

Chapter 01 - Earth and Its Atmosphere

1. Sayings about the weather, such as “red sky at morning, sailor take warning; red sky at night, sailor's delight” are based on the scientific method.

- a. True
- b. False

ANSWER: False

2. Earth's second atmosphere was lighter than its first atmosphere (which formed some 4.6 billion years ago), and developed through the impact of a series of meteorites.

- a. True
- b. False

ANSWER: False

3. Atmospheric concentration of helium has increased from below 300 ppm historically to over 400 ppm presently.

- a. True
- b. False

ANSWER: False

4. Carbon dioxide is a naturally occurring component of the atmosphere.

- a. True
- b. False

ANSWER: True

5. The ozone hole is an actual hole in the atmosphere, a region of complete vacuum.

- a. True
- b. False

ANSWER: False

6. Of the four most abundant gases in our atmosphere, carbon dioxide shows the greatest variation at Earth's surface.

- a. True
- b. False

ANSWER: False

7. Soil dust, salt from ocean waves, forest fire smoke, volcanic ash particles, and pollutants are some of the greenhouse gases found in the atmosphere.

- a. True
- b. False

ANSWER: False

8. On the basis of composition, the layers of the atmosphere from the lowest layer to the highest are the thermosphere, mesosphere, stratosphere, and troposphere.

- a. True
- b. False

ANSWER: False

9. On an average, temperature increases from the surface to the tropopause (around 10 km), then decreases to the

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stratopause (around 50 km), then decreases to the mesopause (around 90 km) and then increases through the thermosphere (90 – 500 km).

- a. True
- b. False

ANSWER: False

10. Someone who says that “the wind direction today is south” likely means that the wind is blowing from the south.

- a. True
- b. False

ANSWER: True

11. Fronts are a band of continuity in temperature, humidity, and wind direction.

- a. True
- b. False

ANSWER: False

12. Meteorology is the study of the atmosphere and its phenomena. The term itself goes back to the Greek philosopher, Aristotle, who wrote a book on natural philosophy entitled *Meteorologica*.

- a. True
- b. False

ANSWER: True

13. Weather in the middle latitudes tends to move from east to west.

- a. True
- b. False

ANSWER: False

14. Storms rank in size from the largest to the smallest, as follows: thunderstorm, middle-latitude cyclonic storm, tornado, hurricane.

- a. True
- b. False

ANSWER: False

15. The lowest average air temperature can be found in the stratosphere.

- a. True
- b. False

ANSWER: False

16. The main atmospheric component of the planet Venus is carbon dioxide.

- a. True
- b. False

ANSWER: False

17. An increase in stratospheric ozone could be beneficial for plants, animals, and humans.

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- a. True
- b. False

ANSWER: True

18. Ultraviolet light from the sun destroys nitrous oxide.

- a. True
- b. False

ANSWER: True

19. In the mid-1990s, the National Weather Service replaced original radars with sophisticated instruments known as Doppler radars that have the ability to peer into a severe thunderstorm, unveil its winds, and show precipitation intensity.

- a. True
- b. False

ANSWER: True

20. The mass of air in a rigid container is the same everywhere in the universe.

- a. True
- b. False

ANSWER: True

21. Our understanding of the atmosphere and how it produces weather is built on the knowledge acquired and applied through the scientific method.

- a. True
- b. False

ANSWER: True

22. The physical laws that control atmospheric behavior can be represented in software packages known as numerical models.

- a. True
- b. False

ANSWER: True

23. Any form of water, either liquid or solid (rain or snow), that falls from clouds and reaches the ground is called particulate matter.

- a. True
- b. False

ANSWER: False

24. A(n) downburst is an intense rotating column of air that extends downward from the base of a thunderstorm with a circulation reaching the ground.

- a. True
- b. False

ANSWER: False

25. The most abundant gases in the Earth's atmosphere by mass are carbon dioxide and argon.

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- a. True
- b. False

ANSWER: False

26. In the middle latitudes of the Northern Hemisphere, surface winds tend to blow inward and clockwise.

- a. True
- b. False

ANSWER: False

27. The atmosphere protects astronauts while they are in the International Space Station.

- a. True
- b. False

ANSWER: False

28. The average or standard lapse rate in the troposphere is about 6.5°C for every 1000 m or about 3.6°F for every 1,000-foot rise in elevation.

- a. True
- b. False

ANSWER: True

29. In the isothermal zone of the atmosphere, the air temperature, on an average, remains constant with height.

- a. True
- b. False

ANSWER: True

30. The region where atoms and molecules shoot off into space is sometimes referred to as the exosphere, which represents the upper limit of our atmosphere.

- a. True
- b. False

ANSWER: True

31. The ozone hole is located over the Gulf of Mexico.

- a. True
- b. False

ANSWER: False

32. The concentration of oxygen is close to 21 percent (by volume) in the upper stratosphere (the same concentration as in the troposphere), and humans can breathe as well there as at sea level.

- a. True
- b. False

ANSWER: False

33. Wind blows counterclockwise around low-pressure areas, and clockwise around high-pressure areas in the Northern Hemisphere.

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- a. True
- b. False

ANSWER: True

34. Weather describes the conditions averaged over a region or over a period, whereas climate describes the condition of the atmosphere at a particular time and place.

- a. True
- b. False

ANSWER: False

35. The two most abundant greenhouse gases in Earth's atmosphere are carbon dioxide and water vapor.

- a. True
- b. False

ANSWER: True

36. The temperature of the tropopause ____.

- a. mirrors the temperature of Earth's oceans.
- b. is much colder than the temperature at Earth's surface.
- c. can never be measured.
- d. is much warmer than the temperature at Earth's surface.
- e. is nearly the same as the sun's temperature.

ANSWER: b

37. In a temperature inversion, air temperature ____.

- a. increases with increasing height.
- b. decreases with increasing height.
- c. is extremely unstable.
- d. fluctuates more at night than during the day.
- e. is warmer during winter than during summer.

ANSWER: a

38. The rate at which temperature decreases with increasing altitude is known as the ____.

- a. temperature slope.
- b. lapse rate.
- c. alpine factor.
- d. thermocline.
- e. zipline.

ANSWER: b

39. In which atmospheric layer is most of the ionosphere found?

- a. troposphere
- b. stratosphere
- c. mesosphere

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- d. thermosphere
- e. exosphere

ANSWER:

d

40. Which process, over millions of years, provided a rich supply of water vapor into the atmosphere that formed into clouds?

- a. evaporation
- b. condensation
- c. precipitation layering
- d. outgassing
- e. seafloor spreading

ANSWER:

d

41. The word “weather” is defined as ____.

- a. the changes that happen to the planet over time.
- b. the climate of a region.
- c. the climate averaged over the course of a year.
- d. any type of falling precipitation.
- e. the condition of the atmosphere at a particular time and place.

ANSWER:

e

42. Wind direction is ____.

- a. the direction from which the wind is blowing.
- b. the direction to which the wind is blowing.
- c. always moving directly from high toward low pressure.
- d. always moving directly from low toward high pressure.
- e. relative to where the person is standing.

ANSWER:

a

43. Meteorology is the study of ____.

- a. landforms
- b. the oceans
- c. the atmosphere
- d. The exosphere
- e. extraterrestrial meteoroids that enter the atmosphere

ANSWER:

c

44. Middle latitude cyclonic storms are also known as ____.

- a. anticyclones
- b. hurricanes
- c. extratropical cyclones
- d. tornadoes
- e. gust fronts

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ANSWER:

c

45. Humidity is _____.

- a. the same in different climates.
- b. any form of water that falls from clouds and reaches the ground.
- c. a measure of the amount of water vapor in the air.
- d. the degree of hotness or coldness of the air.
- e. low when the temperature falls.

ANSWER:

c

46. Precipitation is _____.

- a. the same in different climates.
- b. any form of water that falls from clouds and reaches the ground.
- c. rain only.
- d. the degree of hotness or coldness of the air.
- e. the force of the air above an area.

ANSWER:

b

47. On a weather map, a cold front is marked by _____.

- a. a solid line with arrowheads showing the direction of movement
- b. a red line with half circles
- c. a green line with half circles
- d. a dotted line
- e. a line with hash marks

ANSWER:

a

48. In a warm front, what is being replaced?

- a. cool air
- b. polluted air
- c. the troposphere
- d. contrails
- e. humid air

ANSWER:

a

49. Which statement relates to weather rather than climate?

- a. The average temperature for the month of January is 28 degrees Fahrenheit.
- b. The lowest temperature ever recorded in Frozenlake, Minnesota is -57 degrees Fahrenheit.
- c. The foggiest month of the year is December.
- d. People are worried that the average temperature of the planet is rising.
- e. It is cloudy and snowing outside.

ANSWER:

e

50. With droughts, most people are affected by _____.

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- a. lightning
- b. locusts
- c. sciroccos
- d. crop failures and food shortages
- e. dust storms

ANSWER:

d

51. Ozone in the troposphere ____.

- a. is good for people with respiratory illnesses.
- b. causes warming and is a highly reactive oxidant.
- c. is not one of the main ingredients of photochemical smog.
- d. provides healthy levels of vitamin D to humans.
- e. is an aerosol found in the ionosphere.

ANSWER:

b

52. Which atmospheric layer has the highest temperature, although one might not perceive it?

- a. stratosphere
- b. troposphere
- c. mesosphere
- d. exosphere
- e. ionosphere

ANSWER:

d

53. To be accepted, a ____ has to be shown to be correct through a series of quantitative tests.

- a. theory
- b. scientific method
- c. hypothesis
- d. numerical modeling
- e. question

ANSWER:

b

54. Earth's earliest atmosphere was most likely composed of ____.

- a. water vapor and nitrogen.
- b. carbon dioxide and helium.
- c. hydrogen and helium.
- d. hydrogen and oxygen.
- e. noble gases.

ANSWER:

c

55. Much of the carbon dioxide found in earlier atmospheres is currently locked up in ____.

- a. granite
- b. volcanic rocks
- c. sandstone

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- d. shale
- e. carbonate rocks

ANSWER:

e

56. Most human-made impurities found in the atmosphere present a health and environmental hazard. These are called ____.

- a. nutrients
- b. pollutants
- c. aerosols
- d. dust
- e. particles

ANSWER:

b

57. There are considerably more air molecules near the Earth's surface than higher up, which means, in comparison, air near the surface ____.

- a. is less dense.
- b. has the same density.
- c. is denser.
- d. has no density.
- e. is only half as dense.

ANSWER:

c

58. Weather maps with isobars have been utilized in meteorology since ____.

- a. 1799
- b. 1950
- c. 1843
- d. 1920
- e. 1869

ANSWER:

e

59. A geostationary satellite takes pictures of ____.

- a. the moon as it is seen from Earth
- b. other planets as they are seen from Earth
- c. different areas on Earth when it is stationary
- d. one area on Earth as it moves at the same rate as Earth's spin
- e. any recurring geologic event on Earth

ANSWER:

d

60. On weather maps cold fronts are drawn ____.

- a. in blue, with arrowheads showing the front's general direction of movement.
- b. in red, with arrowheads showing the front's general direction of movement.
- c. in blue, with arrowheads pointing away from the front's general direction of movement.
- d. in black, with arrowheads showing the front's general direction of movement.

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e. in red, with arrowheads pointing away from the front's general direction of movement.

ANSWER:

a

61. Weather and climate affect human lives in many ways, but the most immediate effect is related to ____.

- a. the economy
- b. the environment
- c. comfort
- d. health
- e. Infrastructure

ANSWER:

c

62. A tropical storm system, with its swirling band of rotating clouds and sustained surface winds of 65 knots, is known as a ____.

- a. thunderstorm
- b. hurricane
- c. tornado
- d. cyclical front
- e. downburst

ANSWER:

b

63. The sun is surrounded by Earth and how many other planets?

- a. five
- b. ten
- c. twenty (including the dwarf planets)
- d. twelve
- e. seven

ANSWER:

e

64. ____ began an extremely slow increase in concentration in a process called photodissociation.

- a. Molecular oxygen
- b. Carbon dioxide
- c. Carbon black
- d. Helium
- e. Nitrous oxide

ANSWER:

a

65. The concentrations of invisible gas ____ varies greatly from place to place, and from time to time.

- a. argon
- b. oxygen
- c. carbon dioxide
- d. nitrogen
- e. water vapor

ANSWER:

e

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66. Moving directly from solid to gas form is called ____.

- a. condensation
- b. evaporation
- c. sublimation
- d. crystallization
- e. precipitation

ANSWER:

c

67. ____ uses mathematical models that use computational simulation of different scenarios.

- a. A theory
- b. Numerical modeling
- c. Speculative philosophy
- d. A hypothesis
- e. A question

ANSWER:

b

68. The weight of ____ acts as a force upon Earth.

- a. intermolecular forces
- b. chemical reactions
- c. air quality
- d. winds in the atmosphere
- e. air molecules

ANSWER:

e

69. Earth's atmosphere is a relatively thin, gaseous envelope that comprises mostly ____ and ____, with small amounts of other gases.

- a. nitrogen, oxygen
- b. nitrogen, carbon dioxide
- c. oxygen carbon dioxide
- d. carbon dioxide, water vapor
- e. oxygen, water vapor

ANSWER:

a

70. A constant outpouring of gases from the hot interior—known as ____—provided a rich supply of water vapor, which formed into clouds.

- a. venting
- b. outgassing
- c. vapor drive
- d. seafloor spreading
- e. upwelling

ANSWER:

b

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71. Water vapor can best be described as a ____.

- a. gas
- b. cloud droplet
- c. raindrop
- d. noble gas
- e. liquid

ANSWER:

a

72. In ____ near Earth's surface today, nitrogen occupies 78 percent and oxygen nearly 21 percent.

- a. the volume of air
- b. mass of air
- c. the clouds
- d. troposphere
- e. greenhouse gases

ANSWER:

a

73. Which of the following is considered a variable gas in Earth's atmosphere?

- a. water vapor
- b. nitrogen
- c. every noble gas
- d. argon
- e. helium

ANSWER:

a

74. Water vapor molecules ____.

- a. are invisible.
- b. color the sky blue.
- c. make clouds white.
- d. are very small drops of liquid water.
- e. commonly escape into the ionosphere.

ANSWER:

a

75. The atmospheric concentration of CO₂ has risen by about ____ since 1958, when measurements began at Mauna Loa Observatory in Hawaii.

- a. about 78 percent
- b. about 30 percent
- c. close to 20 percent
- d. around 14 percent
- e. less than 1 percent

ANSWER:

b

76. The majority of ____ on our planet is believed to have come from its hot interior through outgassing, although some of Earth's water may have come from collisions with meteors and comets.

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- a. carbon dioxide
- b. water
- c. molecular oxygen
- d. ozone
- e. carbon

ANSWER:

b

77. The most abundant greenhouse gas in Earth's current atmosphere is ____.

- a. carbon dioxide (CO₂)
- b. nitrous oxide (N₂O)
- c. water vapor (H₂O)
- d. methane (CH₄)
- e. chlorofluorocarbons (CFCs)

ANSWER:

c

78. Ozone (O₃) in the stratosphere has ____.

- a. protected life from harmful ultraviolet rays.
- b. decreased in concentration by 30 percent
- c. remained at about the same concentration from year to year
- d. disappeared entirely
- e. has doubled in concentration

ANSWER:

a

79. Which process acts to remove carbon dioxide from the atmosphere?

- a. increasing greenhouse gases
- b. deforestation
- c. photosynthesis
- d. burning fossil fuels
- e. volcanic eruptions

ANSWER:

c

80. Which of the following is **not** a way for CO₂ to enter the atmosphere?

- a. volcanic eruptions
- b. through phytoplankton fixing CO₂ into organic tissues
- c. burning fossil fuels
- d. animal life respiration
- e. deforestation

ANSWER:

b

81. The unit of pressure most commonly found on a surface weather map is ____.

- a. inches of mercury (Hg)
- b. millibars or hectopascals
- c. pounds per square inch

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- d. millimeters of mercury (Hg)
- e. kilograms per hectare

ANSWER:

b

82. Which weather element *always* decreases as we climb upward in the atmosphere?

- a. wind
- b. temperature
- c. pressure
- d. moisture
- e. dew point

ANSWER:

c

83. Earth's atmosphere is divided into named layers based on the vertical profile of ____.

- a. air pressure
- b. air temperature
- c. air density
- d. wind speed
- e. chemical composition

ANSWER:

b

84. Almost all of Earth's weather occurs in the ____.

- a. exosphere
- b. stratosphere
- c. mesosphere
- d. ionosphere
- e. troposphere

ANSWER:

e

85. The most abundant gas in the stratosphere is ____.

- a. oxygen (O₂).
- b. nitrogen (N₂).
- c. carbon dioxide (CO₂).
- d. ozone (O₃).
- e. chlorofluorocarbons (CFCs).

ANSWER:

b

86. Is there enough oxygen in the stratosphere to breathe comfortably on your own? Explain your answer.

ANSWER: No. The stratosphere is located above 11,000 m. Mount Everest has an altitude of 8,848 m, so it is necessary to carry oxygen. Likewise, a plane must provide oxygen in the cabin and cockpit, otherwise all (including the pilot) will pass out.

87. What happens to water vapor above the tropopause?

ANSWER: Rising air currents transform the invisible water vapor into many billions of tiny liquid droplets that appear as puffy cumulus clouds. If the rising air in the cloud extends to greater heights where air temperatures are

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quite low, some of the liquid droplets would freeze into minute ice crystals.

88. What instruments are used in meteorology? What role did the discovery of instruments play in the emergence of the science of meteorology?

ANSWER: Students should discuss the role of instruments such as hygrometers, barometers, thermometers, radiosondes, radar, numerical models, and satellites in the advancement of meteorology.

89. Describe the various types and relative sizes of storms found in Earth's atmosphere.

ANSWER: Students need to list at least the four main storm types in the following order from small to large: tornadoes, thunderstorms, hurricanes, and middle-latitude cyclonic storm systems (or extratropical cyclones).

90. If the air temperature at sea level (0 feet) is 60 degrees Fahrenheit, what would be the approximate air temperature at an altitude of 10,000 feet, assuming an average atmospheric lapse rate of 3.6 degrees Fahrenheit per 1,000 feet?

ANSWER: The approximate air temperature would be 24 degrees Fahrenheit.

91. Describe how air pressure decreases with increasing altitude.

ANSWER: The amount of force exerted over an area of surface is called atmospheric pressure or, simply, air pressure. The pressure at any level in the atmosphere may be measured in terms of the total mass of air above any point. As we climb in elevation, fewer air molecules are above us; hence, atmospheric pressure always decreases with increasing height. Like air density, air pressure decreases rapidly at first, then more slowly at higher levels.

92. How is carbon dioxide naturally removed from the atmosphere

ANSWER: Carbon dioxide enters the atmosphere mainly from the decay of vegetation, but it also comes from volcanic eruptions, the exhalations of animal life, the burning of fossil fuels (such as coal, oil, and natural gas), and deforestation. The removal of CO₂ from the atmosphere takes place during photosynthesis as plants consume CO₂ to produce oxygen and sugars. The CO₂ is then stored in roots, branches, and leaves. Rain and snow can react with silicate minerals in rocks and remove CO₂ from the atmosphere through a process known as chemical weathering. The oceans serve as a large reservoir for CO₂, as phytoplankton (tiny drifting plants) in surface water fix CO₂ into organic tissues. Carbon dioxide that dissolves directly into surface water mixes downward and circulates through greater depths. Estimates are that the oceans hold more than 50 times the total atmospheric CO₂ content.

93. Why is stratospheric ozone important to plant, animal, and human life?

ANSWER: Stratospheric ozone is important because it shields plants, animals, and humans from the Sun's harmful ultraviolet rays. Stratospheric ozone provides a natural protective shield in the upper atmosphere so that plants on the surface may survive.

94. Describe how air temperature changes in the four main layers of the atmosphere.

ANSWER: Answers should include the terms troposphere, stratosphere, mesosphere, and thermosphere. In the troposphere, temperature decreases with altitude, whereas in the stratosphere it increases with altitude, decreases again in the mesosphere, then rises again in the thermosphere. The troposphere contains all the weather we see on Earth. In the stratosphere we see a temperature inversion. In the mesosphere the percentage of nitrogen and oxygen is approximately the same as at sea level. However, given air's low density in this region, humans could not survive breathing this air. The thermosphere is the so-called "hot layer." Here, oxygen molecules (O₂) absorb energetic solar rays, warming the air.

95. Where did nitrogen in the atmosphere originate?

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ANSWER: Scientists believe nitrogen in our current atmosphere arose from the degassing of volcanoes. Since nitrogen gas (N₂) is not reactive, it built up in the Earth's atmosphere over time.

96. Define the concept of weight.

ANSWER: Weight is defined as the mass of an object times the acceleration of gravity; thus, the relationship is weight = mass x gravity.

97. Write an example of a good working hypothesis for a research problem that is interesting to you. For example, you could seek to explain why the striped bass population in a certain lake is growing.

ANSWER: A good hypothesis would be that striped bass population in the lake is increasing because the fish are thriving due to a ban on fishing permits. If this hypothesis is true, fish stocks should decrease if the ban is lifted, and anglers return to fish in the lake.

98. Explain the concept of "weather."

ANSWER: "Weather" refers to the condition of the atmosphere at any particular time and place. Weather, which is always changing, includes: air temperature, air pressure, humidity, clouds, precipitation, visibility, and wind.

99. Describe the processes in Earth's history that led to an increase in oxygen in the atmosphere.

ANSWER: Earth's first atmosphere (some 4.6 billion years ago) was most likely *hydrogen* and *helium* as well as hydrogen compounds such as methane and ammonia. After volcanic eruptions and outgassing, the next stage was constant rain for many thousands of years, resulting in an increase in Oxygen (O₂) through photo dissociation. After plants evolved, the atmospheric oxygen content increased more rapidly through photosynthesis.

100. Describe the effect that drought can have on human health.

ANSWER: The following health issues could be of concern: crop failures can lead to food shortages and thus malnutrition and even starvation. Lack of income can lead to anxiety and depression.