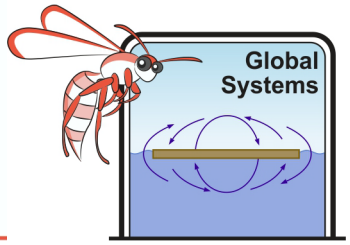


Greenhouse Effect – Teacher Notes

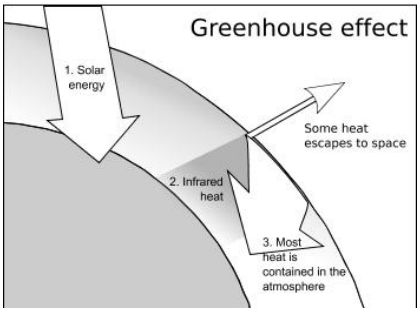
Before our present atmosphere was formed, radiant heat from the Sun was directly reflected from Earth's surface to be lost out into space. The original atmosphere was made up of hydrogen, water vapour, methane and ammonia. Most of this would have been blown away by solar winds.

Outgassing from volcanic activity, with additions from asteroid bombardment, produced our second nitrogen and carbon dioxide rich atmosphere to which was slowly added oxygen produced during photosynthesis by very early life forms (such as those that formed the stromatolite fossils we find in rocks in the Pilbara region of WA).

An increase in photosynthetic plants raised our oxygen levels to near our present levels by the Cambrian times. Changes in atmospheric carbon dioxide levels, due to tectonic movements and related volcanism, can be related to periods of heating and cooling during our geological history. The evidence of past climate variation lies in the rocks.

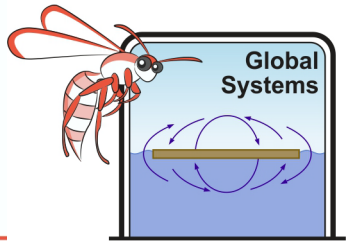
Most of the gas in our atmosphere is nitrogen 78.09% and oxygen 20.95%. These have little effect on retaining heat to maintain plant growth. The gases, which produce the Greenhouse Effect, are sometimes termed aerosol gases. Solar energy warms the Earth's surface and early in Earth's history was radiated back out into space. In the modern atmosphere, the built-up greenhouse gases trap incoming radiation and re-radiate it in all directions, including back to the surface of the planet. Life on Earth is sustained by the Greenhouse Effect. The surface of Earth would be more than 30°C cooler without it.

Water vapour is the most important greenhouse gas in terms of volume and heat retention. Having a short residence time, of four days, in the atmosphere means that it must be constantly replenished by evaporation from the ocean. Although the three other main greenhouse gases, carbon dioxide, methane and nitrous oxide are less present they remain in the atmosphere for very much longer and therefore have a greater continuous heat trapping effect. The largest natural source of carbon dioxide is from volcanic activity.



Gas	Percentage of greenhouse gases	Percentage produced naturally
1. Water vapour H_2O	95.000%	94.99%
2. Carbon dioxide CO_2	3.618%	3.502%
3. Methane CH_4	0.360%	0.294%
4. Nitrous oxide N_2O	0.950%	0.903%
5. Others	0.072%	0.025%

How does water vapour enter the atmosphere? Evaporation from oceans and other water bodies, respiration from plants and animals.



Greenhouse Effect – Teacher Notes

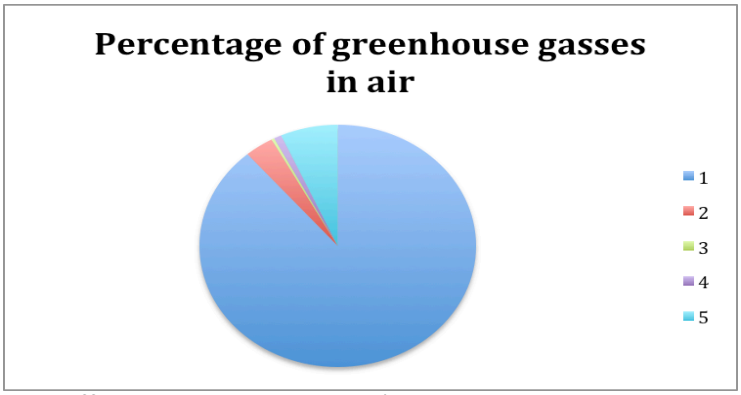
How does carbon dioxide enter the atmosphere? Respiration and decomposition from plants and animals, outgassing from volcanoes and burning fossil fuels.

How does methane enter the atmosphere? Decomposition in wetlands, vegetated soils and the ocean, decomposition in landfill, termite digestion, digestion by-product of ruminants, rice agriculture, burning fossil fuels and industrial processes. It traps 20 times more heat than CO_2.

How does nitrous oxide N_2O enter the atmosphere? Natural decomposition in soils and oceans, fertilisers in agriculture, burning fossil fuels, wastewater management and industrial processes. 300 x the effect of CO_2 and emitted by humans. Lifetime in atmosphere of about 120 years.

Interesting fact: The atmosphere of the planet Venus is 98% CO_2 and its surface temperature is 477^{0}C. It is said to have undergone the "Runaway Greenhouse Effect".

Which style of graph or chart would best represent the relative percentages of different greenhouse gases in the atmosphere? Explain your answer. A pie chart would best demonstrate the relative percentages (parts) of the whole.



Heat affects enzyme efficiency. (See enzyme efficiency and heat activity). Many cold climate gardeners and farmers extend the growing period and productivity of plants by placing seeds in a greenhouse (cold frame or cloche) to encourage germination at an earlier date. Glass permits the heating rays of the Sun to enter and walls stop wind blowing the heat away. Soil is slower to warm than air but retains heat longer. Seedlings are placed into the earth when ambient temperatures are warmer.

In very cold countries, such as Iceland, where mid-summer temperatures may stay below 7^{o}C, geothermal power is used to warm greenhouses so that the ground is warm enough to grow vegetables.

Greenhouse Effect – Teacher Notes

AIM **To demonstrate the Greenhouse Effect.**

Thermometers in greenhouse air, greenhouse soil and in open air

Materials per student or group

- A clean plastic cool drink bottle cut in half
- Two laboratory thermometers. (The class can share readings from one "control" thermometer). Thermo-probes may be used to take a digital recording over a longer period.
- A little plasticine or play dough to seal the thermometer holes in the half bottles
- Access to a garden bed or a laboratory tray with soil
- A sunny day will give the fastest results but a warm classroom window (radiant energy) will also give reasonable results

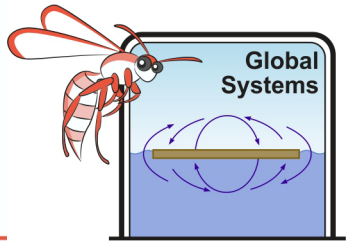
Thermometers are delicate glass tubes and should be treated with respect.
Never hold a thermometer by the bulb as this may affect later readings.
Adjust your position so your eye is level with the top of the liquid in the thermometer to avoid parallax mistakes.

Method

1. Select an area of sunlit soil or fill a laboratory tray with moist soil and place in a sunlit location.
2. Cut a clean clear plastic bottle in half.
3. Make a hole in the bottom half of the bottle. (See below for ideas).
4. Gently push the first thermometer through the hole in the bottom half of the bottle.
5. Set half bottle and thermometer safely upright in soil. The bulb of the thermometer should be in the air above the soil. Seal any gaps with plasticine or dough.
6. Place the second thermometer into the top of the half bottle and set it into the underlying soil. Gently adjust the position of the thermometer so that the bulb lies under the surface of the soil. Seal off the thermometer in the neck of the bottle with plasticine.
7. The control thermometer should be held to read ambient air temperature.
8. Read the temperatures in the air, the air in the bottle and the soil in the bottle.
9. Record your data.

Hypothesise what will happen to the air temperatures inside and outside the flask. You may write this as an "If……. Then ……." statement

If the tray is placed in sunlight then temperatures of air and soil in the bottles (greenhouses) will rise above external temperature.



Greenhouse Effect – Teacher Notes

Results/observations The results below may serve as a guide or be used if it is cloudy or raining

Time minutes	Control air temperature °C	Air temperature in greenhouse °C	Soil temperature in greenhouse °C
0	28	28	28
5	28	30	28
10	28	32	28
15	28	34	30
20	28	34	30
25	28	34	31
30	29	35	32
35	29	35	32
40	29	35	32

Did you observe any other change inside the "greenhouses"? Yes they had condensation on their insides from heated, moist soil.

Conclusions Temperature inside the "greenhouse" is higher than outside. The air heats faster than the soil. Radiant energy is stored within the greenhouse.

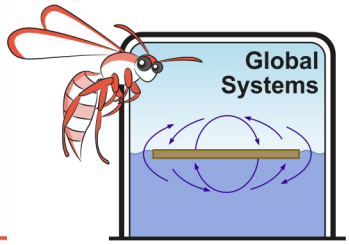
The temperature of soil is not directly related to air temperature. Soil heats and cools more slowly than air. Energy transfer and storage can be affected by soil colour and albedo (reflectivity) of mulch. Darker soil and mulch gain and retain heat better than lighter soils

Discussion

Was your hypothesis supported? Answer depends on the stated hypothesis.
Was your hypothesis proven? No. In science nothing is ever proven because data changes as instruments and ideas change.
How could this experiment be improved? Both accuracy and precision would be improved if a more sensitive temperature measuring device was used (difficult to read thermometer with precision) and the activity be repeated many times (to provide an average result).
What effect would the water vapour have on temperature in the greenhouse? Water vapour is a greenhouse gas and would cause further retention of heat.

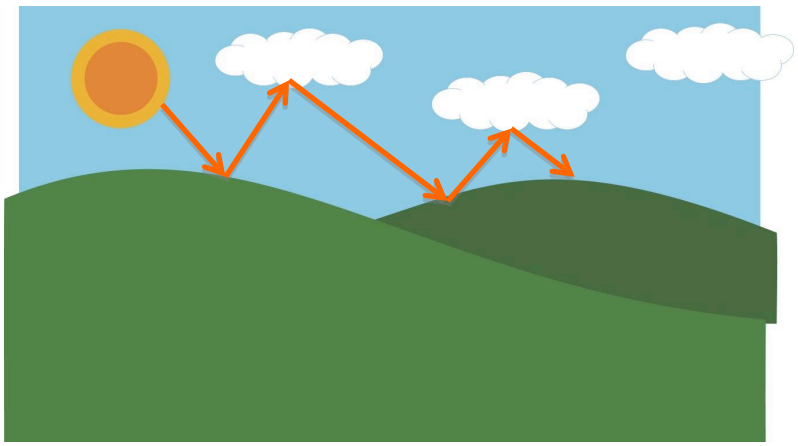
Recall

1. What is meant by the Greenhouse Effect? Atmospheric gases help retain solar heat to support life on Earth. It is a natural process that warms Earth's surface. Solar radiation is reflected back to Earth. This should not be confused with the Enhanced Greenhouse Effect which is a recent rapid rise in atmospheric temperature caused by increased levels of carbon dioxide, methane and nitrous oxide in the atmosphere.



Greenhouse Effect – Teacher Notes

Diagram: Draw the Sun's rays and what happens because of the Greenhouse Effect.



2. Why should we be grateful for the Greenhouse Effect?
The Greenhouse Effect keeps the surface of this planet warm enough to support life.

3. List the four main greenhouse gases from most common to least common. Water, carbon dioxide, methane and nitrous oxide

4. The Enhanced Greenhouse Effect or recent rapid warming of our atmosphere is the result of human/anthropogenic activities such as burning fossil fuels, agricultural practices and industry, including land clearing