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Name:_____ Class:_____ Date:_____

Chapter 02

1. The Karman line defines what?
   a. the line where temperature in the upper atmosphere begins rising with altitude
   b. the half-way point between Earth's surface and the top of the atmosphere
   c. the "top" of the atmosphere
   d. the "top" of the troposphere

ANSWER: c

2. What is the altitude of the Karman line in kilometers?
   a. 1
   b. 10
   c. 100
   d. 1,000

ANSWER: c

3. Which is not a greenhouse gas?
   a. water vapor
   b. oxygen
   c. methane
   d. ozone

ANSWER: b

4. Which molecule comes from bacterial decomposition?
   a. ozone
   b. methane
   c. carbon dioxide
   d. CFCs and HFCs

ANSWER: b

5. Which molecule depends on ultraviolet radiation to form?
   a. ozone
   b. methane
   c. carbon dioxide
   d. CFCs and HFCs

ANSWER: a

6. Which molecule does not occur naturally?
   a. ozone
   b. methane
   c. carbon dioxide
   d. CFCs and HFCs

ANSWER: d

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7. Which is a natural source of carbon dioxide?
   a. photosynthesis
   b. volcanic activity
   c. fossil fuel combustion
   d. ultraviolet radiation

ANSWER: b

8. Which is an anthropogenic source of carbon dioxide?
   a. photosynthesis
   b. volcanoes
   c. fossil fuels
   d. anaerobic bacteria

ANSWER: c

9. Which is a sink for carbon dioxide?
   a. photosynthesis
   b. ultraviolet radiation
   c. soil bacteria
   d. volcanoes

ANSWER: a

10. Which is a natural methane source?
   a. photosynthesis
   b. volcanoes
   c. fossil fuels
   d. anaerobic bacteria

ANSWER: d

11. Which is a methane sink?
   a. photosynthesis
   b. ultraviolet radiation
   c. the oceans
   d. rainfall

ANSWER: b

12. Which molecule directly requires photosynthesis to be made?
   a. oxygen
   b. carbon dioxide
   c. methane
   d. nitrogen

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ANSWER: a

13. Which is a water-vapor source?
    a. evaporation
    b. condensation
    c. ultraviolet radiation
    d. rainfall

ANSWER: a

14. Which is a water-vapor sink?
    a. evaporation
    b. condensation
    c. ultraviolet radiation
    d. fossil fuels

ANSWER: b

15. Which is an ozone source?
    a. photosynthesis
    b. evaporation
    c. ultraviolet radiation
    d. aerosols

ANSWER: c

16. Which is an ozone sink?
    a. photosynthesis
    b. condensation
    c. ultraviolet radiation
    d. fossil fuels

ANSWER: c

17. Which is a nitrous oxide source?
    a. photosynthesis
    b. condensation
    c. ultraviolet radiation
    d. soil bacteria

ANSWER: d

18. Which is a nitrous oxide sink?
    a. photosynthesis
    b. condensation
    c. ultraviolet radiation

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d. soil bacteria

ANSWER: c

19. Which is a CFC source?
    a. human activity
    b. condensation
    c. ultraviolet radiation
    d. soil bacteria

ANSWER: a

20. Which is a CFC sink?
    a. photosynthesis
    b. condensation
    c. ultraviolet radiation
    d. soil bacteria

ANSWER: c

21. Clouds are composed of _____.
    a. water vapor
    b. aerosols
    c. nitrogen
    d. CFCs

ANSWER: b

22. Which of the states of matter are clouds composed mostly of?
    a. water vapor
    b. liquid water
    c. solid water
    d. water gas

ANSWER: b

23. Ninety-nine percent of the atmosphere is found below _____ kilometers.
    a. 32
    b. 100
    c. 170
    d. 200

ANSWER: a

24. At sea level there is/are _____ kilogram(s) per square centimeter of air pressure on average.
    a. 1
    b. 2

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c. 3
d. 4

ANSWER: a

25. At sea level there are _____ pounds per square inch of air pressure on average.
a. 10.8
b. 14.7
c. 15.4
d. 16.8

ANSWER: b

26. Which city has the highest air pressure on average?
a. Winnipeg, Canada—232 meters (761 feet)
b. Cairo, Egypt—23 meters (75 feet)
c. Ulan Bator, Mongolia—1,350 meters (4,429 feet)
d. Santiago, Chile—520 meters (1,706 feet)

ANSWER: b

27. Which city has the lowest air pressure on average?
a. Winnipeg, Canada—232 meters (761 feet)
b. Cairo, Egypt—23 meters (75 feet)
c. Ulan Bator, Mongolia—1,350 meters (4,429 feet)
d. Santiago, Chile—520 meters (1,706 feet)

ANSWER: c

28. What is a radiosonde?
a. a scientific instrument attached to a balloon
b. a type of radar
c. a scientific instrument attached to an ocean buoy
d. a scientific instrument attached to a satellite

ANSWER: a

29. The lowest-most layer of the atmosphere is called the _____.
a. mesosphere
b. stratosphere
c. thermosphere
d. troposphere

ANSWER: d

30. The division between the troposphere and the stratosphere is called the _____.
a. tropopause

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b. stratopause
c. mesopause
d. thermopause

ANSWER: a

31. On average, the top of the troposphere occurs at about _____ kilometers.
a. 5
b. 9
c. 12
d. 18

ANSWER: c

32. The temperature at the top of the troposphere is about _____ degrees Celsius.
a. 0
b. –20
c. –40
d. –60

ANSWER: d

33. Which is not found in the troposphere?
a. a permanent temperature inversion
b. all of Earth's weather
c. the highest atmospheric density
d. vertical mixing

ANSWER: a

34. The tropopause is the division between what?
a. the stratosphere and the mesosphere
b. the troposphere and the mesosphere
c. the troposphere and the stratosphere
d. the stratosphere and the thermosphere

ANSWER: c

35. Clouds in the troposphere end at the tropopause because _____.
a. the stratosphere is too warm
b. there is too little water vapor in the stratosphere
c. the stratosphere is too high for clouds to reach
d. the stratosphere is too cold

ANSWER: a

36. The atmosphere is thicker in the tropics than at higher latitudes mostly because of _____.

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a. air circulation patterns
b. gravity from the Moon
c. Earth's rotation
d. cloudiness

ANSWER: c

37. The division between the stratosphere and the mesosphere is called the _____.
a. tropopause
b. stratopause
c. mesopause
d. thermopause

ANSWER: b

38. The top of the stratosphere occurs at about _____ kilometers.
a. 40
b. 50
c. 60
d. 70

ANSWER: b

39. The temperature at the top of the stratosphere is about _____ degrees Celsius.
a. 0
b. –10
c. –20
d. –30

ANSWER: a

40. Which is a main characteristic of the stratosphere?
a. strong vertical mixing
b. permanent temperature inversion
c. where meteors burn up
d. where all the weather occurs

ANSWER: b

41. The top of the mesosphere occurs at about _____ kilometers.
a. 80
b. 90
c. 100
d. 110

ANSWER: a

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42. The division between the mesosphere and the thermosphere is called the _____.
    a. tropopause
    b. stratopause
    c. mesopause
    d. thermopause

ANSWER: c

43. The temperature at the top of the mesosphere is about _____ degrees Celsius.
    a. 0
    b. –40
    c. –60
    d. –90

ANSWER: d

44. The top of the thermosphere is found at _____ kilometers.
    a. 400
    b. 500
    c. 600
    d. 700

ANSWER: c

45. Temperatures in upper reaches of the thermosphere are as high as _____ degrees Celsius.
    a. 100
    b. 550
    c. 1,200
    d. 2,100

ANSWER: c

46. The division between the thermosphere and the exosphere is called the _____.
    a. tropopause
    b. stratopause
    c. mesopause
    d. thermopause

ANSWER: d

47. Which statement is not true of the exosphere?
    a. It is the top-most layer of the atmosphere that fades to outer space.
    b. Some gas molecules escape from it out to space.
    c. It is where meteors burn up as they enter the atmosphere from space.
    d. There is almost no air pressure.

ANSWER: c

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48. Auroras are caused by _____.
    a. the solar wind
    b. electromagnetic radiation from the Sun
    c. high temperatures in the thermosphere
    d. gas properties of the ionosphere
ANSWER: a

49. The timing of the solar wind coincides with the timing of _____.
    a. drought cycles
    b. solar flare activity
    c. stages of the Moon
    d. Earth's magnetic field strength
ANSWER: b

50. A primary pollutant is defined as _____.
    a. a pollutant that is toxic to humans
    b. a pollutant that enters the air or water directly from the source
    c. a pollutant that has been altered by reactions with other pollutants
    d. a pollutant that is emitted by natural sources such as volcanoes
ANSWER: b

51. Which is not a primary pollutant?
    a. carbon monoxide
    b. nitrogen dioxide
    c. ground-level ozone
    d. sulfur dioxide
ANSWER: c

52. The main source of anthropogenic carbon monoxide in urban areas is _____.
    a. automobiles
    b. coal burning
    c. burning agricultural wastes and forests
    d. unburned gasoline
ANSWER: a

53. The main source of anthropogenic carbon monoxide in urban areas is _____.
    a. automobiles
    b. coal burning
    c. burning agricultural wastes and forests
    d. unburned gasoline

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ANSWER: a

Table 2.4 Anthropogenic Pollutants and Sources

POLLUTANT	MAJOR SOURCES	HEALTH EFFECTS
Carbon monoxide (CO)	Motor vehicles	Headaches, slowed reflexes, drowsiness, death
Nitrogen dioxide (NO_2)	Motor vehicles, coal burning	Lung irritation, pulmonary disease (e.g., asthma, bronchitis)
Ground-level ozone (O_3)	Chemical reactions of NO_2 and VOCs in sunlight	Eye and throat irritation, respiratory disease (e.g., bronchitis and asthma), decreased crop and other plant growth
Sulfur dioxide (SO_2)	Coal burning, oil refineries	Respiratory symptoms (e.g., wheezing, shortness of breath), acid rain ecosystem damage
Particulate matter (PM)	Coal combustion, industrial processes, motor vehicles	Respiratory symptoms (e.g., cough, chest pain, difficulty breathing), pulmonary and cardiovascular disease
Volatile organic compounds (VOCs)	Motor vehicles, industry	Eye and skin irritation, nausea, headaches, damage to the liver, kidneys, and central nervous system

54. Referring to Table 2.4, which of the following pollutants can cause cardiovascular disease?
    a. carbon monoxide
    b. particulate matter
    c. ground-level ozone
    d. sulfur dioxide

ANSWER: b

55. Which pollutant causes acid rain?
    a. carbon monoxide
    b. ground-level ozone
    c. VOCs
    d. sulfur dioxide

ANSWER: d

56. The main source of nitrogen dioxide pollution is _____.
    a. burning of vegetation
    b. burning of coal and gasoline
    c. incomplete burning of gasoline
    d. chemical reactions in sunlight

ANSWER: b

57. The main source of VOCs is _____.
    a. burning of vegetation
    b. burning of coal and gasoline
    c. incomplete burning of gasoline

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d. chemical reactions in sunlight

ANSWER: c

58. Which is photochemical smog?
    a. sulfur dioxide
    b. ground-level ozone
    c. nitrogen dioxide
    d. VOCs

ANSWER: b

59. Which is not an example of particulate matter?
    a. dust
    b. smoke
    c. ozone
    d. pollen

ANSWER: c

60. The main source of particulate matter in the United States is _____.
    a. coal burning
    b. industrial processes
    c. transportation
    d. windblown dust

ANSWER: a

61. The main source of particulate matter in northern Africa is _____.
    a. coal burning
    b. industrial processes
    c. transportation
    d. windblown dust

ANSWER: d

62. When there is _____ it gets warmer as altitude increases.
    a. strong wind
    b. a temperature inversion
    c. an environmental lapse rate
    d. acid rain

ANSWER: b

63. Which of the following is a factor that concentrates air pollution?
    a. oceans
    b. temperature inversions

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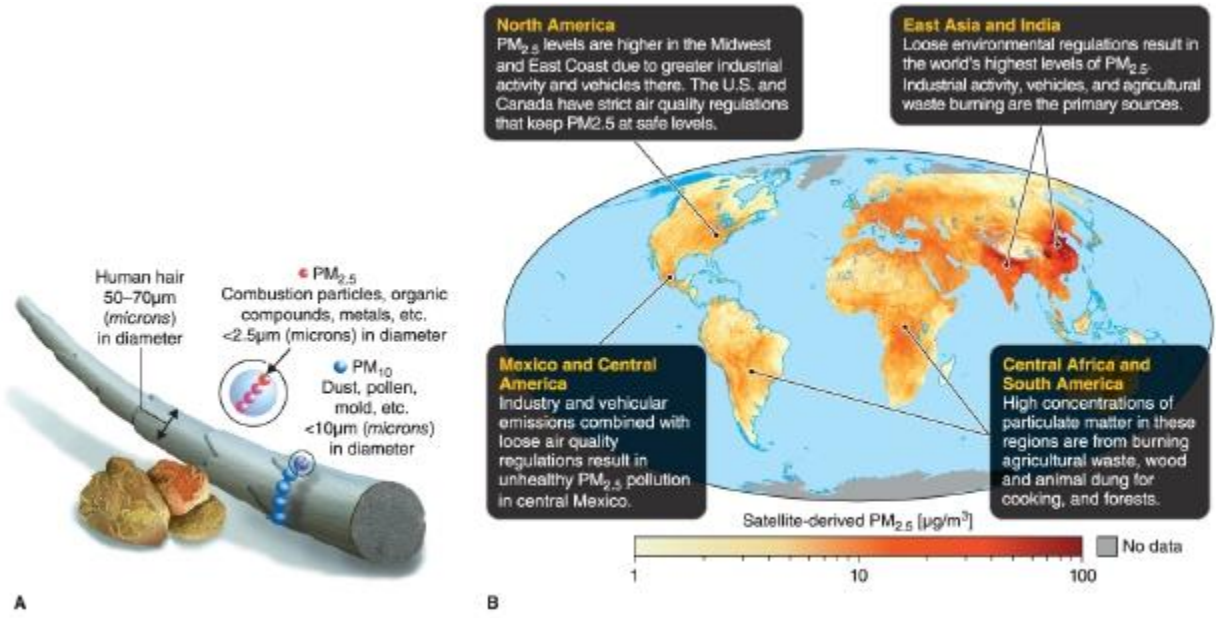
c. vegetation
d. wind
ANSWER: b

64. The Clean Air Act was first enacted in _____.
a. 1963
b. 1970
c. 1977
d. 1990
ANSWER: a



A. U.S. Environmental Protection Agency; B. Data from van Donkelaar et al. / NASA Earth Observatory

65. Referring to the map, what causes particulate matter to be high in the Sahara in northern Africa?
a. dust storms
b. industrial emissions
c. agricultural emissions
d. photochemical reactions
ANSWER: a

66. Referring to the map, what causes particulate matter to be high in the eastern United States?
a. dust storms
b. industrial emissions
c. agricultural emissions
d. photochemical reactions
ANSWER: b

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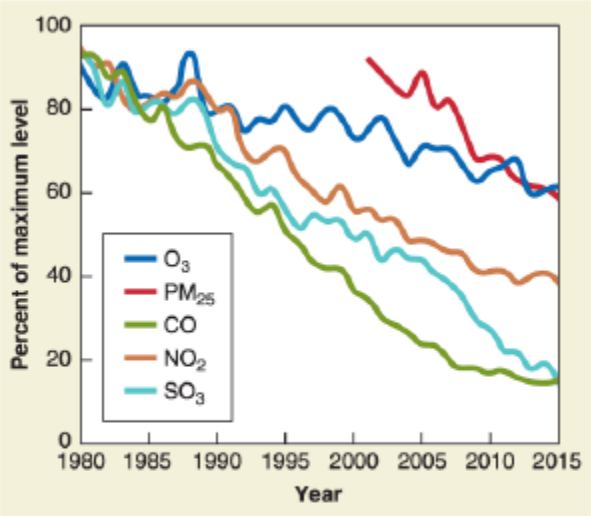
67. Referring to the map, what causes particulate matter to be high in eastern Asia?
    a. dust storms
    b. industrial emissions
    c. agricultural emissions
    d. photochemical reactions

ANSWER: b

68. Referring to the map, what causes particulate matter to be high in northern India?
    a. dust storms
    b. industrial emissions
    c. agricultural emissions
    d. photochemical reactions

ANSWER: b



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69. According to the graph, which air pollutant has dropped most between 1980 and 2015?
    a. CO
    b. NOx
    c. PM_{25}
    d. SO_2

ANSWER: a

70. According to the graph, which of the following air pollutant has dropped least?
    a. CO
    b. NOx
    c. PM_{25}

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d. SO_2

ANSWER: c

71. Referring to the graph, what is responsible for the downward trend in these pollutants?
    a. population decrease
    b. people driving fewer miles
    c. enactment of the U.S. Clean Air Act
    d. different measurement techniques

ANSWER: c

72. An Air Quality Index (AQI) value of 100 indicates air quality that is in the _____ category.
    a. Good
    b. Moderate
    c. Unhealthy for sensitive groups
    d. Unhealthy

ANSWER: b

73. The gas that causes ozonosphere thinning is _____.
    a. methane
    b. ozone
    c. CFCs
    d. carbon dioxide

ANSWER: c

74. The atmospheric lifetime of a CFC molecule can be _____ years or more.
    a. 10
    b. 100
    c. 1,000
    d. 10,000

ANSWER: c

75. Which atom comes from a CFC molecule and breaks ozone apart?
    a. fluorine
    b. chlorine
    c. carbon
    d. oxygen

ANSWER: b

76. What type of solar radiation causes ozone molecules to break apart and reform?
    a. visible sunlight
    b. ultraviolet radiation

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c. thermal radiation
d. microwave radiation

ANSWER: b

77. The geographically most extensive hole in the ozonosphere occurred in what year?
a. 1980
b. 1990
c. 2000
d. 2010

ANSWER: c

78. Where are stratospheric ozone concentrations lowest?
a. over the tropics
b. over the midlatitudes
c. over the North Pole
d. over the South Pole

ANSWER: d

79. _____ facilitate(s) a reduction of ozone in the ozonosphere.
a. Particulate matter
b. Nacreous clouds
c. High atmospheric density
d. The presence of nitrogen dioxide

ANSWER: b

80. When was the Montreal Protocol ratified?
a. 1987
b. 1990
c. 1995
d. 2001

ANSWER: a

81. What did the Montreal Protocol mandate?
a. the phaseout of CFCs
b. the phaseout of fossil fuels
c. the cleaning up of sulfur dioxide
d. the phaseout of ground-level ozone

ANSWER: a

82. The ozonosphere is anticipated to return to 1980 levels by about the year _____.
a. 2020

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b. 2040
c. 2060
d. 2080

ANSWER: b

83. Which condition is not among the human health problems caused by exposure to increased levels of ultraviolet radiation?
a. skin cancer
b. respiratory problems
c. reduced immunity
d. cataracts

ANSWER: b

84. Given the geographic pattern of ozonosphere thinning, which location would have the highest UV radiation levels at ground level?
a. the southern United States
b. northern Canada
c. northern Australia
d. southern Australia

ANSWER: d

85. Under the Montreal Protocol, CFCs have mostly been replaced by what chemical?
a. methane
b. HFCs
c. fluorine
d. carbon dioxide

ANSWER: b

86. A problem with HFCs is that they _____.
a. are toxic pollutants
b. cause ground-level ozone
c. affect plant photosynthesis
d. are strong greenhouse gases

ANSWER: d

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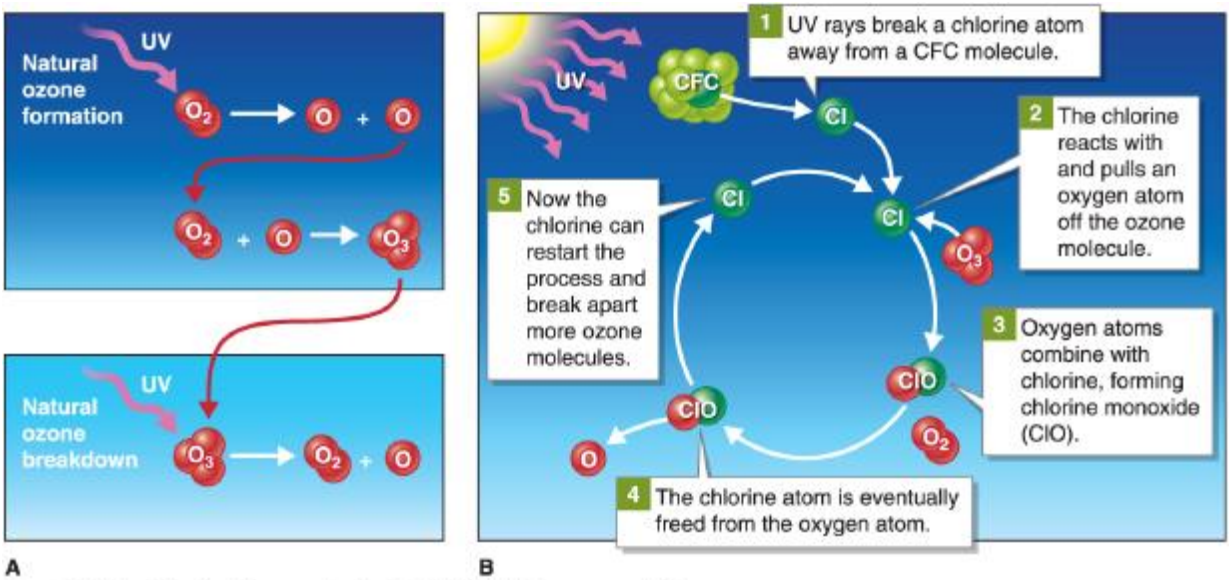

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87. According to this figure, ultraviolet rays do what?
    a. form ozone molecules
    b. break apart ozone molecules
    c. break apart CFC molecules
    d. ultraviolet rays do all of the above

ANSWER: d

88. According to the figure, chlorine atoms change ozone molecules to what?
    a. oxygen molecules and oxygen atoms
    b. CFC molecules
    c. more ozone molecules
    d. chlorine atoms

ANSWER: a

89. According to the figure, how is ozone formed naturally?
    a. by reactions with CFCs
    b. by reactions with chlorine atoms
    c. by reactions with ultraviolet radiation
    d. by reactions with carbon dioxide

ANSWER: c

90. According to the figure, how is ozone broken down naturally?
    a. by reactions with CFCs
    b. by reactions with chlorine atoms
    c. by reactions with ultraviolet radiation

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d. by reactions with carbon dioxide

ANSWER: c

91. The Air Quality Index (AQI) scale indicates atmospheric pressure.
a. True
b. False

ANSWER: False

92. China is among the world leaders in cleaning up its polluted air, even though many Chinese cities have some of the world's worst air quality.
a. True
b. False

ANSWER: True

93. The atmosphere is composed of 78% nitrogen and 21% oxygen molecules.
a. True
b. False

ANSWER: True

94. Water vapor can occupy up to 4% of the atmosphere by volume.
a. True
b. False

ANSWER: True

95. A greenhouse gas absorbs and emits heat.
a. True
b. False

ANSWER: True

96. Methane is a greenhouse gas.
a. True
b. False

ANSWER: True

97. Carbon dioxide is a greenhouse gas.
a. True
b. False

ANSWER: True

98. Oxygen is a greenhouse gas.
a. True
b. False

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ANSWER: False

99. Nitrous oxide is a greenhouse gas.
    a. True
    b. False
ANSWER: True

100. Gases enter the atmosphere through gas sinks.
    a. True
    b. False
ANSWER: False

101. Nitrogen molecules in the atmosphere are a type of aerosol.
    a. True
    b. False
ANSWER: False

102. The atmosphere is kept pinned to Earth by gravity.
    a. True
    b. False
ANSWER: True

103. The higher the molecular density of air, the lower the air pressure.
    a. True
    b. False
ANSWER: False

104. On average, the Dead Sea has the highest air pressure on Earth.
    a. True
    b. False
ANSWER: True

105. The environmental lapse rate in the troposphere is 6.5 degrees Celsius per 1,000 meters.
    a. True
    b. False
ANSWER: True

106. *Tropos* in Greek means to turn over and to mix.
    a. True
    b. False
ANSWER: True

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107. The tropopause is higher above Earth's surface at the poles than at the equator.
    a. True
    b. False
ANSWER: False

108. The height of the equatorial tropopause is roughly 18 kilometers.
    a. True
    b. False
ANSWER: True

109. The height of the polar tropopause is roughly 8 kilometers.
    a. True
    b. False
ANSWER: True

110. In the stratosphere air flows mostly horizontally.
    a. True
    b. False
ANSWER: True

111. Most meteors burn up in the mesosphere.
    a. True
    b. False
ANSWER: True

112. Northern lights occur in the mesosphere.
    a. True
    b. False
ANSWER: False

113. Northern lights are also called aurora borealis.
    a. True
    b. False
ANSWER: True

114. Aurora australis occurs in the Northern Hemisphere.
    a. True
    b. False
ANSWER: False

115. The aurora occur because Earth's magnetic field is protecting us from the solar wind.
    a. True

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b. False

ANSWER: True

116. Most anthropogenic pollutants come from burning fossil fuels.
a. True
b. False

ANSWER: True

117. Volcanoes make acid rain pollution.
a. True
b. False

ANSWER: True

118. PM_{10} is more unhealthy than $PM_{2.5}$.
a. True
b. False

ANSWER: False

119. Ground-level ozone is harmless. Stratospheric ozone is harmful to people.
a. True
b. False

ANSWER: False

120. The Air Quality Index ranks air quality by its effects on human health.
a. True
b. False

ANSWER: True

121. Particulate matter is an aerosol.
a. True
b. False

ANSWER: True

122. CFCs (chlorofluorocarbons) are gases that occur naturally in the atmosphere.
a. True
b. False

ANSWER: False

123. CFCs are toxic gases made by people.
a. True
b. False

ANSWER: False

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124. The problem with the ozonosphere was known since the 1920s, but wasn't taken seriously until 1974.
a. True
b. False
ANSWER: False

125. Ozone molecules form naturally in the stratosphere.
a. True
b. False
ANSWER: True

126. Ozone molecules break apart naturally in the stratosphere.
a. True
b. False
ANSWER: True

127. What would happen to sea-level air pressure if the atmosphere were thinner? What would happen to sea-level pressure if the atmosphere were thicker?
ANSWER: Air pressure would drop if the atmosphere were thinner because there would be less atmosphere to compress. Air pressure would increase if the atmosphere were thicker because the weight of the overlying atmosphere would compress the atmosphere more.

128. Why do CFC molecules persist in the troposphere, then break down in the stratosphere?
ANSWER: CFCs break down when exposed to UV radiation. In the troposphere there is relatively little UV radiation compared to the stratosphere.

129. The atmosphere and the oceans are heavy because they are composed of molecules that have mass and weight. Why, then, don't the atmosphere and oceans pin us down against the surface of Earth?
ANSWER: Only a solid heavy object can pin us down because all of its weight will come from one direction only—from above us. The atmosphere and oceans are fluids, however, and they flow around us. Therefore their weight comes from all directions simultaneously and we are not pinned.

130. How are cumulonimbus clouds prevented from entering the stratosphere?
ANSWER: The stratosphere warms with height. Cumulonimbus clouds become relatively cold, dense, and heavy in the stratosphere and so they cannot rise very far into it.

131. Describe how acid rain forms. Is acid rain decreasing or increasing in the United States? Explain why this trend has occurred.
ANSWER: Acid rain forms when sulfur dioxide combines with rainwater to form sulfuric acid droplets. Acid rain has been decreasing in the United States because of emissions restrictions mandated by the Clean Air Act.

132. Cleaning up the air by reducing emissions is expensive. Industry ultimately passes the costs on to the consumer. Do you think the Clean Air Act is worth the expense? Explain.

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Chapter 02

ANSWER: Answers will vary. On a short-term basis, the two sides basically are pro economy vs. pro environment. Cleaning the air costs money and jobs. But cleaning the air improves the quality of life for people because they are healthier. On a long-term basis, it is much harder to argue for not cleaning up the air. In the long term, it saves money, helps the economy, and improves the quality of life for people.

133. Why do cumulonimbus clouds in the troposphere not enter the stratosphere?

ANSWER: The stratosphere has a permanent temperature inversion. Cumulonimbus clouds rise higher in the troposphere as long as their interiors are warmer than the air outside of them. In the troposphere, it gets colder with altitude so as clouds rise they rise into colder air, keeping them relatively warm and buoyant. The permanent temperature inversion in the stratosphere causes clouds to become colder than the surrounding warm air. As a result, clouds cannot rise very far into the stratosphere.

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