Chapter 1 Solutions

1.7 Use m = molar mass/N_A and 1 u = 1.66×10^{-24} g

(a) For He, $m = \dfrac{4.00 \text{ g/mol}}{6.02 \times 10^{23} \text{ mol}^{-1}} = \boxed{6.64 \times 10^{-24} \text{ g} = 4.00 \text{ u}}$

(b) For Fe, $m = \dfrac{55.9 \text{ g/mol}}{6.02 \times 10^{23} \text{ mol}^{-1}} = \boxed{9.29 \times 10^{-23} \text{ g} = 55.9 \text{ u}}$

(c) For Pb, $m = \dfrac{207 \text{ g/mol}}{6.02 \times 10^{23} \text{ mol}^{-1}} = \boxed{3.44 \times 10^{-22} \text{ g} = 207 \text{ u}}$

1.14 $\left[2\pi\sqrt{\dfrac{\ell}{g}}\right] = \sqrt{\dfrac{L}{L/T^2}} = \sqrt{T^2} = \boxed{T}$

1.16 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

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

1.19 Area A = (100 ft)(150 ft) = 1.50×10^4 ft^2, so

$$A = (1.50 \times 10^4 \text{ ft}^2)(9.29 \times 10^{-2} \text{ m}^2/\text{ft}^2) = \boxed{1.39 \times 10^3 \text{ m}^2}$$

Goal Solution

A rectangular building lot is 100 ft by 150 ft. Determine the area of this lot in m^2.

G: We must calculate the area and convert units. Since a meter is about 3 feet, we should expect the area to be about A ≈ (30 m)(50 m) = 1 500 m^2.

O: Area = Length × Width. Use the conversion: 1 m = 3.281 ft.

A: $A = L \times W = (100 \text{ ft})\left(\dfrac{1 \text{ m}}{3.281 \text{ ft}}\right)(150 \text{ ft})\left(\dfrac{1 \text{ m}}{3.281 \text{ ft}}\right) = 1\,390 \text{ m}^2$

L: Our calculated result agrees reasonably well with our initial estimate and has the proper units of m^2. Unit conversion is a common technique that is applied to many problems.

1.29 (a) $\left(\frac{6\times 10^{12}\ \$}{1000\ \$/\text{s}}\right)\left(\frac{1\ \text{hr}}{3600\ \text{s}}\right)\left(\frac{1\ \text{day}}{24\ \text{hr}}\right)\left(\frac{1\ \text{yr}}{365\ \text{days}}\right)=\boxed{190\ \text{years}}$

(b) The circumference of the Earth at the equator is $2\pi(6378\times 10^3\ \text{m}) = 4.01\times 10^7\ \text{m}$. The length of one dollar bill is 0.155 m so that the length of 6 trillion bills is 9.30×10^{11} m. Thus, the 6 trillion dollars would encircle the Earth

$$\frac{9.30\times 10^{11}\ \text{m}}{4.01\times 10^{7}\ \text{m}}=\boxed{2.32\times 10^{4}\ \text{times}}$$

Goal Solution

At the time of this book's printing, the U.S. national debt is about \$6 trillion. (a) If payments were made at the rate of \$1 000 per second, how many years would it take to pay off a \$6-trillion debt, assuming no interest were charged? (b) A dollar bill is about 15.5 cm long. If six trillion dollar bills were laid end to end around the Earth's equator, how many times would they encircle the Earth? Take the radius of the Earth at the equator to be 6 378 km. (*Note:* Before doing any of these calculations, try to guess at the answers. You may be very surprised.)

(a)

G: \$6 trillion is certainly a large amount of money, so even at a rate of \$1000/second, we might guess that it will take a lifetime (~ 100 years) to pay off the debt.

O: Time to repay the debt will be calculated by dividing the total debt by the rate at which it is repaid.

A: $T=\frac{\$6\text{ trillion}}{\$1000/\text{s}}=\frac{\$6\times 10^{12}}{(\$1000/\text{s})(3.16\times 10^{7}\ \text{s/yr})}=190\ \text{yr}$

L: OK, so our estimate was a bit low. \$6 trillion really is a lot of money!

(b)

G: We might guess that 6 trillion bills would encircle the Earth at least a few hundred times, maybe more since our first estimate was low.

O: The number of bills can be found from the total length of the bills placed end to end divided by the circumference of the Earth.

A: $N=\frac{L}{C}=\frac{(6\times 10^{12})(15.5\ \text{cm})(1\ \text{m}/100\ \text{cm})}{2\pi\, 6.37\times 10^{6}\ \text{m}}=2.32\times 10^{4}\ \text{times}$

L: OK, so again our estimate was low. Knowing that the bills could encircle the earth more than 20 000 times, it might be reasonable to think that 6 trillion bills could cover the entire surface of the earth, but the calculated result is a surprisingly small fraction of the earth's surface area!

***1.48** The typical person probably drinks 2 to 3 soft drinks daily. Perhaps half of these were in aluminum cans. Thus, we will estimate 1 aluminum can disposal per person per day. In the U.S. there are ~250 million people, and 365 days in a year, so $(250\times 10^6\ \text{cans/day})(365\ \text{days/year}) \approx 10^{10}$ cans are thrown away or recycled each year. Guessing that each can weighs around 1/10 of an ounce, we estimate this represents

$(10^{10}\ \text{cans})(0.1\ \text{oz/can})(1\ \text{lb}/16\ \text{oz})(1\ \text{ton}/2000\ \text{lb}) \approx 3.1\times 10^{5}\ \text{tons/year}$.

$\boxed{\sim 10^{5}\ \text{tons}}$

1.49 Assume: Total population = 10^7; one out of every 100 people has a piano; one tuner can serve about 1,000 pianos (about 4 per day for 250 weekdays, assuming each piano is tuned once per year). Therefore,

$$\#\ \text{tuners} \sim \left(\frac{1\ \text{tuner}}{1000\ \text{pianos}}\right)\left(\frac{1\ \text{piano}}{100\ \text{people}}\right)(10^{7}\ \text{people})=\boxed{100}$$