1–1.

Evaluate each of the following and express with an appropriate prefix: (a) $(430\ \text{kg})^2$, (b) $(0.002\ \text{mg})^2$, and (c) $(230\ \text{m})^3$.

SOLUTION

a) $(430\ \text{kg})^2 = 0.185(10^6)\ \text{kg}^2 = 0.185\ \text{Mg}^2$ **Ans.**

b) $(0.002\ \text{mg})^2 = [2(10^{-6})\ \text{g}]^2 = 4\ \mu\text{g}^2$ **Ans.**

c) $(230\ \text{m})^3 = [0.23(10^3)\ \text{m}]^3 = 0.0122\ \text{km}^3$ **Ans.**

Ans:
$0.185\ \text{Mg}^2$
$4\ \mu\text{g}^2$
$0.0122\ \text{km}^3$

1–2.

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

Ans:
Gg/s
kN/m
kN/(kg · s)

1–3.

What is the weight in newtons of an object that has a mass of (a) 8 kg, (b) 0.04 kg, and (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:
$W = 78.5\ \text{N}$
$W = 0.392\ \text{mN}$
$W = 7.46\ \text{MN}$

***1–4.**

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

SOLUTION

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

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

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

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

1–5.

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, and (c) 0.005 32 km.

SOLUTION

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

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

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

Ans:
0.431 g
35.3 kN
5.32 m

1–6.

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, and (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 · N

1–7.

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, and (c) 0.00563 mg.

SOLUTION

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

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

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

Ans:
45.3 MN
56.8 km
5.63 μg

***1–8.**

Represent each of the following combinations of units in the correct SI form: (a) $GN \cdot \mu m$, (b) $kg/\mu m$, (c) N/ks^2, and (d) $KN/\mu s$.

SOLUTION

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

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

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

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

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

1–9.

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

1–10.

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

1–11.

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,

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

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

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

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

$$= 7.41\left(10^{-6}\right)\mathrm{N} = 7.41\ \mu\mathrm{N} \qquad \textbf{Ans.}$$

Ans:
7.41 μN

***1–12.**

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

1–13.

A rocket has a mass of $3.529(10^6)$ kg on earth. Specify (a) its mass in SI units and (b) its weight in SI units. If the rocket is on the moon, where the acceleration due to gravity is $g_m = 1.61\ \text{m/s}^2$,determine to three significant figures (c) its weight in SI units and (d) its mass in SI units.

SOLUTION

a) $3.529(10^6)\ \text{kg} = 3.53\ \text{Gg}$ **Ans.**

b) $W_e = mg = \left[3.529\left(10^6\right)\text{kg}\right]\left(9.81\ \text{m/s}^2\right)$

$= 34.619\left(10^6\right)\ \text{kg}\cdot\text{m/s}^2$

$= 34.6\ \text{MN}$ **Ans.**

c) $W_m = mg_m = \left[3.529\left(10^6\right)\ \text{kg}\right]\left(1.61\ \text{m/s}^2\right)$

$= 5.682\left(10^6\right)\text{N} = 5.68\ \text{MN}$ **Ans.**

Or

$$W_m = W_e\left(\frac{g_m}{g}\right) = (34.619\ \text{MN})\left(\frac{1.61\ \text{m/s}^2}{9.81\ \text{m/s}^2}\right) = 5.68\ \text{MN}$$

d) Since the mass is independent of tis location, then

$m_m = m_e = 3.53\ \text{Gg}$ **Ans.**

Ans:
3.53 Gg
34.6 MN
5.68 MN
$m_m = m_e = 3.53$ Gg

1–14.

Evaluate each of the following to three significant figures and express each answer in Sl units using an appropriate prefix: (a) 354 mg(45 km)/(0.0356 kN), (b) (0.004 53 Mg) (201 ms), and (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) $435\text{ MN/23.2 mm} = \dfrac{435\left(10^{6}\right)\text{ N}}{23.2\left(10^{-3}\right)\text{ m}} = \dfrac{18.75\left(10^{9}\right)\text{ N}}{\text{m}} = 18.8\text{ GN/m}$ **Ans.**

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

1–15.

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) $(52\ 800\ \text{ms})^2$, and (c) $[548(10^6)]^{1/2}\ \text{ms}$.

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 s

***1–16.**

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

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

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

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

1–17.

A concrete column has a diameter of 350 mm and a length of 2 m. If the density (mass/volume) of concrete is 2.45 Mg/m^3, determine the weight of the column.

SOLUTION

$$V = \pi r^2 h = \pi\left(\tfrac{0.35}{2}\,\text{m}\right)^2 (2\,\text{m}) = 0.1924\,\text{m}^3$$

$$m = \rho V = \left(\frac{2.45(10^3)\text{kg}}{\text{m}^3}\right)\left(0.1924\,\text{m}^3\right) = 471.44\,\text{kg}$$

$$W = mg = (471.44\,\text{kg})\left(9.81\,\text{m/s}^2\right) = 4.6248\left(10^3\right)\text{N} = 4.63\,\text{kN}$$ **Ans.**

Ans:
4.63 kN

1–18.

Determine the mass of an object that has a weight of (a) 20 mN, (b) 150 kN, (c) 60 MN. Express the answer to three significant figures.

SOLUTION

a) $m = \dfrac{W}{g} = \dfrac{20\left(10^{-3}\right)\ \text{kg}\cdot\text{m/s}^2}{9.81\ \text{m/s}^2} = 2.04\ \text{g}$ **Ans.**

b) $m = \dfrac{W}{g} = \dfrac{150\left(10^{3}\right)\ \text{kg}\cdot\text{m/s}^2}{9.81\ \text{m/s}^2} = 15.3\ \text{Mg}$ **Ans.**

c) $m = \dfrac{W}{g} = \dfrac{60\left(10^{6}\right)\ \text{kg}\cdot\text{m/s}^2}{9.81\ \text{m/s}^2} = 6.12\ \text{Gg}$ **Ans.**

Ans:
2.04 g
15.3 Mg
6.12 Gg

1–19.

If a man weighs 690 newtons on earth, specify (a) his mass in kilograms. If the man is on the moon, where the acceleration due to gravity is $g_m = 1.61\ \text{m/s}^2$, determine (b) his weight in newtons, and (c) his mass in kilograms.

SOLUTION

(a) $m = \dfrac{690}{9.81} = 70.3\ \text{kg}$ **Ans.**

(b) $W = 690\left[\dfrac{1.61}{9.81}\right] = 113\ \text{N}$ **Ans.**

(c) $m = \dfrac{690}{9.81} = 70.3\ \text{kg}$ **Ans.**

Ans:
70.3 kg
113 N
70.3 kg

***1–20.**

Evaluate each of the following to three significant figures and express each answer in SI units using an appropriate prefix: (a) $(200\ \text{kN})^2$, (b) $(0.005\ \text{mm})^2$, and (c) $(400\ \text{m})^3$.

SOLUTION

(a) $(200\ \text{kN})^2 = 40\,000(10^6)\ \text{N}^2 = 0.04(10^{12})\ \text{N}^2 = 0.04\ \text{MN}^2$ **Ans.**

(b) $(0.005\ \text{mm})^2 = 25(10^{12})\ \text{m}^2 = 25\ \mu\text{m}^2$ **Ans.**

(c) $(400\ \text{m})^3 = 0.064(10^9)\ \text{m}^3 = 0.064\ \text{km}^3$ **Ans.**

Ans:
$0.04\ \text{MN}^2$
$25\ \mu\text{m}^2$
$0.064\ \text{km}^3$

1–21.

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:
$F = 10.0$ nN
$W_1 = 78.5$ N
$W_2 = 118$ N