Chapter 1: Introduction to Physics

Answers to Problems & Conceptual Exercises

2. Multiply the given number by conversion factors to obtain the desired units.

(a) Convert the units: $70\ \mu\text{m} \times \dfrac{1.0\times10^{-6}\ \text{m}}{\mu\text{m}} = \boxed{7.0\times10^{-5}\ \text{m}}$

(b) Convert the units again: $70\ \mu\text{m} \times \dfrac{1.0\times10^{-6}\ \text{m}}{\mu\text{m}} \times \dfrac{1\ \text{km}}{1000\ \text{m}} = \boxed{7.0\times10^{-8}\ \text{km}}$

6. Manipulate the dimensions in the same manner as algebraic expressions.

1. (a) Substitute dimensions for the variables: $vt = \left(\dfrac{\text{m}}{\text{s}}\right)(\text{s}) = \text{m}\quad \boxed{\text{Yes}}$

2. (a) Substitute dimensions for the variables: $\frac{1}{2}at^2 = \frac{1}{2}\left(\dfrac{\text{m}}{\text{s}^2}\right)(\text{s})^2 = \text{m}\quad \boxed{\text{Yes}}$

3. (a) Substitute dimensions for the variables: $2at = 2\left(\dfrac{\text{m}}{\text{s}^2}\right)(\text{s}) = \dfrac{\text{m}}{\text{s}}\quad \boxed{\text{No}}$

4. (a) Substitute dimensions for the variables: $\dfrac{v^2}{a} = \dfrac{(\text{m/s})^2}{\text{m/s}^2} = \text{m}\quad \boxed{\text{Yes}}$

10. Manipulate the dimensions in the same manner as algebraic expressions.

Substitute dimensions for the variables on both sides of the equation:

$$v = v_0 + at$$

$$\frac{[\text{L}]}{[\text{T}]} = \frac{[\text{L}]}{[\text{T}]} + \frac{[\text{L}]}{[\text{T}]^2}[\text{T}]$$

$$\frac{[\text{L}]}{[\text{T}]} = \frac{[\text{L}]}{[\text{T}]}\quad \text{It is dimensionally consistent!}$$

Two numbers must have the same dimensions in order to be added or subtracted.

12. This is a dimensional analysis question. Solve the formula for *k* and substitute the units.

First: Solve for *k*: $T = 2\pi\sqrt{\dfrac{m}{k}}$ square both sides: $T^2 = 4\pi^2\dfrac{m}{k}$ or $k = \dfrac{4\pi^2 m}{T^2}$

Second: Substitute the dimensions: $k = \boxed{\dfrac{[\text{M}]}{[\text{T}]^2}}$

16. Apply the rule for addition of numbers, which states that the number of decimal places after addition equals the smallest number of decimal places in any of the individual terms.

First: Add the numbers**:** **2.35 + 12.1 + 12.13 lb = 26.58 lb**

Second: Round to the smallest number of decimal**:** **26.58 lb** $\Rightarrow$ $\boxed{\textbf{26.6 lb}}$

21. Multiply the known quantity by appropriate conversion factors to change the units.

First: Find the length in feet: $$(2.5\text{ cubit})\left(\frac{17.7\text{ in}}{1\text{ cubit}}\right)\left(\frac{1\text{ ft}}{12\text{ in}}\right)=3.68\text{ ft}$$

Second: Find the volume in cubic feet: $$(1.5\text{ cubit})\left(\frac{17.7\text{ in}}{1\text{ cubit}}\right)\left(\frac{1\text{ ft}}{12\text{ in}}\right)=2.21\text{ ft}$$

. **30.**

Multiply the known quantity by appropriate conversion factors to change the units. One "jiffy" corresponds to the time in seconds that it takes light to travel one centimeter.

(a): Determine the magnitude of a "jiffy":

$$\left(\frac{1\text{ s}}{2.9979\times10^{8}\text{ m}}\right)\left(\frac{1\text{ m}}{100\text{ cm}}\right)=3.3357\times10^{-11}\ \frac{\text{s}}{\text{cm}}=1\ \frac{\text{jiffy}}{\text{cm}}$$

$$1\text{ jiffy}=\boxed{3.3357\times10^{-11}\text{ s}}$$

(b) Convert minutes to jiffys:

$$(1\text{ minute})\left(\frac{60\text{ s}}{1\text{ min}}\right)\left(\frac{1\text{ jiffy}}{3.3357\times10^{-11}\text{ s}}\right)=\boxed{1.7987\times10^{12}\text{ jiffy}}$$

37. This is an order of magnitude problem, meaning we cannot make an exact calculation of how many gallons of milk are consumed in one year. Thus we estimate the population in the sates which is about **250 million** people, and if each of these were to drink a half gallon of milk every week, that's about **25 gallons per person per year**. Each plastic container is estimated to weigh about an ounce.

First: Multiply the quantities to make an estimate of how many gallon os milk are consumed per year:

$$(250\times10^{6}\ \boldsymbol{people})\times\left(25\,\frac{\frac{gal}{year}}{person}\right)\approx 6.25\times10^{9}\ \frac{gsl}{year}\approx10^{9}\ \frac{gal}{year}$$

Second: Multiply the number of gallon by the weight of the plastic:

$$\left(1\times10^{10}\text{ gal/y}\right)(1\text{ oz/gal})\left(\frac{1\text{ lb}}{16\text{ oz}}\right)=6.25\times10^{8}\text{ lb/y}\cong\boxed{10^{9}\text{ lb/y}}$$

46. Multiply the known quantity by appropriate conversion factors to change the units.

(a) The acceleration must be $\boxed{\textbf{greater than}}$ **14 ft/s^2** because there are about 3 ft per meter.

Convert m/s² to ft/s²:

$$\left(14\ \frac{\text{m}}{\text{s}^2}\right)\left(\frac{3.28\ \text{ft}}{\text{m}}\right) = \boxed{46\ \frac{\text{ft}}{\text{s}^2}}$$

Convert m/s² to km/h²:

$$\left(14\ \frac{\text{m}}{\text{s}^2}\right)\left(\frac{1\ \text{km}}{1000\ \text{m}}\right)\left(\frac{3600\ \text{s}}{\text{h}}\right)^2 = \boxed{1.8\times10^5\ \frac{\text{km}}{\text{h}^2}}$$

51. Find $\boldsymbol{q}$ to make the time dimensions match and then $\boldsymbol{p}$ to make the distance dimensions match. Recall $\boldsymbol{L}$ must have dimensions of meters and $\boldsymbol{g}$ dimensions of **m/s²**.

Make the time dimensions match:

$$[\text{T}] = [\text{L}]^p\left(\frac{[\text{L}]}{[\text{T}]^2}\right)^q = [\text{L}]^p\left([\text{L}]\ [\text{T}]^{-2}\right)^q \ \text{ implies } \boxed{q = -\tfrac{1}{2}}$$

Now make the distance units match: $$[\text{T}] = [\text{L}]^p\left(\frac{[\text{L}]}{[\text{T}]^2}\right)^{-\frac{1}{2}} \ \text{ implies } \boxed{p = \tfrac{1}{2}}$$