

Chapter 1 Measurements Notes Answers

Check Your Understanding 1

- (a) $1 \text{ kmh}^{-1} = \frac{1000}{3600} \text{ m s}^{-1}$

$$2.98 \times 10^8 \text{ ms}^{-1} = 2.98 \times 10^8 \times \frac{3600}{1000} = 1.07 \times 10^9 \text{ km h}^{-1}$$

(b) $31 \times 10^{-3} = 3.1 \times 10^2 \text{ A}$

(c) $1 \text{ nm} = 1 \times 10^{-9} \text{ m}$

$$1 \text{ m} = 1 \times 10^9 \text{ nm}$$
$$4.5 \times 10^7 = 4.5 \times 10^7 \times 10^9 \text{ nm} = 4.5 \times 10^{16} \text{ nm}$$
- (a) unit of stress = $\frac{\text{units of force}}{\text{units of area}} = \frac{\text{units of mass} \times \text{acc}}{\text{units of area}} = \frac{\text{kgms}^{-2}}{\text{m}^2} = \text{kgm}^{-1}\text{s}^{-2}$

unit of strain = $\frac{\text{unit of } \Delta\text{length}}{\text{length}} = \frac{\text{m}}{\text{m}}$ (unitless)

unit of young's modulus = unit of stress = $\text{kgm}^{-1}\text{s}^{-2}$

(b) unit of specific heat capacity =

$$\frac{\text{unit of Q (energy)}}{\text{units of mass} \times \text{temp}} = \frac{\text{units of force} \times \text{disp}}{\text{kg} \times \text{K}} = \frac{\text{kgms}^{-2}\text{m}}{\text{kgK}} = \text{m}^2\text{s}^{-2}\text{K}^{-1}$$
- 1 g = $1 \times 10^{-3} \text{ kg}$

$$1 \text{ cm} = 1 \times 10^{-2} \text{ m} \rightarrow 1 \text{ cm}^{-3} = (1 \times 10^{-2})^{-3} = 1 \times 10^6 \text{ m}^{-3}$$
$$13.6 \text{ gcm}^{-3} = 13.6 \times 10^{-3} \times 10^6 = 1.36 \times 10^4 \text{ kgm}^{-3}$$
- units of Q = units of current \times time = As

$$\text{unit of } \epsilon_0 = \frac{(\text{unit of charge})^2}{\text{unit of force} \times (\text{unit of dist})^2} = \frac{\text{A}^2\text{s}^2}{\text{kgms}^{-2}\text{m}^2} = \text{A}^2\text{kg}^{-1}\text{m}^{-3}\text{s}^4$$
- (a) unit of v = m s^{-1}

unit of g = m s^{-2}

unit of λ = m

unit of ρ = kg m^{-3}

$$\text{unit of } \gamma = \frac{\text{unit of force}}{\text{unit of distance}} = \frac{\text{kg m s}^{-2}}{\text{m}} = \text{kg s}^{-2}$$

checking, equation (2) is not homogeneous.

(b) by checking values with equation, (1) is physically incorrect. Thus, only equation (3) is homogeneous and physically right.

Check Your Understanding 2

- $V = A + B = 50 + 12 = 62$
 $\Delta V = \Delta A + \Delta B = 1.1 = 1$ (1s.f.)
 $V = (62 \pm 1)$ ml
- $V = 50 - 25 = 25$
 $\Delta V = 1 + 0.5 = 1.5 = 2$ (1s.f.)
 $V = (25 \pm 2)$ ml
- $R = \frac{V}{I} = \frac{5.0}{2.0} = 2.5 \Omega$
 $\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I} = \frac{0.1}{5.0} + \frac{0.1}{2.0}$
 $\Delta R = 2.5 \left(\frac{0.1}{5.0} + \frac{0.1}{2.0} \right) = 0.2$ (1s.f.)
 $R = (2.5 \pm 0.2) \Omega$
- mass of 1 marble and 1 golf ball = $\frac{1}{6}(\text{mass}_{6 \text{ marbles}}) + \frac{1}{3}(\text{mass}_{3 \text{ golf-balls}}) = \frac{1}{6}(238) + \frac{1}{3}(179) = 99$
 $\Delta m = \frac{1}{6}(5) + \frac{1}{3}(5) = 3$ (1s.f.)
 $m = (99 \pm 3)$ g
- (a) $\frac{1}{98}, \frac{1}{858}, \frac{1}{503}$
(b) $\rho = \frac{m}{V} = \frac{m}{\pi r^2 L} = \frac{m}{\pi \left(\frac{d}{2}\right)^2 L} = \frac{4m}{\pi d^2 L}$
 $\frac{\Delta \rho}{\rho} = \frac{\Delta m}{m} + 2 \frac{\Delta d}{d} + \frac{\Delta L}{L} = 0.0236$
(c) $\Delta \rho = 0.0236 \rho = 2 \times 10^2 \text{ kgm}^{-3}$
- (a) $d = \frac{1}{4}(Y - X) = \frac{1}{4}(5.0 - 1.0) = 1.0$
 $\Delta d = \frac{1}{4}(\Delta Y + \Delta X) = \frac{1}{4}(0.2 + 0.2) = 0.1$ (1s.f.)
 $d = (1.0 \pm 0.1)$ cm
(b) $\frac{0.1}{1.0} \times 100\% = 10\%$
using more balls, or use a more precise instrument, e.g. micrometer screw gauge
- (a) let d be a + b = 6.0
 $\Delta d = \Delta a + \Delta b = 0.2$
 $Z = 2(6.0)(6.5) = 78$

$$\frac{\Delta Z}{Z} = \frac{\Delta d}{d} + \frac{\Delta c}{c} \rightarrow \Delta Z = 78 \left(\frac{0.2}{6.0} + \frac{0.1}{6.5} \right) = 4 \text{ (1s.f.)}$$

$$Z = (78 \pm 4) \text{ cm}^2$$

(b) let d be $a + b = 6.0$

$$\Delta d = \Delta a + \Delta b = 0.2$$

$$W = 9.39 \times 10^{-4} \text{ kg cm}^{-2}$$

$$\frac{\Delta W}{W} = \frac{\Delta m}{m} + 2 \frac{\Delta d}{d} + \frac{\Delta c}{c} \rightarrow \Delta W = 2 \times 10^{-4} \text{ (1s.f.)}$$

$$W = (9 \pm 2) \times 10^{-4} \text{ kg cm}^{-2}$$

Check Your Understanding 3

1. taking downwards as positive:

$$\Delta v = v_f - v_i = -8 - 10 = -18 \text{ (upwards)}$$

- 2.

(a) net horizontal force = $120 \cos 60 - 80 \cos 75 = 39.3 \text{ N}$

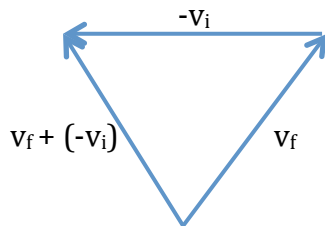
net vertical force = $120 \sin 60 + 80 \sin 75 = 181.2 \text{ N}$

net force = $\sqrt{181.2^2 + 39.29^2} = 185 \text{ N}$

angle = $\tan^{-1} \frac{181.2}{39.3} = 77.8^\circ$

- (b) to create zero net force, third force must be of same magnitude as in (a), but 180° opposite in dir.

3. $\Delta v = v_f - v_i = v_f + (-v_i)$



Since the 3 vectors form an equilateral triangle, $\Delta v = 15 \text{ ms}^{-1}$ at 120° to Ox.