

Problem 1-1

Represent each of the following combinations of units in the correct SI form using an appropriate prefix:

(a) m/ms (b) μkm (c) ks/mg (d) $\text{km}\cdot\mu\text{N}$

Units Used:

$$\mu\text{N} = 10^{-6} \text{ N}$$

$$\mu\text{km} = 10^{-6} \text{ km}$$

$$\text{Gs} = 10^9 \text{ s}$$

$$\text{ks} = 10^3 \text{ s}$$

$$\text{mN} = 10^{-3} \text{ N}$$

$$\text{ms} = 10^{-3} \text{ s}$$

Solution:

$$(a) \quad \frac{\text{m}}{\text{ms}} = 1 \times 10^3 \frac{\text{m}}{\text{s}}$$

$$\frac{\text{m}}{\text{ms}} = 1 \frac{\text{km}}{\text{s}}$$

$$(b) \quad \mu\text{km} = 1 \times 10^{-3} \text{ m}$$

$$\mu\text{km} = 1 \text{ mm}$$

$$(c) \quad \frac{\text{ks}}{\text{mg}} = 1 \times 10^9 \frac{\text{s}}{\text{kg}}$$

$$\frac{\text{ks}}{\text{mg}} = 1 \frac{\text{Gs}}{\text{kg}}$$

$$(d) \quad \text{km}\cdot\mu\text{N} = 1 \times 10^{-3} \text{ mN}$$

$$\text{km}\cdot\mu\text{N} = 1 \text{ mm}\cdot\text{N}$$

Problem 1-2

Wood has a density d . What is its density expressed in SI units?

Units Used:

$$\text{Mg} = 1000 \text{ kg}$$

Given:

$$d = 4.70 \frac{\text{slug}}{\text{ft}^3}$$

Solution:

$$1 \text{ slug} = 14.594 \text{ kg}$$

$$d = 2.42 \frac{\text{Mg}}{\text{m}^3}$$

Problem 1-3

Represent each of the following combinations of units in the correct SI form using an appropriate prefix:

(a) Mg/mm (b) mN/ μ s (c) μ m·Mg

Solution:

$$(a) \quad \frac{\text{Mg}}{\text{mm}} = \frac{10^3 \text{ kg}}{10^{-3} \text{ m}} = \frac{10^6 \text{ kg}}{\text{m}} = \frac{\text{Gg}}{\text{m}}$$

$$\frac{\text{Mg}}{\text{mm}} = \frac{\text{Gg}}{\text{m}}$$

$$(b) \quad \frac{\text{mN}}{\mu\text{s}} = \frac{10^{-3} \text{ N}}{10^{-6} \text{ s}} = \frac{10^3 \text{ N}}{\text{s}} = \frac{\text{kN}}{\text{s}}$$

$$\frac{\text{mN}}{\mu\text{s}} = \frac{\text{kN}}{\text{s}}$$

$$(c) \quad \mu\text{m} \cdot \text{Mg} = (10^{-6} \text{ m})(10^3 \text{ kg}) = 10^{-3} \text{ m} \cdot \text{kg}$$

$$\mu\text{m} \cdot \text{Mg} = \text{mm} \cdot \text{kg}$$

Problem 1-4

Represent each of the following combinations of units in the correct SI form: **(a)** Mg/ms, **(b)** N/mm, **(c)** mN/(kg·μs).

Solution:

$$(a) \frac{\text{Mg}}{\text{ms}} = \frac{10^3 \text{ kg}}{10^{-3} \text{ s}} = \frac{10^6 \text{ kg}}{\text{s}} = \frac{\text{Gg}}{\text{s}}$$

$$\frac{\text{Mg}}{\text{ms}} = \frac{\text{Gg}}{\text{s}}$$

$$(b) \frac{\text{N}}{\text{mm}} = \frac{1 \text{ N}}{10^{-3} \text{ m}} = 10^3 \frac{\text{N}}{\text{m}} = \frac{\text{kN}}{\text{m}}$$

$$\frac{\text{N}}{\text{mm}} = \frac{\text{kN}}{\text{m}}$$

$$(c) \frac{\text{mN}}{\text{kg} \cdot \mu\text{s}} = \frac{10^{-3} \text{ N}}{10^{-6} \text{ kg} \cdot \text{s}} = \frac{\text{kN}}{\text{kg} \cdot \text{s}}$$

$$\frac{\text{mN}}{\text{kg} \cdot \mu\text{s}} = \frac{\text{kN}}{\text{kg} \cdot \text{s}}$$

Problem 1-5

Represent each of the following with SI units having an appropriate prefix: **(a)** S_1 , **(b)** S_2 , **(c)** S_3 .

Units Used:

$$\text{kg} = 1000 \text{ g} \quad \text{ms} = 10^{-3} \text{ s} \quad \text{kN} = 10^3 \text{ N}$$

Given:

$$S_1 = 8653 \text{ ms}$$

$$S_2 = 8368 \text{ N}$$

$$S_3 = 0.893 \text{ kg}$$

Solution:

$$(a) S_1 = 8.653 \text{ s}$$

(b) $S_2 = 8.368 \text{ kN}$

(c) $S_3 = 893 \text{ g}$

Problem 1-6

Represent each of the following to three significant figures and express each answer in SI units using an appropriate prefix: (a) x , (b) y , and (c) z .

Units Used:

$$\text{MN} = 10^6 \text{ N}$$

$$\mu\text{g} = 1 \times 10^{-6} \text{ gm}$$

$$\text{kN} = 10^3 \text{ N}$$

Given:

$$x = 45320 \text{ kN}$$

$$y = (568 \times 10^5) \text{ mm}$$

$$z = 0.00563 \text{ mg}$$

Solution:

(a) $x = 45.3 \text{ MN}$

(b) $y = 56.8 \text{ km}$

(c) $z = 5.63 \mu\text{g}$

Problem 1-7

Evaluate $(a \cdot b)/c$ to three significant figures and express the answer in SI units using an appropriate prefix.

Units Used:

$$\mu\text{m} = 10^{-6} \text{ m}$$

Given:

$$a = (204 \text{ mm})$$

$$b = (0.00457 \text{ kg})$$

$$c = (34.6 \text{ N})$$

Solution:

$$l = \frac{ab}{c} \quad l = 26.945 \frac{\mu\text{m} \cdot \text{kg}}{\text{N}}$$

Problem 1-8

If a car is traveling at speed v , determine its speed in kilometers per hour and meters per second.

Given:

$$v = 55 \frac{\text{mi}}{\text{hr}}$$

Solution:

$$v = 88.514 \frac{\text{km}}{\text{hr}}$$

$$v = 24.6 \frac{\text{m}}{\text{s}}$$

Problem 1-9

Convert: (a) S_1 to $\text{N} \cdot \text{m}$, (b) S_2 to kN/m^3 , (c) S_3 to mm/s . Express the result to three significant figures. Use an appropriate prefix.

Units Used:

$$\text{kN} = 10^3 \text{ N}$$

Given:

$$S_1 = 200 \text{ g} \cdot \text{lb} \cdot \text{ft}$$

$$S_2 = 350 \text{ g} \frac{\text{lb}}{\text{ft}^3}$$

$$S_3 = 8 \frac{\text{ft}}{\text{hr}}$$

Solution:

(a) $S_1 = 271 \text{ N}\cdot\text{m}$

(b) $S_2 = 55.0 \frac{\text{kN}}{\text{m}^3}$

(c) $S_3 = 0.677 \frac{\text{mm}}{\text{s}}$

Problem 1-10

What is the weight in newtons of an object that has a mass of: (a) m_1 , (b) m_2 , (c) m_3 ? Express the result to three significant figures. Use an appropriate prefix.

Units Used:

$$\text{Mg} = 10^3 \text{ kg}$$

$$\text{mN} = 10^{-3} \text{ N}$$

$$\text{kN} = 10^3 \text{ N}$$

Given:

$$m_1 = 10 \text{ kg}$$

$$m_2 = 0.5 \text{ gm}$$

$$m_3 = 4.50 \text{ Mg}$$

Solution:

(a) $W = m_1 g$

$$W = 98.1 \text{ N}$$

(b) $W = m_2 g$

$$W = 4.90 \text{ mN}$$

(c) $W = m_3 g$

$$W = 44.1 \text{ kN}$$

Problem 1-11

If an object has mass m , determine its mass in kilograms.

Given:

$$m = 40 \text{ slug}$$

Solution:

$$m = 584 \text{ kg}$$

Problem 1-12

The specific weight (wt./vol.) of brass is ρ . Determine its density (mass/vol.) in SI units. Use an appropriate prefix.

Units Used:

$$\text{Mg} = 10^3 \text{ kg}$$

Given:

$$\rho = 520 \frac{\text{lb}}{\text{ft}^3}$$

Solution:

$$\rho = 8.33 \frac{\text{Mg}}{\text{m}^3}$$

Problem 1-13

A concrete column has diameter d and length L . If the density (mass/volume) of concrete is ρ , determine the weight of the column in pounds.

Units Used:

$$\text{Mg} = 10^3 \text{ kg}$$

$$\text{kip} = 10^3 \text{ lb}$$

Given:

$$d = 350 \text{ mm}$$

$$L = 2 \text{ m}$$

$$\rho = 2.45 \frac{\text{Mg}}{\text{m}^3}$$

Solution:

$$V = \pi \left(\frac{d}{2}\right)^2 L \quad V = 192.423 \text{ L}$$

$$W = \rho V \quad W = 1.04 \text{ kip}$$

Problem 1-14

The density (mass/volume) of aluminum is ρ . Determine its density in SI units. Use an appropriate prefix.

Units Used:

$$\text{Mg} = 1000 \text{ kg}$$

Given:

$$\rho = 5.26 \frac{\text{slug}}{\text{ft}^3}$$

Solution:

$$\rho = 2.17 \frac{\text{Mg}}{\text{m}^3}$$

Problem 1-15

Determine your own mass in kilograms, your weight in newtons, and your height in meters.

Solution:

Example

$$W = 150 \text{ lb}$$

$$m = W \quad m = 68.039 \text{ kg}$$

$$W g = 667.233 \text{ N}$$

$$h = 72 \text{ in} \quad h = 1.829 \text{ m}$$

Problem 1-16

Two particles have masses m_1 and m_2 , respectively. If they are a distance d apart, determine the force of gravity acting between them. Compare this result with the weight of each particle.

Units Used:

$$G = 66.73 \times 10^{-12} \frac{\text{m}^3}{\text{kg} \cdot \text{s}^2}$$

$$\text{nN} = 10^{-9} \text{ N}$$

Given:

$$m_1 = 8 \text{ kg}$$

$$m_2 = 12 \text{ kg}$$

$$d = 800 \text{ mm}$$

Solution:

$$F = \frac{G m_1 m_2}{d^2}$$

$$F = 10.0 \text{ nN}$$

$$W_1 = m_1 g \quad W_1 = 78.5 \text{ N} \quad \frac{W_1}{F} = 7.85 \times 10^9$$

$$W_2 = m_2 g \quad W_2 = 118 \text{ N} \quad \frac{W_2}{F} = 1.18 \times 10^{10}$$

Problem 1-17

Using the base units of the SI system, show that $F = G(m_1 m_2)/r^2$ is a dimensionally homogeneous equation which gives F in newtons. Compute the gravitational force acting between two identical spheres that are touching each other. The mass of each sphere is m_1 , and the radius is r .

Units Used:

$$\mu\text{N} = 10^{-6} \text{ N} \quad G = 66.73 \times 10^{-12} \frac{\text{m}^3}{\text{kg} \cdot \text{s}^2}$$

Given:

$$m_I = 150 \text{ kg}$$

$$r = 275 \text{ mm}$$

Solution:

$$F = \frac{G m_I^2}{(2r)^2}$$

$$F = 4.96 \text{ } \mu\text{N}$$

Since the force F is measured in Newtons, then the equation is dimensionally homogeneous.

Problem 1-18

Evaluate each of the following to three significant figures and express each answer in SI units using an appropriate prefix: (a) x , (b) y , (c) z .

Units Used:

$$\text{MN} = 10^6 \text{ N}$$

$$\text{kN} = 10^3 \text{ N}$$

$$\mu\text{m} = 10^{-6} \text{ m}$$

Given:

$$x = (200 \text{ kN})^2$$

$$y = (0.005 \text{ mm})^2$$

$$z = (400 \text{ m})^3$$

Solution:

(a) $x = 0.040 \text{ MN}^2$

(b) $y = 25.0 \text{ } \mu\text{m}^2$

(c) $z = 0.0640 \text{ km}^3$

Problem 1-19

Evaluate each of the following to three significant figures and express each answer in SI units using an appropriate prefix: (a) a_1/b_1 , (b) a_2b_2/c_2 , (c) a_3b_3 .

Units Used:

$$\mu\text{m} = 10^{-6} \text{ m} \quad \text{Mm} = 10^6 \text{ m}$$

$$\text{Mg} = 10^6 \text{ gm} \quad \text{kg} = 10^3 \text{ gm}$$

$$\text{ms} = 10^{-3} \text{ s}$$

Given:

$$a_1 = 684 \mu\text{m}$$

$$b_1 = 43 \text{ ms}$$

$$a_2 = 28 \text{ ms}$$

$$b_2 = 0.0458 \text{ Mm}$$

$$c_2 = 348 \text{ mg}$$

$$a_3 = 2.68 \text{ mm}$$

$$b_3 = 426 \text{ Mg}$$

Solution:

$$(a) \quad \frac{a_1}{b_1} = 15.9 \frac{\text{mm}}{\text{s}}$$

$$(b) \quad \frac{a_2 b_2}{c_2} = 3.69 \text{ Mm} \frac{\text{s}}{\text{kg}}$$

$$(c) \quad a_3 b_3 = 1.14 \text{ km} \cdot \text{kg}$$

Problem 1-20

Evaluate each of the following to three significant figures and express each answer in SI units using an appropriate prefix: (a) a_1/b_1^2 (b) $a_2^2b_2^3$.

Units Used:

$$\text{Mm} = 10^6 \text{ m}$$

Given:

$$a_1 = 0.631 \text{ Mm}$$

$$b_1 = 8.60 \text{ kg}$$

$$a_2 = 35 \text{ mm}$$

$$b_2 = 48 \text{ kg}$$

Solution:

$$(a) \quad \frac{a_1}{b_1^2} = 8.532 \frac{\text{km}}{\text{kg}^2}$$

$$(b) \quad a_2^2 b_2^3 = 135.48 \text{ kg}^3 \cdot \text{m}^2$$
