1–1.

What is the weight in newtons of an object that has a mass of (a) 8 kg, (b) 0.04 kg, (c) 760 Mg?

SOLUTION

(a) $W = 9.81(8) = 78.5\text{ N}$ **Ans.**

(b) $W = 9.81(0.04)\left(10^{-3}\right) = 3.92\left(10^{-4}\right)\text{ N} = 0.392\text{ mN}$ **Ans.**

(c) $W = 9.81(760)\left(10^{3}\right) = 7.46\left(10^{6}\right)\text{ N} = 7.46\text{ MN}$ **Ans.**

Ans:
78.5 N
0.392 mN
7.46 MN

1–2.

Represent each of the following combinations of units in the correct SI form using an appropriate prefix: (a) $kN/\mu s$, (b) Mg/mN, (c) $MN/(kg \cdot ms)$.

SOLUTION

(a) $kN/\mu s = 10^3 N/\left(10^{-6}\right) s = GN/s$ **Ans.**

(b) $Mg/mN = 10^6 g/10^{-3} N = Gg/N$ **Ans.**

(c) $MN/(kg \cdot ms) = 10^6 N/kg(10^{-3} s) = GN/(kg \cdot s)$ **Ans.**

Ans:
GN/s
Gg/N
$GN/(kg \cdot s)$

1–3.

Represent each of the following combinations of units in the correct SI form: (a) Mg/ms, (b) N/mm, (c) $\text{mN}/(\text{kg} \cdot \mu\text{s})$.

SOLUTION

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

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

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

Ans:
Gg/s
kN/m
$\text{kN}/(\text{kg} \cdot \text{s})$

***1–4.**

Gd _ a_p gq rp_tcjjgle _r 66,3 ik-f* bcrcpkglc grq speed in meters per second.

SOLUTION

$$88.5\text{ km/h} = \left(\frac{88.5\text{ km}}{1\text{ h}}\right)\left(\frac{1000\text{ m}}{1\text{ km}}\right)\left(\frac{1\text{ h}}{3600\text{ s}}\right) = 24.6\text{ m/s} \qquad \textbf{Ans}$$

Ans:
24.6 m/s

1–5.

Represent each of the following as a number between 0.1 and 1000 using an appropriate prefix: (a) 45 320 kN, (b) $568(10^5)$ mm, (c) 0.00563 mg.

SOLUTION

(a) $45\,320 \text{ kN} = 45.3 \text{ MN}$ **Ans.**

(b) $568\left(10^5\right) \text{ mm} = 56.8 \text{ km}$ **Ans.**

(c) $0.00563 \text{ mg} = 5.63\ \mu\text{g}$ **Ans.**

Ans:
45.3 MN
56.8 km
5.63 μg

1–6.

Round off the following numbers to three significant figures: (a) 58 342 m, (b) 68.534 s, (c) 2553 N, (d) 7555 kg.

SOLUTION

(a) 58.3 km (b) 68.5 s (c) 2.55 kN (d) 7.56 Mg **Ans.**

Ans:
58.3 km
68.5 s
2.55 kN
7.56 Mg

1–7.

Represent each of the following quantities in the correct SI form using an appropriate prefix: (a) 0.000 431 kg, (b) $35.3(10^3)$ N, (c) 0.005 32 km.

SOLUTION

(a) $0.000\ 431\ \text{kg} = 0.000\ 431(10^3)\ \text{g} = 0.431\ \text{g}$ **Ans.**

(b) $35.3(10^3)\ \text{N} = 35.3\ \text{kN}$ **Ans.**

(c) $0.005\ 32\ \text{km} = 0.005\ 32(10^3)\ \text{m} = 5.32\ \text{m}$ **Ans.**

Ans:
0.431 g
35.3 kN
5.32 m

***1–8.**

Represent each of the following combinations of units in the correct SI form using an appropriate prefix: (a) Mg/mm, (b) mN/μs, (c) μm · Mg.

SOLUTION

(a) $\text{Mg/mm} = \dfrac{10^3\ \text{kg}}{10^{-3}\text{m}} = \dfrac{10^6\ \text{kg}}{\text{m}} = \text{Gg/m}$ **Ans.**

(b) $\text{mN}/\mu\text{s} = \dfrac{10^{-3}\ \text{N}}{10^{-6}\ \text{s}} = \dfrac{10^3\ \text{N}}{\text{s}} = \text{kN/s}$ **Ans.**

(c) $\mu\text{m} \cdot \text{Mg} = \left[10^{-6}\ \text{m}\right] \cdot \left[10^3\ \text{kg}\right] = (10)^{-3}\ \text{m} \cdot \text{kg}$

$= \text{mm} \cdot \text{kg}$ **Ans.**

Ans:
Gg/m
kN/s
mm · kg

1–9.

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) km $\cdot$ μN.

SOLUTION

(a) $\text{m/ms} = \left(\dfrac{\text{m}}{(10)^{-3}\,\text{s}}\right) = \left(\dfrac{(10)^{3}\,\text{m}}{\text{s}}\right) = \text{km/s}$ **Ans.**

(b) $\mu\text{km} = (10)^{-6}(10)^{3}\,\text{m} = (10)^{-3}\,\text{m} = \text{mm}$ **Ans.**

(c) $\text{ks/mg} = \left(\dfrac{(10)^{3}\,\text{s}}{(10)^{-6}\,\text{kg}}\right) = \left(\dfrac{(10)^{9}\,\text{s}}{\text{kg}}\right) = \text{Gs/kg}$ **Ans.**

(d) $\text{km}\cdot\mu\text{N} = [(10)^{3}\,\text{m}][(10)^{-6}\,\text{N}] = (10)^{-3}\,\text{m}\cdot\text{N} = \text{mm}\cdot\text{N}$ **Ans.**

Ans:
km/s
mm
Gs/kg
mm $\cdot$ N

1–10.

Represent each of the following combinations of units in the correct SI form using an appropriate prefix: (a) $\text{GN}\cdot\mu\text{m}$, (b) $\text{kg}/\mu\text{m}$, (c) N/ks^2, and (d) $\text{kN}/\mu\text{s}$.

SOLUTION

(a) $\text{GN}\cdot\mu\text{m} = 10^9(10^{-6})\ \text{N}\cdot\text{m} = \text{kN}\cdot\text{m}$ **Ans.**

(b) $\text{kg}/\mu\text{m} = 10^3\ \text{g}/10^{-6}\ \text{m} = \text{Gg}/\text{m}$ **Ans.**

(c) $\text{N}/\text{ks}^2 = \text{N}/10^6\ \text{s}^2 = 10^{-6}\ \text{N}/\text{s}^2 = \mu\text{N}/\text{s}^2$ **Ans.**

(d) $\text{kN}/\mu\text{s} = 10^3\ \text{N}/10^{-6}\ \text{s} = 10^9\ \text{N}/\text{s} = \text{GN}/\text{s}$ **Ans.**

Ans:
$\text{kN}\cdot\text{m}$
Gg/m
$\mu\text{N}/\text{s}^2$
GN/s

1–11.

Represent each of the following with SI units having an appropriate prefix: (a) 8653 ms, (b) 8368 N, (c) 0.893 kg.

SOLUTION

(a) $8653 \text{ ms} = 8.653(10)^3(10^{-3}) \text{ s} = 8.653 \text{ s}$ **Ans.**

(b) $8368 \text{ N} = 8.368 \text{ kN}$ **Ans.**

(c) $0.893 \text{ kg} = 893(10^{-3})(10^3) \text{ g} = 893 \text{ g}$ **Ans.**

Ans:
8.653 s
8.368 kN
893 g

***1–12.**

Evaluate each of the following to three significant figures and express each answer in SI units using an appropriate prefix: (a) $(684\ \mu\text{m})/(43\ \text{ms})$, (b) $(28\ \text{ms})(0.0458\ \text{Mm})/(348\ \text{mg})$, (c) $(2.68\ \text{mm})(426\ \text{Mg})$.

SOLUTION

(a) $$(684\ \mu\text{m})/43\ \text{ms} = \frac{684(10^{-6})\ \text{m}}{43(10^{-3})\ \text{s}} = \frac{15.9(10^{-3})\ \text{m}}{\text{s}}$$

$$= 15.9\ \text{mm/s}$$ **Ans.**

(b) $$(28\ \text{ms})(0.0458\ \text{Mm})/(348\ \text{mg}) = \frac{\left[28(10^{-3})\ \text{s}\right]\left[45.8(10^{-3})(10)^{6}\ \text{m}\right]}{348(10^{-3})(10^{-3})\ \text{kg}}$$

$$= \frac{3.69(10^{6})\ \text{m}\cdot\text{s}}{\text{kg}} = 3.69\ \text{Mm}\cdot\text{s/kg}$$ **Ans.**

(c) $$(2.68\ \text{mm})(426\ \text{Mg}) = \left[2.68\left(10^{-3}\right)\ \text{m}\right]\left[426\left(10^{3}\right)\ \text{kg}\right]$$

$$= 1.14\left(10^{3}\right)\ \text{m}\cdot\text{kg} = 1.14\ \text{km}\cdot\text{kg}$$ **Ans.**

Ans:
15.9 mm/s
3.69 Mm · s/kg
1.14 km · kg

1–13. The specific weight (wt./vol.) of brass is 85 kN/m^3. Determine its density (mass/vol.) in SI units. Use an appropriate prefix.

SOLUTION

$$85\ \text{kN/m}^3 = \left(\frac{85\ (10^3)}{\text{m}^3}\right)\left(\frac{1\ \text{kg}}{9.81\ \text{N}}\right)\left(\frac{1000\ \text{kg}}{1\ \text{kg}}\right)$$

$$= 8.66\ (10^6)\ \text{g} = 8.66\ \text{Mg/m}^3$$ **Ans.**

Ans:
8. 66 Mg/m^3

1–14.

Evaluate each of the following to three significant figures and express each answer in SI units using an appropriate prefix: (a) $(212\ \text{mN})^2$, (b) $(52\,800\ \text{ms})^2$, (c) $[548(10^6)]^{1/2}$ ms.

SOLUTION

(a) $(212\ \text{mN})^2 = \left[212(10)^{-3}\ \text{N}\right]^2 = 0.0449\ \text{N}^2 = 44.9(10)^{-3}\ \text{N}^2$ **Ans.**

(b) $(52\,800\ \text{ms})^2 = \left[52\,800(10)^{-3}\right]^2\ \text{s}^2 = 2788\ \text{s}^2 = 2.79\left(10^3\right)\ \text{s}^2$ **Ans.**

(c) $\left[548(10)^6\right]^{\frac{1}{2}}\ \text{ms} = (23\,409)(10)^{-3}\ \text{s} = 23.4(10)^3(10)^{-3}\ \text{s} = 23.4\ \text{s}$ **Ans.**

Ans:
$44.9(10)^{-3}\ \text{N}^2$
$2.79\left(10^3\right)\ \text{s}^2$
$23.4\ \text{s}$

1–15.

Using the SI system of units, show that Eq. 1–2 is a dimensionally homogeneous equation which gives F in newtons. Determine to three significant figures the gravitational force acting between two spheres that are touching each other. The mass of each sphere is 200 kg and the radius is 300 mm.

SOLUTION

Using Eq. 1–2,

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

$$\text{N} = \left(\frac{\text{m}^3}{\text{kg}\cdot\text{s}^2}\right)\left(\frac{\text{kg}\cdot\text{kg}}{\text{m}^2}\right) = \frac{\text{kg}\cdot\text{m}}{\text{s}^2} \qquad \textbf{\textit{(Q.E.D.)}}$$

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

$$= 66.73\left(10^{-12}\right)\left[\frac{200(200)}{0.6^2}\right]$$

$$= 7.41\left(10^{-6}\right)\text{ N} = 7.41\ \mu\text{N}$$ **Ans.**

Ans:
7.41 μN

***1–16.** The *pascal* (Pa) is actually a very small unit of pressure. Given ($1 \text{ Pa} = 1 \text{ N/m}^2$), and a atmospheric pressure at sea level is 101.325 kN/m^2. How many pascals is this?

SOLUTION

$1 \text{ ATM} = 101.325 \text{ kN/m}^2$

$= 101 \text{ kPa}$ **Ans**

1–17.

What is the weight in newtons of an object that has a mass of: (a) 10 kg, (b) 0.5 g, (c) 4.50 Mg? Express the result to three significant figures. Use an appropriate prefix.

SOLUTION

(a) $W = \left(9.81 \text{ m/s}^2\right)(10 \text{ kg}) = 98.1 \text{ N}$ **Ans.**

(b) $W = \left(9.81 \text{ m/s}^2\right)(0.5 \text{ g})(10^{-3} \text{ kg/g}) = 4.90 \text{ mN}$ **Ans.**

(c) $W = \left(9.81 \text{ m/s}^2\right)(4.5 \text{ Mg})\left(10^3 \text{ kg/Mg}\right) = 44.1 \text{ kN}$ **Ans.**

Ans:
98.1 N
4.90 mN
44.1 kN

1–18.

Evaluate each of the following to three significant figures and express each answer in SI units using an appropriate prefix: (a) 354 mg(45 km)/(0.0356 kN), (b) (0.004 53 Mg)(201 ms), (c) 435 MN/23.2 mm.

SOLUTION

(a) $(354\text{ mg})(45\text{ km})/(0.0356\text{ kN}) = \dfrac{\left[354\left(10^{-3}\right)\text{ g}\right]\left[45\left(10^{3}\right)\text{ m}\right]}{0.0356\left(10^{3}\right)\text{ N}}$

$= \dfrac{0.447\left(10^{3}\right)\text{ g}\cdot\text{m}}{\text{N}}$

$= 0.447\text{ kg}\cdot\text{m/N}$ **Ans.**

(b) $(0.00453\text{ Mg})(201\text{ ms}) = \left[4.53\left(10^{-3}\right)\left(10^{3}\right)\text{kg}\right]\left[201\left(10^{-3}\right)\text{ s}\right]$

$= 0.911\text{ kg}\cdot\text{s}$ **Ans.**

(c) $435\text{ MN}/23.2\text{ mm} = \dfrac{435\left(10^{6}\right)\text{ N}}{23.2\left(10^{-3}\right)\text{ m}} = \dfrac{18.75\left(10^{9}\right)\text{ N}}{\text{m}} = 18.8\text{ GN/m}$ **Ans.**

Ans:
$0.447\text{ kg}\cdot\text{m/N}$
$0.911\text{ kg}\cdot\text{s}$
18.8 GN/m

1–19.

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 newtons.

SOLUTION

The volume of the column is

$$V = \left[\pi\left(\frac{d}{2}\right)^2\right]h = \left[\pi\left(\frac{0.35\text{ m}}{2}\right)^2\right](2\text{m}) = 0.06125\ \pi\ \text{m}^3$$

The density of concrete is

$$P_{\text{con}} = \left[2.45\ (10^6)\frac{\text{g}}{\text{m}^3}\right]\left(\frac{1\text{ kg}}{1000\text{ g}}\right) = 2450\text{ kg/m}^3$$

Then the mass of the Column is

$$M = P_{\text{con}}\,V = (2450\text{ kg/m}^3)(0.06/25\pi\text{ m}^3) = 150.0625\ \pi\text{ kg}$$

Finally, the weight of the Column is

$$\begin{aligned} W = \text{mg} &= (150.0625\ \pi\text{ kg})(9.81\text{ m/s}^2) \\ &= 4.624\ (10^3)\text{N} \\ &= 4.62\text{ kN} \end{aligned}$$ **Ans.**

Ans:
$W = 4.62$ kN

***1–20.**

Two particles have a mass of 8 kg and 12 kg, respectively. If they are 800 mm apart, determine the force of gravity acting between them. Compare this result with the weight of each particle.

SOLUTION

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

Where $G = 66.73\left(10^{-12}\right)\ \text{m}^3/(\text{kg}\cdot\ \text{s}^2)$

$$F = 66.73\left(10^{-12}\right)\left[\frac{8(12)}{(0.8)^2}\right] = 10.0\left(10^{-9}\right)\ \text{N} = 10.0\ \text{nN}$$ **Ans.**

$W_1 = 8(9.81) = 78.5\ \text{N}$ **Ans.**

$W_2 = 12(9.81) = 118\ \text{N}$ **Ans.**

Ans:
$F = 10.0\ \text{nN}$
$W_1 = 78.5\ \text{N}$
$W_2 = 118\ \text{N}$

1–21. A rocket has a mass of $3.65(10^6)$ kg on earth. Specify its weight in SI units. If the rocket is on the moon, where the acceleration due to gravity is $g_m = 1.62$ m/s^2, determine to three significant figures its weight in SI units and its mass in SI units.

SOLUTION

Applying Eq. 1–3, we have

$$W_e = mg = [3.65(10^6)\text{ kg}]\,(9.81\text{ m/s}^2)$$
$$= 35.81(10^6)\text{ kg}\cdot\text{m/s}^2$$
$$= 35.8\text{ MN} \qquad \textbf{Ans}$$

$$W_m = W_e\left(\frac{g_m}{g}\right) = (35.81\text{ MN})\left(\frac{1.62\text{ m/s}^2}{9.81\text{ m/s}^2}\right) = 5.91\text{ MN}$$

Since the mass is independent of its location, then

$$m_m = m_e = 3.65(10^6)\text{ kg} = 3.65\text{ Gg} \qquad \textbf{Ans}$$

Ans:
$W_e = 35.8$ MN, $m_m = 3.65$ Gg