colour depending on the pH of the solution you mix it with. The phenol red dye that you have in your pH kit is an indicator.

Extension

Test all kinds of different liquids. Start with the liquids you drink, such as pop, milk, and juice. Then take the pH kit on a hike and sample a creek, river, pond or puddles of water.

Program Objectives Covered:

Guides – Chemistry Badge, part 5; Engineering Badge, part 4; Science Badge, part 4

Pathfinders – Outdoor Emblem: Natural Environment 11

Water

We are surrounded by water, and use it every day -- to drink, to cook with, to flush our toilets and to wash our dishes. 70 percent of the earth's surface is water. That's a lot of water, isn't it!

Another cool thing about water is that it recycles itself. Most of the water on the earth today has been around for millions of years. It continually evaporates (changes from liquid to gas) and condenses (changes back to liquid). In other words, the rain falling from the sky has fallen millions of times before and will fall millions of times again. For more information on the water cycle see page 49.

To find out how clouds form or how humans keep cool, go to page 51.

Experiment 3. Freeze and Thaw! (S, B, G)

You'll need:

- ❑ a cup
- ❑ some water

1. Pour water into the cup and fill to the brim.
2. Place the cup in the freezer.
3. Predict what will happen.
4. Once frozen leave at room temperature and thaw.
5. Pour the water from the cup into a pot with a lid and heat till it boils (please have an adult help with this part).
6. What do you think will happen to the water?
7. Take the lid off and see what happens.

What is happening?

We usually think of water in its liquid state, flowing from our taps and rivers into our lakes and oceans. But water comes in two other forms depending on the temperature. At 0° Celsius and below, water freezes into its solid form (ice). Above 0° Celsius, in its liquid form, water continually evaporates. Tiny, invisible droplets break off from the liquid mass and float into the air. The warmer the temperature of the water, the faster the droplets break off and the more quickly the water evaporates. That's why rain puddles dry up faster on hot days. If the water temperature reaches 100°C, water boils. In boiling water, the invisible droplets break off so quickly that they form bubbles in the water that rise to the top and release the gas vapor (steam) into the air.

Extension – Popsicles!

Make your own popsicles. Use your own recipe or try the ideas on one of these websites:

http://pbskids.org/rogers/R_house/recipe4.htm

http://dessertrecipe.com/AZ/HmmdPpsicls.asp

http://www.nrlfcu.org/kidzone/article_template.asp?month=August&year=2002&section=Kid Zone

Program Objectives Covered:

Sparks – Keeper: In My Community – Water or Exploring And Experimenting

Brownies – Key To Living World – Interest Badge Water, Water Everywhere (Part 3)

Guides - Physics Badge, part 8; Science Badge, part 5

Experiment 4. Science in the Deep Freeze! (G, P)

You'll need:

- ❑ Whole Milk, Cream, or Half & Half
- ❑ Vanilla extract or chocolate syrup
- ❑ sugar
- ❑ ice
- ❑ salt
- ❑ several large Ziploc-style bags
- ❑ 1 small Ziploc-style baggie for each person

1. Each person should have her own sandwich size Ziploc-style baggie to mix the ingredients in.
2. Add 5 grams (1 teaspoon) of sugar.
3. Add 60 ml (4 tablespoons) of milk, cream, or Half & Half.
4. Add a dash of vanilla extract or about 2.5 ml (1/2 teaspoon) of chocolate syrup.
5. Seal the small baggies and squish everything around to mix it up.
6. Take the large Ziploc-style bag and fill it half full of ice.
7. Next, add approximately 150 grams (10 tablespoons) of salt to the large bag.
8. Take a few of the small baggies and place them into the large bag with the ice and salt (maximum of 3-4 small baggies at a time). Seal the large bag.
9. Carefully shake the large bag for about 5 minutes.
10. What is happening to the contents in the small baggies?
11. Pass out spoons and eat!

What is happening?

Water freezes at a temperature of 0 degrees Celsius (32 degrees Fahrenheit). As the water is cooled, the water molecules slow-down, and when the temperature reaches 0 degrees Celsius (32 degrees Fahrenheit) the water molecules bundle together, not quite immobile, and make ice. The freezing point of salty solutions is lower than 0 degrees Celsius. So when you add salt to the ice, it can turn liquid and still be at 0 degrees or lower. Since liquids are able to "share" their coldness better than solids, you will be able to make ice cream faster if you add salt to the ice, causing your bag to be filled with extra-cold water!

Program Objectives Covered:

Guides – Chemistry Badge part 8; Science Badge part 3 or 4; Tasty Treats Badge part 3 or 6

Pathfinders – Home Emblem: Nutrition and Home Management 7

Surface Tension

Liquid water molecules are friends with each other! They try to stick together. The molecules at the surface do not have as many friends surrounding them, so they hold on more tightly to the ones they do have. This desire of liquid molecules to "stick together" causes the phenomenon known as surface tension.

Surface tension makes it hard for water to be friendly with some other liquids. Can you get water molecules to mix with oil?

Experiment 5. Slippery Stuff! (S, B, G)

You'll need:

- ❑ oil
- ❑ soap
- ❑ water

1. Rub a few drops of cooking oil on your hand.
2. Wash your hands with water? What happens?
3. Wash your hands with soap. Does this make the slippery oil go away?
4. Why do you think you should wash your hands with soap before you eat?

What is happening?

The water molecules stick together tightly and will not mix with the oil on your hand. Soap molecules are friendly with both water and oil. One end of the soap molecule sticks to oil, the other end sticks to water. The soap breaks up the surface tension and keeps the oil drops mixed in with the water so that the oil can be washed off your hand.

Program Objectives Covered:

Sparks – Keeper: Being Healthy

Brownies – Key To STEM – CABOOSH Part 3; Key to Active Living – Good Health Part 5 or Germ Buster Part 4

Guides - Chemistry Badge, part 8; Science Badge, part 4

Experiment 6. Listen to the Lifeguard! (S, B, G)

You'll need:

☑ pepper (Brownies)

☑ a bit of soap on your finger (Lifeguard)

❑ cup of water (pool)

1. Make a list of safety rules for a visit to the pool. Tell the following story as you do the experiment.
2. "One day a group of Brownies went swimming at the pool" - sprinkle pepper into cup.
3. "The Brownies were very smart and new all the rules at the pool, so when they heard the whistle, they knew just what to do!" – with a bit of soap on your finger, dip it into the cup.
4. "The lifeguard was able to save the day, without any Brownies in the way!"
5. "Next time you hear that whistle blow, now you'll know where to go!"

What is happening?

The soap breaks up the surface tension of the water, in a wave that carries the pepper to the edges of the cup.

Program Objectives Covered:

Sparks – Keeper – Experimenting and Exploring or Going Camping – Water Safety

Brownies – Key To STEM – CABOOSH Part 3 or Key To Active Living

Guides - Beyond You, Try New Things part 4; Physics Badge, part 1; Science Badge, part 5

Experiment 7. Make Metal Float (G)

You'll need:

☑ a cup

❑ some water

☑ one paper clip

☑ soap

1. Slide the paper clip onto the surface of the water until it floats.
2. Look for the "skin" formed by the molecules joining together. Can you see it stretch with the weight of the paper clip?
3. Now, amaze your friends by touching your finger gently on the surface of the water after touching it to the bar of soap or a small amount of dish soap. What happens?

4. Hint: Once you put soap into the water, you will no longer be able to float your paper clip—unless you use fresh water!
5. Can you think of any other ways to show surface tension?

What is happening?

The water molecules stick together tightly resulting in a surface "film" which makes it harder for an object to move through the surface layer of the liquid than it is to move through the bottom layers. Soap molecules get in between the water molecules, and cause the surface "film" to disappear which in turn allows the paper clip to sink.

Program Objectives Covered:

Guides – Beyond You, Try New Things part 4; Physics Badge, part 1; Science Badge, part 5

Experiment 8. Touching the Tent (G, P)

You'll need:

- ☑ a piece of material (anything with a tight weave)
- ☑ a cup
- ☑ an elastic band
- ☑ some water

1. Pour the water into the cup and place the material on the top and put an elastic band around to keep it closed.
2. Predict what will happen if you turned the cup upside-down.
3. Turn the cup over and make sure that it is directly up and down.
4. Touch the material underneath and watch the water begin to leak through.
5. What do you think happens when you touch the side of your tent when it's raining?

What's Happening?

The surface tension of the water acts like a skin next to the layer of material - until you touch it. The pressure and the oil on your fingers disrupt the surface tension and the water is able to drip through. Surface tension is what allows pond skaters (insects) to "walk" on water.

Program Objectives Covered:

Guides – Basic Camper Badge, part 5; Camp-out Badge, part 6; Science Badge, part 3

Pathfinders - Outdoor Emblem: Outdoor Skills 19

Experiment 9. Clean it Up! (G, P)

Oil spills can have a negative effect on the environment. Oil spills in the ocean usually contain crude oil, which is like having tacky glue floating across the surface of the water. Now imagine having to swim and eat in that water. Not all animals and plants will die but that depends on the size and ability of the animal to escape the oil. Birds that have not touched the oil can fly away and animals that live on land and water can move away, but there are animals that completely depend on and live within the water.

Fast Facts

- One teaspoon of oil in an Olympic size swimming pool can make all the water undrinkable.
- Oil spills hurt seabirds the most of all the animals. When a bird's feathers get coated in oil they can't keep warm, fly very well, or float on the water.

You'll need:

- ❑ A fairly large bowl or open-top container
- ❑ Some water
- ☑ Gloves
- ☑ Oil
- ☑ Soap
- ☑ Coffee filter
- ❑ Sticks (coffee mixers or popsicle sticks)
- ❑ Pieces of string
- ❑ Paper towel for cleanup

1. Fill container about half full with water and pour a small amount of oil into it.
2. Does the oil float or sink?
3. Now imagine that you are a scientist and you have been asked to clean up the oil spill. What would you do? Use the materials supplied and figure out which way is the best.
4. After trying out the different methods, put a drop of soap into the container. What happens? Is this a good method?

What is happening?

In this case, disrupting the surface tension with soap makes it harder to remove the oil. When you go to camp, remember to use biodegradable soaps, and to wash in designated areas.

Program Objectives Covered:

Guides - Beyond You, Learn About Our Environment part 3 or 6

Pathfinders - Outdoor Emblem: Conservation 7

Capillary Action

You may recognise the word *capillary* as a word that refers to tiny blood vessels in our bodies. Capillary actually means any long, thin tube. Capillary action occurs when water molecules are attracted to the sides of a long, thin tube. As the molecules along the edges are drawn up, the powerful surface tension results in the whole surface rising, which pulls the rest of the liquid along with it.

Experiment 10. Climbing Colours! (S, B, G)

You'll need:

- ❑ Paper towel
- ❑ A cup of water
- ❑ Food colouring 💣 Watch out for stains!

1. Cut the paper towel into fun shapes (triangle, square, diamond, or into the shape of a doll)
2. Add a few drops of food colouring to the water.
3. Touch the very bottom of the paper towel shape to the surface of the water. (With paper dolls, you can make each pant leg a different colour if each foot is in different-coloured water!)
4. Hold it there for several minutes. What do you notice?

What is happening?

Like all materials made of natural fibers, Paper towel has spaces that form tiny capillary tubes.

Program Objectives Covered:

Sparks – Let's Make Arts and Crafts

Guides - Chemistry Badge, part 4

Experiment 11. How Does Water Climb a Tree? (S, B, G)

You'll need:

- ❑ a cup, half-filled with water
- ❑ some blue or red food colouring or jello crystals Watch out for stains!
- ❑ a stalk of celery with some leaves on it

1. Mix a teaspoon of the food colouring into the water.
2. Cut the celery stalk about 2 cm from the bottom to expose a fresh end. Stand the stalk in the cup.
3. When the colour has spread to the tips of the leaves (one to two hours), take the celery out of the water and cut across the stalk. What do you see?

What is happening?

You'll see a row of tiny circles outlined in colour - the cut ends of fine long tubes that travel the length of the stalk. The coloured water travelled up those tubes by capillary action. As the tubes spread out into the leaves, heat evaporates the water molecules at the top, pulling up all the other molecules. *Excerpt from* The Jumbo Book of Science *by the Ontario Science Centre, used by permission of Kids Can Press Ltd., Toronto.*

Program Objectives Covered:

Sparks – Keeper – Experimenting and Exploring

Brownies-Key To Living World – Plant Life Part 2

Guides - Plants and Animals Badge, part 3

Extension - Colour a Flower! S, B

Use a white flower (carnations work great) in place of the celery. Eventually the petals will begin to turn the colour of the water in the vase. This is a fun way to decorate for ceremonies.

Program Objectives Covered:

Sparks – Keeper – Experimenting and Exploring

Brownies-Key To Living World – Plant Life Part 2

Experiment 12. Butterfly Beauties (S, B, G)

You'll need:

- ❑ a shallow dish filled with water
- ❑ a water-soluble black felt pen
- ☑ a coffee filter

1. Fold the coffee filter in half and cut into the shape of a butterfly.
2. Use the felt pen to draw a black line along the fold in the centre for the butterfly's body.
3. Hold the body of the butterfly (along the fold) in the dish of water for several minutes.
4. Watch the colours emerge.

What is happening?

The black colour of the pen is really made up of lots of other colours. The ink is drawn by capillary action along tiny tubes within the paper. Heavier colours don't move as far as lighter ones, so the colours spread out gradually as the water moves further out into the design.

Program Objectives Covered:

Sparks – Let's Make Arts & Crafts

Brownies – Key To The Arts – Interest Badge – Artist At Work – Part 4

Guides - Chemistry Badge, part 4

Experiment 13. Splitting the Smartie (G)

You'll need:

- ☑ coffee filter
- ❑ Tube of smarties
- ❑ A cup
- ❑ water
- ❑ Plate

1. Cut the paper into circles about 15 cm across.
2. Place the plate on a flat surface and the paper on the plate.
3. Place a smartie in the centre of the paper.
4. Dip your finger into the water and hold it above the smartie so water drips onto it.
5. Repeat until the smartie is quite wet and the circle of water on the paper is 5 cm across.
6. After a while you should be able to see rings of colour around the smartie.

What is happening?

The colour in the sugar coating of the smartie shell dissolves in the water. The water is drawn out through the paper by capillary action and moves in a growing circle. The different inks that make up the smartie colour move at different speeds and so they are separated. The colours that migrate the furthest from the candy have less of a mass than the ones closest to the candy. Note that once the shell is wet, the smartie is not so crispy!

Extension – Colour Count

Find out which colour smarties are made of the most different inks. M&M's also work quite well.

Program Objectives Covered:

Guides – Chemistry Badge, part 4

Biology

Groundwater

When rain falls to the ground, the water does not stop moving. Some of it flows along the surface in streams; some of it is used by plants; some evaporates and returns to the atmosphere; and some sinks into the ground. Imagine pouring a glass of water onto a pile of sand. Where does the water go? The water moves into the spaces between the particles of sand and becomes groundwater.

Groundwater is stored in--and moves slowly through--layers of soil, sand and rocks called aquifers. To learn more about groundwater and aquifers, go to page 51.

Experiment 14. Edible Earth Parfaits (G, P)

This activity is a fun and easy way to understand the geology of an aquifer. You will build your own edible aquifer; learn about confining layers, contamination, recharge and water tables.

You'll need:

- ❑ Blue or red food coloring 💣 Watch out for stains!
- ❑ Vanilla ice cream
- ❑ Clear soda pop
- ❑ Crushed ice
- ❑ Drinking straws
- ❑ Variety of colored cake decoration sprinkles and sugars
- ❑ Clear plastic cups (use new ones, not the ones from the Science Box)

1. Fill a clear plastic cup 1/3 full with crushed ice (represents gravels and soils).
2. Add enough soda to just cover the ice.
3. Add a layer of ice cream to serve as a "confining layer" over the water-filled aquifer.
4. Then add more crushed ice on top of the "confining layer".
5. Coloured sugars and sprinkles represent soils and should be sprinkled over the top to create the porous top layer.
6. Now add the food colouring to the soda. The food coloring represents contamination. Watch what happens when it is poured on the top of the "aquifer." Keep in mind that the same thing happens when contaminants are spilled on the earth's surface.
7. Using your straw, drill a well into the center of your aquifer.

8. Slowly begin to pump the well by sucking on the straw. Watch the decline in the water table.
9. Notice how the contaminants can get sucked into the well area and end up in the groundwater by leaking through the confining layer.
10. Now recharge your aquifer by adding more soda, which represents a rain shower.

Program Objectives Covered:

Guides – Beyond You, Learn About Our Environment part 3 or 6; Beyond You, Try New Things part 4 (science sleuth); Water Badge, part 2, 3, or 4

Pathfinders – Outdoor Emblem Conservation 11

Tastebuds

There are only four different types of true tastes - sour, sweet, salt and bitter. Approximately 80-90% of what we perceive as "taste" actually is due to the sense of smell. Just think about how dull food tastes when you have a head cold or a stuffed up nose. It is actually smell that lets us experience the complex, mouth watering flavours we associate with our favourite foods.

For more information about taste, go to page 52.

Experiment 15. Taste Test (S, B)

You'll Need:

- ☐ Life Savers or other flavoured candies

1. Work in pairs.
2. Close your eyes and hold your nose, while a friend feeds you a lifesaver.
3. You should try to guess what flavour the lifesaver is, without letting go of your nose.
4. Observations should proceed for a minute or so as the candy dissolves in your mouth.
5. Is there any change in the taste of the candy from the beginning to the end of the experiment?
6. Describe the tastes.
7. Switch and let your friend try.

Program Objectives Covered:

Sparks – Keeper – Exploring and Experimenting

Brownies – Key To Active Living – Fabulous Food Part 3

Sense of Smell

The nose is so powerful that it can smell up to 10,000 different odours! Identifying smells is your brain's way of telling you about your environment and keeping you safe. When your brain sends a message based on a smell, it's because you've trained your brain to recognize a certain smell.

For more information about the sense of smell see page 52.

Experiment 16. Using Your Nose (B, G)

You'll need:

☑ Container labelled "Using your nose" 1

☑ Container labelled "Using your nose" 2

☑ Container labelled "Using your nose" 3

1. Work with a partner.
2. One partner closes her eyes while the other takes the lid off of container 1.
3. The partner doing the "smelling" should guess what it is.
4. Go through and smell each of the containers.
5. Then switch partners.

Program Objectives Covered:

Brownies – Key To Active Living – Fabulous Food Part 3

Guides – Naturalist Badge, part 5

Physics

Mechanical Generation of Light

Triboluminescence is the mechanical generation of light. Certain chemical bonds will generate light energy when the molecules are torn apart by mechanical crushing. Wintergreen Lifesaver candies contain some of these bonds.

Experiment 17. Flashes of Light (G)

You'll need:

- ❑ Wintergreen Lifesaver candy (no other flavour will work)

1. Find a mirror in a room that can be made very dark. Most bathrooms work well for this experiment.
2. Fill a glass of water to drink in case you choke on the candy.
3. Wait about 15-20 minutes in the darkened room until you can see your teeth in the mirror. Make certain your eyes have adjusted to the dark environment.
4. With your lips open so that you can see your teeth, chew a single lifesaver candy while watching your mouth in the mirror.

What is happening?

Each time a part of a Lifesaver is crushed by your teeth you will see one or more flashes of white light in your mouth! Each piece of candy can produce many flashes of light as it is chewed and crushed.

Program Objectives Covered:

Guides – Physics Badge, part 2; Science Badge, part 5

Super Structures

Circles are among the strongest shapes in nature. External and internal stress distributes itself evenly throughout a round structure. Spaghetti has a shape like a cylinder, while linguini is shaped like a flattened rectangle. A piece of spaghetti has the same strength in any direction it is bent. Linguini will bend more easily in one direction than another.

Experiment 18. Build it! B, (G)

You'll need:

- ❑ marshmallows
- ❑ pieces of raw spaghetti

1. Ask the girls to build the highest structure that they can using the supplies on the table.
2. Set a time limit before you start.

Program Objectives Covered:

Brownies – Key To STEM – Building Up Part 5

Guides – Beyond You, Try New Things part 4; Engineering Badge part 5; Science Badge part 5

Gravity

Gravity is the universal force of attraction in space. It pulls objects with mass together, keeps planets in orbital motion, and holds you and me firmly grounded on Earth.

Experiment 19. Gravity in Motion (B, G)

You'll need:

- ❑ Different types of seeds
- ❑ Other objects to drop

1. Drop various objects and seeds in pairs so that they "race" toward the ground.
2. Have the girls observe the seeds as you drop them.

What is happening?

Gravity pulls equally on all objects, no matter their size. For the most part, objects fall at the same rate; heavy and light objects should reach the floor at the same time. This may not be true of the falling seeds if they have wings or large membranes that slow down their fall.

Program Objectives Covered:

Brownies – Key To STEM

Guides - Physics Badge, part 2; Science Badge, part 5

Things in Motion

Experiment 20. Dancin' Cranberries (S, B)

You'll need:

☑ A plastic cup

❑ 5-6 cranberries or raisins

❑ 125ml clear pop (half a glass)

1. Pour clear pop (Sprite, ginger ale) into the cup.
2. Add the cranberries or raisins. Watch what happens.

What's Happening?

When you add the cranberries/raisins, they become coated with air bubbles. When they sink down, they collect more air bubbles and rise. When they go up they lose bubbles at the surface and start going down again. They keep going up and down for a long time.

Program Objectives Covered:

Sparks – Keeper – Being Healthy – Healthy Snack

Brownies – Key To Active Living – Fabulous Food – Part 3

Experiment 21. Balloon Blowing (B, G)

You'll need:

❑ A balloon

❑ Small-mouthed bottle

☑ Vinegar

❑ Baking soda

1. Blow up a balloon 2-3 times to soften it, and then add baking soda to balloon
2. Add vinegar to bottle.
3. Put balloon over mouth of bottle and shake a bit. Watch the balloon expand.

What is happening?

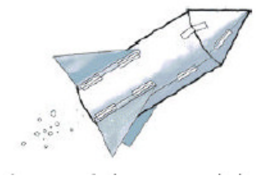
Vinegar and baking soda react to produce carbon dioxide, which causes the balloon to expand.

Program Objectives Covered:

Brownies – Key To STEM

Guides - Beyond You, Try New Things part 4; Chemistry Badge, part 2; Science Badge, part 4

Experiment 22. Poppin' Rockets (G)



You'll need:

- ❑ Paper, regular 8-1/2- by 11-inch paper, such as computer printer paper or notebook paper.
- ❑ Plastic 35-mm film canister (MUST be one with a cap that fits INSIDE the rim)
- ❑ Effervescing (fizzing) antacid tablet (the kind used to settle an upset stomach)
- ❑ scotch tape and scissors
- ❑ Paper towels
- ☑ Water
- ☑ safety glasses
- 💣 Adult supervision suggested

1. You must first decide how to decorate your rocket. Long or short? Fins or no fins?
2. Cut out all the pieces for your rocket. Wrap and tape a tube of paper around the film canister. Hint: Tape the canister to the end of the paper before you start wrapping. Make a cone for the top.
3. Important! Place the lid end of the canister down.
4. Tape fins to your rocket body, if you want.
5. Put on your eye protection.
6. Turn the rocket upside down and remove the canister's lid.
7. Fill the canister one-third full of water.
8. Drop one-half of an effervescing antacid tablet into the canister and snap the lid on tight.
9. Stand your rocket on a launch platform, such as your sidewalk or driveway.
10. Stand back and wait. Your rocket will blast off!

This idea is from the following website: http://spaceplace.jpl.nasa.gov/rocket.htm

What is happening:

You are creating a gas when the tablet reacts with water. Pressure builds up until the small canister can no longer contain the gas. The lid pops off, gas escapes, and the canister shoots up.

Program Objectives Covered:

Guides – Beyond You, Try New Things part 4; Chemistry Badge, part 2; Science Badge, part 4

Astronomy

Astronomy is the scientific study of the positions, distributions, motion, and composition of celestial bodies. In other words, people who study astronomy study the wide spectrum of objects outside our planet. To learn about astronomers, go to page 53.

Program Objectives Covered:

Brownie – Key To STEM – Reach For The Stars Part 6 or Key To STEM Interest Badge Exploring Space

Guides - Astronomy Badge, part 4, 6, 7; Basic Camper Badge, part 6; Camp-out Badge, part 7; Experienced Camper, part 2; Science Badge, part 5

Night Sky Observation

This information was taken from a Girl Scouts manual (2000) called "Star Gazers" which can be found at http://www.plugged-in.org/pdf/stargazers/pdf.

Selecting a Location

The best night sky viewing is away from the city lights, in a relatively flat area with few trees. Some Internet sites will assist in locating the darkest skies in your area.

Using Binoculars

Binoculars are wonderful for night sky observation. Some of the more interesting sky objects to view with binoculars include:

- Planets — Binoculars make it possible to see some moons and rings of some planets.
- Earth's moon — Binoculars are great for seeing craters and other details of the moon's surface. Look at the edge between the dark and light of the moon. Observation is most successful when the moon is new or waning. A full moon produces too much light to see surface details.
- Constellations — Some of the constellations include groups of stars not readily seen with the naked eye. Binoculars can greatly enhance the visibility of such stars. Some good examples include Orion's Belt, the Pleiades (seven sisters), Delphinus the Dolphin, and Lyra the Harp.

Tip: If possible, have each girl bring her own pair of binoculars on the night of your sky viewing. Bring something for the girls to lie down on. Laying down will help the girls keep their arms steady.

Using Telescopes

Experienced sky observers make good telescope users. Telescopes typically have a very small field of view, allowing you to see only a small area of the sky. For this reason, a person needs to be fairly familiar with the positions of planets and constellations to be successful when using a telescope.

Tip: If you want to keep your flashlight on so the girls know where you are at all times, bring a second flashlight and cover the end with red cellophane. This keeps the light from disrupting the observation.

Tip: Due to the Earth's rotation, the planets, stars, and moon appear to move toward the West. As a result, frequent small adjustments will have to be made to the position of the telescope. Many telescopes require adjustments that seem to be upside-down and backwards. Tell the girls to let you know if the object they are trying to see goes out of view.

Each night sky observation is different depending on the date, the weather, and your location. Before you take the unit out, you can (and should!) think of some guiding questions to direct the girls' search. Let the girls' interests and the night dictate the schedule of events. If they are interested in seeing the moon, encourage them to do so don't drag them away from it just to cross something else off a list. A good way to get started is to have the girls find the Big Dipper and the North Star. These "constants" are good to start with to build the girls' confidence and enthusiasm for finding more difficult constellations.

Using Computer-Generated Sky Charts

The computer-generated sky charts are detailed and specific for a particular location and time. You should be able to find a specific constellation if you observe at the time indicated on your printout.

Some questions to get the girls thinking about…

- What constellations and planets were you able to find?
- How did you go about finding the constellation or planet?
- Could you use the same method for finding a new constellation or planet?
- Can you show another group how to use your techniques?
- Why is it important to be able to find constellations or planets?

Tip: Just as the sun and moon rise and set, the constellations move through the sky on a regular basis. If your observation time is off by a day, or even an hour, the position of the constellations and planets will appear to have shifted due to the rotation of the planet on its axis and its rotation around the sun.

Tip: To help girls find objects in the sky, use a flashlight as a pointer. The light will reflect off the atmosphere and guide their search.

Activity 23. The Star-Finder Game

Finding the Constellations

We see different views of the Universe from where we live as Earth makes its yearly trip around the solar system. That is why we have a different Star Finder for each month, as different constellations come into view. Also, as Earth rotates on its axis toward the east throughout the hours of the night, the whole sky seems to shift toward the west.

The Star Finder charts are for latitude of 34° N, which is about as far north of the equator as Los Angeles, California. (Charts are from *The Griffith Observer* magazine.) The farther north you are, the more the constellations will be shifted south from the Star Finder charts. The Star Finder charts show the sky at about 10 PM for the first of the month, 9 PM for the middle of the month, and 8 PM for the last of the month. These are local standard times. For months with Daylight Savings Time, star chart times are an hour later.

The star charts are maps of the sky overhead. So, to get the directions lined up, hold the map over your head and look up at it, and turn it so the northern horizon side is facing north.

To Play the Star Finder Game

The Star Finder can be photocopied from page 35. Blow up to a larger size if you wish.

Stick your thumbs and first two fingers into the four pockets on the bottom of the Star Finder.

Ask another person to choose one of the top four squares. Then, depending on the number on the square she chose, open and close the Star Finder that many times (open up and down, close, open side to side, close, etc.). For example, if she chose number 6, open and close the Star Finder 6 times.

Then, ask the person to look inside the Star Finder and pick one of the four visible constellations. This time, open and close the Star Finder once for each letter to spell out his choice. For example, if he chose "Lyra," you would open and close the Star Finder 4 times, once for each letter: L - Y - R - A. Ask the player again to pick one of the four constellations visible. Open the panel to see the name of a constellation she will try to find in the sky for this month. For some of the months, not every part of the Star Finder may show a highlighted constellation for you to find. In this case, just try to find the constellation that is nearest to the part of the sky you picked. Or, just find any constellation!

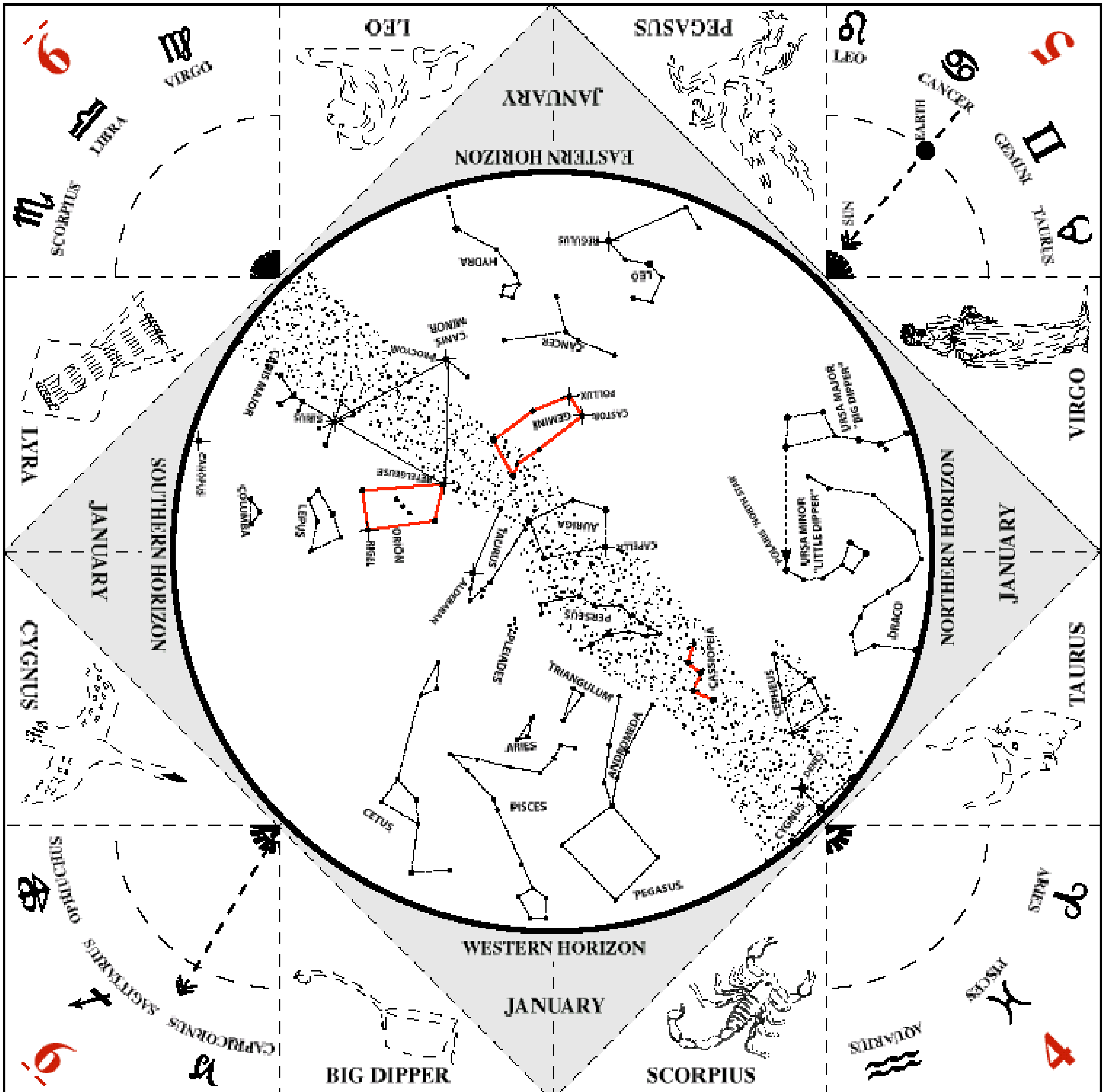
A constellation is group of stars like a dot-to-dot puzzle. If you join the dots--stars, that is--and use lots of imagination, the picture would look like an object, animal, or person. For example, Orion is a group of stars that the Greeks thought looked like a giant hunter with a sword attached to his belt.

Other than making a pattern in Earth's sky, these stars may not be related at all. For example, Alnitak, the star at the left side of Orion's belt, is 817 light years away. (A *light year* is the *distance* light travels in one Earth year, almost 6 trillion miles!) Alnilam, the star in the middle of the belt, is 1340 light years away. And Mintaka at the right side of the belt is 916 light years away. Yet they all appear from Earth to have the same brightness.

Even the closest star is almost unimaginably far away. Because they are so far away, the shapes and positions of the constellations in Earth's sky change very, very slowly. During one human lifetime, they change hardly at all. So, since humans first noticed the night sky they have navigated by the stars. Sailors have steered their ships by the stars. Even the Apollo astronauts going to the Moon had to know how to navigate by the stars in case their navigation instruments failed.

Go to http://spaceplace.jpl.nasa.gov/st6starfinder/st6starfinder.htm for future star finders.

Star Finder



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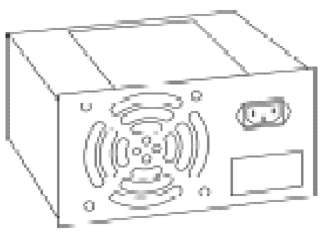
Technology

Computer Guts (G)

This information was taken from a Girl Scouts manual called "Computer Insiders" found at http://www.plugged-in.org/pdf/computer_insiders.pdf.

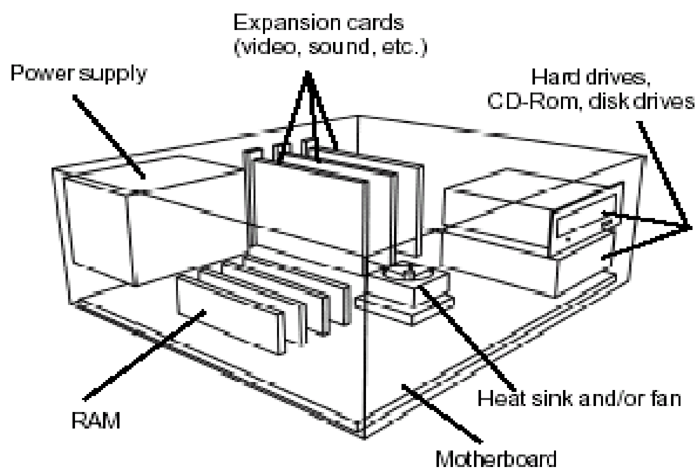


POWER SUPPLY BOX

All computers need electricity to function. The power supply box takes the electricity and supplies it to the motherboard where it can be used by all of the computer's parts. Usually, the power supply box is located near a fan to keep it from overheating and damaging the computer's components.

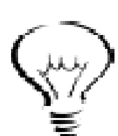
Have the girls find the power supply box by following the power cord into the inside of the computer. (The electrical components are contained inside a box to keep people from accidentally touching something that could give them a shock or damage the computer.)

Do not open the power supply box! Although it's usually easy to open, it isn't safe to do so.

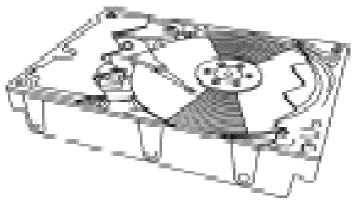


BASIC OLDER COMPUTER MODEL

The arrangement of components inside different models of computers varies to some degree, but this illustration should give you a starting point as you attempt to identify the different parts of the computers you and the girls will be dissecting.



Tip: When working with older, donated computers, you will find each model opens up in a slightly different way, and that no two models look exactly the same on the inside. The main point is that computers aren't magical — they have components that work together to make them operate. Once you've identified the major parts, it is usually pretty simple to locate them in any machine.



HARD DRIVE

The size of your hard drive affects the number and complexity of the computer programs that you can run on your computer. It is another component that is modular and easy to remove and upgrade. The hard drive is hermetically sealed, meaning that no dust can get inside. *Never open up a hard drive on an operational computer.* One speck of dust can make the hard drive unable to store information again. If your hard drive is damaged in any way, you will probably have to replace it.

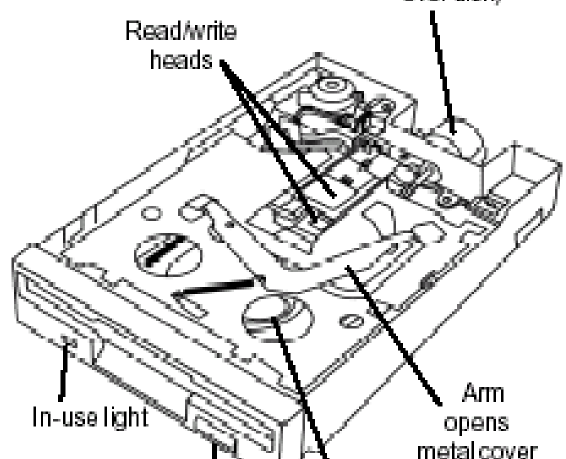
FLOPPY DISK DRIVE

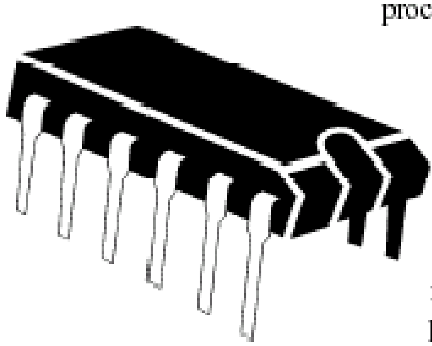
All floppy drives have a light inside that tells the computer what is on the disk and where.

Older drives feature levers that need to be moved to lock disks in place.

Others lock automatically, but feature an eject button.

Feel free to completely disassemble the drive and locate the inner light.





ROM

THE CHIPS

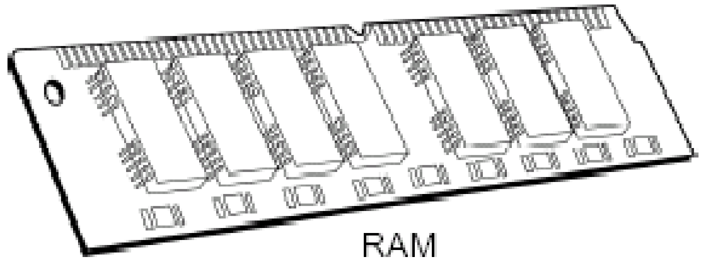
The chips all work together to process information needed by the computer. Each chip is made from a tiny wafer a few tenths of an inch square. The components that comprise the integrated circuit (IC) are etched on the chip, and the entire chip is encased in plastic or a ceramic shell to protect the extremely small circuits inside.

Small pins extend from the shell and connect to tiny wires inside the integrated circuit. These wires fit onto the motherboard. Computers use many different ICs, usually referred to as "chips."

A chip may contain a ranging number of transistors (short for transfer resistors) — anywhere from a few to many millions — that control the flow of electrical current. Chips are complex, delicate, and difficult to manufacture. Factories end up throwing away the majority of all chips manufactured because only a small number actually work properly!

ROM AND RAM

Read-only Memory (better known as ROM) chips have information permanently stored on them that helps computers to start up. ROM helps the computer with basic input and output functions such as the mouse, keyboard, and speakers.



Random Access Memory (RAM) chips are temporary memory. Every time we load and run a program, information is written from the floppy disk or hard drive into RAM.

The computer uses these instructions to run the program. When we are finished using the program and load another program, the old information is replaced with new information. When we turn the computer off, the information stored in RAM is cleared.

RAM capacity (temporary memory) is completely independent of hard drive capacity (storage space).

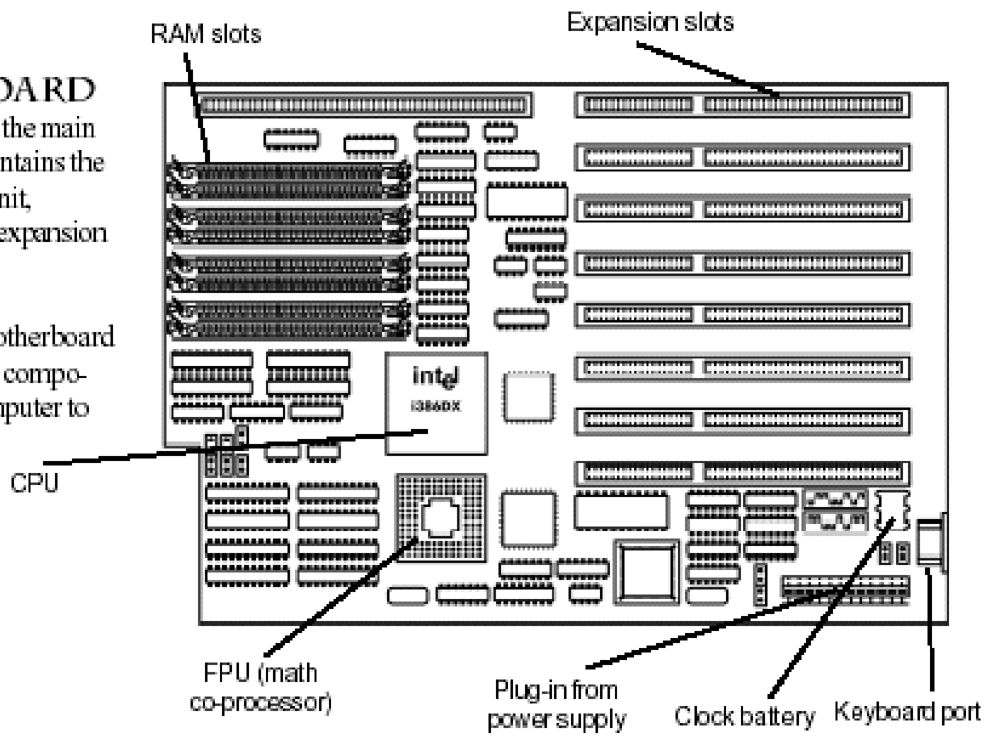
Think of RAM as a book bag that can hold up to three books. Think of the hard drive as a bookshelf with space for up to 15 books. If you added another shelf to double your storage, you could still carry only three books in your book bag.

By the same token, if you increased the size of your book bag, your bookshelf would not be affected. No matter how much space is on your hard drive, the amount of RAM you have doesn't change.

THE MOTHERBOARD

The motherboard is the main circuit board and contains the central processing unit, memory chips, and expansion slots.

The wires on the motherboard connect the various components inside the computer to each other.



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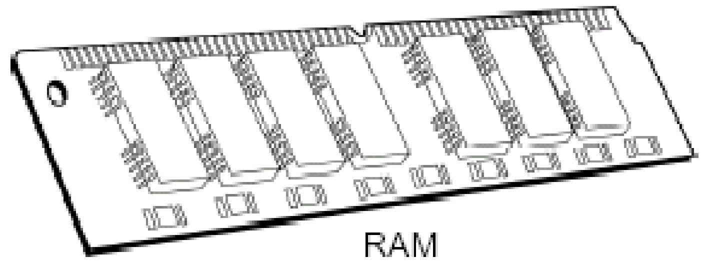

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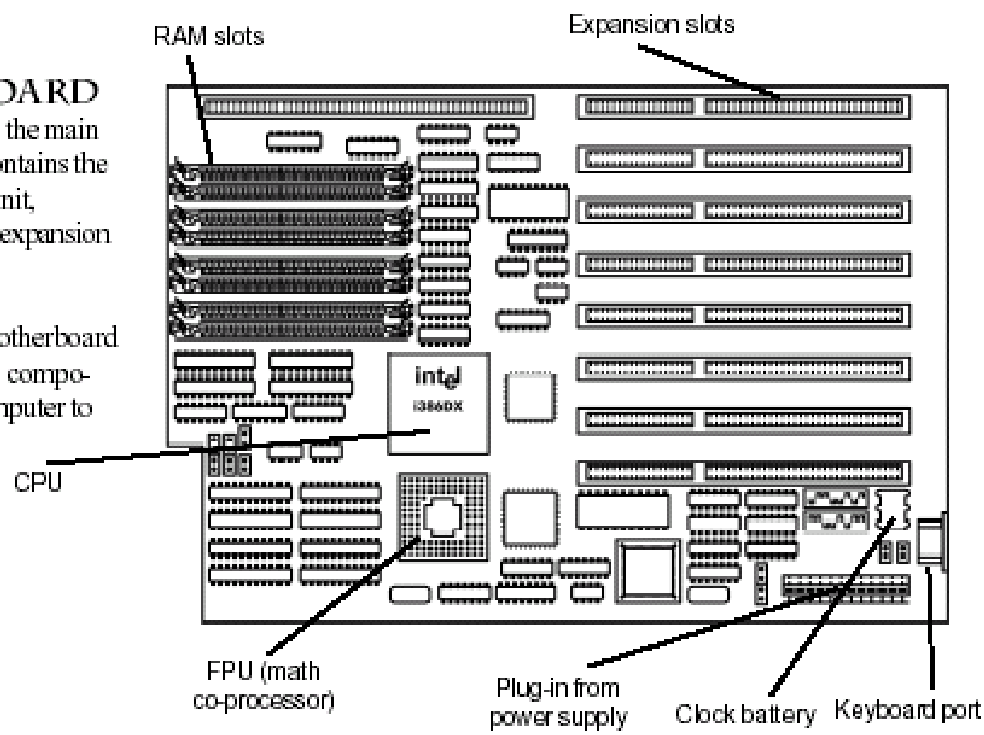
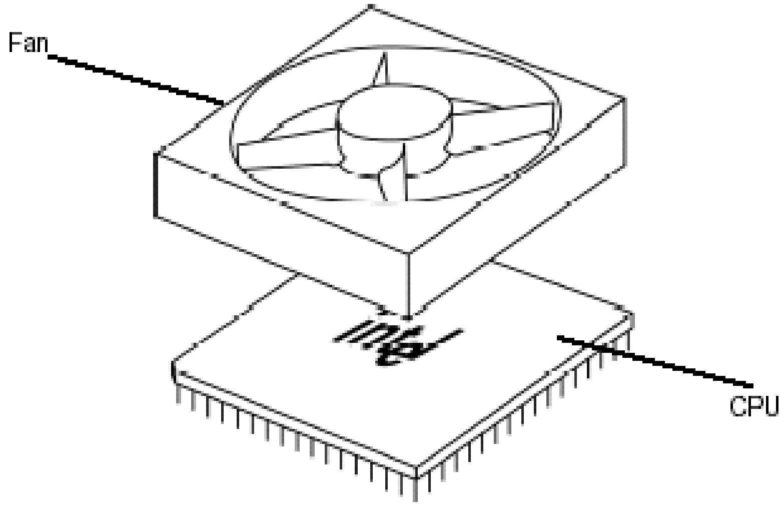


Central Processing Unit (CPU)



The CPU is the largest chip on the motherboard. This chip, also called a microprocessor, is commonly referred to as the "brains" of the computer. The CPU interprets and carries out the instructions of the software and transfers data to and from other components.

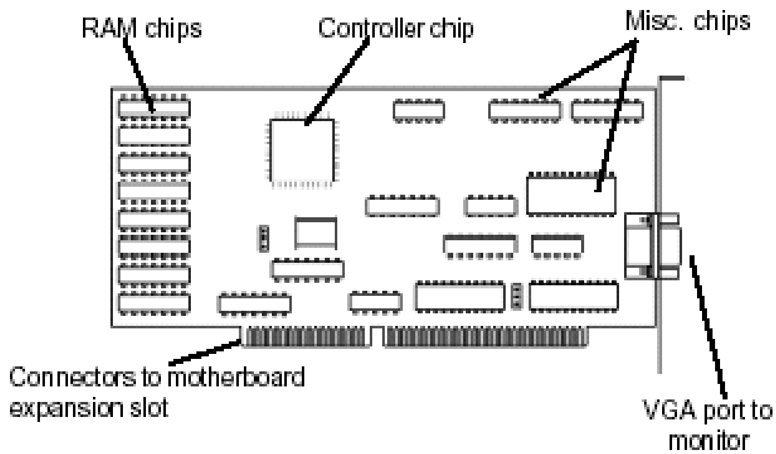
The CPU performs the arithmetical and logic functions required by programs. Without the CPU, the computer wouldn't be able to solve problems. Older microprocessors have different capacities, such as 286, 386, 486, and 586. The higher the number, the more powerful the chip.

Fan

The computer fan is a critical device. The electronics and components generate a lot of heat. Without a fan and a few other heat-control devices, the system would overheat and stop running. In older computers, the fan is located near the power supply box. In newer computers, an additional fan or heat-sink device is located with the CPU.

Computers should be run at temperatures of 80 degrees or less. They can be run at higher temperatures, but must be turned off periodically to allow them to cool.

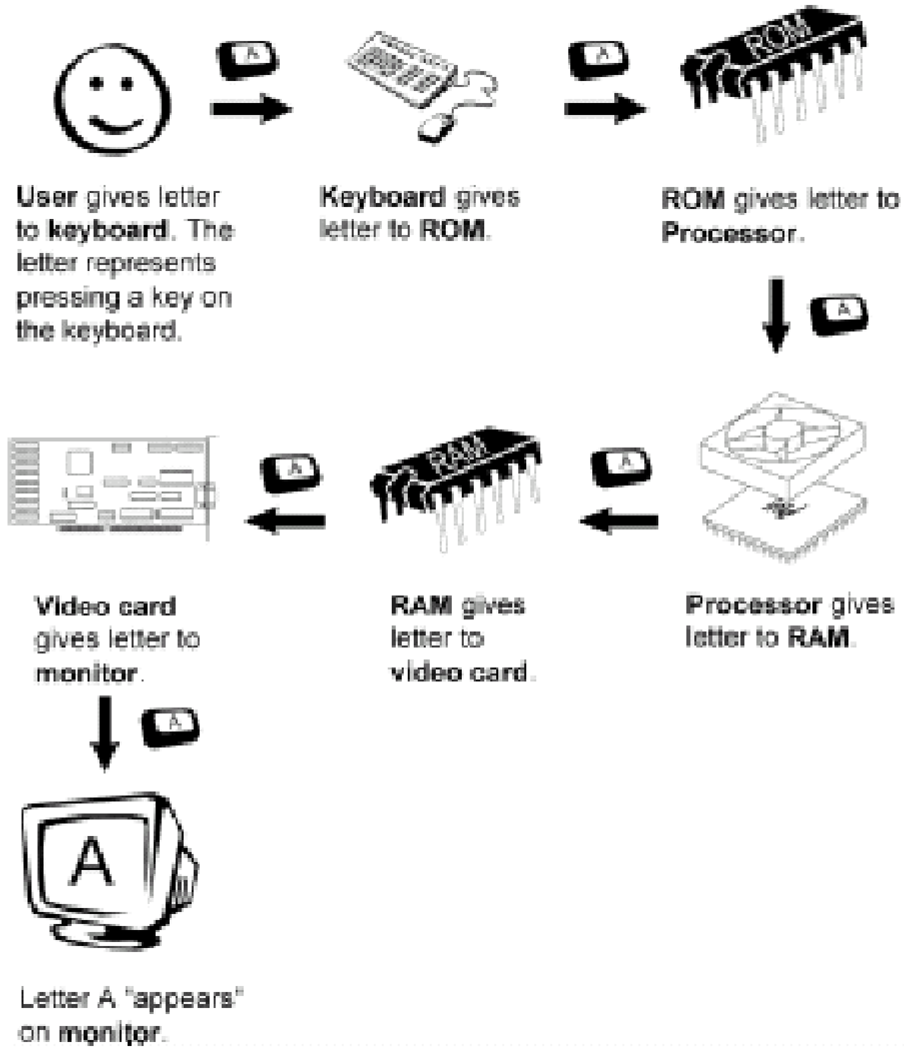
Video and Sound Cards



Computers can be adapted to have extra "abilities" through a piece of equipment called a "card." These cards plug into the motherboard, and they provide computers with the tools needed to do such things as play sounds or digital video.

A video card is required to create the images you see on the monitor. Other cards, such as sound cards, plug into the motherboard and provide connections for speakers, headphones, and microphones. This allows you to do neat "extras" like play and record digital sounds and music.

Most computers sold today come with pre-installed sound and video cards, but many of the computers the girls will be working on might be missing sound cards. Most cards can be upgraded to better, more efficient cards, so it is good for people to understand how to install them. People often pay for card installation; however, once you see how easy it is to install them, you will wonder why more people don't do it themselves!



Program Objectives Covered:

Guides - Computer Skills Badge, part 4

You Go Girl in Technology Challenge

http://www.girlguides.ca/technology/

- Each Challenge level includes activities, background information for leaders and ideas for connecting the Challenge to the Program.
- Each level has basic activities, and one advanced one. There is at least one activity per level that does not require computer access. Girls must participate in at least two activities.
- Activities that require Internet access can be completed in various places, such as a public library, community centre, school library, computer lab or at home with parental supervision.
- Guiders are encouraged to bring in older girls to help. This will encourage mentoring and leadership skills. Besides, young people are often the experts when it comes to technology!
- Many activities have a wide age range, depending on the how much Internet experience the girls have. Check the activities for all the levels, then choose the most appropriate ones for your unit.
- YGGT Challenge crests are available at your local guide store.

Girl Guides of Canada
Guides du Canada

MEDIA AWARENESS NETWORK
RÉSEAU ÉDUCATION MÉDIAS

Activity 24. Cyber-Sense Poem (S, B)

Objective:

After doing this activity girls should understand what personal information is and how to protect their privacy on the Internet.

You'll need:

☑ Cyber-Sense Poem handout (below). No computers are needed for this activity.

1. Copy the Cyber-Sense Poem handout and distribute.
2. Read the poem out loud, and then discuss the following ideas with your unit:
3. Explain what personal information is. Have the girls make a list of examples: name, school, telephone number, parents' names, etc.
4. Talk about the idea of having a secret identity. Has anyone created one when playing a game?
5. Ask the girls if they have ever used the Internet. Have they ever been asked to share information about themselves on a Web site? Are they aware that they should always ask an adult before giving out any personal information online?
6. Explain that a "cybername" should never reveal anything about a person, such as her sex, age or interests. Have the girls come up with some fun cybernames, using the criteria you've discussed.
7. Encourage the girls to take their CyberSense Poem home and discuss it with their parents.

Cyber-Sense

I have a special secret,
Whenever I'm online –
I don't share with others
The things that are just mine.
My e-mail and my home address,
My phone number and name –
These are just for me to know,
On Web sites or in games.

Instead, I use my nonsense name –
It's my online identity!
When people ask me who I am,
I introduce my "cyber-me."
And when I want to surf the Web,
for places that are cool,
I get some help from mom or dad,
or teachers from my school.

Resources

Where to Buy Supplies When You Run Out

Ammonia: When putting the ammonia in the pH experiment containers, please dilute. It doesn't have to be exact but a suggestion is half household ammonia, half water. Please caution the girls to avoid smelling the liquid directly from the container.

Latex Gloves: Any pharmacy will be able to supply you with gloves. We suggest using **non-latex gloves** to avoid allergies.

pH red phenol dye: This is easily purchased at hot tub or pool stores. If one of these stores is not available, check at a local hardware store.

Books

Search your local library and the internet for these excellent books:

Food and the Kitchen: Step-by-step Science Activity Projects from the Smithsonian Institution. Hands-On Science. *Smithsonian Institution.* Milwaukee, WI: G. Stevens, 1993. NAL Call No.: j TX355.F545--1993 ISBN: 0836809556

- Instructions for a variety of experiments and activities involving food, including making cheese, growing vegetables, and testing different foods for fat content.

Foodworks: Over 100 Science Activities and Fascinating Facts That Explore the Magic of Food. *Hendry, Linda,* Ontario Science Centre. Reading, MA: Addison-Wesley Pub. Co. 1987. NAL Call No.: j TX355.F66 ISBN: 0201114704 (paperback.)

- Step-by-step instruction for science projects using household items.

Hocus Pocus Stir and Cook: The Kitchen Science Magic Book *James Lewis* New York: Meadowbrook Press, 1991. 71 pp.

Incredible Edibles: Science You Can Eat! *Susan J. Buckbee, et al.* 1991. 62 pp. Available from the National Convention Center, 80 W. Bowery Street, Suite 201, Akron, Ohio 44308.

The Science Chef : 100 Fun Food Experiments and Recipes for Kids. *D'Amico, Joan, 1957, Karen Eich Drummond, and Tina Cash-Walsh, 1960-* New York : J. Wiley, 1995. 180 p. NAL Call No.: j TX355.D3--1995 ISBN: 047131045X (paperback., alkaline paper)

- Biology, chemistry and nutrition experiments for children.

Websites

http://www.plugged-in.org/index.html (Girl Scout Science and Technology website)

http://publish.uwo.ca/~cagis/ (Canadian Association of Girls in Science)

http://www.cbc4kids.cbc.ca/general/the-lab/links/default.html (lots of cool links)

http://www.ala.org/parentspage/greatsites/science.html (more links)

Appendix

Guide Scavenger Hunt

Set up stations for the girls to earn the Guide Scientist Badge.

- ❑ Station 1: Slippery Stuff!
- ❑ Station 2: Touching the Tent!
- ❑ Station 3: Guess 5 careers from items spread out on the table. List them below.
- ❑ Station 4: Read about 2 women scientists from the information provided. Fill in the lines below with their names and careers.
- ❑ Station 5: Make a poster showing five ways that science and technology affect your life.
- ❑ Station 6: Using Your Nose! Can you identify the 3 things in the bottles with your eyes closed? List them below.
- ❑ Station 7: Make Metal Float!
- ❑ Station 8: Splitting the Smartie!
- ❑ Station 9: Taste Test!
- ❑ Station 10: Mix 'n Match! Please wear safety glasses and gloves.
- ❑ Station 11: Super Structures. How high a tower can you build with 20 pieces of spaghetti and 10 marshmallows?

Station 3: List the 5 careers:

1. ____________________ 4. ____________________

2. ____________________ 5. ____________________

3. ____________________

Station 4: Name two women scientists:

1. ____________________ 2. ____________________

Station 6: Identify the three smells:

1. ____________________ 3. ____________________

2. ____________________

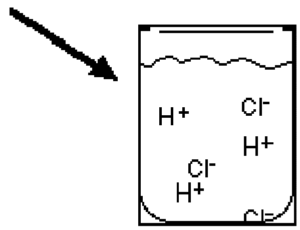
Name: ________________________________

Acids, Bases, and the pH Scale

Acids

Acids are ionic compounds (a compound with a positive or negative charge) that break apart in water to form a hydrogen ion (H^+). The strength of an acid is based on the concentration of H^+ ions in the solution. The more H^+ ions, the stronger the acid.

Example: HCl (Hydrochloric acid) in water:

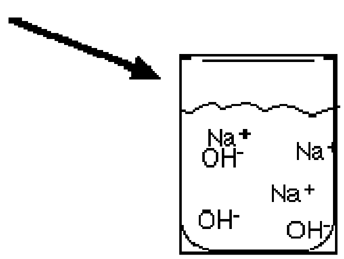


Characteristics of Acids	Examples of Acids
Acids taste sour	Vinegar
Acids react strongly with metals (Zn + HCl)	Stomach Acid (HCl)
Strong acids are dangerous and can burn your skin	Citrus Fruits

Bases

Bases are ionic compounds that break apart to form a negatively charged hydroxide ion (OH^-) in water. The strength of a base is determined by the concentration of hydroxide ions (OH^-). The greater the concentration of OH^- ions, the stronger the base. Solutions containing bases are often called ***alkaline***.

Example: NaOH (Sodium Hydroxide-a strong base) in water:



Characteristics of Bases	**Examples of Bases**
Bases taste bitter	Lye (Sodium Hydroxide)
Bases feel slippery	Ammonia (in glass cleaner)
Strong bases are very dangerous and can burn your skin	Baking Soda (Sodium bicarbonate)

Neutralization Reactions

When acids and bases are added to each other they react to neutralize each other if an equal number of hydrogen and hydroxide ions are present. When this reaction occurs salt and water are formed.

$$HCl + NaOH \rightarrow NaCl + H_2O$$

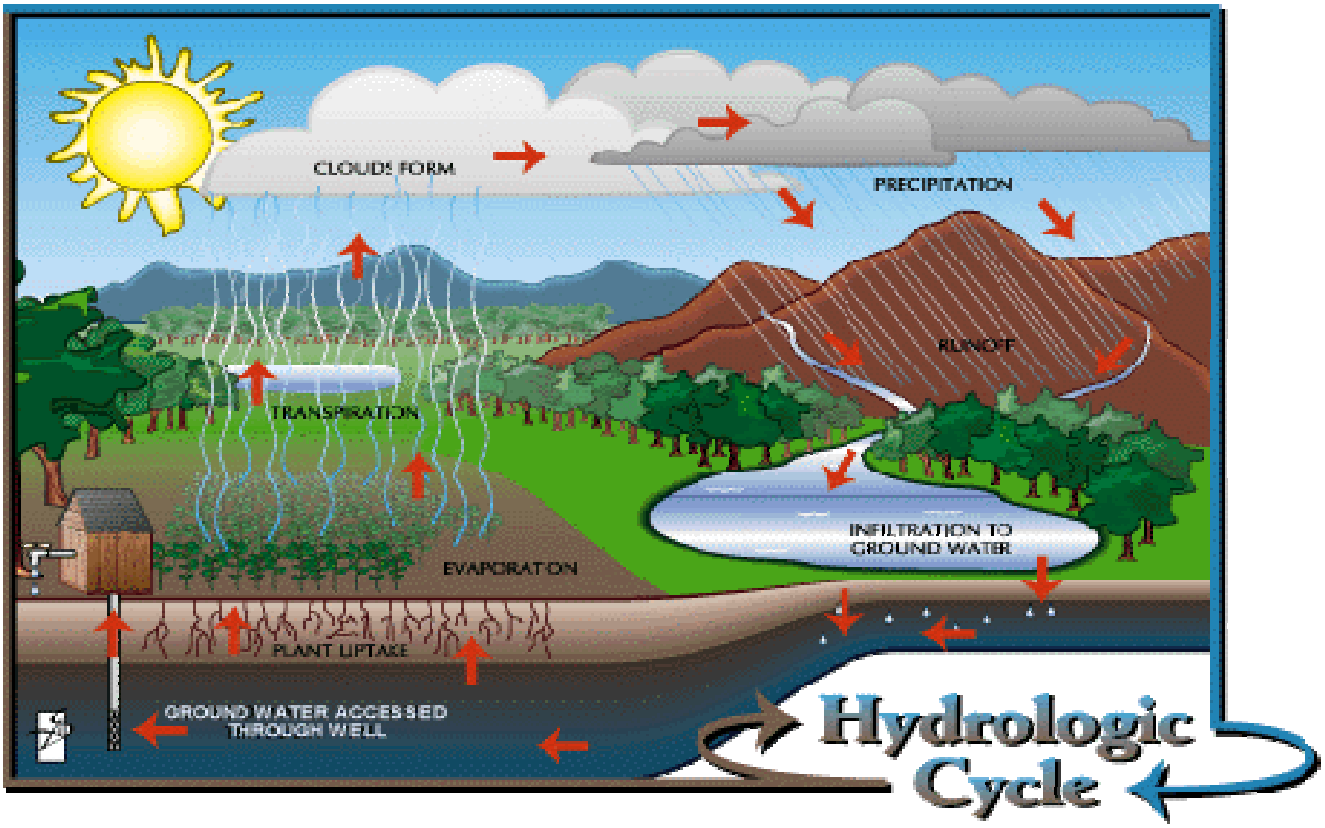
(Acid) (Base) → (Salt) (Water)

pH Scale and Indicators

The strength of an acid or base in a solution is measured on a scale called a pH scale. The pH scale is a measure of the hydrogen ion concentration. It spans from 0 to 14 with the middle point (pH 7) being neutral (neither acidic nor basic). Any pH number **greater than 7** is considered a **base** and any **pH number less than 7** is considered an **acid**. 0 is the strongest acid and 14 is the strongest base.

The Water Cycle

The Water Cycle (also known as the hydrologic cycle) is the journey water takes as it circulates from the land to the sky and back again. The following diagram shows what a water cycle looks like.



The Sun's heat provides energy to evaporate water from the Earth's surface (oceans, lakes, etc.). Plants also lose water to the air (this is called transpiration). The water vapor eventually condenses, forming tiny droplets in clouds. When the clouds meet cool air over land, precipitation (rain, sleet, or snow) is triggered, and water returns to the land (or sea). Some of the precipitation soaks into the ground. Some of the underground water is trapped between rock or clay layers; this is called groundwater. But most of the water flows downhill as runoff (above ground or underground), eventually returning to the seas as slightly salty water.

The earth's water supply remains constant, but man is capable of altering the cycle of that fixed supply. Population increases, rising living standards, and industrial and economic growth have placed greater demands on our natural environment. Our activities can create an imbalance in the hydrologic equation and can affect the quantity and quality of natural water resources available to current and future generations.

Water use by households, industries, and farms has increased. People demand clean water at reasonable costs, yet the amount of fresh water is limited and the easily accessible sources have been developed. As the population increases, so will our need to withdraw more water from rivers, lakes and aquifers, threatening local resources and future water supplies. A larger population will not only use more water but will discharge more wastewater. Domestic, agricultural, and industrial wastes, including the intensive use of pesticides, herbicides and fertilizers, often overload water supplies with hazardous chemicals and bacteria. Also, poor irrigation practices raise soil salinity and evaporation rates. These factors contribute to a reduction in the availability of potable water, putting even greater pressure on existing water resources.

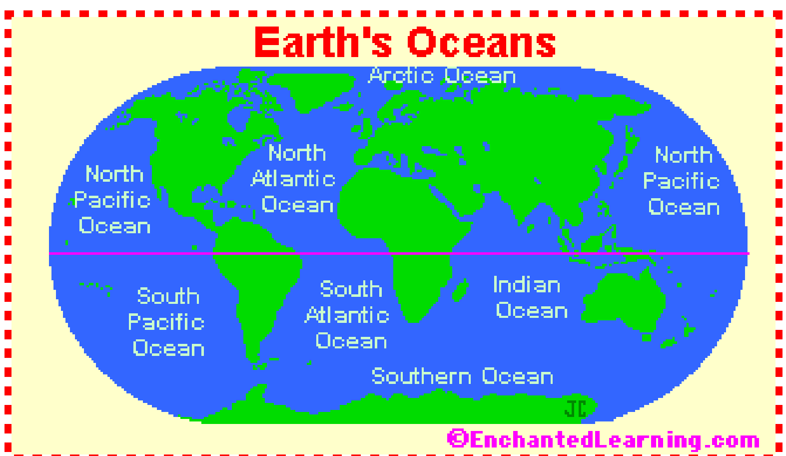
Large cities and urban sprawl particularly affect local climate and hydrology. Urbanization is accompanied by accelerated drainage of water through road drains and city sewer systems, which even increases the magnitude of urban flood events. This alters the rates of infiltration, evaporation, and transpiration that would otherwise occur in a natural setting. The replenishing of ground water aquifers does not occur or occurs at a slower rate.

Together, these various effects determine the amount of water in the system and can result in extremely negative consequences for river watersheds, lake levels, aquifers, and the environment as a whole. Therefore, it is vital to learn about and protect our water resources.

Why Are the Oceans Salty?

As water flows in rivers, it picks up small amounts of mineral salts from the rocks and soil of the river beds. This very-slightly salty water flows into the oceans and seas. Water can only leave the ocean by evaporating (and the freezing of polar ice), but the salt remains dissolved in the ocean - it does not evaporate. So the remaining water gets saltier and saltier as time passes.

Oceans cover about 70% of the Earth's surface and contain roughly 97% of the Earth's water supply.



How Do Clouds Form?

Have you ever seen mist sitting over a lake or field, or steam rising from a hot bath and wondered why it was there? Well, when water vapor hits cooler air, the invisible droplets start clinging together until they become big enough for our eyes to see, but they remain small enough to float in the air. The mist hovering over a lake or field is very much like a cloud in the sky.

Clouds are gatherings of water droplets that have evaporated from the earth. As temperatures cool, more and more droplets gather combine until they are too heavy to keep floating in the cloud. Then they fall from the sky and we have rain. If the air temperature is lower than 0°C, the droplets will keep condensing until they turn into snow.

Groundwater

Groundwater is water that is found underground in cracks and spaces in soil, sand and rocks. The area where water fills these spaces is called the saturated zone. The top of this zone is called the water table. The water table may be deep or shallow: it may be only a foot below the ground's surface or it may be hundreds of feet down. The water table may also rise or fall. Heavy rains or melting snow may cause the water table to rise, or an extended period of dry weather may cause the water table to fall.

Groundwater is stored in—and moves slowly through—layers of soil, sand and rocks called aquifers. Aquifers typically consist of gravel, sand, sandstone, or fractured rock, like limestone. These materials are permeable because they have large connected spaces that allow water to flow through. The speed at which groundwater flows depends on the size of the spaces in the soil or rock and how well the spaces are connected.

Water in aquifers is brought to the surface naturally through a spring or can be discharged into lakes and streams. This water can also be extracted through a well drilled into the aquifer. A well is a pipe in the ground that fills with groundwater. This water then can be brought to the surface by a pump. Shallow wells may go dry if the water table falls below the bottom of the well. Some wells, called artesian wells, do not need a pump because of natural pressures that force the water up and out of the well.

Groundwater supplies are replenished, or recharged, by rain and snow melt. In some areas of the world, people face serious water shortages because groundwater is used faster than it is naturally replenished. In other areas groundwater is polluted by human activities. In areas where material above the aquifer is permeable, pollutants can sink into the groundwater. Groundwater can be polluted by landfills, septic tanks, leaky underground gas tanks, and from overuse of fertilizers and pesticides. If groundwater becomes polluted, it will no longer be safe to drink.

Groundwater is used for drinking water by more than 50% of the people in the United States, including almost everyone who lives in rural areas. The largest use for groundwater is to irrigate crops. It is important for all of us to learn to protect our groundwater.

The Human Body

How Do Humans Keep Cool?

Humans sweat to keep cool. When you get hot, your body releases sweat through tiny holes (pores) on your skin. The sweat then evaporates into the air, taking heat with it and cooling your body.

Fun Fact: Though humans are not the fastest runners, we can run for a much longer period of time than most animals. This is because our bodies sweat to keep from overheating. If we didn't perspire we'd have to rest more often to let our bodies cool down. Of course, we have to drink water if we sweat a lot, or else our bodies will run dry (dehydrate). Have you ever noticed that dogs hang their tongues and pant when they are hot? That's their way of keeping cool: the water on their tongues evaporates. Think of how much cooler they would be if they could evaporate water from their entire bodies like humans can!

Tastebuds

There are only four different types of true tastes: sour, sweet, salt and bitter. Each of these types of receptors binds to a specific structure of a "taste" molecule. Sweet receptors recognize hydroxyl groups (OH) in sugars, sour receptors respond to acids (H+), the metal ions in salts (such as the sodium (Na+) in table salt). Alkaloids trigger the bitter receptors—alkaloids are nitrogen containing bases with complex ring structures which have significant physiological activity. Some examples of alkaloids are nicotine, quinine, morphine, strychnine, and reserpine. Many poisons are alkaloids, and the presence of receptors for the bitter taste at the back of the tongue may help to trigger the vomiting response.

Approximately 80-90% of what we perceive as "taste" actually is due to the sense of smell. Just think about how dull food tastes when you have a head cold or a stuffed up nose. At first you may not be able to tell the specific flavour of the candy, just perhaps a sensation of sweetness or sourness. If you are patient, some may notice that as the candy dissolves they can identify the specific taste. This is because some scent molecules volatilize and travel up to the olfactory organ through a "back door"—that is up a passage at the back of the throat and to the nose. Since we can only taste four different true "tastes", it is actually smell that lets us experience the complex, mouth-watering flavours we associate with our favourite foods

Sense of Smell

The nose is so powerful that it can smell up to 10,000 different odours! It does this with help from many parts hidden deep inside your nasal cavity and head. Up on the roof of the nasal cavity (the hole behind your nose) is the olfactory epithelium (say: ohl-fac-ter-ee eh-pith-eel-ee-um). Olfactory is a fancy word that has to do with smelling. The olfactory epithelium is a tiny patch of nerve cells with microscopic hairs called cilia (say: sill-ee-uh) coming out from the cells. The cilia are covered with special receptors that are sensitive to odour molecules that travel through the air. These receptors are very small - there are at least 10 million of them in your nose! There are at least 20 different kinds of receptors, and each kind has the ability to sense a certain range of odour molecules.

When odour molecules enter your nose, they stimulate the cilia to start producing nerve signals. The nerve signals move along the receptors and travel to the olfactory nerve, which then transmits the signals to the olfactory bulb. This is a spot right underneath the front of your brain at the top of the nasal cavity. The brain's job is to interpret the nerve signals and identify the smell for you.

Identifying smells is your brain's way of telling you about your environment and keeping you safe. Think back to the last time you smelled toast burning. In an instant, your olfactory epithelium and olfactory nerve worked together to get a message to your olfactory bulb. Once your brain unscrambled the nerve impulses, it recognized the smell as a dangerous one, and you knew to check on your toast. Or if you've ever waited too long to change your cat's litter box or clean your hamster's cage, you know that's a pretty icky smell! Your brain unscrambled the smell message and you knew it was time to clean things up.

When your brain sends a message based on a smell, it's because you've trained your brain to recognize a certain smell. The first time you smelled peanut butter, it was a new smell that your brain had to translate. But now your brain can "remember" the smell of peanut butter instantly and let you recognize it every time you get a whiff of a peanut butter and jelly sandwich.

Atronomers

What do Astronomers Do?

Astronomers use physics, mathematics, and computers to learn about the universe, including the sun, moon, planets, stars, and galaxies. They also apply their knowledge to solving problems in navigation and space flight, and to develop instruments and techniques used in observing and collecting astronomical data.

Where Do Astronomers Work?

As the American Astronomical Society points out, some people think astronomy is "hard" to grasp because astronomers don't have laboratories like chemists, biologists, or even paleontologists. Astronomers can't put stars in test tubes. Instead, they study objects located billions of light-years away. There are about 6,000 professional astronomers in North America. The majority of them work in research or teaching positions. Universities, museums, national observatories, and governmental and private research labs are the most common places you will find astronomers.

Astronomers sometimes spend long periods of time in observatories, which are often located in remote locations. They often keep irregular schedules, spending much of their time doing research at night. Some people in the astronomy field work in public service jobs, such as those in planetariums, science museums, or secondary education.

Science in a Box Question and Comment Form

The BC Program Committee wants to hear from you about your experiences with the Science in a Box. Please take a few minutes to send us your feedback! Here is a chance to let us know so that we can include the answers in our "Frequently Asked Questions" section of the Science in Box web link on the BC Girl Guide webpage (www.bc-girlguides.org).

What kinds of questions are the girls asking when you pull out the Science in a Box? What questions do you have yourself?

Please fax this form to BC Council- Program at 714-604-6645 or email to Science in a Box at program@bc-girlguides.org.

Thanks, and we hope you had fun with the box.