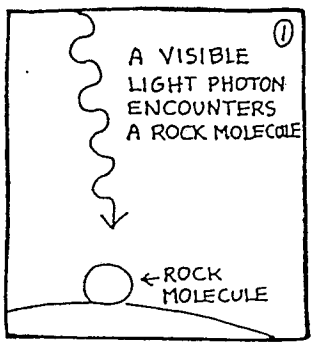
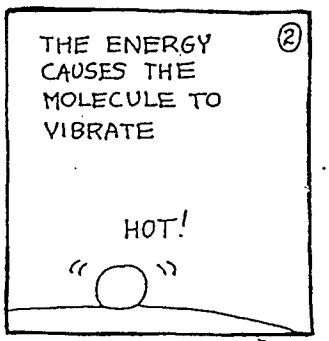
Teacher Background Information: The Greenhouse Gases

The Sun's energy is radiated in all directions in the form of photons, or packets of solar energy. One property of photons is that they are like waves. We perceive photons with relatively short wavelengths as visible light when they strike our eyes. Other photons that have relatively long wavelengths are perceived as heat when they strike our bodies, a rock or a body of water. These photons are infra-red.

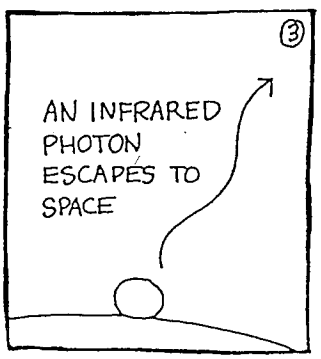
Only a small fraction of the huge number of photons emitted by the Sun encounter the Earth. Of those that do encounter the Earth, about 30% are immediately reflected back to space. Another 24% are absorbed in the atmosphere and about 46 percent are absorbed by the oceans and the continents making them warmer.

As a photon of visible light makes the 8 minute journey from the Sun to the Earth, it vibrates because it has some heat energy. If it manages to miss dust particles and clouds in the Earth's atmosphere it will eventually collide with a single rock or water molecule on the surface. The rock or dust molecules are already vibrating because they too, have some heat energy. When the photon hits the rock molecule, the energy of the photon causes a rock molecule to vibrate even more. If you were to touch the rock, you would feel the vibration of the molecules against your skin as warmth.

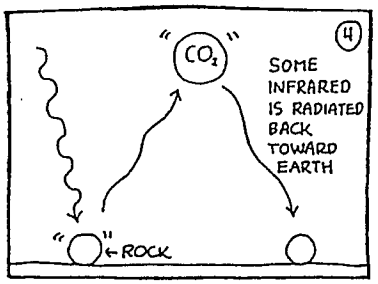




When the rock or water molecule is no longer bombarded by photons (in the shade or at night), it cools off. If you could see a rock molecule cool off, you would see it lose its energy by emitting longwave infrared photons. If you placed your hand a few inches from the rock, you would feel infrared photons leaving the rock as heat radiation.



Only a fraction of the photons emitted from the Earth's surface escape directly into space. Most of them are absorbed by gases in the Earth's atmosphere. The gases that make up most of the mass of our atmosphere, nitrogen and oxygen, are nearly transparent to both shortwave and longwave photons, and allow them to escape. However, other gases, like water vapor, carbon dioxide, methane, nitrous oxide and ozone all absorb infrared photons easily. These gases are called "greenhouse gases because they act somewhat like the glass in a greenhouse. They are transparent to visible light, but they can absorb infrared.



These gases make up only a small percent of the Earth's atmosphere, but they account for just about all of its heat-trapping capacity. How do the greenhouse gases trap heat? First they absorb infrared photons the same way that a rock or water molecule does, by vibrating. They cool off in the same way, by emitting an infrared photon. The infrared photon can go in any direction: upwards into space, sideways, it may encounter another greenhouse gas molecule and warm the atmosphere again, or downwards, where it may again warm the Earth's surface. Thus the greenhouse gases act as a "blanket" around the Earth.