Planet Earth Patch

A Joint Project of the Girl Scouts of Central Maryland and the NASA/Goddard Space Flight Center

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Introduction

The best way to come to an understanding of the planet we all call home is to view it from space. From this vantage point we see the land, oceans, clouds and ice caps. If we look closely we can separate the dark areas that are covered with forests from bright areas that are deserts. We can see dust and smoke particles in the atmosphere. If we watch for awhile we can see the movements of the clouds and weather. We can see the daily passage of sunlight and darkness, and we will even begin to see clouds developing in tune with the cycles of day and night.

In fact the planet functions as a single, interconnected system with the land, water, atmosphere, life and energy contributing as important pieces of the whole.

Let's explore this system together by earning a Patch, and while we are working towards the Patch we will learn a little bit about our home, our Planet Earth.

Planet Earth Patch Requirements

Fulfill the required number of activities or skills in each of the 5 areas: (1) Earth System Knowledge (2) Awesome Math and Tech Activities (3) Physics is Phun! (4) Art and Literature (5) Actions. Note carefully the different number of requirements for each age group.

(1) Earth System Knowledge - Brownie Girl Scouts complete activity 1-1. Junior Girl Scouts complete activity 1-1 AND 1-2. Cadette and Senior Girl Scouts complete activity 1-3.

1-1 Make a poster from magazine cut-outs or original drawings that show all the parts of the earth system. Include representatives of the atmosphere, the oceans and the land.

1-2 What is a system? How is the earth a system? Answer these questions after doing at least ONE of the following:
(a) Read the accompanying resource material.
(b) Play the game "A Tangled System"
(c) Play the game "The Water Cycle"
(d) Put on a skit or write an entry in an imaginary journal in which you are an astronaut on the Space Shuttle looking down on the earth below. Use the picture of the earth on the front page of this packet as a guide. Describe what you see and any thoughts that you might have.

1-3: Do some research and learn more about the earth as a system, some environmental issues affecting this planet or some of the techniques scientists use for learning about the earth. Some topic ideas include: climate and climate change, global warming, deforestation or desertification, changing agricultural practices, air-sea interaction, or satellite remote sensing. Present your new knowledge as a written report, as an article or letter in a school or community newspaper, in a presentation to a Girl Scout, school or community group, or by some other significant means.

(2) Awesome Math and Tech - Brownie and Junior complete at least ONE activity of the following activities. 2-1 is most appropriate for Brownie. Cadette and Senior complete TWO activities.

2-1 Learn what "data" means. Learn how to make careful observations. Analyze your data mathematically and graphically. Make a prediction based on your observations and then check to see if your prediction is correct. Some ideas on data collection: Record the temperature as you heat water to a boil. Measure the length and/or angle of a shadow as the afternoon progresses. Make daily weather observations. Record the height of a growing plant.

2-2 Learn how to read a weather map, a topographic map, a ocean chart or a geologic map. Lean how to draw contour lines, how to draw cross sections, and how to visualize a 3 dimensional object from a 2 dimensional drawing.

2-3 Build your own instrument and take readings with it. Calibrate your instrument by taking data at the same time as another already calibrated instrument and comparing the results. Homemade barometers, sundials are easy. More sophisticated are homemade sunphotometers. (*See page 5 for Earth System Knowledge activity description and reference materials.*)

(3) Physics is Phun! - These activities explore the physical concepts important to understanding the earth as a system. Brownie do at least THREE activities in at least TWO of the categories. Junior do at least FOUR activities in at least THREE categories. Cadette and Senior do at least SIX activities in at least FOUR categories, including the one starred in 3-5. If a specific activity falls under two categories you may only do the activity once. (*See page 8 for Physics Phun activity description and reference materials.*)

3-1 Air (There's Air in There!, Heavy Air, Push-Up, Bye-Bye Oxygen)

3-2 Water (Dribble Can)

3-3 Density (Making Things Float, Buoyancy, Water Floats!?)

3-4 Mixing (Mixing & Stirring)

3-5 Vapor/Water/Ice (Melting/Boiling*, Preventing Hypothermia Activity #1)

3-6 Optics (Particle Man, Spinning tops)

3-7 Energy absorption (Ice Party, Absorbing Jars)

3-8 Greenhouse effect: (Making a Greenhouse)

3-9 Heat (Preventing Hypothermia, Heat currents)

3-10 Land/Water (Fresh water)

(4) Arts and Literature - All age groups do at least ONE of the following.

4-1 Read a book, fiction or nonfiction, in which you learn about the earth's atmosphere, oceans or land areas. (Cadette and Senior, this must be in addition to 1-3).

4-2 Write a story or poem or draw a picture or make photography or do some other artwork that describes the earth as a system of land, oceans and atmosphere. (Brownie and Junior, this must be in addition to 1-1).

(5) Actions – All age groups, do at least ONE of the following.

5-1 Visit a center where the earth's atmosphere, oceans or land is studied. Examples are a science center, aquarium, university or government laboratory. Talk with a scientist or educational aide at the center. Find out what part of the earth's system is studied at the center, what types of people work there, what technology do they use and what interesting new things have they learned.

5-2 Make a virtual visit using the internet to explore the following site: http://earthobservatory.nasa.gov/

Junior and older should enter the experiments section and do at least one of the activities. Report back on something you learned while exploring the site.

5-3 Make an appointment and speak to someone whose career is connected to earth system science. Find out everything you can about what this person does. If possible watch them at work.

5-4 Participate in collecting data for a real ongoing scientific project. Follow instructions carefully so that your data is useful. Turn the data over to the scientist or team leader. Ask for copies of the results so that you can see how your work fits into the larger picture.

Resource Materials for: Earth System Knowledge

1-2 What is a system? How is the earth a system?

A System is a combination of parts that work together as a unit to do something.

Your car is a system. The engine makes the wheels turn. The tires on the wheels grab the pavement to move the car forward. The brakes slow or stop the car. Each part does its own job. Altogether the different parts make a complete system.

An orchestra is a system. Your body is a system. Your Girl Scout troop works as a system.

Your home is a system. The house or apartment you live in provides shelter from the weather. Water, electricity and heating fuel enter into the system through pipes or deliveries. Waste water passes out through pipes and exits the system. You and your family are part of the home system too. You use the water and energy. Your family repairs the house and things in the house when something breaks. Your family helps each other, with household tasks, with homework, by driving you to your activities, by talking through problems. Each part of your home does its own job. The different parts work together to complete the system.

The earth is a system much like your home. It is a very complex system with many different parts. Water gathers in the oceans, but is then evaporated, condenses into clouds, falls back down as rain and returns to the ocean. The water can sink into the soil, be absorbed by plant roots, and enter into plant leaves. In the leaves the water dissolves the chemicals that make the leaves appear green and work to turn sunlight into food in the plant. On its journey the water enters into or affects many different parts of the earth system: the oceans, the atmosphere, the land, the sunlight and living things. *The earth is a system because it is made up of many different parts, but the parts work together to make up a single unit.*

Some Games For Teaching

(1) A Tangled System

Assign a role to each girl: Oxygen, ocean, wind, sun, dolphin, cloud, rain, tree, pollen. (These are only examples.) Have the girls stand in a circle facing towards the center.
One girl starts. Let's say "oxygen." She says, "I'm oxygen and a dolphin needs me to breathe." Then she reaches in and takes the hand of the girl who is "dolphin." The girls remain more or less in the same place in the circle so that their arms criss-cross the circle.

Then "dolphin" says, "I'm dolphin and I swim in the ocean." "Dolphin reaches in with her free hand and takes the hand of "ocean."

"Ocean" says, "I'm ocean and wind makes waves at my top." She reaches across the circle with her free hand (still holding hands with dolphin) to take the hand of "wind."

"Wind" says, "I'm wind and I move pollen from flower to flower." She takes "pollen's" hand.

"Pollen says, "I'm pollen and I'm blown into a blossom on a tree." She takes "tree's " hand. The girls should be making an interlocking knot with their hands joined. Some hands will have to pass through other girls' arms. It should start to look like a complete mess. Keep going.

Tree says, "I'm tree and I need the rain to grow."
"I'm rain and I fall from a cloud."
"I'm cloud and who's left. Oh, sun. Oh I don't know. I'm cloud and I block the sun which keeps things cooler on the ground."
"I'm sun and I have to connect back to oxygen. Oh, oxygen absorbs some of my energy as sunlight passes through the atmosphere."

Sun then takes oxygen's free hand and the knot is complete. Every girl should be connected to two other girls and only two other girls. Now without dropping hands, untangle the knot. Do this by passing under and stepping over other girls' arms.

Eventually you will recover a full circle, maybe with some girls facing inwards and some outwards. Sometimes you end up with two independent circles.

The point is to teach the complexity of the earth system and the interconnectedness of the different parts. There is no single path to connect all the different pieces. Oxygen could just as easily made her first connection to wind. "I'm oxygen and when the wind blows, I move with the air." Or to tree (Trees give off oxygen). Or to ocean (you can find me in the ocean).

Hint: You may want to think through several connections before you present this to the group so that you can prompt the girls with ideas. For younger girls and for older ones to get started, you may want to narrate a text rather than prompting the girls to make their own decisions. By Junior level, the girls should be able to play at least one round making their own decision on who to reach to in order to make a connection. Below are some lists of roles. These are just ideas. There are many, many others.

Hurricane, ocean, sun, cloud, rain, wind, wave, soil, fish, plankton, grass.
Corn, river, water vapor, farmer, cow, water, lighting, salt, erosion, pollution.
Desert, algae, mountain, snow, volcano, gases, tornado, drought, flood, fires.

(2) The Water Cycle

For this you need to make card board signs (about 8x11" in size) in advance. You need one sign for every participant. The signs are: oceans, evaporation, water vapor, condenses, water cloud, freeze, ice cloud, snow, rain, melts, streams, rivers, lakes, ground water, roots, stems, leaves. Write the word and draw a symbolic picture on each sign.

Hand out the signs so that every girl has one. Explain the definitions so that every body understands what they are holding. If you are uncomfortable with any of the above words, then just don't use that word.

Now tell the story of the water cycle. When you mention the word on the sign that girl stands up with her sign until the next word is mentioned and a new girl stands up. Sometimes a girl's word appears more than once in the story. Tell the story at least twice, switching signs so the girls have to listen for different words each time.

The Water Cycle story. We start with the *oceans*. The sun warms the ocean and causes *evaporation*. Evaporation is when liquid water becomes *water vapor*. Water vapor is a gas. You can't see it like you can't see air, but it is there in the atmosphere. The water vapor rises into the sky and as it goes up, it cools. When it cools enough it *condenses*. This means *water vapor* turns back into liquid water. Now the liquid water is in the form of small droplets high in the atmosphere. This is called a *water cloud*. If the water cloud continues to rise in the sky, it gets even colder and the water droplets *freeze*. Freezing is when liquid turns to solid. The cloud is now an *ice cloud* made up of tiny ice particles. If the particles become heavy enough they fall as *snow*. If the droplets in a *water cloud* become too heavy they fall as *rain*. When the weather warms up, the *snow* on the ground *melts*. Melting is when solid turns to liquid. The liquid water from the *snow* joins the water from the *rain* and becomes a *stream*. Streams run together and become *rivers*. Sometimes rivers flow into *lakes*. Some water seeps down into the soil and becomes *ground water*. A plant *root* reaches out to the *ground water* and takes up some of this water. The water moves from the plant *root* to the plant *stem* and into the plant *leaves*. In the leaves some of the water is used by the plant to make food. The sun warms the leaves and causes *evaporation,* turning the liquid into *water vapor*. The water vapor escapes from the leaves and rises into the atmosphere again to become *water clouds*, *ice clouds*, *snow* and *rain* again. Some of the water in the *lakes* and *rivers* doesn't go into the soil and doesn't get taken up by plants. Instead it flows down back to the *ocean* where we can once again start the story.

The point here is that the water cycle is an important piece of the earth system that takes place in the oceans, the atmosphere, on the land and within living things.

(3) Mousetrap

The board game *Mousetrap* is a wonderful example of a system. I find the game itself to be tedious, but constructing the mousetrap is a fun activity for groups of 3-4 girls.

Resource Materials for: Physics is Phun.

Demonstrations and Experiments that explore the physical concepts behind understanding the earth as a system.

3-1 Air

(a) There's Air in There! is described on the PUMAS printout (**See page 10**). I've never missed with this activity. However, I've had reports of failure from other people who have tried. Don't scrunch up the wad of newspaper too tightly. It should gently fill the entrance of the bottle.

(b) Heavy Air. You need a flat table, a full sheet of newspaper, and a thin, flat wooden stick at least 3 ft long. I'm thinking of sticks or slats resembling the old flimsy wooden yardsticks of my childhood. We were not able to get this to work outside on a picnic table, but it worked fine inside.

Place the stick on the table so that 2/3 is on the table and 1/3 is hanging off the edge of the table. Lay the unfolded sheet of newspaper on the table, covering the part of the stick on the table. No parts of the newspaper should hang over the table's edge. Carefully smooth down the newspaper. You don't want air pockets between the newspaper and the table. Air pockets will ruin this demonstration.

When you are satisfied that the newspaper is smooth. Stand near the piece of stick hanging off the edge of the table. With one, swift, downward stroke, hit the end of the stick. Hit it hard. Think karate chop.

What should happen? The stick should break.

Why? Isn't the newspaper lightweight? Shouldn't the stick act as a lever and your downward stroke send the newspaper flying? No. Because even though the paper is light weight you still have to lift **all that air that is sitting on top of the newspaper**. Air is heavy. It has mass and takes up space. It presses downward onto the newspaper.

How much does it weigh? About 20,000 pounds.

Yikes! Why aren't we all crushed under all that air? Because it doesn't just push downward like a solid weight. Air is a gas so that it is pushing in all directions simultaneously. Pressure acts in all directions equally, not just downward. The air around us is also pushing upward with the same force. The downward force and the upward force cancel.

If you had left air pockets between the newspaper and the table, those air pockets would be pushing upwards with sufficient force to cancel the downward force, and your stick would not have broken.

(c) Push-Up. You need a drinking glass, some water and an index card large enough to cover the entire mouth of the glass. *Adapted from Hann (1991).*

You can prove that air pressure pushes upward as well as down with this demonstration. Fill the glass to the brim with water, and carefully slide the index card over the top. Keep your hand pressed on the card, turn the glass upside down. Take your hand away. If the seal is air tight, meaning that if you haven't left air bubbles between the surface of the water and the card, then the card should stay in place, held up by air pressure. (Yes, there is an adhesion factor with the water also, but most of the explanation is due to air pressure.)

(d) Bye-Bye Oxygen You need a candle, a large glass jar, a shallow pan of water and matches. I use a wide candle that can stand by itself and a 9" cake pan.

Put the candle in the center of the pan. Make sure the pan is about 3/4 full of water and the candle is at least 2-3" above the water line. Light the candle. Let it burn for a minute. Place the jar over the candle, leaving some space for water to flow from the surrounding pan into the upside down jar.

You will notice two things. The candle's flame will go out, and the water will rise in the jar. The water level in the jar will be higher than the water level in the pan.

Why? Fire needs three things to burn: heat, fuel and oxygen. The flame uses up the oxygen in the jar. When all the oxygen is used up the flame goes out. The water rises in the jar to take the place of the oxygen that was consumed. Notice the water has risen about 1/5 of the way up the jar because air is made up of roughly 4/5 nitrogen and 1/5 oxygen.

There's Air in There!

From: The PUMAS Collection http://pumas.jpl.nasa.gov

Concept: Air pressure. Air has mass and takes up space. This is sometimes a difficult concept for kids to really understand.

Materials: 20 oz, preferably long-necked soda bottle; 1 inch square newspaper wadded up into a ball; some drinking straws.

Physical Set-up: Put soda bottle horizontally on table in front of class. Place wadded-up newspaper in mouth of bottle. Paper should be just inside bottle neck but close to opening.

Patter: Step right up! Step right up! Who can blow the paper into the bottle? How about you, young woman? (pick a student from the audience). Without touching the bottle or paper, go ahead and blow the paper into the bottle. (She blows hard and the paper ball blows right back into her face. You will probably have to hold the bottle in place.) I said, INTO the bottle, not OUT of the bottle! Next! (Choose another student. Set it up again. Hold the bottle and have him or her blow. The paper ball will come back OUTSIDE the bottle.) What's wrong with you people? Can't you do a simple thing and get the paper INTO the bottle? Next!

Experience: The students will begin to try different angles and different amounts of pressure. Some will be able to blow the paper without it coming out of the bottle, but none will be able to blow it in. Some will want to put their lips on the bottle mouth. You may want to discourage this for sanitary reasons, but physically it won't make a difference. Sometimes I take the paper wad outside the bottle and blow it across the table just to demonstrate the yes, my breath CAN move the paper. **Caution:** This demonstration (like ALL demonstrations) should be practiced at home before introducing it into the classroom. There may be difficulties associated with the size and shape of the bottle and/or paper wad.

Physics: There is no room in the bottle for the blown air from the students' breath because the bottle is already filled with air. Air coming from the students' mouths just rebounds from meeting the air already in the bottle. The paper wad is simply a tracer for the air stream coming from the students' mouths.
Solutions: 1) Some students will suggest putting a hole at the back of the bottle. Yes, this would work because it permits the bottle air to leave and make room for the blown air.
2) Another solution involves changing the way **The Straw** is used: Let several students try with a straw. Most will keep BLOWING air into the bottle. This will not work. Finally, someone will solve the problem. Stick the straw into the bottle without disturbing the paper wad and SUCK air out. The paper will jump inside the bottle. You've removed air with the straw and created room inside the bottle for outside air carrying the paper wad to enter.

3-2 Water

(a) <u>Dribble Can</u> You need 2 large empty cans or 2 2-quart plastic soda bottles. If you are using soda bottles cut off the top of the bottle with scissors. With one can or bottle use a nail to punch three holes in the vertical at three different levels. With the other can or bottle punch three holes around the can in the horizontal so that all three holes are at the same level.

Place one of the cans or bottles in a dish or basin, or do the experiment outside where you don't mind water running onto the ground. Pour water all the way to the top of the can or bottle and watch the water drain out of the holes. Repeat using the other can or bottle.

What should you see? In the can with horizontal holes, all at the same level the water should push out evenly all around. In the can with the vertical holes, all at different levels, the water at the top hole will just dribble out while the hole at the bottom will have the longest, most vigorous jet of water.

Why? The pressure at each level in the can depends on the weight of the water above it. The greatest pressure is at the bottom of the can. The least pressure at the top. The pressure creates the force that pushes the water out the holes.

3-3 Density = Weight/Volume

(a) Making things float You will need a basin 3/4 full with water and modeling clay. *Adapted from Hann (1991).*

Make a mark on the basin showing the water level. Now make a compact ball with the clay. Drop it gently into the water so that you don't lose any water from the basin. The ball sinks because it is denser than water. Note where the water line is now. The water has risen because the ball displaces its own volume of water.

Now take the ball and reshape it into a boat with tall sides, like a canoe. You are increasing the volume of the object. Drop it gently into the water. This time the clay floats. Note the water level. It should be higher than the time with the ball. The higher water level indicates that a greater volume of water is displaced by the combination of the boat and the air that the boat contains.

Increasing the volume for the same amount of material decreases the material's density.

Now take your boat and smash it back into a ball. Cut the ball in half and gently drop it into the basin. It sinks, even though it weighs less than the first ball or the boat. Note the water level. So the volume is less than in the previous attempts. Even though the weight decreases, the volume decreases also. This gives you the same density as when you started.

Decreasing weight is not the same as decreasing density, if the volume decreases at the same time.

(b) Buoyancy You will need a kitchen scale, a large glass jar, a small floating object, a rectangular baking pan, a cup and water. Not recommended for Brownies. *Adapted from Hann (1991).*

Put the scale in the baking pan. With nothing on the scale, adjust the needle so that it reads zero, or making note of what the zero reading should be. Put the glass jar on the scale and fill it to the brim with water. Write down the weight of the jar with water.

Gently drop the floating object into the water. Some water will spill out. That's okay. Write down the weight registered by the scale.

Carefully lift the jar off the scale and take the floater out. Take the scale out of the baking pan. Pour the water from the baking pan into a cup. Weigh the floating object. Weigh the cup with the displaced water. Spill the water back into the pan and weigh the empty cup.

You should have these numbers written down:

1) Weight of empty scale:
2) Weight of jar full of water
3) Weight of jar, water and floater
4) Weight of dry floater
5) Weight of cup with displaced water
6) Weight of empty cup.

If everything went right, (2) = (3). And (4)=(5)-(6). The upthrust of the water is equal to the weight of the object. That is why the object floats.

(c) <u>Water Floats!?</u> You need a tall glass or glass jar, syrup, glycerol, water colored with red food coloring, olive oil, rubbing alcohol colored with blue food coloring. *Adapted from Hann (1991).* A simplified approach would be syrup, water and oil to give three layers.

Trickle in the liquids slowly by dribbling them down the side of the glass. Wait for each one to settle before adding the next. Go in this order: syrup, glycerol, water, oil, rubbing alcohol. The one on top is the least dense. The one on bottom is the most dense.

But isn't density = weight/volume? These liquids don't have volumes, how can they have density? For liquids and gases we calculate density for a standard volume like square centimeter or square inch. The alcohol has the least weight per square centimeter. The syrup has the most weight per square centimeter. The syrup is the most dense and stays on the bottom of the stack.

Try slowly stirring the layers with a spoon or pencil. Can you get the layers to mix? After mixing if you leave the mixture alone for awhile the layers should separate again.

Did you notice any waves passing through the layer boundaries? The ocean and the atmosphere are two different fluids of different densities. The ocean always stays below the atmosphere because it is denser. At the boundary between the ocean and atmosphere we often see waves. Within the ocean itself we find water of different densities due to differences in temperature and salt content. Often waves form at these internal boundaries in the ocean even though we can't see them like we can at the ocean's surface. <u>You can't have waves without a density difference between two fluids!</u>

3-4 Mixing

(a) <u>Mixing & Stirring</u> is described by the PUMAS printout (**See page 13**).

Mixing and Stirring

From: The PUMAS Collection http://pumas.jpl.nasa.gov

Concept: Combining two fluids (confluence of two rivers, Mediterranean water spilling over the straits of Gibraltar into the Atlantic) involves two processes: (1) stirring -- stretching of the bulk fluid, and (2) mixing -- exchange of materials on the molecular level (diffusion).

Materials: Dancing music (optional), Milk, chocolate milk, several shallow pie pans and spoons, cups for all...

Dancing Molecules: Move the desks so that you have a large, uncluttered area someplace in the room. Have all the students stand in this area. Divide into two teams. Have each team cluster together. Inform the students that each one of them has been transformed into a milk molecule and that all molecules dance. Class starts dancing! (The dancing simulates the natural movement of molecules in a fluid -- vibrating, rotating and translation.) Music helps. After a short time, stop the dance and examine the two groups. If they were clustered together in the beginning, there shouldn't be too much mixing of groups. Now do some stirring. Have each team hold hands. Take the two team leaders and walk them around the open space in the room. Because they are holding hands the clusters should spread out as you move the team leaders. Make the two chains of students parallel to each other, in some kind of serpentine figure. OK, class, drop hands and start dancing! After a short time, this time you shouldn't be able to tell who belongs to which team. The fluids have mixed.

Chocolate Milk: Let's mix some fluids! Divide the class into groups of about 4 with each group in possession of a pie pan and a spoon. Pour equal amounts of chocolate and regular milk into the pie pans so that there is roughly 1/4 to 1/2 inch of combined milk in each pan. Pour gently so that you have a blob of chocolate milk residing in the white milk (or vice versa). Ask the question: Do the fluids mix? NO! Gently take the spoon and draw it through the milks. Do this several times. You will start to get long strings of different colored milk. Have the fluids mixed? NO! Play with the milks for awhile. You can make some very pretty patterns with the strands of different colored milks getting thinner and thinner. As long as you can discriminate between the different colors, the fluids have not mixed. Eventually stir with more vigor and the fluids will mix. Then I always celebrate by passing out a sample of chocolate milk to all the students.

Physics: Molecular motions of molecules permit very little exchange between two neighboring fluids. Two rivers can flow together for miles, side by side, and not mix properties. Blobs of Mediterranean water can be traced, unmixed, in the Atlantic for years. Eventually, molecular diffusion will mix two fluids, but it has a very long time scale. Turbulent stirring stretches the two fluids and increases the amount of contact between the fluids. This permits mixing to occur much more quickly because molecular diffusion is randomly exchanging molecules in many more places (the surface where the two fluids touch has a larger area). **Stirring without diffusion is NOT mixing and CAN be reversed.** This would correspond to not permitting the student chains to drop hands and dance. Without the molecular mixing (dancing), you could just reverse your steps with the team leaders and package each team back up as separate clusters. You need both: the stretching of the fluids to increase contact area

AND the irreversible exchange of materials on the molecular level. With the milks, you have to make the strands so thin that the distance of molecular movement is on the same scale as the strand width. If you had stopped stirring during one of the pretty patterns, after several hours you would notice that the thinnest strands might have disappeared. If you pour milk into hot coffee, you may notice the edges of the milk blob getting fuzzy before you stir. That's the molecular mixing at work. It goes faster than the milks because of the temperature. Hot molecules move faster. Still in coffee, you have to stretch out the milk blob by stirring in order to get the fluids to mix. So coffee has its advantages, but chocolate milk goes over much better with kids.

Note on ages: The material is appropriate for grades 6-8, although I've done this with slightly younger kids as well. I'm not sure how much the younger kids really understand (but they do like the chocolate milk!). Sometimes the 6-8th graders are too shy to dance. Eventually, with enough encouragement and by personal example, I get them up and moving.

Note to teachers: The concept of diffusion is difficult. The paragraph above may not be enough information for you to feel completely comfortable in introducing the concept to your students. Supplemental reference material can be found in books on oceanography (look under Mixing in the index), basic physics texts and Encyclopedias (look under Diffusion, Fluids and Fluid Mechanics or Fluid Dynamics and possibly Oceanography). A really nice example comes from oceanography with Gulf Stream meanders and rings. Two fluids are attempting to mix and the result looks a lot like chocolate milk mixing when viewed from space. Oceanography books often show these satellite images.

3-5 Vapor/Water/Ice

(a) Melting/Boiling. You need a pot, a heat source such as a stove, a thermometer with a wide temperature range of 20^{0}F (less than 0^{0}C) to 225^{0}F (over 100^{0}C), 2 cups of ice cubes and a watch that has seconds. Not recommended for Brownies.

Put the ice in the pot. Put the thermometer in between the ice cubes in the pot. Let it stabilize for about a minute. Record the temperature. Start heating the ice. Read and write down the temperature every 30 seconds.

Watch for signs that the ice is melting. Write down the time that you start to see water in the pan. Write down the time when the last of the ice has melted. Keep recording the temperature every 30 seconds.

Now that it is water, watch for signs that the water is changing to vapor. Write down the time that you start to see little bubbles in the water. Write down the time when you get a rolling boil. Keep recording the temperature until you have 5 recordings after the start of the rolling boil.

Now look at your numbers. At what temperature does ice melt? At what temperature does water boil?

Try plotting your numbers with time along the bottom axis and temperature along the side axis. Draw lines to connect the dots on your graph and put arrows to indicated first sign of water, last of the water, first sign of small bubbles, and rolling boil.

During the time when you have only water in the pot the temperature should increase quickly with time. All of your energy is going into heating the water. However, when you have a phase change either ice into water or water into vapor, then your temperature stays almost constant in time. All of your energy is going into making the phase change and nothing goes into changing the temperature!

You have to put energy into liquid water in order to change it to vapor. You get that energy back when the vapor condenses back to liquid. Water vapor represents a higher energy level than liquid, which in turn represents a higher energy level than ice.

The heat that goes into making a phase change is very important in the atmospheres and oceans. The sun puts energy into surface water changing liquid to vapor. The vapor rises carrying that heat inside. Higher in the atmosphere the vapor cools and then condenses back into liquid water droplets and forms a cloud. When it condenses it releases the heat back into the environment. The extra energy released up high contributes to making the cloud. Thus cloud formation is a self-perpetuating process in which the energy released by the phase change plays a key role.

(b) Preventing Hypothermia Activity #1 is described in the PUMAS printout **(Page 22)**.

3-6 Optics

(a) Particle Man is described in the PUMAS printout **(Page 17)**. Concentrate on Step 2. You can use a flashlight instead of a projector.

(b) Spinning tops. You will need white cardboard, scissors, water based paints (red, orange, yellow, violet, green, indigo, cobalt blue), paint brushes, sharpened pencil stubs, and waxed paper. *Adapted from Hann (1991).*

Cut out a 4-6" disk from the white cardboard. Divide it into sectors and paint each sector a different color. Make a hole in the center of the disk to fit the pencil. Push the pencil through the hole. Spin the wheel on the pointed end of the pencil.

If you divide into 7 equal sectors and paint each sector a different color from the list above, and if your paint colors were pure, then the colors will disappear and the disk should appear gray or maybe white if you are lucky.

But it is interesting to see what different combinations of colors become when blended. Try a disk with equal parts red and green. Try another one with equal parts green and blue. Try one with equal parts yellow and blue.

Next try mixing the paint pigments together on the wax paper. Try equal amounts of all the colors and any combinations used on the spinning disks. How do the mixtures of the paints themselves differ from the mixtures seen on the spinning disks?

All of our lives we have been mixing paints or pigments so we have an intuitive feeling that mixing blue and yellow makes green, mixing all the colors makes black, etc. However, pigments work by absorbing colors, while the spinning disk represents the blending of light itself in your eye with no absorption. Blue pigment means all colors except blue are absorbed. Red pigment means all colors except red are absorbed. So if you mix all pigment colors together you end up absorbing all colors of light. The mixture becomes darker and darker until no light is left, and you achieve black. This is very different from adding all the colors of light in which the mixture becomes brighter and brighter until you achieve white light.

In using satellites to study the earth we make use of the different colors of light to see different things on the earth. Especially useful are the "colors" of light that we cannot see with the human eye.

Particle Man and the Photon

From: The PUMAS Collection http://pumas.jpl.nasa.gov

Concept: When a photon (a very small increment of light energy) encounters a substance one of three things may happen. (1) The photon may be *transmitted* -- it passes through without alteration. (2) The photon may be *absorbed* -- the photon never leaves the particle. (3) The photon may be *scattered* -- its path may be altered.

Materials: Step 1: A small ball. **Step 2**: Overhead projector, 4 clear cups (glass or plastic), 4 different liquids (milk, water, black ink, grape juice), flashlight. . Optional: music by They Might Be Giants: "Particle Man".

The demonstration: (Step 1): The students need to be comfortable with two technical words before you begin: photon and radiation. They should know that light is the radiation that we can see. We can think of light or radiation as a stream of photons.

We do this with two people. One of us stands in the front of the room with a big paper 'P' taped to his shirt. He is Particle Man. He explains: "I am a particle of a substance. For example, a water droplet." The other person stands about 10 feet away with the ball. The second person is the ball tosser. Hold up the ball:

"This is an incoming photon. Are you ready particle man?"
"Yep. I'm ready. Let me have it."
"Are you sure you're ready?"

The more patter and build up, the better the student response.

"OK, Particle Man. Here comes the photon."

The tosser gently tosses the ball towards Particle Man. Particle man dodges the ball without letting it touch him. **TRANSMISSION!** The photon passes through without changing its path.

The ball is given back to the tosser. Repeat the procedure. "Are you ready Particle Man?" "Yep, I'm ready. Let me have it." "OK, Here comes the photon." This time Particle Man catches the ball, and draws it towards his body like a football running back. **ABSORPTION!** The photon never leaves the particle.

One more time. Here comes the photon. This time Particle Man deflects the ball with his hand. **SCATTERING!** The photon changed direction.

(Step 2): Turn on the overhead projector and place the 4 cups each filled with a different liquid on the projector. Look at the projection.

— The water demonstrates transmission. Most of the light is passing through the water and appearing on the screen. This is just like the ball passing by Particle Man with no change.

- The black ink demonstrates absorption. None of the photons are making it through the ink to get to the screen. All the light is absorbed just like when Particle Man caught the ball and kept it.
- The milk demonstrates scattering. Look on the screen. Like the ink, none of the photons make it to the screen, but these photons are not absorbed. Where do they go? Hold the cup up and shine a flashlight at the bottom of the cup. In a darkened room you will see the light "leaking out" of the side of the cup. Do the same for the ink. No leakage. The reason milk is white is that it scatters photons to your eye and therefore appears bright. The reason ink is black is that it absorbs all of the photons and sends nothing to your eye. The milk is deflecting photons from their path as did Particle Man when he hit the incoming photon.
- The grape juice represents a color selective absorption. All the photons except at the purple wavelength are absorbed. The purple photons are transmitted and scattered. You can use the flashlight to check for scattering.

Conclusion: Some substances transmit, some absorb, some scatter and some combine more than one process.

Options: We work this as a pair. If you are going solo, take the role of Particle Man and choose a *responsible* student-volunteer to toss the ball to you. The other thing we do that enhances the lesson is to play the song "Particle Man" by They Might Be Giants. The music is fun, but it adds nothing to the science. We never seem to have black ink around. Chocolate syrup works fine.

Acknowledgment: The idea behind Step 2 was taken from Craig F. Bohren's book Clouds in a Glass of Beer [1987, Wiley & Sons, New York, 195pp.]. This is an excellent reference, although we felt we had to start from a more basic level in order to reach a younger audience. Thus Particle Man was born.

3-7 Energy absorption

(a) <u>Ice Party</u> You will need food coloring and the ability to make several trays of ice.

Make several different colors of ice using the food coloring. Make at least one tray a really, really dark color. Ideally you should have half a tray of ice of each color and a half tray of plain uncolored ice. The ice trays need to be identical so that the shape of the ice cubes is identical.

On a sunny day place the ice cubes out in the sun in separate piles according to color. The ice in each color needs to be set on identical surfaces and arranged in an identical manner. Laying the cubes out flat works just fine. Make sure that the distance between cubes in each pile is identical. You want to see which pile melts faster and you don't want your experiment contaminated by other factors.

Which color melts fastest? Dark colors absorb more light than light colors. Your darkest ice should melt fastest because it is absorbing light and light is a form of energy.

Different surface types on the earth's surface absorb light from the sun at different rates. Some of these differences in energy absorption are due to differences in colors. Other differences are due to the materials themselves. Try the other demonstrations in this section.

(b) <u>Absorbing Jars</u>. You will need five identical jars with lids, a thermometer, aluminum foil, water, sand or dirt, modeling clay, black paint, cardboard, tape and a watch.

Paint one of the jars black on the outside. Make sure it is dark and opaque. Punch holes in the lid tops so that the thermometer can slide easily in and out. Cover one of the jars in the foil. Fill two of the jars 3/4 of the way full with the dirt or sand. It is best if the sand can be the same temperature as the water. You could keep both the water and the sand overnight in the refrigerator. Fill to the 3/4 mark the three empty jars with the same temperature water. Add some water to one of the jars containing sand. You want to get the sand wet but you don't want to raise the level of the substance in the jar. Be sure that all 5 jars are filled to the same level when you start.

Measure the temperature of every jar to start.

Screw on the lids, plug the thermometer holes with modeling clay and put the jars out in the sun. The jars will absorb the sun's heat rays, but they will also lose heat on the shady side. Tape cardboard to the shady side of each jar.

Put all the jars out in the sun. Every three minutes push the thermometer through the lid hole and measure the temperature inside. Plug the hole after each reading.

Which jar warms fastest? Which slowest?

The earth's surface consists of various materials such as sandy deserts, oceans, vegetation etc. Each of these materials reflects and absorbs the sun's heat at different rates. Each of these materials also has a different ability to warm up or lose heat, which is a separate issue from its ability to reflect or absorb. Water takes longer to heat up or cool down than land. That is why coastal cities have a milder climate than interior cities.

The difference in heating rates also drives weather patterns. The land warms up faster than the ocean. Warm air over the land rises and makes clouds. That's why we sometimes have afternoon cloudiness and thunderstorms in the summer. At night the land cools off faster and by morning the clouds have gone. However, the reverse is true over the ocean: more clouds at night and in the early morning when the air above the water is warmer than the air above the land.

What about reflectance and absorption? Dark vegetation absorbs more of the sun's energy than bright deserts. Why are vegetated areas cooler than deserts? The answer again is water. Plants consist mostly of water and it is that water in the plants that keeps vegetated areas cooler than dry deserts. Water cooling keeps things cool enough to cancel the absorption of energy by the substance called chlorophyll used by plants to make food.

3-8 Greenhouse effect

(a) Making a greenhouse. You need two large identical cans painted black on the inside and a piece of glass or clear Plexiglas that completely covers the open end of the can. You also need a thermometer.

This is very simple. Fill each can half full with the same temperature water. You want plenty of room for air to circulate so don't fill the cans too full. The water level needs to be the same in both cans. Cover one can with the glass and set both out in the sun.

Give the cans at least an hour in the sun and measure the water temperature in each one. Is there a difference? Does the glass covered can stay warmer?

The earth's atmosphere acts like a transparent blanket over the earth. The atmosphere allows the sun's energy through to warm up the surface, but traps outgoing energy so that the earth doesn't cool as fast. Most of the outgoing energy is trapped by water vapor in the atmosphere. Other gases in the atmosphere also act as "greenhouse glass."

3-9 Heat

(a) Preventing Hypothermia is described in the PUMAS printout **(See page 22)**.

(b) Heat Currents You need a Pyrex or other clear heat proof flask, beaker or pot, a heat source and plastic beads or paper dots from a hole puncher. *Adapted from Hann (1991).*

Put the beads or dots into the beaker and add water. Heat the water. The water over the heat source warms and starts to rise carrying the dots with it. At the top, the water cools and is pushed outward by water rising behind and sinks at the edges.

This is exactly how a thunderstorm works. Air over a warm region starts to rise and as it rises it forms a cloud that develops into a thunderstorm. Air comes out of the top of the cloud and moves to the sides. Then it sinks along the sides of the cloud. You have strong upward movement inside the cloud and downward movement of cooler air outside the cloud.

Preventing Hypothermia

Concepts: Hypothermia occurs when a warm-blooded animal, such as a person, becomes extremely cold, and loses control of his or her body's core temperature. This is much more likely to happen when a person is wet than dry. Hypothermia can cause death. Oftentimes it is difficult to know when someone starts to go into hypothermia. It is even difficult to know when you yourself are experiencing the beginning signs.

Background: I am very sensitive to the dangers of hypothermia from a real life experience involving my best friend in high school who almost died on a back packing trip in the Sierra Nevada mountains. It wasn't very cold, about 40 F, but it was raining. Her clothing was completely soaked. She was tired and hungry from physical exertion. She went through an episode of shivering, then the shivering stopped and she thought she was fine. That's when she slipped into unconsciousness. Her hiking partners acted quickly. They stopped immediately, set up a tent and warmed her up with their own body heat. She was lucky.

Materials: Desk fan. Thermometer with exposed bulb. Cotton or gauze. Bowl of water. Socks or fabric consisting of a variety of materials including cotton and wool. Perhaps a magnifying glass. Big paper doll with a wardrobe of paper clothing both appropriate and inappropriate for cold weather activity.

Prelude: As an introduction to these activities I sometimes read from Laura Ingalls Wilder's *The Long Winter*. See PUMAS example: Hypothermia in the Little House **(Page 24)** .

Activity #1: Cooling by evaporation. Hold up the thermometer. Have volunteers come up to read the temperature. Get several readings. Next, turn on your desk fan. Hold the thermometer in the "wind" produced from the desk fan. Have several volunteers read the temperature. The temperature should be the same as before. Then, dip the cotton gauze in the bowl of water. Hold the wet gauze on the thermometer bulb and hold the thermometer in the "wind" from the fan. This time when the kids come up to read the temperatures they will find that the temperatures are dropping.

What is happening? The water next to the thermometer bulb is evaporating, and evaporation causes cooling. The reason that evaporation cools is that the gas state of water molecules is more active and at a higher energy level than the more organized liquid state. It takes energy to get those molecules up and moving. The energy that goes into the water to make gas from liquid has to come from the environment surrounding the water. The environment loses energy and cools when the water gains energy and turns from liquid to gas. The moving air accelerates the evaporation allowing liquid to turn into gas more quickly.

Why didn't the wind cause a cooling? What about wind chill? Wind chill only affects warm bodies that manufacture their own heat. A warm body conducts heat into the air layer that directly touches the body. That warm layer of air, in part, insulates the body from the colder air beyond. If a wind comes along and moves those warmer air molecules away and replaces the warmer air molecules with colder molecules, the warm body has to go to work again to warm up the insulating air layer. The reason it feels colder to you with a wind than without is because your body has to work harder repeatedly heating up the air molecules that are in direct contact with your body. The thermometer doesn't manufacture its own heat therefore it is the same temperature as the air in the room and doesn't lose heat in warming up the air around itself.

Moral of this lesson: Don't get wet when it's cold!

Activity #2: Have the kids dip different fabrics in the bowl of water. I use socks. Note carefully which socks get wet immediately and which stay dry on the inside. Note when you see air bubbles. Cotton absorbs water right away. Wool produces a lot of air bubbles and stays dry for a long time. Examine wool fiber closely, maybe with a magnifying lens. Wool fibers are squiggly.

Clothing keeps you warm because 1) it keeps you dry and 2) it traps an insulating layer of air around your body. The squiggly wool fibers trap a lot of air. Even when you dunk wool in water, it doesn't lose all the air trapped in the fibers. Wool will keep you warm a long time. Cotton will not. Your denim blue jeans are made from cotton, and will get wet right away. They'll cause evaporation against your skin right away and will make your body work hard at keeping warm.

Moral of this lesson: Don't wear cotton. Wear wool. (Man-made fibers vary. Some are like wool and some like cotton.)

Activity #3: Choosing clothing. I made two paper dolls, one a boy, one a girl. They are about 12 inches high and come with a variety of color-coordinated clothing. It took me about 90 minutes to make each doll with its wardrobe. Each doll has thermal underware, denim pants, wool pants, wool socks and cotton socks, canvas tennis shoes, boots, mittens, wool sweater, short sleeve T'shirt, long sleeve cotton shirt, hooded cotton sweatshirt, rain pants and a rain poncho, ear muffs, a wool ski cap and a baseball hat.

The kids and I spend some time dressing him or her for winter activities. I might say, "It's cold and rainy." Then I would expect the clothing choices to include boots, rain pants and the poncho. I might say, "It's snowing." Then the poncho is less important and the wool sweater is more important. The ski cap is essential and the baseball hat and the earmuffs are useless. (You lose most of your body heat through your head and neck.) I emphasize layering, protection from wet, and a head covering. Canvas tennis shoes are bad. Wool is better than cotton. Make sure your thermal underwear isn't all cotton. The idea is to let the kids make the choices, and to guide them into making the right choices. It's a nice application of science into everyday life.

Hypothermia in the Little House

From: The PUMAS Collection http://pumas.jpl.nasa.gov

Materials: Laura Ingalls Wilder's book *The Long Winter*.

Science in Children's Literature: Among the cornerstones of science are careful observation and accurate description. Like scientists, authors must also be careful observers. Mrs. Wilder's book presents a fine example in her depiction of the symptoms and treatment of hypothermia. Every time I read it I am more impressed with her scientific accuracy. It is worth starting early to develop skills at noticing what happens around you and at describing what you see.

I have used this example with very young students as an introduction to preparing for outdoor winter activity. I read a few sentences or paragraphs, and then break the narrative to ask questions and begin discussion. By the time Laura and Carrie stumble back into the house, I am stopping at almost every sentence. I emphasize to my students that dressing correctly and eating properly will preserve health and enhance enjoyment of the outdoors. I can also envision using this example within a general unit on health and the human body, or even as an introduction to a writing assignment on observations. I leave it to the individual teachers to incorporate this example into their own curriculums and at the appropriate level for their classes.

Concepts: Hypothermia occurs when a warm-blooded animal, such as a person, becomes extremely cold and loses control of his or her body's core temperature. This is much more likely to happen when a person is wet rather than dry. Hypothermia can cause death. Oftentimes, it is difficult to know when someone starts to go into hypothermia. It is even difficult to know when you yourself are experiencing the beginning signs.

Below are highlights from Mrs. Wilder's book. The italics are direct quotes from the book. My interpretations are in plain font. I'm working from the paperback First Harper Trophy edition, 1971. I start in Chapter 9 "Cap Garland."

p.83. *"But when Monday came Laura was cross because her red flannel underwear was so hot and scratchy. It made her back itch,....that red flannel almost drove her crazy."* In Laura's time flannel meant wool. She is complaining of itchy wool long underwear.

p.87. *"Laura wrapped the muffler .... and took firm hold of her [Carrie's] mittened hand."* The girls are dressing properly for cold weather. Mittens actually keep your hands warmer than gloves.

p.87-88. The winds make walking difficult. Laura is using energy just to keep up with the group. The physical exertion means her cells are working hard, converting stored food energy to kinetic energy and making metabolic heat. However, they are also using up their own reserves.

p.88. They stopped. *"Then Laura began to know how cold she was."* When she stopped, metabolic heat production slowed down, and now she was cold.

p.88. *"Her mittened hand was so numb..."* When the body starts to go into temperature distress, it makes maintenance of the core temperature its first priority. This means it shuts down circulation to extremities like hands and feet.

p.88-89. *"She was shaking all over..."* Shivering is an involuntary muscular movement. Its purpose is to increase metabolic heat production.

p.90. *"Carrie...stumbling and flopping..".* Her stumbling is partly due to physical exertion, which means she is running out of reserves for temperature maintenance. It may also be due to numb feet or loss of motor control. As hypothermia advances it affects higher level brain function. The body's only interest is to maintain life support -- circulation to heart and lungs.

p.93. Laura and Carrie have made it home. *"Laura's hands fumbled at the doorknob..."* Another example of numb extremities and loss of motor control.

p.93. Ma has examined the girls and found no frostbite. Normally the blood carries oxygen to the cells and takes away waste. If blood stops flowing to parts of the body, the tissue in those body parts dies. This happens when cold causes the body to stop servicing the extremities and is called frostbite.

p.93. *"Laura could hardly move."* Advanced hypothermia.

p.93. Snow was driven into her clothing, under her skirts, into her shoes. Her inner clothing was probably wet. Remember that woolen underwear? Wool keeps you warm even when wet. The wool probably saved her life.

p.94. *"she staggered toward the stove. ... Laura sat stiffly down."* Loss of motor control. The stove is Laura's best bet. Her muscles have used every bit of stored energy for heating and now there is nothing left for heating or for movement. That is why she is staggering. To survive she needs external heat until her body builds up enough reserve to maintain temperature again.

p.94. *"She felt numb and stupid."* Disorientation. Mental slowness. Feeling stupid. All are symptoms of advanced hypothermia. The brain shuts down its higher level "thinking" functions. This is why people with hypothermia often don't realize it. They can't think clearly.

p.94. *"she could feel the heat on her skin, but she was cold inside."* Her core temperature had dropped below the normal of 98.6 F.

p.94. Pa is holding Carrie next to the fire. Pa is using his body heat to help Carrie regain her temperature regulation. When you are out in the wilderness with no stoves, the only heat source you may have to save someone's life is your own body, transferring heat directly from skin to skin.

p.94. Carrie is shivering and can't get warm. Carrie actually may be in better shape than Laura. Her muscles still have some reserves and are shivering in order to make heat. Laura has stopped shivering. This may be because she is starting to warm up or maybe because she is so far gone that her muscles have no reserves left. The end of shivering doesn't necessarily indicate recovery.

p.94. Ma makes ginger tea. Warm food and drink are other sources of external heat. Laura and Carrie are going to need a lot of food in the next few days in order to replenish all the calories that their bodies used in trying to stay warm.

p.95. Ma says that the girls are going to need *"a good long sleep."* Ma is absolutely right. Sleep and food so that their bodies can build up reserves.

Note: Books by Farley Mowat and Jack London also contain great descriptions of life in cold climates. If you want to know more about hypothermia, I've written up a companion PUMAS example, Preventing Hypothermia, where I suggest 3 additional activities.

3-10 Land/Water

(a) Fresh water. You need cupful of coarsely broken charcoal, cupful of rinsed wet sand, and cupful of washed gravel, 6" in diameter clay flowerpot, large dish and a jug of dirty pond water. *Adapted from Hann (1991).*

You do a better job of cleaning the water if you line the flowerpot first with a coffee filter, but I want to show the natural cleaning power of the earth itself.

Place the flowerpot in the dish. Starting with the crushed charcoal, then the wet sand and finally the gravel, layer each substance into the flowerpot in equal parts. Pack each layer down as you go. Gently pour a cup of the dirty pond water into the now full pot. Do not disturb the layers.

Capture the exiting water in the dish. Compare the water before and after the filtering process.

Fresh water is an extremely valuable resource. Some fresh water can be found on the earth's surface in rivers and lakes. Much more of the water is hidden underground and can only be reached by digging wells or at natural springs where the water flows out of the ground. The water underground gets there by slowly seeping downward through the soil and rocks. As it goes downward it is filtered and cleaned. Unless it meets a chemical contaminant in the rocks during this process, well and spring water can be safe for drinking.

Planet Earth Patch

General Information

The Planet Earth Patch is a multi- level patch program. Activities are based on an individual troop/group level. Choose those activities specific to your level and enjoy the program.

When ordering the patch consider the following:

- **The number of girls receiving the patch for the first time.**
- **The number of rocker bars needed for your present troop level.**

This special patch can be re-visited as girls/ troops /groups advance. A girl may only receive only one *Planet Earth patch.* Rocker bars are added to fit the need of the new GS level.

At present the only cost is $1.50 to cover mailing. Please include this fee when returning the patch evaluation and order form found in the back of this booklet.

*This program is also available to individually registered Girl Scouts. Parents can complete the evaluation form for them.

GIRL SCOUTS OF CENTRAL MARYLAND

PLANET EARTH PATCH PROGRAM
EVALUATION AND ORDER SHEET

The form must be completed and forwarded to the Program Department, Girl Scout Service Center, 4806 Seton Drive, Baltimore, MD 21215.

I. Your Information Date ___/___/___

Leader's Name ______________________________ Phone ______________(E)
______________(D)

Address ____
Street City State Zip

Troop # ____ and Level Brownie __ Junior __ Cadette __ Senior __

List below the activities your troop completed:

EARTH SYSTEM KNOWLEDGE	AWESOME MATH & TECH	PHYSICS IS PHUN	ARTS AND LITERATURE	ACTIONS

II. EVALUATION

Check a box or answer the question

1. The girls in my troop/group
   Agree Disagree

Comment: ____

____

2. The materials were easy to understand.
   Agree Disagree

Comment: ____

____

3. I learned along with the girls in my troop.
   Agree Disagree

Comment: ____

____

(over)

4. If I could change one thing in the program, it would be:

____

____

Why? ____

____

5. What would you tell another leader about the PLANET EARTH PATCH PROGRAM?

____

____

____

III. ORDER FORM

Please include $1.50 to cover cost of mailing.

How many girls participated in *Planet Earth Patch Program*? ______

How many patches are needed? _________

How many rocker bars are needed? _______

Indicate troop/group level
Brownie __
Junior __
Cadette/Senior __

Signature ____

Office Use Only
Mailing Date ___/___/___
Initials