

## Problem 20

The record for the largest glass bottle was set in 1992 by a team in Millville, New Jersey—they blew a bottle with a volume of 193 U.S. fluid gallons. (a) How much short of 1.0 million cubic centimeters is that? (b) If the bottle were filled with water at the leisurely rate of 1.8 g/min, how long would the filling take? Water has a density of 1000 kg/m<sup>3</sup>.

### Solution

#### Part (a)

To change from U.S. fluid gallons to cubic centimeters, use conversion factors; the ones for volume are listed in Appendix D on page A-6 ( $277.4 \text{ in}^3 = 1.201 \text{ U.S. fluid gallons}$ ).

$$193 \text{ U.S. fluid gallons} = 193 \text{ U.S. fluid gallons} \times \frac{277.4 \text{ in}^3}{1.201 \text{ U.S. fluid gallons}} \times \left( \frac{2.54 \text{ cm}}{1 \text{ in}} \right)^3$$

$$\approx 7.31 \times 10^5 \text{ cm}^3$$

Subtract this from 1 million to find how much short of a million the volume is.

$$(10^6 - 7.31 \times 10^5) \text{ cm}^3 \approx 2.69 \times 10^5 \text{ cm}^3$$

#### Part (b)

Use conversion factors to go from the given volume to the time it takes to fill the bottle.

$$193 \text{ U.S. fl gal} \times \frac{277.4 \text{ in}^3}{1.201 \text{ U.S. fl gal}} \times \left( \frac{2.54 \text{ cm}}{1 \text{ in}} \right)^3 \times \left( \frac{1 \text{ m}}{100 \text{ cm}} \right)^3 \times \frac{1000 \text{ kg}}{1 \text{ m}^3} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ min}}{1.8 \text{ g}} \approx 4.1 \times 10^5 \text{ min}$$