1. What two things can happen when energy from the Sun interacts with the ground?
   Energy from the Sun can be reflected back into space, or it can be absorbed by Earth’s surface.

2. How does carbon dioxide ($CO_2$) interact with the two types of radiation (sunlight and infrared) shown in this model?
   Carbon dioxide is not affected by sunlight. But the infrared radiation changes direction when it hits a carbon dioxide molecule.

3. How does atmospheric carbon dioxide affect global temperature?
   Increased levels of atmospheric carbon dioxide cause increases in the temperature.

4. What happens if you remove all of the carbon dioxide from the atmosphere?
   The temperature decreases.

5. Explain your answer.
   When I removed all of the carbon dioxide from the atmosphere, the temperature dropped.

6. How certain are you about your claim based on your explanation?
   Answers will vary.

7. Explain what influenced your certainty rating.
   Answers will vary. Scientific evidence includes: carbon dioxide causes increases in temperature and specific reference to experiments with the model.

8. What happens when the sunlight hits particles in the ground? (Try resetting the model and turning on “Display heat molecules.” Redder shading means higher energy.)
   When sunlight hits the particles in the ground, they get hotter.

9. What happens when the sunlight hits greenhouse gas molecules?
   Nothing happens to the temperature when sunlight hits greenhouse gases.

10. What happens when infrared radiation hits the greenhouse gas molecules? How does the temperature change as a result?
    When infrared radiation hits greenhouse gases, it is absorbed and deflected. The greenhouse gas is excited by the radiation (it glows), and the infrared radiation is re-emitted in a different direction. The temperature increases as a result.
Interactions Within Earth’s Atmosphere Answer Key, continued

11. Based on the Earth system model and the molecular model, how do carbon dioxide (CO$_2$) and other greenhouse gases cause Earth’s atmosphere to warm? (Choose all correct answers.)

Greenhouse gases
- absorb outgoing infrared radiation.
- emit outgoing infrared radiation.

12. Describe the similarities between the molecular model and the Earth system model.

The molecular model is similar to the Earth system model because both show the interactions of solar and infrared radiation with greenhouse gases and the ground. The infrared radiation is absorbed and re-emitted by the greenhouse gases, keeping the infrared radiation (heat) in the atmosphere for longer, which raises the temperature of the molecular model and the temperature of the Earth in the Earth system model.

13. Which factor is represented by the purple arrows in the Earth system model?

infrared radiation

14. What evidence do you have to support this?

The purple arrows are deflected when they hit carbon dioxide molecules. Carbon dioxide molecules are greenhouse gases. Greenhouse gases absorb and re-emit infrared radiation. The re-emission would cause the deflection that you see with the purple arrows in the Earth system model when they hit carbon dioxide molecules.

15. What are some of the causes of the carbon dioxide increase over the past 50 years?

Some causes of the carbon dioxide increase over the past 50 years are burning of fossil fuels and removal and burning of forests.

16. Why does the carbon dioxide level fluctuate during a single year (the red “wiggles” in the CO$_2$ plot)? (Hint: Think about some natural reasons that CO$_2$ would increase and decrease over a yearly period.)

The carbon dioxide level fluctuates within a single year because of plant growth. During the growing season, plants take up carbon dioxide, decreasing the atmospheric levels. During the non-growing season, plants decay, releasing carbon dioxide back into the atmosphere.

17. How many years of data are available from the Vostok ice core?

420,000 years

18. Temperature is related to the amount of carbon dioxide in the atmosphere. How does the temperature of 125,000 years ago compare to the temperature of 355,000 years ago? The temperature 125,000 years ago was likely higher than 355,000 years ago.
19. Explain your answer.
   The temperature was likely higher 125,000 years ago than it was 355,000 years ago because the carbon dioxide concentration 125,000 years ago was higher than it was 355,000 years ago. Carbon dioxide levels are related to temperature; when there is more carbon dioxide, more heat can be retained in the atmosphere, leading to warmer temperatures. With lower levels of carbon dioxide, the temperature of 355,000 years ago was likely lower.

20. How certain are you about your claim based on your explanation?
   Answers will vary.

21. Explain what influenced your certainty rating.
   Answers will vary. Scientific evidence includes: carbon dioxide is a greenhouse gas, greenhouse gases trap heat energy in the atmosphere, higher concentrations of carbon dioxide lead to higher temperatures, and the carbon dioxide level of 125,000 years ago was higher than the CO₂ level of 355,000 years ago.