EXAMPLE 2 Graphing Exponential Decay

As the height above sea level increases, atmospheric pressure decreases exponentially at a rate of about 3.8% per 1000 feet. At sea level, atmospheric pressure is denoted by 1 atmosphere (atm). Commercial jets typically fly at about 35,000 feet. Sketch a graph showing the decrease in atmospheric pressure as a jet climbs from sea level to 35,000 feet. Use the graph to estimate the atmospheric pressure at 35,000 feet.

SOLUTION

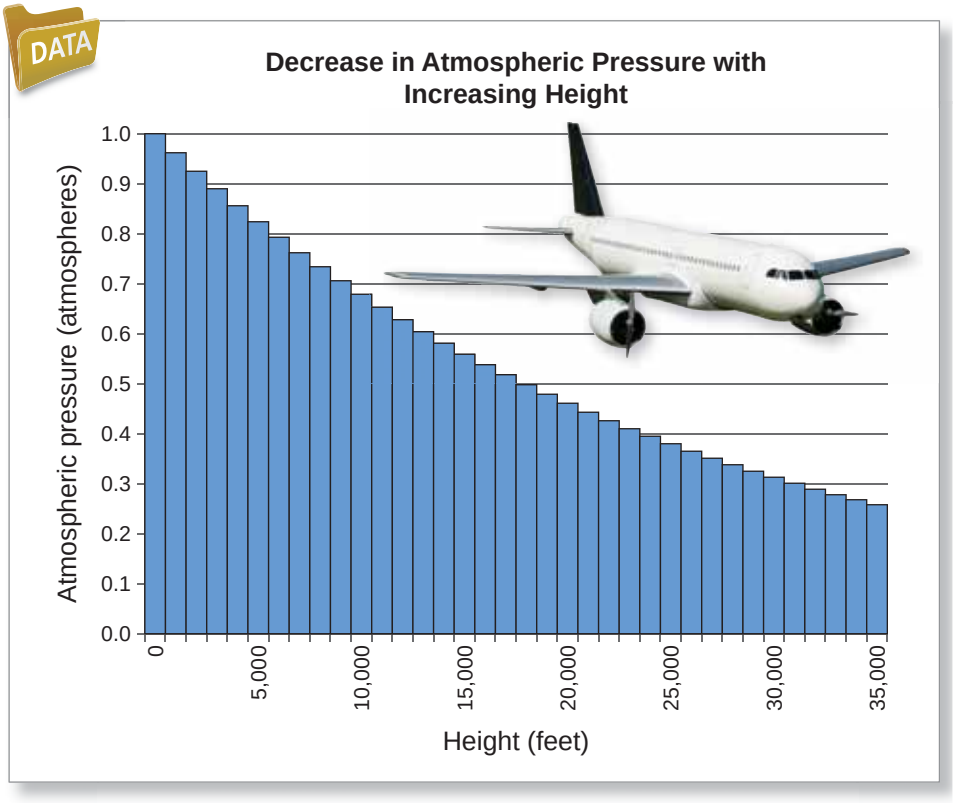
In the 17th century, scientists discovered that air actually has weight. Evangelista Torricelli, one of the first to discover atmospheric pressure, said, "We live submerged at the bottom of an ocean of the element air." Earth's gravitational field pulls on air, and this pull is called atmospheric pressure. Torricelli went on to develop the mercury barometer to measure atmospheric pressure.

The formula for this exponential decay is

$$A = P(1 - r)^n = 1(1 - 0.038)^n. \qquad P = 1,\ r = 3.8\% = 0.038$$

Enter this formula into a spreadsheet and graph the results as shown.

DATA



From the graph, the atmospheric pressure at 35,000 feet appears to be about 0.25 atmosphere. You can check this using the formula.

$$A = P(1 - r)^n = 1(1 - 0.038)^{35} = 1(0.962)^{35} \approx 0.258 \text{ atm}$$

So, at 35,000 feet above sea level, the atmospheric pressure is about a quarter of what it is at sea level.

Checkpoint

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There are many mountains in the United States that have heights of 14,000 feet or greater. They are all in Alaska, California, Colorado, and Washington. Mount McKinley in Alaska has a height of about 20,320 feet. How much more does the atmospheric pressure decrease as you climb from 14,000 feet to 20,320 feet?