SOLUTIONS TO PROBLEMS

P1.2 Modeling the Earth as a sphere, we find its volume as $\frac{4}{3}\pi r^3 = \frac{4}{3}\pi\left(6.37\times10^6\text{ m}\right)^3 = 1.08\times10^{21}\text{ m}^3$. Its density is then $\rho = \frac{m}{V} = \frac{5.98\times10^{24}\text{ kg}}{1.08\times10^{21}\text{ m}^3} = \boxed{5.52\times10^3\text{ kg/m}^3}$. This value is intermediate between the tabulated densities of aluminum and iron. Typical rocks have densities around 2 000 to $3\,000\text{ kg/m}^3$. The average density of the Earth is significantly higher, so higher-density material must be down below the surface.

P1.17 Inserting the proper units for everything except *G*,

$$\left[\frac{\text{kg m}}{\text{s}^2}\right] = \frac{G[\text{kg}]^2}{[\text{m}]^2}.$$

Multiply both sides by $[\text{m}]^2$ and divide by $[\text{kg}]^2$; the units of *G* are $\boxed{\frac{\text{m}^3}{\text{kg}\cdot\text{s}^2}}$.

P1.30 $N_{\text{atoms}} = \frac{m_{\text{Sun}}}{m_{\text{atom}}} = \frac{1.99\times10^{30}\text{ kg}}{1.67\times10^{-27}\text{ kg}} = \boxed{1.19\times10^{57}\text{ atoms}}$

P1.32

$$V = \frac{1}{3}Bh = \frac{\left[(13.0\text{ acres})\left(43\,560\text{ ft}^2/\text{acre}\right)\right]}{3}(481\text{ ft})$$
$$= 9.08\times10^7\text{ ft}^3,$$

or

$$V = \left(9.08\times10^7\text{ ft}^3\right)\left(\frac{2.83\times10^{-2}\text{ m}^3}{1\text{ ft}^3}\right)$$
$$= \boxed{2.57\times10^6\text{ m}^3}$$

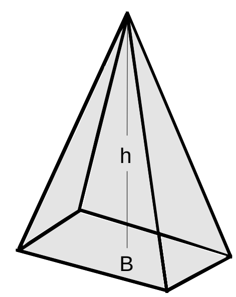

FIG. P1.32

P1.44 A typical raindrop is spherical and might have a radius of about 0.1 inch. Its volume is then approximately $4\times10^{-3}\text{ in}^3$. Since $1\text{ acre} = 43\,560\text{ ft}^2$, the volume of water required to cover it to a depth of 1 inch is

$$(1\text{ acre})(1\text{ inch}) = (1\text{ acre}\cdot\text{in})\left(\frac{43\,560\text{ ft}^2}{1\text{ acre}}\right)\left(\frac{144\text{ in}^2}{1\text{ ft}^2}\right) \approx 6.3\times10^6\text{ in}^3.$$

The number of raindrops required is

$$n = \frac{\text{volume of water required}}{\text{volume of a single drop}} = \frac{6.3\times10^6\text{ in}^3}{4\times10^{-3}\text{ in}^3} = 1.6\times10^9 \sim \boxed{10^9}.$$