Chapter 1 Physics and Measurement

P1.3 Let V represent the volume of the model, the same in $\rho = \frac{m}{V}$ for both. Then

$\rho_{\text{iron}} = 9.35\ \text{kg}/V$ and $\rho_{\text{gold}} = \frac{m_{\text{gold}}}{V}$. Next,

$\frac{\rho_{\text{gold}}}{\rho_{\text{iron}}} = \frac{m_{\text{gold}}}{9.35\ \text{kg}}$ and $m_{\text{gold}} = 9.35\ \text{kg}\left(\frac{19.3\times10^3\ \text{kg/m}^3}{7.86\times10^3\ \text{kg/m}^3}\right) = \boxed{23.0\ \text{kg}}$.

P1.5 For either sphere the volume is $V = \frac{4}{3}\pi r^3$ and the mass is $m = \rho V = \rho\frac{4}{3}\pi r^3$. We divide this equation for the larger sphere by the same equation for the smaller:

$$\frac{m_l}{m_s} = \frac{\rho 4\pi r_l^3 3}{\rho 4\pi r_s^3 3} = \frac{r_l^3}{r_s^3} = 5\,.$$

Then $r_l = r_s\sqrt[3]{5} = 4.50\ \text{cm}(1.71) = \boxed{7.69\ \text{cm}}$.

P1.9 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 $\boxed{\frac{\text{m}^3}{\text{kg}\cdot\text{s}^2}}$.

P1.10 Apply the following conversion factors:

$$1\ \text{in} = 2.54\ \text{cm},\ 1\ \text{d} = 86\,400\ \text{s},\ 100\ \text{cm} = 1\ \text{m},\ \text{and}\ 10^9\ \text{nm} = 1\ \text{m}$$

$$\left(\frac{1}{32}\ \text{in/day}\right)\frac{(2.54\ \text{cm/in})(10^{-2}\ \text{m/cm})(10^9\ \text{nm/m})}{86\,400\ \text{s/day}} = \boxed{9.19\ \text{nm/s}}\,.$$

This means the proteins are assembled at a rate of many layers of atoms each second!

P1.12 (a) $V = (40.0\ \text{m})(20.0\ \text{m})(12.0\ \text{m}) = 9.60\times10^3\ \text{m}^3$

$V = 9.60\times10^3\ \text{m}^3(3.28\ \text{ft}/1\ \text{m})^3 = \boxed{3.39\times10^5\ \text{ft}^3}$

(b) The mass of the air is

$$m = \rho_{\text{air}}V = (1.20\ \text{kg/m}^3)(9.60\times10^3\ \text{m}^3) = 1.15\times10^4\ \text{kg}\,.$$

The student must look up weight in the index to find

$$F_g = mg = (1.15\times10^4\ \text{kg})(9.80\ \text{m/s}^2) = 1.13\times10^5\ \text{N}\,.$$

Converting to pounds, $F_g = (1.13\times10^5\ \text{N})(1\ \text{lb}/4.45\ \text{N}) = \boxed{2.54\times10^4\ \text{lb}}$.

***P1.13** The area of the four walls is (3.6 + 3.8 + 3.6 + 3.8)m (2.5 m) = 37 m^2. Each sheet in the book has area

(0.21 m) (0.28 m) = 0.059 m^2. The number of sheets required for wallpaper is

37 m^2/0.059 m^2 = 629 sheets = 629 sheets(2 pages/1 sheet) = 1260 pages.

$\boxed{\text{The pages from volume one are inadequate, but the full version has enough pages.}}$

P1.17 (a) $$\left(\frac{8\times10^{12}\ \$}{1000\ \$/\text{s}}\right)\left(\frac{1\ \text{h}}{3\,600\ \text{s}}\right)\left(\frac{1\ \text{day}}{24\ \text{h}}\right)\left(\frac{1\ \text{yr}}{365\ \text{days}}\right)=\boxed{250\ \text{years}}$$

(b) The circumference of the Earth at the equator is $2\pi\left(6.378\times10^{3}\ \text{m}\right)=4.01\times10^{7}\ \text{m}$. The length of one dollar bill is 0.155 m so that the length of 8 trillion bills is $1.24\times10^{12}\ \text{m}$. Thus, the 8 trillion dollars would encircle the Earth

$$\frac{1.24\times10^{12}\ \text{m}}{4.01\times10^{7}\ \text{m}}=\boxed{3.09\times10^{4}\ \text{times}}$$

P1.19 $$F_g=\left(2.50\ \text{tons/block}\right)\left(2.00\times10^{6}\ \text{blocks}\right)\left(2\,000\ \text{lb/ton}\right)=\boxed{1.00\times10^{10}\ \text{lbs}}$$

P1.26 A reasonable guess for the diameter of a tire might be 2.5 ft, with a circumference of about 8 ft. Thus, the tire would make $\left(50\,000\ \text{mi}\right)\left(5\,280\ \text{ft/mi}\right)\left(1\ \text{rev}/8\ \text{ft}\right)=3\times10^{7}\ \text{rev}\sim\boxed{10^{7}\ \text{rev}}$.

P1.30 METHOD ONE

We treat the best value with its uncertainty as a binomial $(21.3\pm0.2)\,\text{cm}\ (9.8\pm0.1)\,\text{cm}$,

$$A=\left[21.3(9.8)\pm21.3(0.1)\pm0.2(9.8)\pm(0.2)(0.1)\right]\ \text{cm}^2.$$

The first term gives the best value of the area. The cross terms add together to give the uncertainty and the fourth term is negligible.

$$A=\boxed{209\ \text{cm}^2\pm4\ \text{cm}^2}.$$

METHOD TWO We add the fractional uncertainties in the data.

$$A=(21.3\ \text{cm})(9.8\ \text{cm})\pm\left(\frac{0.2}{21.3}+\frac{0.1}{9.8}\right)=209\ \text{cm}^2\pm2\%=209\ \text{cm}^2\pm4\ \text{cm}^2$$

P1.33 (a)

```
 756.??
  37.2?
   0.83
+  2.5?
 796./5/3  = 797
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$\boxed{797}$

(b) $$0.003\,2\,(2\ \text{s.f.})\times356.3\,(4\ \text{s.f.})=1.140\,16=(2\ \text{s.f.})\ \boxed{1.1}$$

(c) $$5.620\,(4\ \text{s.f.})\times\pi\,(>4\ \text{s.f.})=17.656=(4\ \text{s.f.})\ \boxed{17.66}$$

***P1.50** The rate of volume increase is

$$\frac{dV}{dt}=\frac{d}{dt}\frac{4}{3}\pi r^3=\frac{4}{3}\pi 3r^2\frac{dr}{dt}=4\pi r^2\frac{dr}{dt}.$$

(a) $dV/dt = 4\pi(6.5\text{ cm})^2(0.9\text{ cm/s}) = \boxed{478\text{ cm}^3/\text{s}}$

(b) $\frac{dr}{dt}=\frac{dV/dt}{4\pi r^2}=\frac{478\text{ cm}^3/\text{s}}{4\pi(13\text{ cm})^2}=\boxed{0.225\text{ cm}^3/\text{s}}$

(c) When the balloon radius is twice as large, its surface area is four times larger. The new volume added in one second in the inflation process is equal to this larger area times an extra radial thickness that is one-fourth as large as it was when the balloon was smaller.

P1.53

$$2\pi r = 15.0\text{ m}$$
$$r = 2.39\text{ m}$$
$$\frac{h}{r}=\tan 55.0°$$
$$h=(2.39\text{ m})\tan(55.0°)=\boxed{3.41\text{ m}}$$

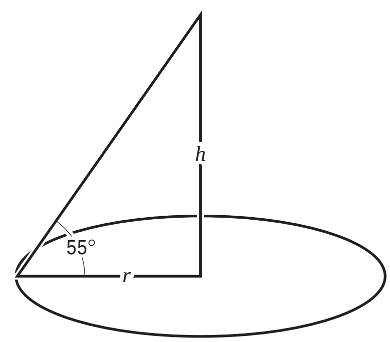

FIG. P1.53

P1.55 The actual number of seconds in a year is

$$(86\,400\text{ s/day})(365.25\text{ day/yr})=31\,557\,600\text{ s/yr}.$$

The percent error in the approximation is

$$\frac{\left|(\pi\times 10^7\text{ s/yr})-(31\,557\,600\text{ s/yr})\right|}{31\,557\,600\text{ s/yr}}\times 100\%=\boxed{0.449\%}.$$

P1.57 (a) The speed of rise may be found from

$$v=\frac{(\text{Vol rate of flow})}{(\text{Area: }\pi D^2/4)}=\frac{16.5\text{ cm}^3/\text{s}}{\pi(6.30\text{ cm})^2/4}=\boxed{0.529\text{ cm/s}}.$$

(b) Likewise, at a 1.35 cm diameter,

$$v=\frac{16.5\text{ cm}^3/\text{s}}{\pi(1.35\text{ cm})^2/4}=\boxed{11.5\text{ cm/s}}.$$