Hot car inside in the summertime—way hotter than the outside air.

Summer is a great time of year. The weather is warm. People spend a lot of time outside. Eventually you have to return home. Imagine you have spent the entire day playing outside, while your car was parked in a parking lot. You open the door to climb in your car. It feels like you are climbing into an oven!

Based on your own experiences record observations and questions about this phenomena.

Observations	Questions

Explain why the inside of a car that is parked outside during the summer can become so hot.

The Greenhouse Effect

Standard 6.3.4: Construct an explanation supported by evidence for the role of the natural greenhouse effect in Earth's energy balance, and how it enables life to exist on Earth. Examples could include comparisons between Earth and other planets such as Venus and Mars.

As you read this section, focus on how energy from the Sun interacts with Earth and the atmosphere. Think about how the natural greenhouse effect contributes to Earth's energy balance, and allows for life to exist on Earth.

What is the Greenhouse Effect?

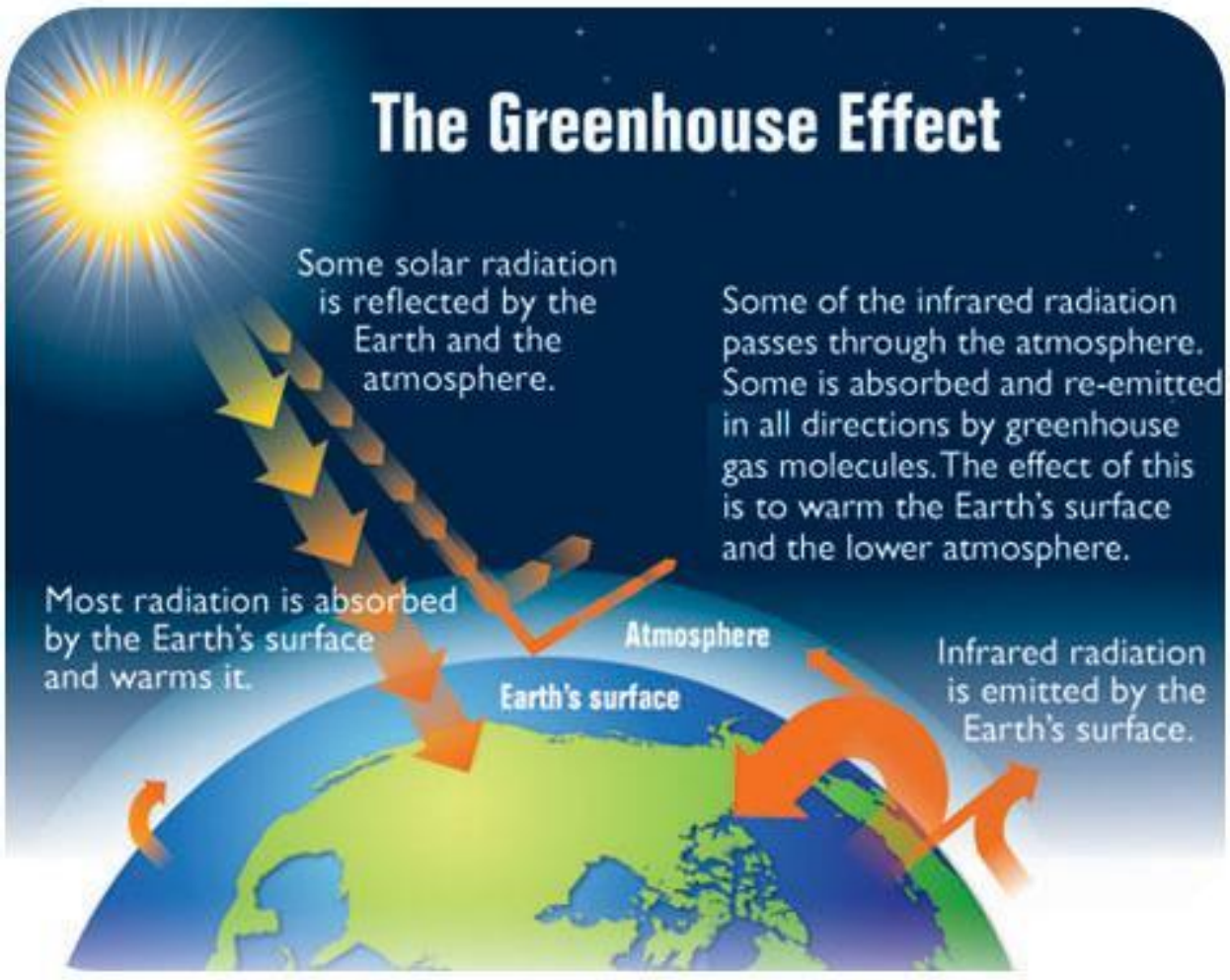
When sunlight heats Earth's surface, some of the heat radiates into the atmosphere. Some of this heat is absorbed by gases in the atmosphere. This is the greenhouse effect, and it keeps Earth warm. The greenhouse effect allows Earth to have temperatures that can support life.

Gases that absorb heat in the atmosphere are called greenhouse gases. They include carbon dioxide and water vapor. Like a blanket on a sleeping person, greenhouse gases act as insulation for the planet. The warming of the atmosphere is because of insulation by greenhouse gases. Greenhouse gases are the component of the atmosphere that moderate Earth's temperatures.

The greenhouse effect is a natural feature of Earth's atmosphere. Without the greenhouse effect, Earth's surface temperature would average -18ºC (0ºF) a temperature far too cold to support life as we know it. With the greenhouse effect, Earth's surface temperature averages 15ºC (5ºF), and it is this temperature range to which today's diversity of life has adapted.

The movement of energy due to the greenhouse effect is summarized in the figure below . Of the solar radiation which reaches the Earth's surface, as much as 30% is reflected back into space. About 70% is absorbed as heat , warming the land, waters, and atmosphere. If there were no atmosphere, most of the heat would radiate back out

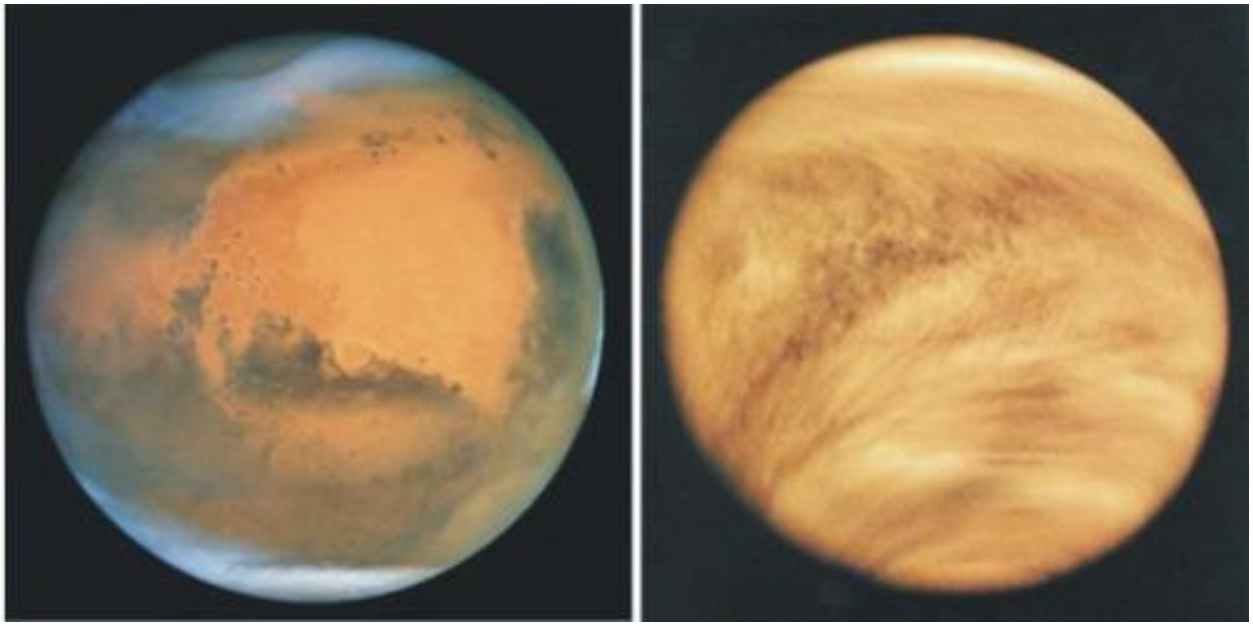
into space as infrared radiation. Earth's atmosphere contains molecules of water (H_2O), carbon dioxide (CO_2), methane (CH_4), and ozone (O_3), which absorb some of the infrared radiation. Some of this absorbed radiation further warms the atmosphere, and some is emitted, radiating back down to the Earth's surface or out into space. A balance between the heat which is absorbed and the heat which is radiated out into space results in an equilibrium which maintains a constant average temperature for the Earth.



Without greenhouse gases, most of the sun's energy (transformed to heat) would be radiated back out into space. Greenhouse gases in the atmosphere absorb and reflect back to the surface much of the heat which would otherwise be radiated.

If we compare Earth's atmosphere to the atmospheres which surround Mars and Venus (Figure below) we can understand why the composition of the Earth's atmosphere is important. Mars ' atmosphere is very thin, exerting less than 1% of the surface pressure of the Earth. As you might expect, the thin atmosphere cannot hold

heat and the average surface temperature is -55°C (-67°F) – even though that atmosphere is 95% CO_2 and contains a great deal of dust. Daily variations in temperature are extreme, because the atmosphere cannot hold heat.



The thickness of a planet's atmosphere strongly influences its temperature through the greenhouse effect. Mars (left) has an extremely thin atmosphere, and an average temperature near -55ºC. Venus (right) has a far more dense atmosphere than Earth, and surface temperatures reach 500ºC.

In contrast, Venus ' atmosphere is much thicker than Earth's, exerting 92 times the surface pressure of our own. Moreover, 96% of the atmosphere is CO_2, so a strong greenhouse effect heats the surface temperature of Venus as high as 500°C, hottest of any planet in our solar system. The thick atmosphere prevents heat from escaping at night, so daily variations are minimal.

Focus Questions:

- Explain how the atmosphere keeps the Earth warm?
- Draw a Venn diagram comparing the atmosphere of Mars and Venus.
- How would Earth's temperature be affected if the greenhouse gases in the atmosphere decreased? How would Earth's temperature be affected if the greenhouse gases in the atmosphere increased?

Putting it all together:

Summer is a great time of year. The weather is warm. People spend a lot of time outside. Eventually you have to return home. Imagine you have spent the entire day playing outside, while your car was parked in a parking lot. You open the door to climb in your car. It feels like you are climbing into an oven!

Review your explanation for why a car parked outside during the summer can become so hot. Based on what you have learned, revise your explanation for why a car can become so hot, and explain what you can do to prevent a car from becoming too hot during the summer.