Pages 549–550 Test yourself

1 **a)** m s^{-1}

b) Ω m

c) kg m^{-3}

d) Hz or s^{-1}

2 **a)** 2 × 60 × 60 = 7200 s

b) 1 mm^3 = $(10^{-3}$ m$)^3$ = 10^{-9} m^3

So 300 mm^3 = 3 × 10^{-7} m^3

c) 2 × 1.6 × 10^{-19} = 3.2 × 10^{-19} 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 $= \frac{4}{3}\pi r^3$

$= \frac{4}{3} \times \pi \times (3.4 \times 10^{-3})^3$

$= 1.6 \times 10^{-7}$ m^3 = 164 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 answers is 9.505.

8 **a)** 2

b) 3

c) 3

d) 2

9 Volume = $3.4^3 = 39.304\ m^3$
Data is quoted to 2 significant figures, so the answers is $39\ m^3$

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

$\Delta t = 3 \times 60 = 180$ s

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

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

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

Volume $= \pi r^2 l$

$= \pi \times (\frac{5.6}{2} \times 10^{-3})^2 \times 1.00$

$= 2.5 \times 10^{-5}\ m^3$

b) The error is 2 × % error of radius, plus % error in length

$= 2 \times (\frac{0.1}{5.6}) \times 100\% + (\frac{0.01}{1.00}) \times 100\%$

$= 2 \times 1.79 + 1 = 4.58\%$.

The absolute error is 4.58% of $2.5 \times 10^{-5}\ m^3 = 0.0115 \times 10^{-5}\ m^3$ or $1.15 \times 10^{-7}\ m^3$

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

$r \approx 10\,000\,000$ m or 10^7 m

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

b) density $\approx 10\,000\ kg\ m^{-3}$
mass of Earth = density × volume $\approx 10\,000 \times 10^{21} \approx 10^{25}$ kg
The value is 6×10^{24} kg so, in this case, the answer is of the same order of magnitude.

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13 a) 1.08

b) 3.81

c) 0.033

d) 125.9

12 $A = A_o e^{-\lambda t}$

$= 48 \times e^{-0.03 \times 35}$

$= 16.8$ Bq

13 $T_{½} = \ln 2/\lambda$

$= \ln 2/3.4 \times 10^{-2}$

$= 20.4$ s

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16 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).

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

b) $F = k\,\Delta l$

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

18 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: $r = \frac{V}{I} - R$

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

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

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

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

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

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

$= 187.5$ ohms

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

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

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

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

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

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

$= 3.6$ m s^{-2}

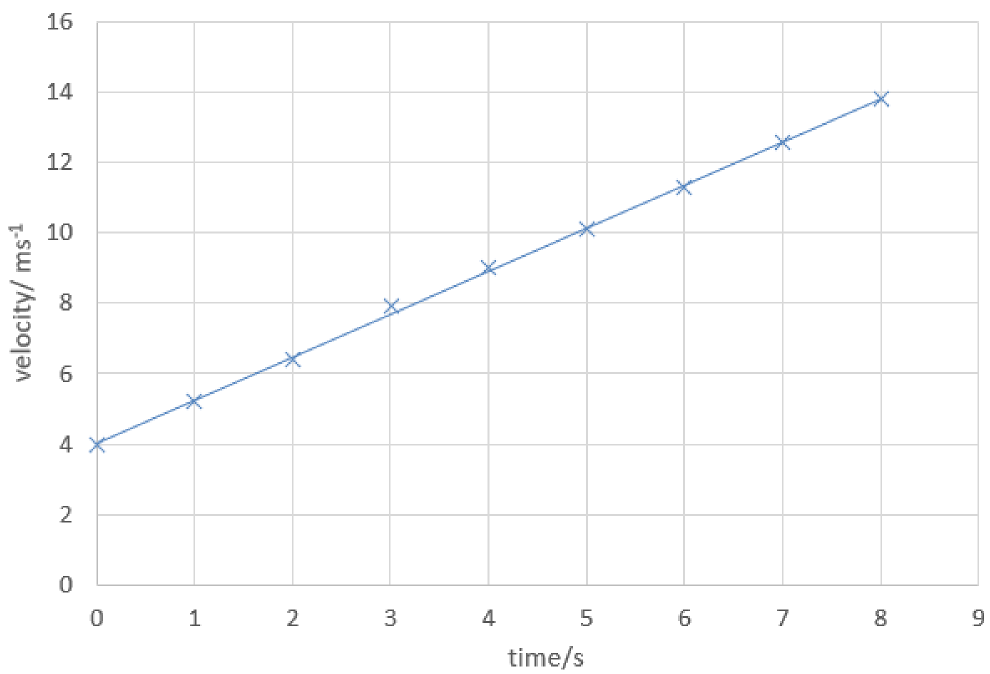
Pages 564–565 Test yourself

20 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.

21



22 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

23 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:

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

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

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

b) distance travelled = area under graph.
There are various ways of measuring this, but your answer should be approximately 300 m.

25 a) F is proportional to $1/r^2$ so tripling the separation would reduce the force by a factor of 9.

b) F is proportional to Qq so doubling each charge would increase the force by a factor of 4.

c) Halving charge reduces force by a factor of 4; halving separation increases force by a factor of 4; the force would be unchanged.

26 Electrostatic force = $Qq/4\pi\varepsilon r^2$; gravitational force = GMm/r^2.

So changing the separation does not affect the ratio of these two forces, because each force changes by the same ratio.

27 a) Gravitational force = GMm/r^2, but GM is constant so the ratio of forces is:

$m_A/r_A^2 : m_B/r_B^2$

substituting the given values, this becomes

$10^{24}/10^{16} : 10^{22}/10^{12}$

or $10^8 : 10^{10} = 1 : 10^2$

So $F_A : F_B = 1 : 100$

b) Comparing the equation for each planet, $T_A^2/T_B^2 = r_A^3/r_B^3$

Substituting known values gives $T_A^2/T_B^2 = (5 \times 10^8)^3/(5 \times 10^6)^3 = 10^6$

Taking square roots of $T_A^2/T_B^2 = 10^6$ gives

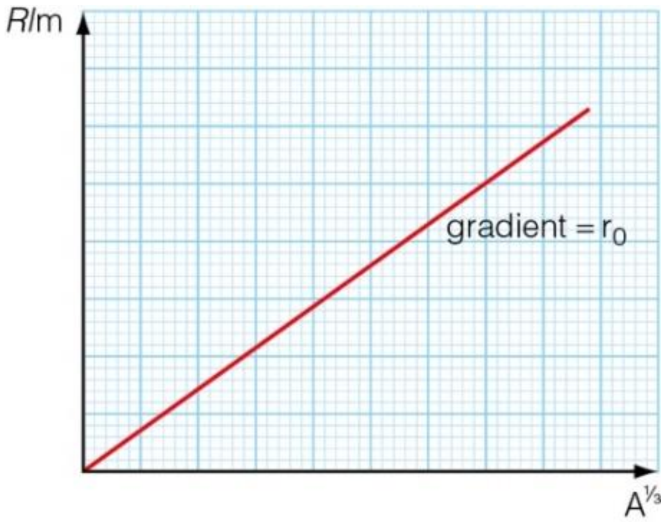
$T_A/T_B = 10^3$

So $T_A : T_B = 1000 : 1$

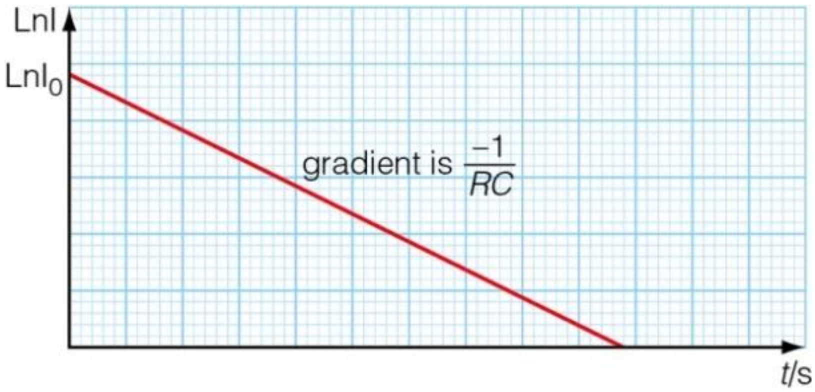
28

Period (s)	Length (m)
0.8	0.13
1.3	0.35
1.9	0.83
2.7	1.7
4.0	4.3

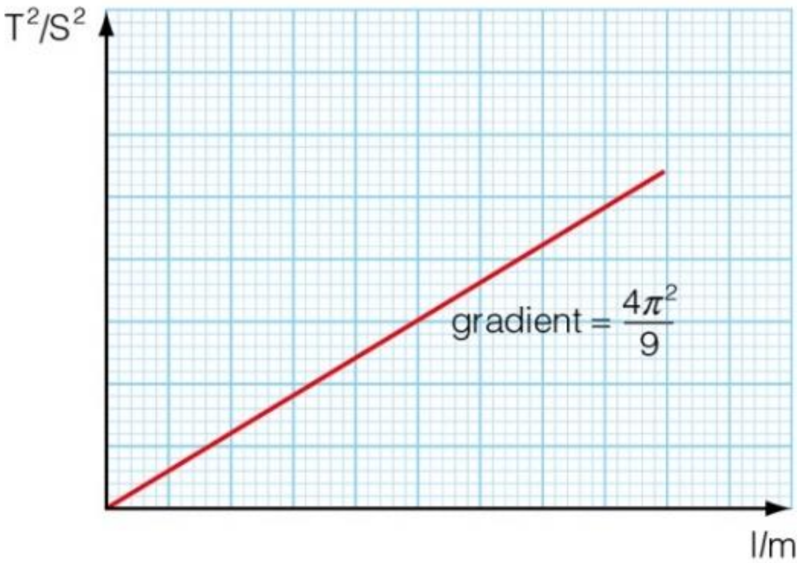
29 a) R on the y axis; $A^{1/3}$ on the × axis; intercept is at the origin; r_o is the gradient



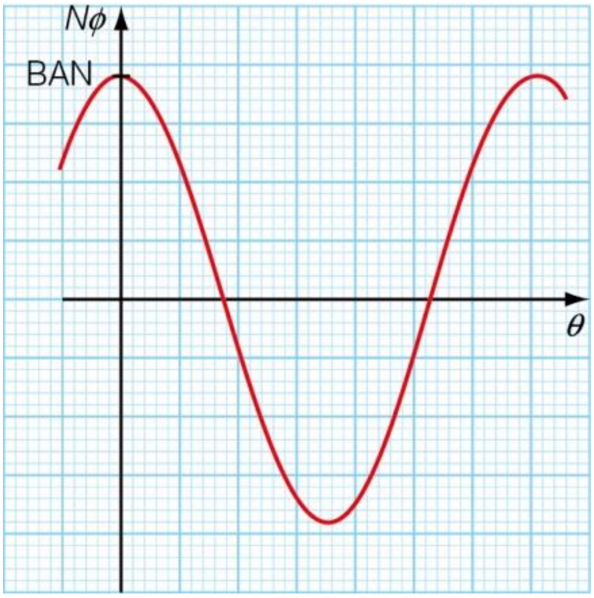
b) ln I = ln I_o – t/RC; so we plot In I on the y-axis, t on the x-axis; so the intercept, C is ln I_o and the gradient m is – 1/RC.



c) T^2 = y axis, l = × axis; intercept is at the origin; $4\pi^2/g$ is the gradient.



30



Pages 569–570 Test yourself

31 a) Cross-sectional area $= \pi r^2$

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

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

b) Cross-section area $= \pi r^2$

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

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

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

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

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

32 a) Z = 180 – 48 – 32 = 100°

X = 48°

Y = 180 – 32 = 148°

b) In triangle OCE, Angle OCE = 180° – 90° – θ = 90° – θ

Considering the right angle OCD, angle OCE = 90° – α

Comparing these expressions for angle OCE gives 90° – θ = 90° – α

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

c) Parallel component is W sin θ = 120 sin 40 = 77 N

Perpendicular is W cos θ = 120 cos 40 = 92 N

d) Parallel component is W sin θ = 67 sin 34 = 37 N

Perpendicular is W cos θ = 67 cos 34 = 56 N

33 a) Horizontal component: 4 cos 30 = 3.46 m s^{-1}

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

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

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

34 a) 0.53

b) –0.306

c) 23.1°

35 a) 0.38

b) √3

c) 0.403

36 a) Since 360° = 2π radians,

40° $= 40 \times \frac{2\pi}{360}$

= 0.22π radians or 0.69 radians

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

= 0.97π radians or 3.05 radians

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

= 1.5π radians or 4.71 radians

37 a) Since 360° = 2π radians, $\frac{\pi}{4 \text{ radians}} = \frac{\pi}{4} \times (\frac{360}{2}) = 45°$

(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 radians = $0.3 \times (\frac{360}{2\pi}) = 17.2°$

c) 1.6 radians = $1.6 \times (\frac{360}{2\pi}) = 91.7°$

38 a) 0.01

b) 1

c) 0.03