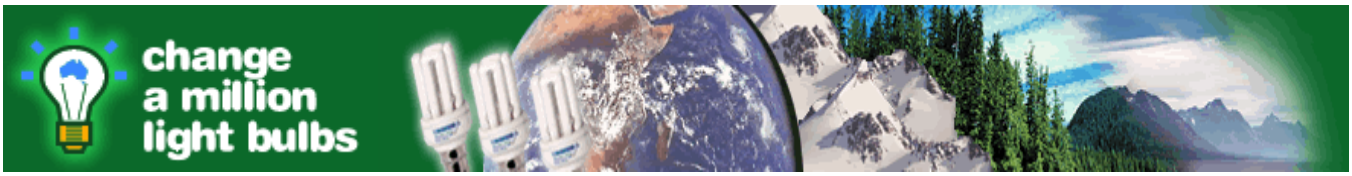


www.changeamillionlightbulbs.com

LEARNING MODULES

Introduction

Change a Million Light Bulbs began as an idea of a 15 year student. It has since grown into a campaign to have every Australian household and business change their lighting to more efficient and lower wattage lighting.

The following learning materials were developed in conjunction with Standby Saturday 24/7 – a campaign that aims to TURN OFF 1,000,000 AUSTRALIANS.

These experiments and ideas can be used for students of all ages. For secondary schools it is suggested that you include a large research aspect where the students explain the processes behind the practicals.

For more resources check out the Change a Million Light Bulbs website.

Activity grid

Activity number	Activity title	Activity purpose
1	Standby - we have a problem	This activity allows the students to be aware of how much energy is unconsciously being wasted by remaining on standby.
2	Shade Effect	This activity allows the students to explore the affect of shade and colour on the temperature of a “house”.
3	Heat From Light Bulbs	This activity allows the students to explore the relationship between a light bulb’s wattage and the heat it produces.
4	Greenhouse Effect	This activity allows the students to explore the greenhouse effect.

Also check out the Energy Busters Program that RMIT University developed for the Victorian Government on http://www.education.vic.gov.au/about/deptpolicies/environment/resources.htm

Activity 1: Standby – we have a problem

Purpose

This activity allows the students to be aware of how much energy is unconsciously being wasted by remaining on standby. This exercise can be run in a school environment as well as done at home. It can be the beginning of a campaign to reduce the energy usage in the home and at the school.

Requirements

- Mains Power Meter or alternative Power Metering device (see www.standbysaturday.com.au for a range of meters that can be purchased)
- Activity Sheet S1: Power Usage
- Activity Sheet S2: Sample Household usage sheet
- Appliances to measure (computers, screens, TVs, microwaves, IPod Chargers, etc)

Description

- Have an inquiry with the students about Climate Change. What are scientists saying causes it? You can use the information contained on the background page and the resources page on www.changeamillionlightbulbs.com.
- Ask the students how they waste energy? List the ways on the board. They will say things like long showers, leaving lights on, having the computers and TV and music on, etc
- Point out there is one area that most people forget about around wasting energy – standby. Today they are going to do an experiment to see how much energy is wasted around the school on standby.
- Have the students form groups of 2 – 4 people.
- Hand out one copy of Activity Sheet S1 per group and one Mains Power Meter.
- In some schools there are a ready range of appliances in the room (such as computers, etc) so use what is handy. You may need to bring in some appliances such as kettles, chargers, TV's, etc. Make the number of appliances as wide as possible to make it interesting.
- Have the groups measure the amount of energy used on, off, and on standby (if it has it)
- Have them work out how much energy, money and greenhouse gases would be saved if all the appliances were switched off.
- **Extension:** For older students, have the students test the appliances at their homes and report back their results. The students can begin a campaign to reduce standby energy across their homes and their school. Register at www.standbysaturday.com.au.
- With this extension the students can compare their results to the sample household (Activity Sheet S2) and the class can discuss what difference would it make to Australia if they campaigned to reduce standby energy.
- **Extension:** Run the exercise on all the equipment in the school and produce a report for the principal with recommendations.

Handy hints

- There must be a teacher or an adult present at all times for the younger students as they are dealing with electricity. Please ensure that you follow safety procedures all the time – every time.
- The Mains Power Meter is not sensitive enough to measure the usage of all equipment. Digital clocks obviously use very little power but the sensitivity of the cheaper Mains Power Meter is not enough to get a reading. More expensive power meters (e.g. the Powermate) do provide a more accurate reading. With that said the cheaper power meter is sufficient for this exercise for most purposes.
- You will notice that the Power Factor changes with some appliances. The simplest way (without explaining a whole page of theory – http://en.wikipedia.org/wiki/Power_factor) is to take the power reading (in watts) and multiply by (100 / power factor) to get an approximate power reading for the appliance.

Web links

Website	Description
www.changeamillionlightbulbs.com	Light Bulb Fundraiser Page with a great and simple background on Climate change and the importance of reducing energy.
http://en.wikipedia.org/wiki/Power_factor	Discussion about what “power factor” is
www.standbysaturday.com.au	Australian Standby Saturday 24/7 website

Activity Sheet S1: Power Usage

Appliance	Power Usage (Watts)		
	Off	Standby	On
TOTAL	w	w	w

Over a year

Standby energy = _____ w x 24 hours x 365 days = _____ **kwh**

This amounts to _____ kwh x 1.2 kg = _____**kg of Greenhouse gases per yr**

And costs: _____ kwh x $0.14 = $ _____ (based on 14cents per kwh)

Activity Sheet S2: Sample Household Usage

Appliance	Power Usage (Watts)		
	Off	Standby	On
Sunbeam Ultra 5500 Iron	0 w		1701 w
LG TV	0 w	11 w	49 w
Audiosonic DVD / Radio	3 w	9 w	15 w
IBM Laptop	0 w	30 w	30 w
Lamp with 40 w incandescent bulb	0 w		38 w
Lamp with 10 w Compact Fluorescent bulb	0 w		9 w
Microwave (rated at 1330 w)	0 w	3 w	1220 w
Refrigerator (5 Star – 560 kwh / year)	0 w	Door Closed 9 w	Door Open 18 w
LG 7 Kg Front Loader Washing Machine (4 Star – 235 kwh / yr)	0 w	7 w	26 – 33 w
Nokia Phone Charger	0 w		7 w
Room Fan	0 w		Level 1: 38 w Level 2: 43 w Level 3: 47 w
Sunbeam Hair dryer (rated at 1100 – 1200 w)	0 w		1030 w
LG Radio / CD Player (Rated: 11 w)	0 w	2 w	7 w
Epson Multifunction Printer	0 w	7 – 9 w	11 – 15 w
Dell PC	7 – 9 w	7 – 9 w	42 – 66 w
Dell 15” Computer Screen	7 w	9 – 11 w	40 – 45 w
Modem	0 w		11 w
TOTAL	19 w	100 w	4340 w

Over a year

Standby energy = 100 W x 24 hours x 365 days = **876 kWh**

This amounts to **1051.2 kg of Greenhouse gases per year** (based on 1.2 kg per kWh)

And costs: **$122.60** (based on 14 cents per kWh)

Across 100,000 households

Standby energy = **87.6 MWh**

This amounts to **105.12 tonnes of Greenhouse gases per year** (based on 1.2 kg per kWh)

And costs: **12.26 million dollars** (based on 14 cents per kWh)

Activity 2: Shade effect

(Adapted from http://www.energyquest.ca.gov/projects)

Purpose

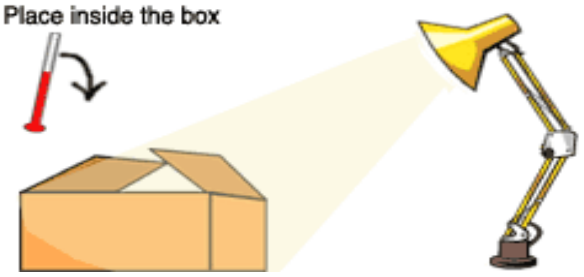
This activity allows the students to explore the affect of shade and colour on the temperature of a "house". This is a great experiment to begin a discussion about how the landscape can affect the design of houses and the importance of shade in an environment. It could also bring up a discussion about deforestation. Make the conversation after the experiments very rich. It is a great opportunity for the students to take on projects that make a difference to their environments.

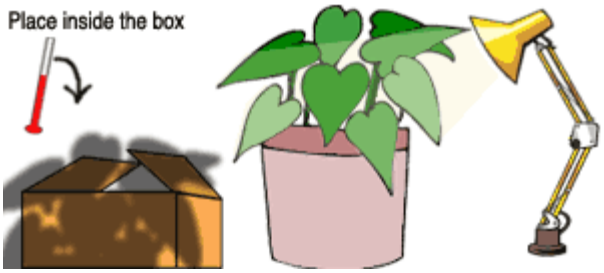
Requirements

- Two shoe boxes or small cardboard boxes
- A reflector lamp with a 100 watt incandescent light bulb in it (you can also use the sun instead of a lamp)
- Various types of plants in pots.
- Two good thermometers to measure air temperature. If you have a digital thermometer that measures inside temperature with an external sensor to measure outside temperature, that would be best.
- Small can of black or dark-colour paint and small can of white paint

Experiment 1

This experiment shows the affect of shade on the temperature of a house. It is also a great conversation starter for the students to look at why they get hot. An incandescent lamp emits a lot of energy in the infrared range and this is where the heat comes from. This activity can also be done with a lower wattage bulb. Also try it with a CFL bulb to see the difference between incandescent and compact fluorescent bulbs.





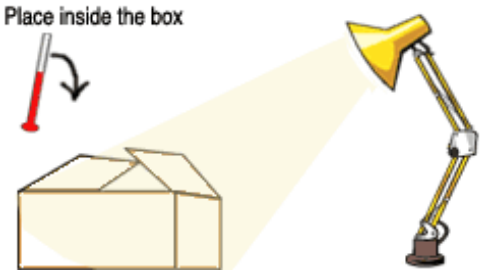
- Take the two boxes and put them an equal distance from the lamp so they get approximately the same amount of light hitting them.
- Put the thermometers inside the boxes
- Measure the ambient temperature
- Place the plants between one of the boxes and the lamp such that the shadows cover most of the box.
- Turn on the lamp
- Measure the air temperature in each over a period of time. Which box has a higher temperature? Does the temperature change? Subtract or add plants…do the number of plants change the temperature of the shaded "house?"

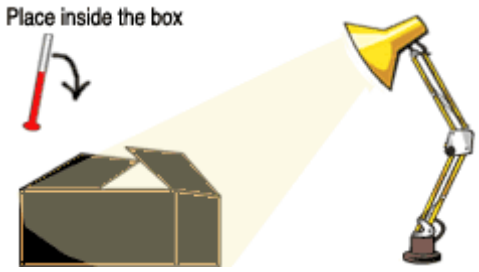
Lead a discussion about the results. How would this apply to the real world? How could they use these results in designing a house? Would they put plants around their houses now? What type of plants would be best (ones that drop their leaves in autumn? Why?)

As an extension to this experiment have the students do some internet research as to how they can use the heat from the sun to make a positive difference to their house (solar powered air-conditioning, solar powered water heater for winter, etc)

Experiment 2

This experiment shows the affect of colour on the temperature of a house. It is also a great conversation starter for the students to look at the difference that colour of clothes makes to those who wear them.





- Paint on of the boxes white and the other a dark colour (or black).
- Take the two boxes and put them an equal distance from the lamp so they get approximately the same amount of light hitting them.
- Put the thermometers inside the boxes
- Measure the ambient temperature
- Place the plants between one of the boxes and the lamp such that the shadows cover most of the box.
- Turn on the lamp
- Measure the air temperature in each over a period of time. Which box has a higher temperature? Does the temperature change?

An extension of this experiment is to have the students research the difference that colour has on the radiative effects of bodies. What colour clothes do people in hot climates wear? Why?

One further experiment is to repeat Experiment 1 with the painted boxes and note the differences. Is there a cumulative effect?

End the class with a discussion about what they learnt from the experiments. What actions can they take at home? What actions can they take around the school? Have the class list 5 actions they will take and put them up on a poster in the class.

Web links

Website	Description
http://www.energyquest.ca.gov/projects	Excellent website for a range of energy related projects.
http://coolcosmos.ipac.caltech.edu/cosmic_kids/learn_ir/index.html	Cool Cosmos page discussing Infrared light. Excellent pictures demonstrating the principle.
http://www.eia.doe.gov/kids/energyfacts/sources/renewable/solar.html	Nifty energy page for kids from the USA Department of Energy.

Activity 3: Heat from Light Bulbs

(Adapted from http://www.energyquest.ca.gov/projects)

Purpose

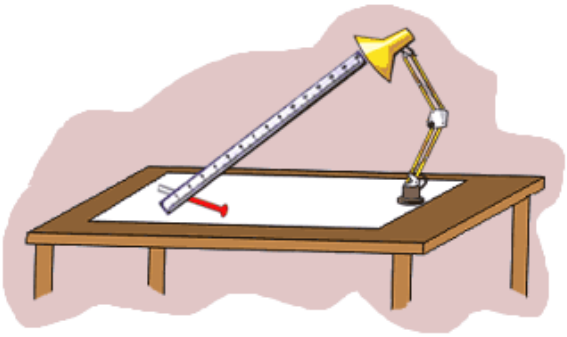
This activity allows the students to explore the relationship between a light bulb's wattage and the heat it produces. Incandescent light bulbs give off infra-red energy (heat) as well as light. In fact, for incandescent light bulbs, light is a by-product of the design. Up to 95% of a incandescent's wattage is used to produce heat. The higher the wattage of the light bulb, the higher the temperature. A compact fluorescent bulb gives off very little heat energy because they do not use resistance and cause a light to glow hot.

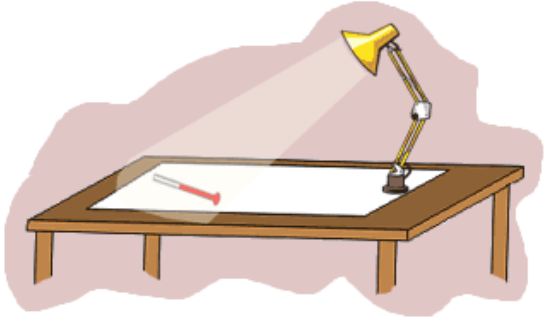
Requirements

- A goose-neck style lamp.
- An extension cord.
- Different wattage of incandescent light bulbs - 20 watt, 40 watt, 60 watt, 75 watt, 100 watt.
- Compact Fluorescent light bulbs - 11 watt, 15 watt, 20 watt (check out the one's provided at www.changeamillionlightbulbs.com or www.standbysaturday.com.au)
- Thermometer.
- A ruler or metre stick to measure distance from the thermometer to the light bulb.
- A white towel.
- A watch or stop watch to measure the time.
- A piece of paper and pencil to record your observations.

Experiment

1. Put the towel on a flat table.
2. Put the goose neck lamp on the end of the towel on the table
3. Put the thermometer under the light of the lamp and measure the distance from the bulb. Make sure that the angle of the lamps will have the light fall on the thermometer.
4. Make sure the lamp is unplugged and insert in the smallest wattage light bulb
5. Measure the temperature and write down the start temperature.
6. Turn on lamp.
7. Leave lamp shining on the thermometer for at least five minutes
8. Start watch and at the end of five minutes read the temperature and mark down what the final temperature is.
9. Repeat the steps above for each different light bulb.





Discuss the results with the students.

- What did they notice?
- What did they notice about a 20 watt incandescent and a 20 watt compact fluorescent?
- What does this mean about the design of the incandescent light bulb?
- Find out the difference between how an incandescent light bulb and a compact fluorescent light bulb work (see wikipedia references below)
- In a home or office, lots of incandescent lights means that the air conditioner would have to use more energy during the summer to remove the extra heat given off by the lights. Also, a number of fires have been started by incandescent light bulbs

Handy hints

- Allow the lamp and desk to cool between each bulb. If you have several lamps and towels you can move quicker through the experiment.
- Do not take out the light bulb right after turning off the lamp as the bulb may be hot and can burn you.
- Unplug the lamp before changing the bulb.
- Make sure the distance between the thermometer and the light bulb is the same for each different bulb. The thermometer should be in the same spot.
- The starting temperature for thermometer should be about the same for each light bulb.

Web links

Website	Description
http://www.energyquest.ca.gov/projects	Excellent website for a range of energy related projects.
www.changeamillionlightbulbs.com	Light Bulb Fundraiser Page with a great and simple background on Climate change and the importance of reducing energy.
http://en.wikipedia.org/wiki/Compact_fluorescent_lamp	Wikipedia entry for compact fluorescent light bulbs
http://en.wikipedia.org/wiki/Incandescent_lamp	Wikipedia entry for Incandescent light bulbs
www.standbysaturday.com.au	Australian Standby Saturday 24/7 website

Activity 4: Greenhouse Effect

(Adapted from http://www.energyquest.ca.gov/projects)

Purpose

The Earth's climate has changed many times in the past. Subtropical forests have spread from the south into more temperate (or milder, cooler climates) areas. Millions of years later, ice sheets spread from the north covering much of the northern United States, Europe and Asia with great glaciers. Today, nearly all scientists believe human beings are changing the climate. How can that be?

Over the past few centuries, people have been burning more amounts of fuels such as wood, coal, oil, natural gas and gasoline. The gases formed by the burning, such as carbon dioxide, are building up in the atmosphere. They act like greenhouse glass. The result, experts believe, is that the Earth heating up and undergoing **global warming**. How can you show the **greenhouse effect?**

This activity allows the students to explore the greenhouse effect.

Requirements

- Two identical glass jars
- 4 cups cold water
- 10 ice cubes
- One clear plastic bag
- Thermometer

Experiment

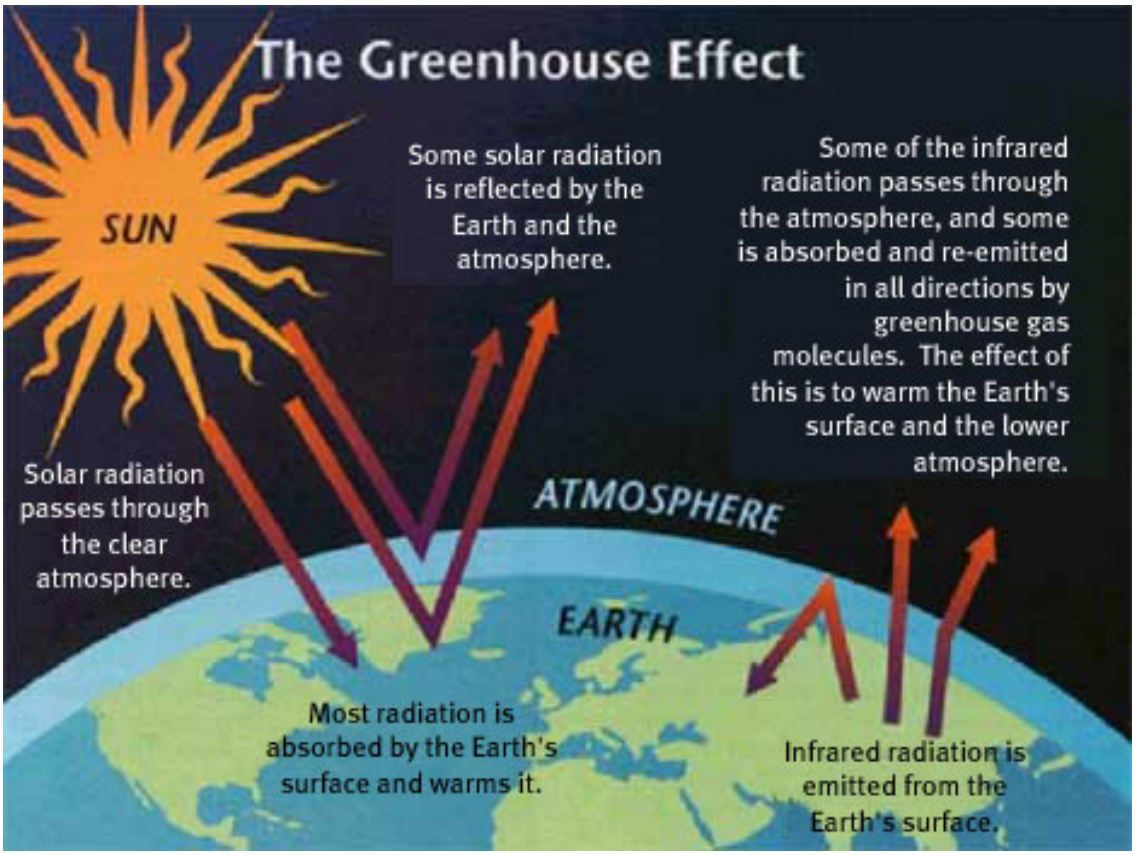
1. Take two identical glass jars each containing 2 cups of cold water.
2. Add 5 ice cubes to each jar.
3. Wrap one in a plastic bag (this is the greenhouse glass).
4. Leave both jars in the sun (or under a 100W incandescent bulb) for one hour.
5. Measure the temperature of the water in each jar.

Discuss the following

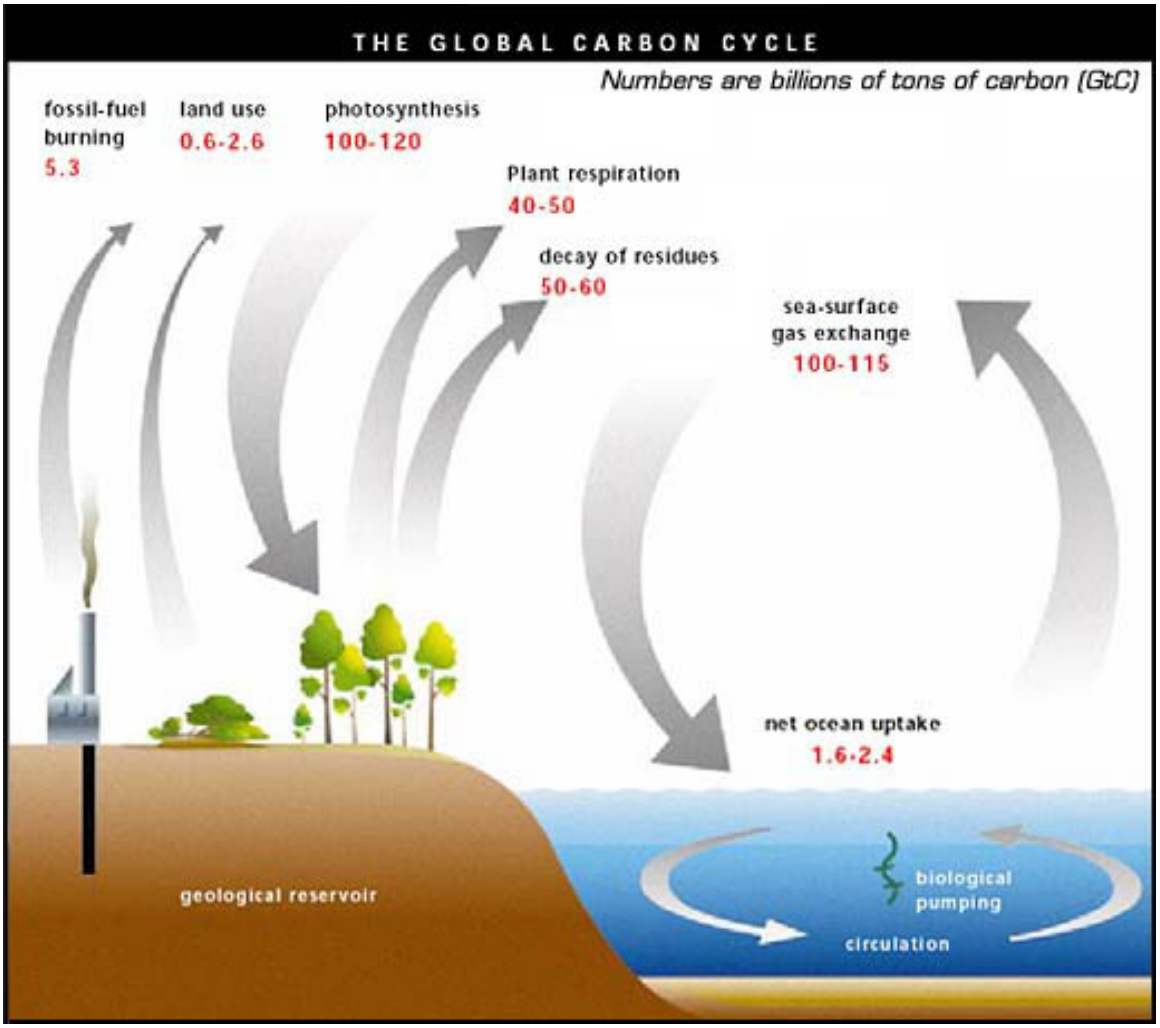
- In bright sunshine, the air inside a greenhouse becomes warm. The greenhouse glass lets in the sun's light energy and some of its heat energy (infrared). This heat builds up inside the greenhouse. You just showed a small **greenhouse effect**. What could happen if this **greenhouse effect** changed the Earth's climate?
    - Search the internet to see what the potential impacts would be of the greenhouse effect. At www.changeamillionlightbulbs.com there is a great list of resources with links to articles about the perceived impact of climate change on different parts of the world.
- Another version of a greenhouse is what happens inside a car parked in the sun. The sun's light and heat gets into the vehicle and is trapped inside, like the plastic bag around the jar. The temperature inside a car can get over 49 degrees Celsius. Discuss the effect of this.

Web links

Website	Description
http://www.energyquest.ca.gov/projects	Excellent website for a range of energy related projects.
www.changeamillionlightbulbs.com	Light Bulb Fundraiser Page with a great resource page
http://www.thirteen.org/edonline/ntti/resources/lessons/infrared/	Lessons on infrared energy and its effect
www.safeclimate.net	US website with a lot of useful information about climate change and the impact on business
http://en.wikipedia.org/wiki/Greenhouse_effect	Wikipedia entry on GreenHouse Effect
www.standbysaturday.com.au	Australian Standby Saturday 24/7 website



Source: www.safeclimate.net



Source: http://www.esd.ornl.gov/iab/iab2-2.htm