Review Questions

1. Where does the greatest amount of daily weather change take place?
   (1) tropopause
   (2) stratopause
   (3) troposphere
   (4) stratosphere

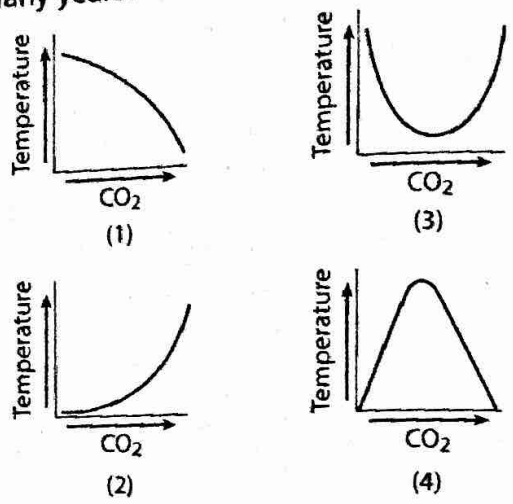
2. The highest air temperature ever recorded in Albany, New York, is 104°F, which occurred on July 4, 1911. This temperature is equal to
   (1) 35°C
   (2) 40°C
   (3) 45°C
   (4) 50°C

3. Which source provides the most energy for atmospheric weather changes?
   (1) radiation from the sun
   (2) radioactivity from Earth's interior
   (3) heat stored in ocean water
   (4) heat stored in polar ice caps

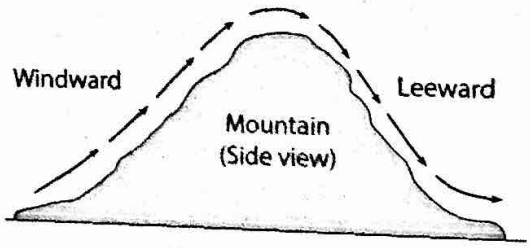
4. The transfer of heat energy within the troposphere occurs primarily by
   (1) insolation
   (2) conduction
   (3) radiation
   (4) convection

5. As a mass of air rises in the troposphere its temperature will usually
   (1) decrease due to expansion
   (2) decrease due to compression
   (3) increase due to expansion
   (4) increase due to compression

6. Which graph best represents what most likely happens to the temperature of Earth's atmosphere as the amount of carbon dioxide in the atmosphere increases over a period of many years?



7. The diagram below shows the direction of movement of air over a mountain. As the air moves down the leeward side of the mountain, the air will



   (1) warm due to compression
   (2) warm due to expansion
   (3) cool due to compression
   (4) cool due to expansion

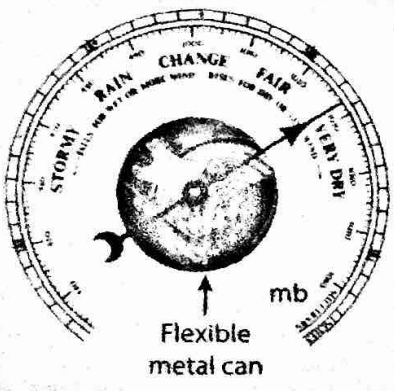


Figure 7-1. Aneroid Barometer

Atmospheric Pressure and Density

Air pressure and density are directly related. The denser the atmosphere, the greater the weight of a given volume of air, and therefore the greater the air pressure it exerts. **Atmospheric pressure**—also called **barometric pressure** and **air pressure**—is the pressure due to the weight of the overlying atmosphere pushing down on any given area.

Measurement of and Changes in Air Pressure

Instruments called **barometers** are used to measure air pressure. Two types of barometers are used—the mercury barometer and the aneroid barometer. In a mercury barometer, a tube with a closed top is placed in a container of mercury. When a column of air from above pushes down on

the mercury in the container, the mercury rises in the tube. The air pressure is read in inches of mercury. In an aneroid barometer (Figure 7-1), a metal can contains a partial vacuum that expands and contracts with changes in air pressure, and a series of mechanical parts display a reading on a dial.

The mercury barometer is the standard reference instrument, but it is difficult to transport, and there is the danger of mercury vapor. Standard air pressure (one atmosphere) at sea level is 14.7 pounds per square inch, 29.92 inches of mercury, or 1013.2 millibars. Barometric pressure in millibars can be converted to inches of mercury using the Pressure chart in the *Earth Science Reference Tables*. (See Figure 7-2.) The barometric trend—shown on weather maps—is how the magnitude of the air pressure has changed over the past three hours. Air pressure is often shown on weather maps by the use of isolines called **isobars,** as shown in Figures 7-6, 7-18 and 7-22A.

Effect of Temperature on Air Pressure Changes in the temperature of the air cause changes in air pressure. As the temperature of air increases, the air expands and its density and pressure decrease. Decreasing temperature has the reverse effect.

Effect of Water Vapor on Air Pressure The greater the amount of water vapor in the air (called moisture content, absolute humidity, and humidity), the lower the air density and pressure. Each water molecule in the atmosphere replaces another molecule of air, usually oxygen or nitrogen. Since a water molecule weighs less than either an oxygen or a nitrogen molecule, the greater the amount of water vapor in the air, the less dense the air as a whole becomes. (See Figure 7-3.)

Effect of Altitude on Atmospheric Pressure As altitude or elevation increases, atmospheric density and pressure decrease. As you go up higher in the atmosphere, the less gas there is above you. If you have ever climbed a high mountain, the lower air pressure, and thus less oxygen, was the reason you were "short of breath." (See Atmospheric Pressure with Selected Properties of Earth's Atmosphere in the *Earth Science Reference Tables*.)

To summarize, as either altitude, temperature, or moisture content in the atmosphere increases, air density and air pressure decrease.

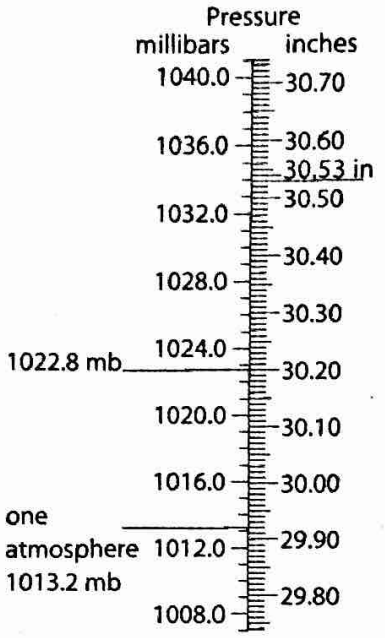


Figure 7-2. Method of converting from millibars to inches of mercury in air pressure readings: This is part of the chart from the *Earth Science Reference Tables*. The millibar part of the table has divisions for each whole millibar. You should be able to estimate to the nearest tenth of a millibar within three tenths. The inch part of the scale's big divisions is for each tenth of an inch, and smaller divisions are for hundredths of an inch. Because of the smallness of these divisions, a measurement to the nearest hundredth of an inch is a reasonable answer. Some conversions are 1013.2 millibars (mb) = 29.92 inches, 1022.8 mb = 30.20 inches, 30.53 inches = 1034.0 mb, 29.81 inches = 1009.5 mb.

Type of Gas	Relative Molecular Weight
$N = N_2$, nitrogen molecules	28
$O = O_2$, oxygen molecules	32
$W = H_2O$, water molecules	18

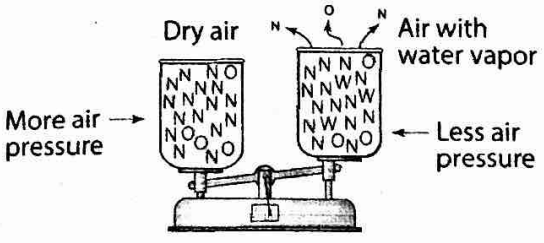


Figure 7-3. Effect of water vapor on air pressure: When water vapor is "added" to volume of air, it is not really added. A molecule of water vapor replaces a molecule of nitrogen or oxygen in that volume of air—resulting in the same number of molecules as there were before the water vapor was added. Since each molecule of water has less weight and mass than nitrogen and oxygen, the more water vapor in a given volume of air, the less the air's weight, density, and pressure. The effect shown in the diagram is greatly exaggerated.

Review Questions

8. A balloon carrying weather instruments is released at Earth's surface and rises through the troposphere. As the balloon rises, what will the instruments generally indicate?

(1) a decrease in both air temperature and air pressure
(2) an increase in both air temperature and air pressure
(3) an increase in air temperature and a decrease in air pressure
(4) a decrease in air temperature and an increase in air pressure

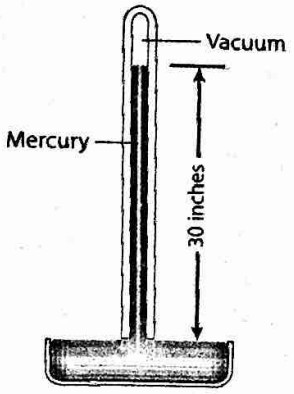
9. An air pressure of 1023 millibars is equal to how many inches of mercury?

(1) 30.10 (2) 30.15 (3) 30.19 (4) 30.21

10. An air pressure of 30.15 inches of mercury is equal to

(1) 1017 mb
(2) 1019 mb
(3) 1021 mb
(4) 1023 mb

11. Which weather variable is the following instrument designed to measure?



(1) visibility
(2) relative humidity
(3) dew point
(4) air pressure

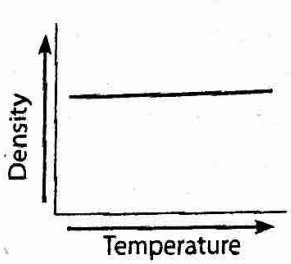
12. A barometer indicates a pressure of 30 inches of mercury at sea level; at $3\frac{1}{2}$ miles above sea level, it indicates a pressure of 15 inches. What is the best conclusion you can draw from these data?

(1) humidity affects the pressure
(2) temperature affects the pressure
(3) of the total mass of air, about 99 percent is within $3\frac{1}{2}$ miles of sea level
(4) of the total mass of air, about 50 percent is less than $3\frac{1}{2}$ miles above sea level

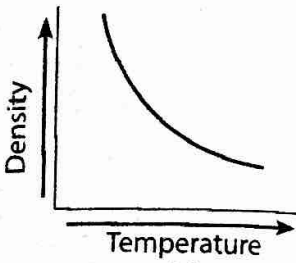
13. At sea level, as the temperature of the atmosphere decreases, the air pressure usually

(1) decreases
(2) increases
(3) remains the same

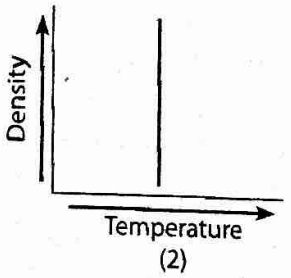
14. Which graph best represents the relationship between air temperature and air density in the atmosphere?



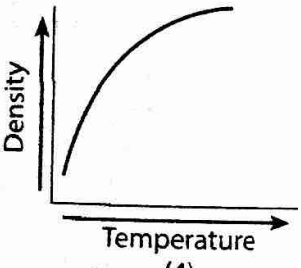
(1)



(3)



(2)



(4)

15. If the air humidity increases and the temperature remains the same, the air pressure will

(1) decrease
(2) remain the same
(3) increase
(4) first increase, then decrease

16. What is the approximate elevation above sea level at which atmospheric pressure is 0.2 atmosphere?

(1) 7.0 km
(2) 17 km
(3) 27 km
(4) 37 km

17. As a parcel of air increases in altitude, its pressure will

(1) decrease
(2) increase
(3) remain the same