SCIENCE WORLD
BRITISH COLUMBIA

THE POWER AND IMPORTANCE OF THE SUN

OBJECTIVES:

- Identify the sun as the main source of the earth's energy
- Identify methods of protecting ourselves from harmful solar radiation
- Demonstrate ways to convert solar energy into thermal and mechanical energy

CURRICULUM CONNECTIONS BY GRADE:

K. Processes and Skills of Science
1. Life Science
2. Processes and Skills of Science
2. Physical Science
3. Processes and Skills of Science
3. Life Science
3. Mathematics
4. Processes and Skills of Science
5. Earth and Space Science
6. Mathematics

LIST OF ACTIVITIES:

- Will it Wilt?
- Light Patterns
- UV Beads
- Solar Relay
- Solar UFOs
- Solar Oven
- Radiometer
- Solar Panels and Motors

INTRODUCTION

Energy from the sun is powerful and useful. People harness the sun's energy in many ways, from growing plants for food to installing solar panels for electricity generation.

Students will see what happens when a plant is deprived of light. While investigating the power of the sun, students will discuss methods of protecting themselves from the sun's harmful ultraviolet radiation. They will explore solar thermal energy by examining a radiometer, playing with a solar UFO and creating solar ovens. They will use photovoltaic cells to power small motors.

BACKGROUND

Every second, the sun gives off more energy than humans have used in all of history. Only about one billionth of the sun's energy ever reaches the earth. Approximately 30% of this energy is directly reflected back into space. The rest is absorbed by clouds, oceans and land masses.

Solar energy is electromagnetic radiation (including infrared, visible and ultraviolet light) released by thermonuclear reactions in the core of the sun.

With a few exceptions (e.g. nuclear energy, geothermal energy), solar energy is the source of all energy used by humans. Indirect forms include hydroelectricity, ocean thermal energy, tidal energy and wind energy. The sun also powers the process of photosynthesis, the original source of the energy contained in biomass, peat, coal and petroleum (oil and gas). Usually, however, the term solar energy refers to the portion of the sun's radiant energy harnessed directly, such as through solar panels.

Solar technologies include active and passive solar techniques. Active techniques include things such as using photovoltaic panels and solar thermal collectors to convert sunlight into useful outputs. Passive techniques include things such as orienting a building to the sun and designing spaces that naturally circulate air.

Solar power is the conversion of sunlight into electricity. Sunlight can be converted directly into electricity using photovoltaics. It can also be converted indirectly with concentrating solar power (CSP) systems. CSPs normally focus the sun's energy to boil water and create steam which is then used to provide power to a generator.

Photovoltaics were initially used to power small and medium-sized applications, from the calculator powered by a single solar cell to off-grid homes powered by a photovoltaic array.

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DEMONSTRATION

ACTIVITY 1: WILL IT WILT?

MATERIALS:
- two identical house plants
- box
- paper and pencils
- a sunny window sill

Students examine the differences between two identical plants when one plant is deprived of sunlight.

A plant cannot survive without sunlight because it needs light to make its own food. It does this by a process called photosynthesis. Photosynthesis is a process where plants absorb sunlight through their leaves and convert it to energy. When provided with everything else a plant needs to grow and survive (water, air, soil nutrients), we can observe what happens if it has no sunlight.

WHAT TO DO

1. Place two identical plants on the windowsill or in another sunny location.
2. Cover one plant with a box to stop the sunlight from reaching it.
3. Periodically, water both plants equally.
4. Measure and record the height and colour of each plant daily.

KEY QUESTIONS

» What differences can you observe?
» Why does a plant without sunlight stop growing?

EXTENSIONS

» Record the progress of the plants by taking photos or drawing pictures each day. Or, measure their sizes and create a growth chart.
» What does a plant need for photosynthesis to occur?
» What happens when the sun-deprived plant is removed from the box? Will it grow again?
» On a large piece of paper, create a food web that starts with the sun. Discuss what happens if the sun is removed from the food web.

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MAKE + TAKE

ACTIVITY 2: LIGHT PATTERNS

MATERIALS:

- many small objects (washers, leaves, coins, buttons, keys)
- trays filled with water
- bright sunny day

* light-sensitive paper may be purchased from: http://boreal.com/ as Sunprint paper, through http://www.teachersource.com/ as Nature Print Paper, and through http://www.escience.ca/ as Solargraphics

Students use various objects to make patterns on light-sensitive paper.

Have you ever noticed that curtains or furniture will fade if they are exposed to sunshine? The sun's rays can cause material to change.

Light-sensitive paper is a special type of paper which is very sensitive to the sun's rays. When light hits it, chemicals in the paper react to the suns' rays and change colour. Putting objects on top of the paper prevents the light from reaching the chemicals. When placed in water, the paper reacts and the image is fixed onto the paper.

WHAT TO DO

1. Arrange objects on a piece of light-sensitive paper.
2. Allow the paper to stay in the sun until the paper turns light (according to manufacturer's directions).
3. Immerse the paper in water and allow it to dry.

EXTENSIONS

» Put some coins or buttons on ordinary coloured paper or construction paper. Leave it on a sunny windowsill for a few days. How are the results similar to or different from your light-sensitive paper?

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ACTIVITY

ACTIVITY 3: UV BEADS

MATERIALS:

- sunscreen
- UV-sensitive beads
- sunny day (indoor lighting won't work)
- pipe cleaners or string
- regular beads

* UV-sensitive beads may be purchased from: http://www.teachersource.com/Product.aspx?DeptID=1231

Students use colour-changing, ultraviolet-sensitive beads to observe how sunscreen can block the harmful effects of the sun's rays.

One type of light from the sun, called ultraviolet (UV) light, is invisible. Too much UV light can cause sunburns and skin cancer.

We don't use photosynthesis to make our food, but the sun is still very important for us. Among other things, we need the sun to help our skin make vitamin D. Without vitamin D our bones cannot grow properly and they get soft and bendy (rickets).

How can you tell if you have had enough UV radiation? Your skin will change colour. Unfortunately, it can take a few hours for a tan to show.

UV beads have special chemicals that change colour very quickly when UV light hits them. Sunscreen blocks some UV light so the beads change colour more slowly if they are covered with sunscreen.

WHAT TO DO

1. Divide the beads into two groups.
2. Cover one group of beads with sunscreen.
3. Mix the beads up.
4. Take the beads outside into the sun.
5. Watch what happens to the beads with sunscreen and the beads without.
6. Make a UV–detecting bracelet or zipper pull by stringing UV and regular beads on a pipe cleaner.

KEY QUESTIONS

» Can you tell which beads have sunscreen on them?
» How long can the beads with sunscreen stay in the sun before they change colour?

EXTENSIONS

» Experiment further by placing beads on a windowsill and test UV-blocking fabric, window coverings, plain glass or cellophane.

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GAME

ACTIVITY 4: SOLAR RELAY

MATERIALS:

- sun-safe items (long-sleeve t-shirts, hats, fans, water bottles, sunscreen)
- other items (warm toques, short-sleeve t-shirts, hats without a brim)

A team relay activity where students decide which objects help protect them from the sun and which objects do not.

Chimpanzees avoid the peak hours of the sun—most of their activities are in the early morning and late afternoon. Rhinos use mud as a natural sun block. They roll in the mud to thickly coat themselves and protect their skins from the sun. The skin of hippos secretes a natural "sun-screen." The sun is very powerful. How can we protect ourselves from having too much sun?

WHAT TO DO

1. Organize the class into two or three teams of five or more students and line the teams up on one side of the room.
2. Across the room, place a set of items (including sun-safe and other clothes) for each team.
3. Chose a model from each team to stand near the clothes.
4. Team members take turns running to the pile, selecting a sun-safe item, dressing the model and then returning to tag the next team member.
5. The first team to correctly dress their model and be sitting down in their original line up is the winner.

KEY QUESTIONS

» Do we need to be sun-safe year-round?

EXTENSIONS

» How does sunscreen work?
» Does sunscreen work as well as wearing clothing?

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DEMONSTRATION

ACTIVITY 5: SOLAR UFO'S?

MATERIALS:
- solar balloon
- sunny, wind-less day (mornings are best)

* (solar balloons may be purchased from: http://intothewind.com/shop/Whats_New/UFO_Solar_Balloon or http://boreal.com/ (search for Solar Bag) or http://www.teachersource.com/ (search for Solar Tube)

Students fill an ultra-thin plastic bag with air, allow the air to heat up under the sun's radiation and watch the bag float. Students observe the transfer of solar energy to thermal energy and are introduced to the concept that hot air rises.

Different colours absorb different amounts of the sun's energy. Black absorbs the most energy of all the colours so it gets hot quickly.

If a black bag is filled with air and put it in the sun, the air in the bag will become hotter than the air around the bag. Hotter air is lighter than cooler air so the UFO bag will float because of the sun's energy.

WHAT TO DO

Do this activity outside in a large, open area.

1. Tie one end of the solar balloon.
2. Fill the bag with air and tie the other end.
3. Attach the string to the bag as you would to a kite.

KEY QUESTIONS

» What makes the bag rise up?
» Have you seen anything hot rise before?

EXTENSIONS

» Time different sized bags to see if they raise at different rates.
» Estimate how much power the heat energy has generated by trying to lift small objects off of the ground.

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MAKE + TAKE

ACTIVITY 6: SOLAR OVEN

MATERIALS:
- aluminum foil
- plastic wrap
- mirrors
- boxes
- chocolate, marshmallows, and graham crackers
- small plates

For Intermediate Students

Students use various materials to focus the sun's rays and make solar s'mores!

In North America, we use electricity or gas to cook our food. But over half the world's population uses wood or animal dung to cook. Every year, almost 2 billion tonnes of wood are burned in cooking fires.

In the eighteenth century, Europeans discovered how to boil water by trapping the sun's energy as heat behind glass—a solar oven! The glass allows the sun's rays to enter the oven. The rays are converted to heat energy and the glass prevents the heat from leaving.

Have you ever noticed how hot cars get when they are parked in the sun? Solar ovens can get very hot so be careful!

WHAT TO DO
1. Cut the top off a cardboard box.
2. Line the inside of the box with aluminum foil.
3. Prepare s'mores—marshmallows and chocolate sandwiched between graham crackers. Put a s'more on a plate inside the box.
4. Place mirrors in various places around the inside of the box to direct and reflect the sun's rays towards the s'more.
5. Cover the top of the box in 4 layers of thick plastic wrap (to let light rays in and to keep the heat from escaping).

KEY QUESTIONS
» How could we make the ovens hotter?

EXTENSIONS
» Put a thermometer inside the solar oven and measure the temperature.
» How might we insulate the container?
» How much heat-absorbing material is useful?
» How could the sun's rays be directed more efficiently towards the box?

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DEMONSTRATION

ACTIVITY 7: RADIOMETER

MATERIALS:
- lamp
- radiometer

* radiometers may be purchased from (~$15): http://www.thinkgeek.com/geek-toys/science/9bec/

A radiometer turns solar energy into heat and mechanical energy.

When light rays hit the vanes, the black sides of the vanes absorb the rays better than the white sides. The black sides heat up and the molecules in the air around them move faster than the molecules in the air near the white sides. The difference in pressure on the vanes causes them to turn. The brighter the light, the faster the vanes will rotate. A partial vacuum inside the glass allows the vanes to spin easily.

The solar energy is changed first to thermal energy (the molecules on the black sides heat up), and then to mechanical energy (the vanes spin).

WHAT TO DO
1. Shine the light on the radiometer and watch it move.

KEY QUESTIONS
» What happens when you shine less light on the vanes? More light?
» Can you aim the lamp so that the light only hits the white sides of the vane? The black side? Is there a difference in how fast the radiometer spins?
» What is causing the vanes to spin?
» Is the colour important?

EXTENSIONS
» On a sunny day, experiment with wearing a black shirt and then a white shirt. Do you notice a difference in temperature?
» Leave one thermometer on a black car and one on a white car. Is one car hotter than the other?

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DEMONSTRATION

ACTIVITY 8: SOLAR PANELS AND MOTORS

MATERIALS:

- alligator clips
- small motors
- sun (or natural light light bulbs and lamp)
- art supplies (paper circles, old CDs, popsicle sticks, etc.)

* solar panels may be purchased from: http://www.legoeducation.us/store/detail.aspx?ID=783&bhcp=1)&retest=1&domainalert=1

For Intermediate Students

Students learn how solar energy can be harnessed to create an electric current.

Students play with solar panels, complete a solar panel-motor circuit, and use art materials to create spinning masterpieces.

What do you need to make a motor turn? Usually we use an electric current provided by a battery or an electrical socket. The sun can also generate an electric current with the help of the same element that is in sand, silicon. When sunlight heats specially-prepared silicon (photovoltaic cells), it causes some of the electrons to move, and an electric current is generated.

WHAT TO DO

1. Divide students into groups with one solar panel and one motor per group.
2. Attach solar panels to motors.
3. Face the solar panels towards the sun, and than face them away from the sun. Observe any differences?
4. Use art materials to create spinning sculptures or small vehicles for your motor to power.

KEY QUESTIONS

» How does the behaviour of the motor change?

EXTENSIONS

» Use mirrors to reflect sunlight or lamp light onto your solar panel.

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VOCABULARY

Atmosphere - A thin layer of gas that surrounds the earth. The atmosphere gives us air to breathe and protects us from harmful solar radiation.
Electric Current - Moving electrons.
Energy - The ability to do work.
Mechanical Energy - Energy in moving things.
Solar - Having to do with the sun.
Solar energy - Energy from the sun.
Photosynthesis - The process plants use to make their own food from sunlight and carbon dioxide.
Photovoltaic cell - Solar cell which changes light energy into electrical energy. The word "photovoltaic" comes from 2 words. "Photo" refers to light and "voltaic" refers to electricity.
Pressure - How much an object is pushed on.
Thermal Energy - Heat energy.
Ultraviolet radiation/Ultraviolet light - Also known as UV radiation/UV light. The sun emits many wavelengths of light, but it's the ultraviolet waves that cause sunburn. UV light is not visible to humans.

REFERENCES

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» http://alternative-energy-news.info/technology/solar-power/caps.ou.edu/CAPS/teachsun.html

RESOURCES

» Science World school programs: http://scienceworld.ca/school_programs.html
- *Electricity*
- *Enviro Challenge*

» Science World's Our World Gallery
» Climate Change Showdown Workshop by the BC Sustainable Energy Association
http://bcsea.org/learn/resources-for-educators/climate-change-showdown
» Sierra Club of BC school programmes:
http://sierraclub.bc.ca/education/ed_schools/current-programs
» Power Smart Student Program by BC Hydro:
http://bchydro.com/community/youth_education.html?WT.mc_id=education
» Solar BC Installation Incentives for Schools:
http://solarbc.ca/install/schools

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