Appendix

The solutions here are for the problems in Appendix 9.

1. (a) Without accounting for buoyancy, the volume of water is

$$\frac{9.9814\text{ g}}{0.99707\text{ g/cm}^3} = 10.011\text{ cm}^3 = 10.011\text{ mL}$$

When we correct for buoyancy, however, the volume is

$$W_v = 9.9814\text{ g} \times \left[1 + \left\{\frac{1}{0.99707\text{ g/cm}^3} - \frac{1}{8.40\text{ g/cm}^3}\right\} \times 0.0012\text{g/cm}^3\right]$$

$$W_v = 9.9920\text{ g}$$

(b) The absolute and relative errors in the mass are

$$10.011\text{ mL} - 10.021\text{ mL} = -0.010\text{ mL}$$

$$\frac{-0.010\text{ mL}}{10.021\text{ mL}} \times 100 = -0.10\%$$

Table 4.9 shows us that the standard deviation for the calibration of a 10-mL pipet is on the order of ± 0.006 mL. Failing to correct for the effect of buoyancy gives a determinate error of –0.010 mL that is slightly larger than ± 0.006 mL, suggesting that it introduces a small, but significant determinate error.

2. The sample's true weight is

$$W_v = 0.2500\text{ g} \times \left[1 + \left\{\frac{1}{2.50\text{ g/cm}^3} - \frac{1}{8.40\text{ g/cm}^3}\right\} \times 0.0012\text{g/cm}^3\right]$$

$$W_v = 0.2501\text{ g}$$

In this case the absolute and relative errors in mass are –0.0001 g and –0.040%.

3. The true weight is the product of the weight measured in air and the buoyancy correction factor, which makes this a proportional error. The percentage error introduced when we ignore the buoyancy correction is independent of mass and a function only of the difference between the density of the object being weighed and the density of the calibration weights.

4. To determine the minimum density, we note that the buoyancy correction factor equals 1.00 if the density of the calibration weights and the density of the sample are the same. The correction factor is greater than 1.00 if D_o is smaller than D_w; thus, the following inequality applies

$$\left(\frac{1}{D_o} - \frac{1}{8.40}\right) \times 0.0012 \leq (1.00)(0.0001)$$

Solving for D_o shows that the sample's density must be greater than 4.94 g/cm^3 to ensure an error of less than 0.01%.