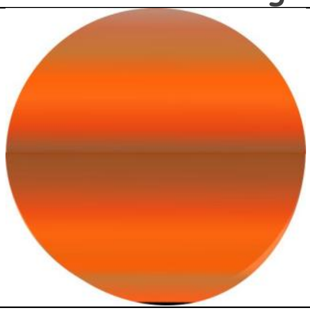
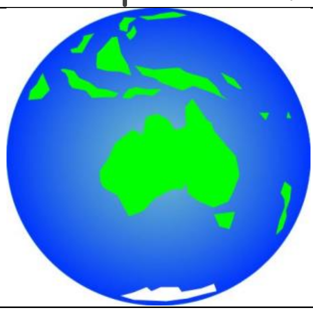
Energy for Planets – Teacher's Notes

Our Sun emits radiation across space and only some of it arrives on Earth. This radiation comes from the thermo nuclear reactions that take place as gravitational forces within our massive sun smashes together hydrogen atoms to form the gas helium and energy is left over. Solar energy is radiated out into space in all directions.

"Goldilocks" Earth is just the right distance from the Sun to be able to have liquid water. It has just the right magnetic field to deflect some of the nastier forms of solar radiation and just the right atmosphere to be able to retain some heat. These three important characteristics mean it can maintain life.
Venus is too close to the sun and is too hot. Mars is further away from the Sun, has lost its atmosphere and is too cold, though things were different in the past.

Average surface temperature of three planets

		
Venus	**Earth**	**Mars**
450°C	13°C	-87°C to 20°C

Most solar energy is deflected past Earth by our magnetic field. Long wave energy is mostly light (both visible and ultra-violet light). Short wave radiation is mostly heat (infra-red energy). Heat energy can pass through high thin cloud but is reflected by low thick cloud and by the surface of the Earth. High thin cloud will return outgoing heat back to Earth. This is a delicate balance that requires just the right proportion of gases in our atmosphere.

Common Student Misconception

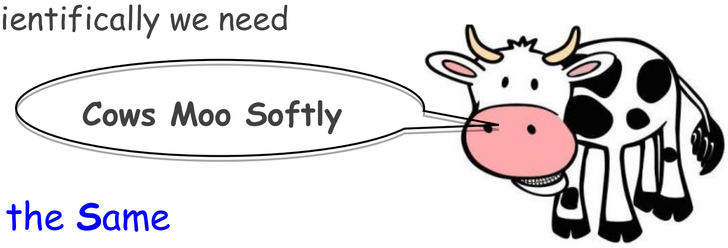
The Greenhouse effect is BAD!

Without clouds reflecting back heat from the Sun and gases retaining heat, our Earth would be too cold for life.
Like greenhouses in icy parts of the world, they keep plants warm enough to grow. Living things' body processes depend on enzymes, which only work within a narrow range of temperatures.

To Find if the Sun Heat the Atmosphere and Which School Location is the Warmest

If we want to experiment scientifically we need to follow the same rules:

Change one thing
Measure one thing
S Everything else **S**tays the **S**ame



We also need to be able to use technology that will give us accurate and precise measurements. What technology can we use to measure heat? A thermometer or thermo-probe. There is more information and activities on using a thermometer in PALMS2 p39-53.

Improving the safety and accuracy of using a glass thermometer.

1. Never hold it by the bulb end. Why? If you hold the thermometer by the bulb you will be taking the external temperature of your body, not of the atmosphere.

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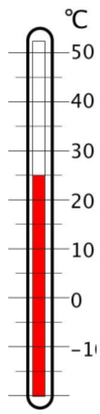
2. Carry the thermometer horizontally across your body when moving. Why? If you slip you won't poke the glass rod into someone else or fall on it cutting yourself.
3. Always raise the thermometer so that your eyes are level with the fluid when you read the temperature. Why? This avoids parallax (misreading at an angle).
4. How accurately can you estimate the temperature using this technology? Most students should be able to estimate to half a degree Celsius. Thermo-probes should however give readings to two decimal places

If students work in groups of three, one can be the experimenter and hold the thermometer, one the note taker and the last kneels or bends down to read the thermometer with eyes level with the liquid.



Materials per group

- A thermometer (laboratory thermometers - no mercury)
- A worksheet and pen
- A roll of masking tape
- A ruler
- A map of the school with three locations marked on it.

Method

1. Measure a height of 1m on the classroom wall or door and mark with masking tape.
2. One student in each group lines up with the measured mark and places a piece of masking tape on himself or herself at exactly the same (1m) height as the marking on the wall. This student is in charge of the thermometer.
3. Care must be taken to ensure to select similar locations but one in full sun and the other in shade. As much as possible everything else

should be the same (closeness to buildings or dark surfaces, both out of wind etc.)

4. At the first location, the student in charge of the thermometer holds it vertically away from their body with the bulb level with their 1m mark. After waiting one minute, three readings are taken and entered in the worksheet.
5. Students move to the second location and repeat.
6. Calculate the average temperature of the readings in shade and those in full sun.

Observations for location 1

	Shade (°C)	Full sunlight (°C)
Reading 1		
Reading 2		
Reading 3		
Average Reading		

Observations for location 2

	Shade (°C)	Full sunlight (°C)
Reading 1		
Reading 2		
Reading 3		
Average Reading		

Observations for location 3

	Shade (°C)	Full sunlight (°C)
Reading 1		
Reading 2		
Reading 3		
Average Reading		

Conclusion A conclusion is the idea that our collected data leads us to state.
Which location about the school is the warmest? Will depend on school/day.
What can you conclude from this data? Sunlight heats the atmosphere. The Sun produces heat energy.
Why did we hold the thermometer 1m above the surface? We wanted to measure the temperature of the atmosphere and not the ground.
Why did we take three readings and not just one? Nature isn't constant. The more readings we take the better our data will be.

Extra for Experts

Weather scientists take readings from stations set 1.2m above ground to minimise the effect of heat radiated back from the ground. The equipment is held behind double louvered walls to minimise the cooling effect of wind or rain and under double roofs. The box is called a Stevenson Screen. Students may wish to return to their reading locations and contrast readings when the reading is taken close to the ground, with a wet thermometer bulb or if "wind" is blown onto the bulb.

Why wouldn't you erect a weather station near the barbeque? The local air would be heated when the barbeque was on.
Why aren't weather stations erected under the eaves of a building? They are in shade, getting less heat from the sun and would be cooler than general atmospheric temperature.
Why wouldn't you paint the walls of the station black? Black surfaces absorb heat and the temperature reading would be too high.

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Is There Anybody Out There?

Scientists have been looking at other solar systems to see if any have exoplanets suitable for life. By early 2017 they had found 3,449 of them. Most were gas planets. However in February 2017 they found a star in the constellation of Aquarius called Trappist1. It lies 40 light years away from us. By conventional spacecraft it would take 700,000 years to reach. Although the energy it emits is 2,000 times fainter than our sun, it is surrounded by 7 rocky exoplanets, which orbit within the habitable "Goldilocks zone".

More information can be found at:
https://www.theguardian.com/science/2017/feb/22/thrilling-discovery-of-seven-earth-sized-planets-discovered-orbiting-trappist-1-star

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