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- 1 a) m s^{-1}
b) $\Omega \text{ m}$
c) kg m^{-3}
d) Hz or s^{-1}
- 2 a) $2 \times 60 \times 60 = 7200 \text{ s}$
b) $1 \text{ mm}^3 = (10^{-3} \text{ m})^3 = 10^{-9} \text{ m}^3$
So $300 \text{ mm}^3 = 3 \times 10^{-7} \text{ m}^3$
c) $2 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19} \text{ J}$
- 3 a) 5.109×10^{-1}
b) 3.6×10^3
c) 3.00×10^8
d) 9.354×10^{-3}
- 4 a) $\frac{600 \text{ MW}}{1500 \text{ MW}} \times 100\% = 40\%$
b) volume $= \frac{4}{3} \pi r^3$
 $= \frac{4}{3} \times \pi \times (3.4 \times 10^{-3})^3$
 $= 1.6 \times 10^{-7} \text{ m}^3 = 164 \text{ mm}^3$
- 5 a) Kinetic energy increases fourfold if velocity doubles, as KE is proportional to v^2 .
b) Doubling the diameter quadruples the area, A.
 Δl is proportional to $\frac{1}{A}$ so the extension will fall by a factor of 4.
c) Halving the wavelength halves the fringe spacing as wavelength and fringe spacing are proportional.
- 6 a) 4.9725×10^{-28}
b) 18.466
c) 0.675
d) 0.707

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- 7 $9.445 + 9.663 + 8.567 + 10.346 = 38.021$. The mean is $\frac{38.021}{4} = 9.50525$.
Data is quoted to 4 significant figures, so the answer is 9.505.
- 8 a) 2
b) 3
c) 3

d) 2

9 Volume = $3.4^3 = 39.304 \text{ m}^3$

Data is quoted to 2 significant figures, so the answer is 39 m^3

10 $\Delta N = 960 - 1000 = -40$;

$\Delta t = 3 \times 60 = 180 \text{ s}$

$$\text{so } \lambda = \frac{(\Delta N / \Delta t)}{N}$$

$$= \frac{(40/180)}{1000} = 2.2 \times 10^{-4} \text{ s}^{-1}$$

11 a) All units must be consistent so convert the diameter from mm to m; convert diameter into a radius;

$$\begin{aligned} \text{Volume} &= \pi r^2 l \\ &= \pi \times \left(\frac{5.6}{2} \times 10^{-3}\right)^2 \times 1.00 \\ &= 2.5 \times 10^{-5} \text{ m}^3 \end{aligned}$$

b) The error is $2 \times \%$ error of radius, plus $\%$ error in length

$$\begin{aligned} &= 2 \times \left(\frac{0.1}{5.6}\right) \times 100\% + \left(\frac{0.01}{1.00}\right) \times 100\% \\ &= 2 \times 1.79 + 1 = 4.58\%. \end{aligned}$$

The absolute error is 4.58% of $2.5 \times 10^{-5} \text{ m}^3 = 0.0115 \times 10^{-5} \text{ m}^3$ or $1.15 \times 10^{-7} \text{ m}^3$ 12 a) Volume of a sphere is $\frac{4}{3}\pi r^3$ but $\frac{4}{3}\pi \approx 4$ which, to the nearest order of magnitude, is 1

$r \approx 10\,000\,000 \text{ m}$ or 10^7 m

$\text{So volume} \approx 1 \times (10^7)^3 \approx 10^{21} \text{ m}^3$

b) density $\approx 10\,000 \text{ kg m}^{-3}$

$\text{mass of Earth} = \text{density} \times \text{volume} \approx 10\,000 \times 10^{21} \approx 10^{25} \text{ kg}$

The value is $6 \times 10^{24} \text{ kg}$ so, in this case, the answer is of the same order of magnitude.

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13 a) acceleration equals change in velocity divided by change in time

b) sine of the critical angle equals the refractive index of material 2 divided by the refractive index of material 1 for the refractive index of material 1 (which must be greater than the refractive index of material 2).

14 a) $\lambda = \frac{h}{p}$

b) $F = k \Delta l$

c) $v = \frac{s}{t}$

15 a) $E = mc^2$

Divide both sides by m : $\frac{E}{m} = c^2$

Take the square root of both sides: $\left(\frac{E}{m}\right)^{\frac{1}{2}} = c$

b) $v^2 = u^2 + 2as$

Subtract u^2 from both sides: $v^2 - u^2 = 2as$

Divide both sides by $2a$: $\frac{(v^2 - u^2)}{2a} = s$

(Remember to use brackets)

c) $n_1 \sin_1 = n_2 \sin_2$

Divide both sides by \sin_2 : $n_1 \frac{\sin_1}{\sin_2} = n_2$

d) $V = I(R + r)$

Multiply out the brackets: $V = IR + Ir$

Subtract IR from both sides: $V - IR = Ir$

Divide both sides by I : $r = \frac{(V - IR)}{I}$ (remember the brackets).

This can also be expressed as: $r = \frac{V}{I} - R$

16 a) Rearranging, $f = \frac{c}{\lambda}$

$$f = \frac{(3 \times 10^8 \text{ m s}^{-1})}{(900 \times 10^{-9} \text{ m})}$$

$$= 3.3 \times 10^{14} \text{ Hz}$$

b) $\frac{1}{R} = \frac{1}{300} + \frac{1}{500}$

$$= 5.33 \times 10^{-3}$$

$$R = \frac{1}{5.33} \times 10^3$$

$$= 187.5 \text{ ohms}$$

c) $v = 3 \times 10^5 + (2 \times 10^4 \times 3)$

$$= 3.6 \times 10^5 \text{ m s}^{-1}$$

You must include enough significant figures to show the effect of acceleration.

d) Rearranging, $\frac{(v^2 - u^2)}{2s} = a$

$$a = \frac{(15^2 - 3^2) \text{ m}^2 \text{ s}^{-2}}{(2 \times 30 \text{ m})}$$

$$= \frac{216 \text{ m}^2 \text{ s}^{-2}}{60 \text{ m}}$$

$$= 3.6 \text{ m s}^{-2}$$

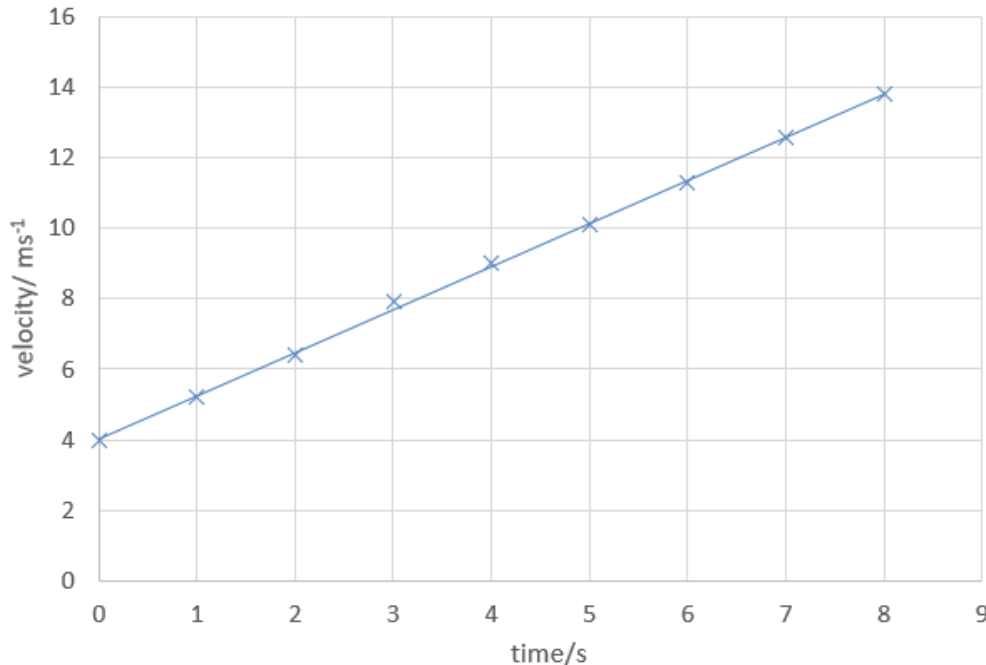
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17 a) The graph should be similar to Figure 28.2 from the Student book, with the x-axis labelled V , and the y-axis labelled I .

b) The graph should be similar to Figure 28.3, with the x-axis labelled v , and the y-axis labelled E .

- c) The graph should be similar to Figure 28.4, but should only include the positive values of x , i.e. including the right-hand side of the graph only. The x -axis should be labelled λ , and the y -axis should be labelled E .

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- 19 a) $s = y$ axis, $t^2 = x$ axis; intercept is at the origin; $\frac{a}{2}$ is the gradient
 b) $\frac{1}{\lambda} = y$ axis, $v^2 = x$ axis; $\frac{\phi}{hc}$ is the intercept, $\frac{m}{2hc}$ is the gradient
 c) $R = y$ axis, $L = x$ axis; intercept is at the origin; ρ/A is the gradient
 20 Do not make the mistake of thinking that the gradient of the graph gives the resistance, it does not. You need to use the graph to measure the potential difference (voltage), when the current is 0.4 A. Then:

$$R = \frac{V}{I}$$

$$= \frac{1.3V}{0.4A} = 3.3 \Omega$$

21 a) acceleration = gradient = $\frac{v}{t} = \frac{(38-2) \text{ (m s}^{-1}\text{)}}{(25-9) \text{ s}} = 2.25 \text{ m s}^{-2}$

- b) distance travelled = area under graph.

There are various ways of measuring this, but your answer should be approximately 300 m.

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21 a) Cross-sectional area = πr^2

$$= \pi \times (6.378 \times 10^6)^2$$

$$= 1.278 \times 10^{14} \text{ m}^2$$

b) Cross-section area = πr^2

$$= \pi \times (90/2 \times 10^{-6})^2$$

$$= 6.4 \times 10^{-9} \text{ m}^2$$

c) Surface area = $4\pi r^2$

$$= 4 \times \pi \times (5/2 \times 10^{-2})^2$$

$$= 8 \times 10^{-3} \text{ m}^2$$

23 a) $Z = 180 - 48 - 32 = 100^\circ$

$$X = 48^\circ$$

$$Y = 180 - 32 = 148^\circ$$

b) In triangle OCE, Angle OCE = $180^\circ - 90^\circ - \theta = 90^\circ - \theta$

Considering the right angle OCD, angle OCE = $90^\circ - \alpha$

Comparing these expressions for angle OCE gives $90^\circ - \theta = 90^\circ - \alpha$

This is only true if θ and α are the same.

c) Parallel component is $W \sin \theta = 120 \sin 40 = 77 \text{ N}$

Perpendicular is $W \cos \theta = 120 \cos 40 = 92 \text{ N}$

d) Parallel component is $W \sin \theta = 67 \sin 34 = 37 \text{ N}$

Perpendicular is $W \cos \theta = 67 \cos 34 = 56 \text{ N}$

24 a) Horizontal component: $4 \cos 30 = 3.46 \text{ m s}^{-1}$

Vertical component: $4 \sin 30 = 2 \text{ m s}^{-1}$

b) Horizontal component: $12 \cos 45 = 8.48 \text{ m s}^{-1}$

Vertical component = $12 \sin 45 = 8.48 \text{ m s}^{-1}$

25 a) Since $360^\circ = 2\pi$ radians,

$$40^\circ = 40 \times \frac{2\pi}{360}$$

$$= 0.22\pi \text{ radians or } 0.69 \text{ radians}$$

b) $175^\circ = \frac{175 \times 2\pi}{360}$

$$= 0.97\pi \text{ radians or } 3.05 \text{ radians}$$

c) $270^\circ = \frac{270 \times 2\pi}{360}$

$$= 1.5\pi \text{ radians or } 4.71 \text{ radians}$$

26 a) Since $360^\circ = 2\pi$ radians, $\frac{\pi}{4 \text{ radians}} = \frac{\pi}{4} \times \left(\frac{360}{2}\right) = 45^\circ$

(Note it is not acceptable to leave answers in degrees in terms of π , but this can be acceptable for answers in radians.)

b) $0.3 \text{ radians} = 0.3 \times \left(\frac{360}{2\pi}\right) = 17.2^\circ$

c) $1.6 \text{ radians} = 1.6 \times \left(\frac{360}{2\pi}\right) = 91.7^\circ$

27 a) 0.01

b) 1

c) 0.03