Chapter 02 - Energy - Warming the Earth and the Atmosphere

1. Each year, Earth's surface radiates away more energy than it receives from the Sun.
   a. True
   b. False

ANSWER: False
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

2. Good absorbers of radiation are usually poor emitters of radiation.
   a. True
   b. False

ANSWER: False
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

3. At night, low clouds weaken the atmospheric greenhouse effect.
   a. True
   b. False

ANSWER: False
DIFFICULTY: Bloom's: Understand
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.8: - Discuss the atmospheric greenhouse effect, and assess its impact on climate and life on Earth.

4. The atmosphere near Earth's surface is "heated from below" by heat energy from Earth’s interior.
   a. True
   b. False

ANSWER: False
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

5. Occasionally, the aurora can be observed in the United States.
   a. True
   b. False

ANSWER: True
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.12: - Identify the differences between solar winds and storms and their respective phenomena as observed in Earth's atmosphere.

6. A temperature of 250 K is considered extremely hot.
   a. True

b. False

ANSWER: False
DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.2: - Compare the Fahrenheit, Celsius and Kelvin temperature scales and outline their scientific backgrounds and uses today.

7. Heat is transferred in Earth's atmosphere by radiation.
a. True
b. False

ANSWER: True
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.9: - Examine the effect that conduction, convection, scattering, and reflection have on Earth's radiant energy budget

8. Even though Earth is cooler than the Sun, it emits much more radiation than the Sun.
a. True
b. False

ANSWER: False
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

9. In the atmosphere, advection is horizontal, convection is vertical.
a. True
b. False

ANSWER: True
DIFFICULTY: Bloom's: Remember
REFERENCES: Heat Transfer in the Atmosphere
LEARNING OBJECTIVES: METT.AHRE.16.2.4: - Describe the principles of conduction, convection and advection and summarize their roles in Earth's atmosphere.

10. The infrared portion of the electromagnetic spectrum carries the most amount of energy.
a. True
b. False

ANSWER: False
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

11. Carbon dioxide and water vapor are called selective absorbing greenhouse gases.
a. True
b. False

ANSWER: True

DIFFICULTY: Bloom's: Understand
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.7: - Define the terms blackbody, radiative equilibrium temperature, selective absorber, atmospheric window, and describe their relationship to the atmospheric greenhouse effect.

12. Both Earth and the Sun can be treated as blackbodies.
    a. True
    b. False
ANSWER: True
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

13. The aurora usually occur more frequently above Maine than above Washington State.
    a. True
    b. False
ANSWER: True
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.11: - Describe the solar wind and its interaction with Earth's magnetic field.

14. The solar wind is not responsible for solar storms. Solar wind and solar storm are simply different names for the same phenomena.
    a. True
    b. False
ANSWER: False
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.12: - Identify the differences between solar winds and storms and their respective phenomena as observed in Earth's atmosphere.

15. Without water vapor to absorb Earth's emitted infrared radiation, Earth would lose more heat.
    a. True
    b. False
ANSWER: True
DIFFICULTY: Bloom's: Understand
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.7: - Define the terms blackbody, radiative equilibrium temperature, selective absorber, atmospheric window, and describe their relationship to the atmospheric greenhouse effect.

16. Visible radiation is more successful in dislodging electrons from air atoms and molecules than ultraviolet radiation.

a. True
b. False

ANSWER: False
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

17. Most of the solar wind emitted by the Sun never reaches Earth due to Earth's tilt.
a. True
b. False

ANSWER: False
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.11: - Describe the solar wind and its interaction with Earth's magnetic field.

18. Temperature and heat describe the same characteristic of Earth's atmosphere.
a. True
b. False

ANSWER: False
DIFFICULTY: Bloom's: Remember
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.1: - Define the terms energy, potential energy, kinetic energy, radiant energy, temperature and heat, and describe their relationships in the context of Earth's atmosphere.

19. A change of one degree on the Celsius scale is ____ a change of one degree on the Fahrenheit scale.
a. equal to
b. larger than
c. smaller than
d. in the opposite direction of
e. insignificant in comparison to

ANSWER: b
DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.2: - Compare the Fahrenheit, Celsius and Kelvin temperature scales and outline their scientific backgrounds and uses today.

20. If the temperature of the air is said to be at absolute zero, one might conclude that the
a. motion of the molecules is at a maximum.
b. molecules are occupying a large volume.
c. molecules contain a minimum amount of energy.
d. temperature is 0°F.
e. air temperature is 0°C.

ANSWER: c

DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.2: - Compare the Fahrenheit, Celsius and Kelvin temperature scales and outline their scientific backgrounds and uses today.

21. Energy of motion is also known as
    a. dynamic energy.
    b. kinetic energy.
    c. sensible heat energy.
    d. static energy.
    e. latent heat energy.

ANSWER: b
DIFFICULTY: Bloom's: Remember
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.1: - Define the terms energy, potential energy, kinetic energy, radiant energy, temperature and heat, and describe their relationships in the context of Earth's atmosphere.

22. The heat energy released when water vapor changes to a liquid is called
    a. specific heat of evaporation.
    b. latent heat of fusion.
    c. latent heat of fission.
    d. latent heat of condensation.
    e. specific heat of condensation.

ANSWER: d
DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.3: - Differentiate heat capacity, specific heat, latent heat and sensible heat, and explain how they relate to evaporation-transportation-condensation cycles in Earth's atmosphere.

23. When water changes from a liquid to a vapor, we call this process
    a. freezing
    b. condensation
    c. sublimation
    d. deposition
    e. evaporation

ANSWER: e
DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.3: - Differentiate heat capacity, specific heat, latent heat and sensible heat, and explain how they relate to evaporation-transportation-condensation cycles in Earth's atmosphere.

24. What is released as sensible heat during the formation of clouds?
    a. deposition

b. longwave radiation
c. latent heat
d. shortwave radiation
e. sublimation

ANSWER: c
DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.3: - Differentiate heat capacity, specific heat, latent heat and sensible heat, and explain how they relate to evaporation-transportation-condensation cycles in Earth's atmosphere.

25. The processes of condensation and freezing
a. both release sensible heat into the environment.
b. both absorb sensible heat from the environment.
c. do not affect the temperature of their surroundings.
d. do not involve energy transport.
e. are both negative processes.

ANSWER: a
DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.3: - Differentiate heat capacity, specific heat, latent heat and sensible heat, and explain how they relate to evaporation-transportation-condensation cycles in Earth's atmosphere.

26. Which of the following is the poorest conductor of heat?
a. still air
b. water
c. ice
d. snow
e. soil

ANSWER: a
DIFFICULTY: Bloom's: Remember
REFERENCES: Heat Transfer in the Atmosphere
LEARNING OBJECTIVES: METT.AHRE.16.2.4: - Describe the principles of conduction, convection, and advection and summarize their roles in Earth's atmosphere.

27. Horizontal transport by the wind is called
a. advection
b. radiation
c. conduction
d. latent heat.
e. reflection

ANSWER: a
DIFFICULTY: Bloom's: Remember
REFERENCES: Heat Transfer in the Atmosphere

LEARNING OBJECTIVES: METT.AHRE.16.2.4: - Describe the principles of conduction, convection, and advection and summarize their roles in Earth's atmosphere.

28. The amount of heat energy required to bring about a change in temperature in a substance is called the
    a. radiative equilibrium.
    b. dead heat.
    c. conduction heat.
    d. latent heat.
    e. heat capacity.

ANSWER: e
DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.3: - Differentiate heat capacity, specific heat, latent heat and sensible heat, and explain how they relate to evaporation-transportation-condensation cycles in Earth's atmosphere.

29. Snow will usually melt on the roof of a home that is
    a. facing south.
    b. a good conductor of heat.
    c. well insulated.
    d. poorly insulated.
    e. a poor radiator of heat

ANSWER: b
DIFFICULTY: Bloom's: Remember
REFERENCES: Heat Transfer in the Atmosphere
LEARNING OBJECTIVES: METT.AHRE.16.2.4: - Describe the principles of conduction, convection, and advection and summarize their roles in Earth's atmosphere.

30. A vertical exchange of heat is called
    a. expansion
    b. evaporation.
    c. compression
    d. condensation
    e. convection

ANSWER: e
DIFFICULTY: Bloom's: Remember
REFERENCES: Heat Transfer in the Atmosphere
LEARNING OBJECTIVES: METT.AHRE.16.2.4: - Describe the principles of conduction, convection, and advection and summarize their roles in Earth's atmosphere.

31. The temperature of a rising air parcel
    a. always cools due to expansion.
    b. always warms due to expansion.
    c. always cools due to compression.
    d. always warms due to compression.

e. remains constant.

ANSWER: a
DIFFICULTY: Bloom's: Remember
REFERENCES: Heat Transfer in the Atmosphere
LEARNING OBJECTIVES: METT.AHRE.16.2.4: - Describe the principles of conduction, convection and advection and summarize their roles in Earth's atmosphere.

32. The proper order from shortest to longest wavelength is
a. visible, infrared, and ultraviolet.
b. infrared, visible, and ultraviolet.
c. ultraviolet, visible, and infrared.
d. visible, ultraviolet, and infrared.

ANSWER: c
DIFFICULTY: Bloom's: Remember
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

33. Sinking air warms as a result of
a. compression
b. expansion
c. condensation
d. friction
e. conduction

ANSWER: a
DIFFICULTY: Bloom's: Remember
REFERENCES: Heat Transfer in the Atmosphere
LEARNING OBJECTIVES: METT.AHRE.16.2.4: - Describe the principles of conduction, convection and advection and summarize their roles in Earth's atmosphere.

34. How do red and blue light differ?
a. Blue light has a higher speed of propagation.
b. The wavelength of red light is longer.
c. Red light has a higher intensity.
d. Red and blue light have different directions of propagation.
e. The wavelength of blue light is longer.

ANSWER: b
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

35. Solar radiation reaches Earth's surface as
a. visible radiation only.
b. ultraviolet radiation only.
c. infrared radiation only.
d. visible and infrared radiation only.

e. ultraviolet, visible, and infrared radiation.

ANSWER: e
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

36. What determines the type (wavelength) and amount of radiation that an object emits?
a. temperature
b. thermal conductivity
c. density
d. latent heat
e. specific heat

ANSWER: a
DIFFICULTY: Bloom's: Remember
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.5: - Define electromagnetic energy and radiant energy, and illustrate the relationship between radiation and temperature.

37. Often before sunrise on a clear, calm, cold morning, ice (frost) can be seen on the tops of parked cars, even when the air temperature is above freezing because the tops of cars are cooling by a loss of
a. conduction.
b. convection.
c. latent heat.
d. radiation.
e. condensation.

ANSWER: d
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.5: - Define electromagnetic energy and radiant energy, and illustrate the relationship between radiation and temperature.

38. To keep an object cool while exposed to direct sunlight,
a. put it inside a brown paper bag.
b. wrap it in black paper.
c. wrap it in plastic wrap.
d. wrap it in aluminum foil with the shiny side facing outward
e. put it inside a clear container.

ANSWER: d
DIFFICULTY: Bloom's: Remember
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.5: - Define electromagnetic energy and radiant energy, and illustrate the relationship between radiation and temperature.

39. What type of energy has a wavelength shorter than that of violet light?
a. green visible radiation

b. blue visible radiation
c. infrared radiation
d. red visible radiation
e. ultraviolet radiation

ANSWER: e
DIFFICULTY: Bloom's: Remember
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

40. At which temperature would Earth be radiating energy at the greatest rate or intensity?
a. -5°F
b. -40°F
c. 60°F
d. 32°F
e. 105°F

ANSWER: e
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

41. Most of the radiation emitted by a human body is in the form of
a. ultraviolet radiation and is invisible.
b. visible radiation but is too weak to be visible.
c. infrared radiation and is invisible.
d. humans do not emit electromagnetic radiation.
e. the whole electromagnetic spectrum.

ANSWER: c
DIFFICULTY: Bloom's: Remember
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.5: - Define electromagnetic energy and radiant energy, and illustrate the relationship between radiation and temperature.

42. Clouds form by the process of
a. sublimation
b. condensation
c. evaporation
d. deposition
e. both deposition and condensation.

ANSWER: e
DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.3: - Differentiate heat capacity, specific heat, latent heat and sensible heat, and explain how they relate to evaporation-transportation-condensation cycles in Earth's atmosphere.

43. The Sun emits its greatest intensity of radiation in the
    a. visible portion of the spectrum.
    b. infrared portion of the spectrum.
    c. ultraviolet portion of the spectrum.
    d. x-ray portion of the spectrum.
    e. gamma ray portion of the spectrum.

ANSWER: a
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

44. Earth emits radiation with greatest intensity at
    a. infrared wavelengths.
    b. radio wavelengths.
    c. visible wavelengths.
    d. ultraviolet wavelengths.
    e. X-ray wavelengths.

ANSWER: a
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

45. Which principle best describes why melting occurs first in snow around tree trunks?
    a. Snow is a good absorber of infrared energy.
    b. Snow is a poor emitter of infrared energy.
    c. Snow is a poor reflector of visible light.
    d. Snow is a poor absorber of visible light.
    e. Snow is a poor absorber of ultraviolet light.

ANSWER: a
DIFFICULTY: Bloom's: Apply
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.7: - Define the terms blackbody, radiative equilibrium temperature, selective absorber, atmospheric window, and describe their relationship to the atmospheric greenhouse effect.

46. Without the atmospheric greenhouse effect, the average surface temperature would be
    a. higher than at present.
    b. lower than at present.
    c. the same as it is now.
    d. static
    e. radiative

ANSWER: b
DIFFICULTY: Bloom's: Understand
REFERENCES: Radiation - Absorption, Emission, Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.8: - Discuss the atmospheric greenhouse effect, and assess its impact on

climate and life on Earth.

47. The atmospheric greenhouse effect is produced mainly by the absorption and re-emission of
    a. visible light by the atmosphere.
    b. ultraviolet radiation by the atmosphere.
    c. infrared radiation by the atmosphere.
    d. visible light by clouds.
    e. visible light by the ground.

ANSWER: c
DIFFICULTY: Bloom's: Understand
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.8: - Discuss the atmospheric greenhouse effect, and assess its impact on climate and life on Earth.

48. Suppose last night was clear and calm. Tonight's forecast indicates that low clouds will be present. From this, you would conclude that tonight's minimum temperature will be
    a. higher than last night's minimum temperature.
    b. lower than last night's minimum temperature.
    c. the same as last night's minimum temperature.
    d. above freezing.
    e. below freezing.

ANSWER: a
DIFFICULTY: Bloom's: Understand
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.8: - Discuss the atmospheric greenhouse effect, and assess its impact on climate and life on Earth.

49. Which gases are primarily responsible for the atmospheric greenhouse effect in Earth's atmosphere?
    a. oxygen and nitrogen
    b. nitrogen and carbon dioxide
    c. ozone and oxygen
    d. water vapor and carbon dioxide
    e. nitrous oxide and chlorofluorocarbons.

ANSWER: d
DIFFICULTY: Bloom's: Understand
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.7: - Define the terms blackbody, radiative equilibrium temperature, selective absorber, atmospheric window, and describe their relationship to the atmospheric greenhouse effect.

50. The combined albedo of Earth and the atmosphere is approximately ____ percent.
    a. 4
    b. 10
    c. 30
    d. 50

e. 90

ANSWER: c
DIFFICULTY: Bloom's: Remember
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.9: - Examine the effect that conduction, convection, scattering, and reflection have on Earth’s radiant energy budget

51. The albedo of the Moon is 7 percent. This means that
a. the Moon can absorb seven times more energy than Earth.
b. 7 percent of sunlight striking the Moon is absorbed.
c. the Moon emits only 7 percent as much energy as it absorbs from the Sun.
d. 93 percent of sunlight striking the Moon is reflected.
e. 7 percent of sunlight striking the moon is reflected.

ANSWER: e
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.9: - Examine the effect that conduction, convection, scattering, and reflection have on Earth’s radiant energy budget

52. As ocean temperatures increase, which greenhouse gas increases and enhances the atmospheric greenhouse effect, thereby illustrating a positive feedback process?
a. nitrogen
b. oxygen
c. argon
d. water vapor
e. hydrogen sulfide

ANSWER: d
DIFFICULTY: Bloom's: Understand
REFERENCES: Radiation - Absorption, Emission, and Equilbrium
LEARNING OBJECTIVES: METT.AHRE.16.2.7: - Define the terms blackbody, radiative equilibrium temperature, selective absorber, atmospheric window, and describe their relationship to the atmospheric greenhouse effect.

53. On average, what percentage of solar energy striking the outer atmosphere eventually reaches Earth's surface?
a. 5 percent
b. 15 percent
c. 30 percent
d. 50 percent
e. 70 percent

ANSWER: d
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

54. If the amount of energy lost by Earth to space each year were not approximately equal to that received,
    a. the atmosphere's average temperature would change.
    b. the length of the year would change.
    c. the Sun's output would change.
    d. the mass of the atmosphere would change.
    e. nothing would change.

ANSWER: a
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

55. Sunlight that bounces off a surface is said to be ____ from the surface.
    a. radiated
    b. absorbed
    c. emitted
    d. reflected
    e. conducted

ANSWER: d
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.9: - Examine the effect that conduction, convection, scattering, and reflection have on Earth’s radiant energy budget

56. The main process responsible for warming in the lower atmosphere is
    a. the release of latent heat during condensation.
    b. the conduction of heat upward from the surface.
    c. the absorption of infrared radiation.
    d. the direct absorption of sunlight by the atmosphere.
    e. related to Earth’s albedo.

ANSWER: c
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

57. Earth's radiative equilibrium temperature is the
    a. average temperature at which Earth is absorbing solar radiation and emitting infrared radiation at equal rates.
    b. average temperature at which Earth is radiating energy at maximum intensity.
    c. average temperature Earth must maintain to prevent oceans from freezing solid.
    d. temperature at which rates of evaporation and condensation on Earth are in balance.
    e. temperature that humans and animals can survive in on Earth.

ANSWER: a

DIFFICULTY: Bloom's: Remember
REFERENCES: Radiation - Absorption, Emission, and Equilbrium
LEARNING OBJECTIVES: METT.AHRE.16.2.7: - Define the terms blackbody, radiative equilibrium temperature, selective absorber, atmospheric window, and describe their relationship to the atmospheric greenhouse effect.

58. Auroras are seen
    a. in the Northern Hemisphere only.
    b. in the Southern Hemisphere only.
    c. in both the Northern and Southern Hemispheres at high latitudes.
    d. in both the Northern and Southern Hemispheres near the equator.
    e. everywhere on Earth

ANSWER: c
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.12: - Identify the differences between solar winds and storms and their respective phenomena as observed in Earth's atmosphere.

59. Earth’s magnetic field protects Earth from some of the
    a. pollutants found in the atmosphere.
    b. dangerous ozone present in the atmosphere.
    c. dangerous gamma rays emitted by the Sun.
    d. ultraviolet radiation.
    e. particles emitted by the Sun in the form of solar winds and storms.

ANSWER: e
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.11: - Describe the solar wind and its interaction with Earth's magnetic field.

60. Solar winds are composed of
    a. charged particles.
    b. aerosols and other pollutants.
    c. water vapor.
    d. a variety of gases that have no charge.
    e. eletromagnetic waves.

ANSWER: a
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.11: - Describe the solar wind and its interaction with Earth's magnetic field.

61. The magnetosphere is
    a. composed of greenhouse gases.
    b. a thin, magnetic layer surrounding the Sun.

c. a tear-dropped shaped cavity when it interacts with the solar wind.
d. a tiny magnetic field found surrounding the particles in solar winds and storms.
e. the Moon's magnetic field.

ANSWER: c
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.11: - Describe the solar wind and its interaction with Earth's magnetic field.

62. Normally, solar wind approaches Earth at an average speed of ____.
a. 300 km/sec
b. 400 km/sec
c. 500 km/sec
d. 100 km/sec
e. 1000 km/sec

ANSWER: b
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.11: - Describe the solar wind and its interaction with Earth's magnetic field.

63. Airlines sometimes reroute planes away from polar regions during solar storms because
a. radio communication can be affected by solar storms.
b. solar storms can lead to severe turbulence.
c. solar storms increase air temperature, which can present a danger.
d. the plane could get hit by particles.
e. the sky can become too bright for safe navigation.

ANSWER: a
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.12: - Identify the differences between solar winds and storms and their respective phenomena as observed in Earth's atmosphere.

64. The ability or capacity to do work on some form of matter is called
a. temperature
b. latent heat.
c. specific heat.
d. heat
e. energy

ANSWER: e
DIFFICULTY: Bloom's: Remember
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.1: - Define the terms energy, potential energy, kinetic energy, radiant energy, temperature and heat, and describe their relationships in the context of Earth's atmosphere.

65. The total amount of energy stored in an object is called
    a. potential energy
    b. kinetic energy.
    c. heat.
    d. temperature
    e. pressure

ANSWER: a
DIFFICULTY: Bloom's: Remember
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.1: - Define the terms energy, potential energy, kinetic energy, radiant energy, temperature and heat, and describe their relationships in the context of Earth's atmosphere.

66. What is the lowest possible temperature on any of the three common temperature scales?
    a. -273 degrees Fahrenheit.
    b. 0 Kelvin.
    c. -100 degrees Celsius.
    d. -273 Kelvin.
    e. -100 degrees Fahrenheit.

ANSWER: b
DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.2: - Compare the Fahrenheit, Celsius and Kelvin temperature scales and outline their scientific backgrounds and uses today.

67. In most of the world temperature is recorded in
    a. Fahrenheit.
    b. Kelvin
    c. Celsius
    d. equal proportions - all three sclaes are used.
    e. both Kelvin and Celsius.

ANSWER: c
DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.2: - Compare the Fahrenheit, Celsius and Kelvin temperature scales and outline their scientific backgrounds and uses today.

68. Temperature is a measure of the average speed of _____ and _____.
ANSWER: atoms; molecules
molecules; atoms
DIFFICULTY: Bloom's: Remember
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.1: - Define the terms energy, potential energy, kinetic energy, radiant energy, temperature and heat, and describe their relationships in the context of Earth's atmosphere.

69. If Earth's average surface temperature were to increase, the amount of radiation emitted from Earth's surface would _____, and the wavelength of peak emission would shift toward _____ wavelengths.

ANSWER: increase; shorter
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

70. In the Northern Hemisphere, we call the green-yellow light show observed in the sky the _____; its counterpart in the Southern Hemisphere is the _____.

ANSWER: aurora borealis; aurora australis
northern lights; southern lights
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.12: - Identify the differences between solar winds and storms and their respective phenomena as observed in Earth's atmosphere.

71. _____ can have adverse effects on electrical systems, satellites, and radio communications.

ANSWER: Solar storms
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.12: - Identify the differences between solar winds and storms and their respective phenomena as observed in Earth's atmosphere.

72. _____ is energy in the process of being transferred from one object to another because of the _____ difference between them.

ANSWER: Heat, temperature
DIFFICULTY: Bloom's: Remember
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.1: - Define the terms energy, potential energy, kinetic energy, radiant energy, temperature and heat, and describe their relationships in the context of Earth's atmosphere.

73. A small increase in temperature results in a large _____ in the amount of radiation emitted because doubling the absolute temperature of an object _____ the maximum energy output by a factor of 16, or 24.

ANSWER: increase; increases
DIFFICULTY: Bloom's: Remember
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.5: - Define electromagnetic energy and radiant energy, and illustrate the relationship between radiation and temperature.

74. Because Earth is _____ than the Sun, it emits _____ radiation than the Sun.

ANSWER: cooler; less
colder; less

DIFFICULTY: Bloom's: Remember
REFERENCES: Radiant Energy
LEARNING OBJECTIVES: METT.AHRE.16.2.5: - Define electromagnetic energy and radiant energy, and illustrate the relationship between radiation and temperature.

75. The atmospheric greenhouse effect occurs because the atmosphere allows _____ radiation to pass through, but inhibits to some degree the passage of _____ radiation leaving Earth's surface.
ANSWER: visible; infrared
DIFFICULTY: Bloom's: Understand
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.7: - Define the terms blackbody, radiative equilibrium temperature, selective absorber, atmospheric window, and describe their relationship to the atmospheric greenhouse effect.

76. Most climate models predict that Earth's average surface temperature will increase by an additional _____ by the end of this century.
ANSWER: 3.0°C
3°C
5.4°F
3.0 degrees Celsius
3 degrees Celsius
5.4 degrees Fahrenheit
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

77. An increase in cloud cover surrounding Earth would _____ Earth's albedo, yet not necessarily lead to a lower Earth surface temperature.
ANSWER: increase
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilibrium
LEARNING OBJECTIVES: METT.AHRE.16.2.8: - Discuss the atmospheric greenhouse effect, and assess its impact on climate and life on Earth.

78. Earth's surface temperature often _____ on a calm night as a low cloud moves overhead.
ANSWER: increases
DIFFICULTY: Bloom's: Analyze
REFERENCES: Radiation - Absorption, Emission, and Equilbrium
LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

79. Solar wind is composed of _____, or _____, travelling through space.
ANSWER: charged particles; plasma
plasma; charged particles
DIFFICULTY: Bloom's: Remember

REFERENCES: Solar Particles, the Aurora, and Space Weather

LEARNING OBJECTIVES: METT.AHRE.16.2.11: - Describe the solar wind and its interaction with Earth's magnetic field.

80. The lower atmosphere is warmed from the surface upward through longwave radiation from Earth, _____, and _____.

ANSWER: conduction; convection
convection; conduction

DIFFICULTY: Bloom's: Analyze

REFERENCES: Radiation - Absorption, Emission, and Equilibrium

LEARNING OBJECTIVES: METT.AHRE.16.2.9: - Examine the effect that conduction, convection, scattering, and reflection have on Earth’s radiant energy budget

81. Carbon dioxide, _____, nitrous oxide, and _____ are the greenhouse gases that appear to be responsible for the enhancement of Earth’s atmospheric greenhouse effect.

ANSWER: methane; chlorofluorocarbons
chlorofluorocarbons; methane

DIFFICULTY: Bloom's: Understand

REFERENCES: Radiation - Absorption, Emission, and Equilibrium

LEARNING OBJECTIVES: METT.AHRE.16.2.7: - Define the terms blackbody, radiative equilibrium temperature, selective absorber, atmospheric window, and describe their relationship to the atmospheric greenhouse effect.

82. When water vapor condenses into clouds, _____ is released into the atmosphere. This provides a tremendous amount of heat in storms, such as thunderstorms and hurricanes.

ANSWER: latent heat

DIFFICULTY: Bloom's: Understand

REFERENCES: Energy, Temperature, and Heat

LEARNING OBJECTIVES: METT.AHRE.16.2.3: - Differentiate heat capacity, specific heat, latent heat and sensible heat, and explain how they relate to evaporation-transportation-condensation cycles in Earth's atmosphere.

83. When a body reaches a(n) _____equilibrium temperature, the amount of radiation entering the surface of the body equals the amount exiting the surface of the body.

ANSWER: radiative

DIFFICULTY: Bloom's: Analyze

REFERENCES: Radiation - Absorption, Emission, and Equilibrium

LEARNING OBJECTIVES: METT.AHRE.16.2.7: - Define the terms blackbody, radiative equilibrium temperature, selective absorber, atmospheric window, and describe their relationship to the atmospheric greenhouse effect.

84. Earth’s albedo is _____ percent.

ANSWER: 30
thirty

DIFFICULTY: Bloom's: Analyze

REFERENCES: Radiation - Absorption, Emission, and Equilibrium

LEARNING OBJECTIVES: METT.AHRE.16.2.9: - Examine the effect that conduction, convection, scattering, and reflection have on Earth’s radiant energy budget

85. In the discussion of Earth's annual energy balance, we saw that Earth absorbed approximately 51 units of solar energy but emitted 117 units of infrared energy. What prevents Earth from getting colder and colder?

ANSWER: Although Earth receives solar radiation only during the day, it constantly emits infrared energy both during the day and at night. The atmosphere above only allows a small fraction of this energy (6 units) to pass through into space. The majority (111 units) is absorbed mainly by the greenhouse gases water vapor and CO_2, and by clouds. Much of this energy (96 units) is radiated back to Earth, producing the atmospheric greenhouse effect. Hence, Earth's surface receives nearly twice as much longwave infrared energy from its atmosphere as it does shortwave radiation from the sun. In all of these exchanges, the energy lost at Earth's surface (147 units) is exactly balanced by the energy gained (147 units), which is why the average temperature on Earth stays constant.

DIFFICULTY: Bloom's: Analyze

REFERENCES: Radiation - Absorption, Emission, and Equilbrium

LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

86. Will a rising parcel of air always expand? Does this expansion cause the air temperature to increase or decrease?

ANSWER: Rising air always expands, whereas sinking air always shrinks. The reason is that air pressure decreases as we move up into the atmosphere. Consequently, as air rises, it enters a region where the surrounding air pressure is lower. To equalize the pressure, air molecules inside a rising parcel push the parcel walls outward causing expansion.
Expansion causes a decrease in air temperature. Because there is no other energy source, air molecules inside the parcel use some of their own energy to expand the parcel. This energy loss shows up as slower molecular speeds, representing a lower parcel temperature.

DIFFICULTY: Bloom's: Remember

REFERENCES: Heat Transfer in the Atmosphere

LEARNING OBJECTIVES: METT.AHRE.16.2.4: - Describe the principles of conduction, convection and advection and summarize their roles in Earth's atmosphere.

87. Explain how energy in the form of sunlight absorbed at the ground could be transferred upward in the atmosphere in the form of latent heat. How or when is the latent heat energy released in the air above the ground?

ANSWER: Latent heat is an important source of atmospheric energy. Latent heat energy can be released into the atmosphere through the evaporation of vapor molecules from Earth's surface. Once vapor molecules become separated from Earth's surface, they are swept away by the wind much like dust in front of a broom. Rising to high altitudes where the air is cold, the vapor changes into liquid and ice cloud particles. During these processes, a tremendous amount of heat energy is released into the environment. The heat provides energy for storms, such as hurricanes, middle latitude cyclones, and thunderstorms.
Furthermore, water vapor evaporated from warm, tropical water can be carried into polar regions where it condenses and gives up its heat energy. Thus, evaporation–transportation–condensation is an extremely important mechanism for the relocation of heat energy (as well as water) in the atmosphere.

DIFFICULTY: Bloom's: Understand

REFERENCES: Energy, Temperature, and Heat

LEARNING OBJECTIVES: METT.AHRE.16.2.3: - Differentiate heat capacity, specific heat, latent heat and sensible heat, and explain how they relate to evaporation-transportation-condensation cycles in Earth's atmosphere.

88. Describe and give examples of the various ways that heat can be transported in the atmosphere.

ANSWER: The main methods of transporting heat in the atmosphere are conduction, convection, and radiation.
Conduction is heat transferred from a warmer region to colder region. Air is a very poor heat conductor, thus, in calm weather hot ground actually only warms a shallow layer of air a few centimeters thick.
Convection is the transfer of heat by the mass movement of a fluid (such as water and air). Because liquids and gases are able to move freely, heat transfer occurs. Convection occurs naturally in the atmosphere. On a warm, sunny day certain areas of Earth's surface absorb more heat from the sun than others. As a result, the air near Earth's surface is heated somewhat unevenly. Air molecules adjacent to these hot surfaces bounce against them, thereby gaining some extra energy by conduction. The heated air expands and becomes less dense than the surrounding cooler air. The expanded warm air is buoyed upward and rises. In this manner, large bubbles of warm air rise and transfer heat energy upward. Cooler, heavier air flows toward the surface to replace the rising air. This cooler air becomes heated and rises, and the cycle is repeated. In meteorology, the vertical exchange of heat is called convection, and rising air bubbles are known as thermals.
Radiant energy is the energy Earth receives from the Sun. Radiation travels in the form of waves that release energy when they are absorbed by objects. Because these waves have magnetic and electrical properties, they are called electromagnetic waves. Electromagnetic waves do not need molecules to propagate them, but can move through a vacuum.

DIFFICULTY: Bloom's: Remember

REFERENCES: Heat Transfer in the Atmosphere

LEARNING OBJECTIVES: METT.AHRE.16.2.4: - Describe the principles of conduction, convection and advection and summarize their roles in Earth's atmosphere.

89. Describe the atmospheric greenhouse effect. Is there any difference between the way the atmospheric greenhouse effect works on a clear night and on a cloudy night?

ANSWER: The atmospheric greenhouse effect is defined as the absorption of infrared radiation from Earth by water vapor, CO_2, and other greenhouse gases. As these gases absorb infrared radiation emitted from Earth's surface, they gain kinetic energy (the energy of motion). Gas molecules share this energy by colliding with neighboring air molecules, such as oxygen and nitrogen (both of which are poor absorbers of infrared energy). Collisions increase the average kinetic energy of the air resulting in an increase in air temperature.
Clouds can enhance the atmospheric greenhouse effect. Tiny liquid cloud droplets are selective absorbers in that they are good absorbers of infrared radiation but poor absorbers of visible solar radiation. Clouds even absorb wavelengths between 8 and 11 μm, which are otherwise passed up by water vapor and CO_2. Thus, they have the effect of enhancing the atmospheric greenhouse effect by closing the atmospheric window.

DIFFICULTY: Bloom's: Understand

REFERENCES: Radiation - Absorption, Emission, and Equilibrium

LEARNING OBJECTIVES: METT.AHRE.16.2.8: - Discuss the atmospheric greenhouse effect, and assess its impact on climate and life on Earth.

90. When you remove a cold beverage from a refrigerator in a humid room, water vapor will condense on the sides of the container. Would this act to warm or cool the beverage, or would the condensation have no effect on the beverage's temperature?

ANSWER: Condensation is a warming process, therefore, the temperature of the beverage will increase. If the beverage contains ice, the temperature of the beverage does not change since all energy is used to melt the ice.

DIFFICULTY: Bloom's: Understand

REFERENCES: Energy, Temperature, and Heat

LEARNING OBJECTIVES: METT.AHRE.16.2.3: - Differentiate heat capacity, specific heat, latent heat and sensible heat, and explain how they relate to evaporation-transportation-condensation cycles in Earth's atmosphere.

91. Imagine that the temperature of the Sun were to change. Describe or discuss some of the effects that this might have on Earth's energy budget and Earth's climate.

ANSWER: Changes in the Sun's temperature and energy would affect how much energy could reach Earth's system, and would alter Earth's climate. Earth's energy budget would change in the sense that less or more energy would be absorbed and emitted.

DIFFICULTY: Bloom's: Analyze

REFERENCES: Radiation - Absorption, Emission, and Equilibrium

LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

92. Many people will blow on a bowl of hot soup to try to cool it. In your view, what are the two most important heat transport processes being used to cool the soup?

ANSWER: The most important heat transport processes are likely conduction and convection. Conduction warms the air close to the soup's surface and convection moves the warm air upward. In turn, cooler air flows downward.

DIFFICULTY: Bloom's: Understand

REFERENCES: Energy, Temperature, and Heat

LEARNING OBJECTIVES: METT.AHRE.16.2.3: - Differentiate heat capacity, specific heat, latent heat and sensible heat, and explain how they relate to evaporation-transportation-condensation cycles in Earth's atmosphere.

93. In what ways is the atmospheric greenhouse different from an agricultural greenhouse?

ANSWER: In a greenhouse, glass allows visible radiation to enter but inhibits, to some degree, the passage of outgoing infrared radiation. For this reason, the absorption of infrared radiation from Earth by water vapor and CO_2 is popularly called the greenhouse effect. However, scientific research indicates that the warm air inside a greenhouse is likely caused more by the air's inability to circulate and mix with cooler outside air, rather than by the entrapment of infrared energy. Due to these findings, some scientists suggest that the greenhouse effect should be called the atmospheric effect. To accommodate everyone, we generally use the term atmospheric greenhouse effect to describe the role that water vapor, CO_2, and other greenhouse gases play in keeping Earth's mean surface temperature higher than it would be otherwise.

DIFFICULTY: Bloom's: Understand

REFERENCES: Radiation - Absorption, Emission, and Equilibrium

LEARNING OBJECTIVES: METT.AHRE.16.2.8: - Discuss the atmospheric greenhouse effect, and assess its impact on climate and life on Earth.

94. What are other factors, in addition to increasing CO_2 concentrations that affect global warming?

ANSWER: The main cause of global warming is thought to be the greenhouse gas CO_2, whose concentration has been increasing primarily due to the burning of fossil fuels and deforestation. However, increasing concentrations of other greenhouse gases, such as

methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons (CFCs) have collectively been shown to have an effect approaching that of CO_2. Overall, water vapor accounts for almost 60 percent of the atmospheric greenhouse effect. CO_2 accounts for ˜26 percent, methane ˜7 percent, and remaining greenhouse gases ˜7 percent.

DIFFICULTY: Bloom's: Understand

REFERENCES: Radiation - Absorption, Emission, and Equilbrium

LEARNING OBJECTIVES: METT.AHRE.16.2.8: - Discuss the atmospheric greenhouse effect, and assess its impact on climate and life on Earth.

95. Explain how Earth and its atmosphere balance incoming energy with outgoing energy.

ANSWER: On a sunny day, Earth's surface warms by absorbing more energy from the Sun and the atmosphere than it radiates, while at night Earth cools by radiating more energy than it absorbs from its surroundings.

DIFFICULTY: Bloom's: Analyze

REFERENCES: Radiation - Absorption, Emission, and Equilibrium

LEARNING OBJECTIVES: METT.AHRE.16.2.10: - Investigate the roles of energy absorption and emission with regard to Earth's energy balance, and in this context, explain latitudinal temperature fluctuations observed on Earth.

96. What would have the greatest impact on Earth's greenhouse effect: removing all of the CO2 from the atmosphere or removing all of the water vapor? Explain your reasoning.

ANSWER: Students should describe that removing water vapor would have the greatest impact because water vapor is a strong absorber of infrared radiation and because atmospheric concentrations of H_2O are much higher than concentrations of CO_2

DIFFICULTY: Bloom's: Understand

REFERENCES: Radiation - Absorption, Emission, and Equilibrium

LEARNING OBJECTIVES: METT.AHRE.16.2.8: - Discuss the atmospheric greenhouse effect, and assess its impact on climate and life on Earth.

97. Suppose the Sun's surface temperature suddenly cools to 2000oC. Why would the sky appear more red than blue?

ANSWER: Based on Wien's Law, if the Sun were to cool to a lower temperature, the Sun would emit a peak in radiation at longer wavelengths. The longer wavelengths would be shifted toward the lower energy red portion of the visible spectrum. At present, the top of Earth's atmosphere reflects shorter blue wavelengths of light. If the Sun's energy spectrum were to be shifted, the Earth's atmosphere would be impacted by longer wavelengths of light and create a redder atmosphere.

DIFFICULTY: Bloom's: Apply

REFERENCES: Radiant Energy

LEARNING OBJECTIVES: METT.AHRE.16.2.6: - Apply the principles of radiant energy to the Sun and Earth.

98. Explain why the Kelvin temperature scale is also called the absolute temperature scale.

ANSWER: The Kelvin scale is named after Lord Kelvin (1824–1907), a famous British scientist who first introduced it. Absolute zero is the starting point for this temperature scale, which is why it is called the absolute scale. Because the Kelvin scale begins at absolute zero, it contains no negative numbers and is therefore quite convenient for scientific calculations. Absolute zero or 0 Kelvin (-273 degrees Celsius; -459 degrees Fahrenheit) is the lowest temperature possible; at this temperature atoms and molecules would possess a minimum amount of energy and theoretically no thermal motion.

Chapter 02 - Energy - Warming the Earth and the Atmosphere

DIFFICULTY: Bloom's: Understand
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.2: - Compare the Fahrenheit, Celsius and Kelvin temperature scales and outline their scientific backgrounds and uses today.

99. Explain how an aurora is produced.
ANSWER: An aurora is produced by solar wind disturbing the magnetosphere. The disturbance involves high-energy particles within the magnetosphere being ejected into Earth's upper atmosphere, where they excite atoms and molecules. The excited atmospheric gases emit visible radiation, which causes the sky to glow like a neon light.
DIFFICULTY: Bloom's: Remember
REFERENCES: Solar Particles, the Aurora, and Space Weather
LEARNING OBJECTIVES: METT.AHRE.16.2.12: - Identify the differences between solar winds and storms and their respective phenomena as observed in Earth's atmosphere.

100. Which measurement indicates the average speed of air molecules?
a. pressure
b. temperature
c. density
d. heat
e. gravity
ANSWER: b
DIFFICULTY: Bloom's: Remember
REFERENCES: Energy, Temperature, and Heat
LEARNING OBJECTIVES: METT.AHRE.16.2.1: - Define the terms energy, potential energy, kinetic energy, radiant energy, temperature and heat, and describe their relationships in the context of Earth's atmosphere.