

Answers

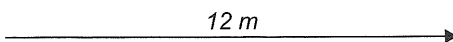
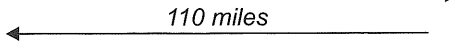
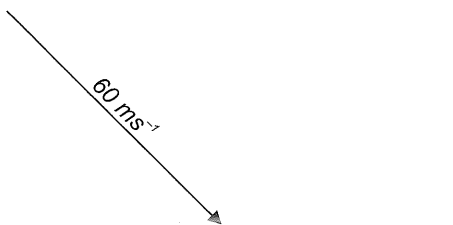
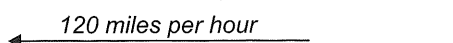
N.B. — All numerical answers here have been rounded to the same number of significant figures as the given data value with the least number of significant figures (see page 1).

Section 1 — Forces and Motion

Page 2 — Speed, Displacement and Velocity

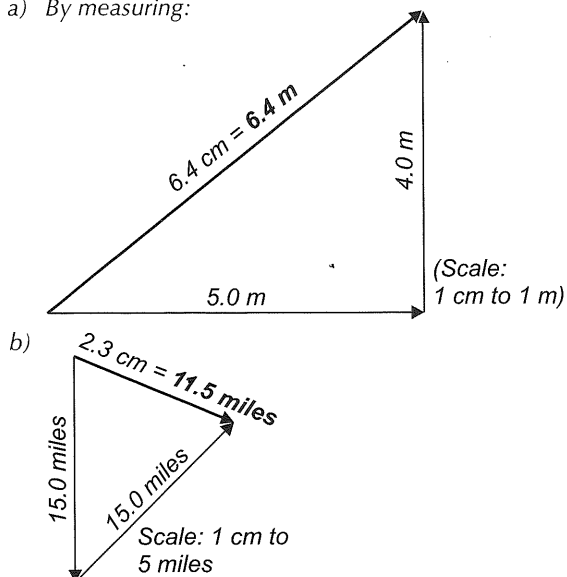
- speed = distance \div time = $1500 \div 210 = 7.142\dots$
= **7.1 ms^{-1} (to 2 s.f.)**
- distance = speed \times time = $(3.0 \times 10^8) \times (8.3 \times 60)$
= 1.494×10^{11}
= **$1.5 \times 10^{11} \text{ m}$ (to 2 s.f.)**
- time = distance \div speed. $1.5 \text{ m} = 150 \text{ cm}$,
so time = $150 \div 0.24 = 625 =$ **620 seconds (to 2 s.f.)**
- $t = s \div v = (1 \times 1000) \div 50 =$ **20 s**
- $s = v \times t = 7.50 \times 15.0 = 112.5$
= **113 m south (to 3 s.f.)**

Page 3 — Drawing Displacements and Velocities

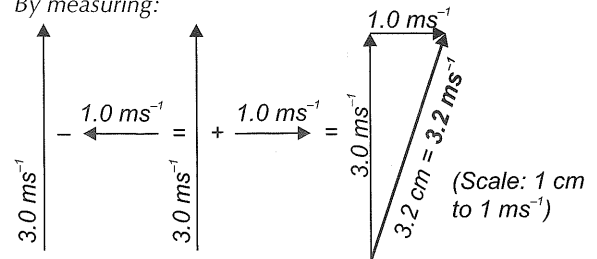
- a) 
b) 
- a) 
b) 

Page 4 — Combining Displacements and Velocities

- a) By measuring:



- By measuring:



Or by Pythagoras: $\Delta v = \sqrt{3.0^2 + 1.0^2} = 3.162\dots$
= **3.2 m (to 2 s.f.)**

Page 5 — Resolving Vectors

- Horizontal component = $v_x = v \cos \theta = 12 \times \cos 68$
= $4.495\dots =$ **4.5 ms^{-1} (to 2 s.f.)**
Vertical component = $v_y = v \sin \theta = 12 \times \sin 68$
= $11.128\dots =$ **11 ms^{-1} (to 2 s.f.)**
- $\cos \theta = \frac{v_x}{v}$. Rearranging for θ gives:
 $\theta = \cos^{-1}\left(\frac{v_x}{v}\right) = \cos^{-1}\left(\frac{67}{98}\right) = 46.868\dots$
= **47° (to 2 s.f.)**
- Vertical velocity = $v_y = v \sin \theta = 5.9 \times \sin 23$
= $2.305\dots \text{ ms}^{-1}$
Time taken to descend $150 \text{ m} = \frac{s}{v_y} = \frac{150}{2.305\dots}$
= $65.067\dots$
= **65 s (to 2 s.f.)**

Page 6 — Acceleration

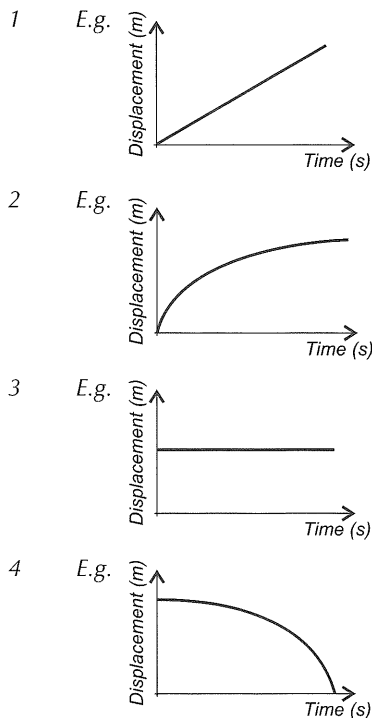
- $u = 12.8 \text{ ms}^{-1}$ to the left = -12.8 ms^{-1}
 $v = 18.3 \text{ ms}^{-1}$ to the right = $+18.3 \text{ ms}^{-1}$
 $a = \frac{v - u}{t} = \frac{18.3 - (-12.8)}{22.0} = 1.4136\dots$
= **1.41 ms^{-2} to the right (to 2 s.f.)**
- $t = \frac{v - u}{a} = \frac{4.5 - 1.5}{0.18} = 16.66\dots =$ **17 s (to 2 s.f.)**
- $u = v - (a \times t) = 0 - (-0.41 \times 3.7) = 1.517$
= **1.5 ms^{-1} (to 2 s.f.)**

Page 7 — Acceleration Due To Gravity

- $t = \frac{v - u}{a} = \frac{-4.9 - 0}{-9.81} = 0.4994\dots =$ **0.50 s (to 2 s.f.)**
- $u = v - (a \times t) = -26.5 - (-9.81 \times 2.15) = -5.4085$
= **5.41 ms^{-1} downwards (to 3 s.f.)**
- $v = u + (a \times t) = 0 + (-9.81 \times 10.0) = -98.1$
= **98.1 ms^{-1} down**
- $t = \frac{v - u}{a} = \frac{-24.5 - 0}{-9.81} = 2.4974\dots =$ **2.50 s (to 3 s.f.)**
- $u = v - (a \times t) = -10.7 - (-9.81 \times 1.90) = 7.939$
= **7.94 ms^{-1} up (to 3 s.f.)**

Answers

Page 8 — Displacement-Time Graphs



Page 9 — Displacement-Time Graphs

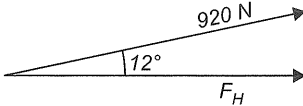
- 1 a) It is accelerating (towards the start line).
 b) Between 3 and 4 seconds it is moving towards the start line and decelerating until it is stationary. It travels 20 metres in this time. Between 4 and 6 seconds it remains stationary zero metres from the start line.
 c) Velocity = $(160 - 40) \div (10 - 8)$
 $= 120 \div 2 = 60 \text{ ms}^{-1}$
 d) Average velocity = $(180 - 80) \div 14 = 100 \div 14$
 $= 7.1428... = 7 \text{ ms}^{-1}$ (to 1 s.f.)
 e) Average speed = $(80 + 180) \div 14 = 260 \div 14$
 $= 18.571... = 20 \text{ ms}^{-1}$ (to 1 s.f.)

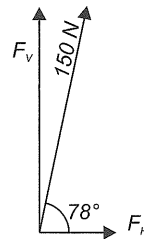
Page 11 — Velocity-Time Graphs

- 1 a) A (0 s-10 s), acceleration = $\frac{10-6}{10-0} = 0.4 \text{ ms}^{-2}$,
 B (10 s-20 s), acceleration = $\frac{10-10}{20-10} = 0 \text{ ms}^{-2}$,
 C (20 s-30 s), acceleration = $\frac{2-10}{30-20} = -0.8 \text{ ms}^{-2}$
 b) A (0 s-10 s), area = $\frac{1}{2}(6 + 10) \times 10 = 80 \text{ m}$
 B (10 s-20 s), area = $10 \times 10 = 100 \text{ m}$
 C (20 s-30 s), area = $\frac{1}{2}(10 + 2) \times 10 = 60 \text{ m}$
 Total distance travelled = $80 + 100 + 60 = 240 \text{ m}$
- 2 a) A (0 s-3 s), acceleration = $\frac{15-0}{3-0} = 5 \text{ ms}^{-2}$
 B (3 s-4 s), acceleration = $\frac{10-15}{4-3} = -5 \text{ ms}^{-2}$
 C (4 s-6 s), acceleration = $\frac{20-10}{6-4} = 5 \text{ ms}^{-2}$
 b) A (0 s-3 s), area = $\frac{1}{2} \times 15 \times 3 = 22.5 \text{ m}$
 B (3 s-4 s), area = $\frac{1}{2}(15 + 10) \times 1 = 12.5 \text{ m}$
 C (4 s-6 s), area = $\frac{1}{2}(10 + 20) \times 2 = 30 \text{ m}$
 Total distance travelled = $22.5 + 12.5 + 30 = 65 \text{ m}$

Page 12 — Adding and Resolving Forces

- 1 a) $8 - 5 = 3 \text{ N}$ to the right, forces are unbalanced.
 b) $700 - 200 = 500 \text{ N}$ to the left, forces are unbalanced.
 c) $2 - 2 = 0 \text{ N}$, forces are balanced.

- 2 
 $F_H = F \cos \theta = 920 \times \cos 12 = 899.89...$
 $= 900 \text{ N}$ (to 2 s.f.)
- 3 $F_V = F \sin \theta = 150 \times \sin 78 = 146.72...$
 $= 150 \text{ N}$ (to 2 s.f.)



Page 14 — Forces and Acceleration

- 1 $F = m \times a = 840 \times 0.50 = 420 \text{ N}$
 2 $F = m \times a = 0.120 \times 9.81 = 1.1772$
 $= 1.18 \text{ N}$ (to 3 s.f.)
 3 $a = F \div m = 250 \div 0.5 = 500 \text{ N}$
 4 $m = F \div a = 55\,000 \div 0.275 = 200\,000 \text{ kg}$
 5 $a = F \div m = 8600 \div 15\,000 = 0.573... \text{ ms}^{-2}$
 $a = \frac{v-u}{t}$, so $v = u + (a \times t) = 0 + (0.573... \times 25)$
 $= 14.333... = 14 \text{ ms}^{-1}$ (to 2 s.f.)

Answers

Section 2 — Energy

Page 15 — Kinetic Energy

- $E_k = \frac{1}{2} \times m \times v^2 = \frac{1}{2} \times 0.125 \times 72.0^2 = \mathbf{324 \text{ J}}$
- $E_k = \frac{1}{2} \times m \times v^2$ so $m = \frac{2 \times E_k}{v^2} = \frac{2 \times 5.4 \times 10^7}{15^2} = \mathbf{4.8 \times 10^5 \text{ kg}}$
- $v = \sqrt{\frac{2 \times E_k}{m}} = \sqrt{\frac{2 \times 1.0 \times 10^{-6}}{0.057}} = 5.9234... \times 10^{-3} = \mathbf{5.9 \times 10^{-3} \text{ ms}^{-1}}$ (or 0.59 cms^{-1}) (to 2 s.f.)

Page 16 — Gravitational Potential Energy

- $E_p = m \times g \times h = 750 \times 9.81 \times 350 = 2\,575\,125 = \mathbf{2.6 \times 10^6 \text{ J}}$ (to 2 s.f.)
- $m = \frac{E_p}{g \times h} = \frac{1715}{9.81 \times 7.00} = 24.974... = \mathbf{25.0 \text{ kg}}$ (to 3 s.f.)
- $h = \frac{E_p}{m \times g} = \frac{24\,700}{65.0 \times 9.81} = 38.735... = \mathbf{38.7 \text{ m}}$ (to 3 s.f.)

Page 17 — Conservation of Energy

- $E_k \text{ lost} = E_p \text{ gained} = 2850 \text{ J}$
So $E_p = m \times g \times h = 2850 \text{ J}$
 $m = \frac{E_p}{g \times h} = \frac{2850}{9.81 \times 5.10} = 56.964... = \mathbf{57.0 \text{ kg}}$ (to 3 s.f.)
- $E_p \text{ lost} = m \times g \times h = 0.475 \times 9.81 \times 0.920 = 4.28697 \text{ J}$
 $E_p \text{ lost} = E_k \text{ gained}$, so $E_k = \frac{1}{2} \times m \times v^2 = 4.28697 \text{ J}$
 $v = \sqrt{\frac{2 \times E_k}{m}} = \sqrt{\frac{2 \times 4.28697}{0.475}} = 4.2485... = \mathbf{4.25 \text{ ms}^{-1}}$ (to 3 s.f.)
- $E_k \text{ lost} = \frac{1}{2} \times m \times v^2 = \frac{1}{2} \times 0.015 \times 420^2 = 1323 \text{ J}$
 $E_p \text{ gained} = E_k \text{ lost}$, so $E_p = m \times g \times h = 1323 \text{ J}$
 $h = \frac{E_p}{m \times g} = \frac{1323}{0.015 \times 9.81} = 8990.8... = \mathbf{9000 \text{ m}}$ (to 2 s.f.)

Page 18 — Work

- $W = F \times s = 25 \times 44 = \mathbf{1100 \text{ J}}$
- $W = F \cos \theta \times s = 17 \times \cos 35 \times 2.5 = 34.81... = \mathbf{35 \text{ J}}$ (to 2 s.f.)

Page 19 — Work

- $W = F \times s = 125 \times 2.50 = 312.5 = \mathbf{313 \text{ J}}$ (to 3 s.f.)
- $E_p = m \times g \times h = 5.75 \times 9.81 \times 2.50 = 141.01... = \mathbf{141 \text{ J}}$ (to 3 s.f.)
- Work done = increase in E_k + increase in E_p so:
 $E_k = W - E_p = 312.5 - 141.01... = 171.48... = \mathbf{171 \text{ J}}$ (to 3 s.f.)
- $v = \sqrt{\frac{2 \times E_k}{m}} = \sqrt{\frac{2 \times 171.48...}{5.75}} = 7.7230... = \mathbf{7.72 \text{ ms}^{-1}}$ (to 3 s.f.)

Page 20 — Power

- $P = \frac{W}{t} = \frac{250}{4.0} = 62.5 = \mathbf{63 \text{ W}}$ (to 2 s.f.)
- $t = \frac{W}{P} = \frac{91 \times 1000}{14 \times 1000} = \frac{91\,000}{14\,000} = \mathbf{6.5 \text{ s}}$
- $W = F \times s = 276 \times (1.25 \times 1000) = 345\,000 \text{ J}$
 $P = \frac{W}{t} = \frac{345\,000}{2.5 \times 60} = \mathbf{2300 \text{ W}}$

Page 21 — Power

- $P = F \times v = 1.80 \times 10^5 \times 40.0 = \mathbf{7.20 \times 10^6 \text{ W}}$ (or 7.20 MW)
- The skydiver's weight is equal to the force, F , exerted by gravity on her mass, so:
 $F = \frac{P}{v} = \frac{31\,500}{45} = \mathbf{700 \text{ N}}$
- $v = \frac{P}{F} = \frac{5.20 \times 10^4}{1650} = 31.515... = \mathbf{31.5 \text{ ms}^{-1}}$ (to 3 s.f.)

Page 22 — Efficiency

- Useful energy out = $E_p = m \times g \times h = 12.9 \times 9.81 \times 2.50 = 316.3725 \text{ J}$
Efficiency = $\frac{\text{useful energy out}}{\text{total energy in}} \times 100\% = \frac{316.3725}{375} \times 100\% = 84.366 = \mathbf{84.4\%}$
- a) $E_k = \frac{1}{2} \times m \times v^2 = \frac{1}{2} \times 560 \times 25^2 = 1.75 \times 10^5 = \mathbf{1.8 \times 10^5 \text{ J}}$ (or 180 kJ) (to 2 s.f.)
b) Efficiency = $\frac{\text{useful energy out}}{\text{total energy in}} \times 100\% = \frac{1.75 \times 10^5}{1.4 \times 10^6} \times 100\% = 12.5 = \mathbf{13\%}$ (to 2 s.f.)

Section 3 — Materials

Page 24 — Forces and Springs

- $F = k \times \Delta l = 64.1 \times 0.245 = 15.7045 = \mathbf{15.7 \text{ N}}$ (to 3 s.f.)
- $\Delta l = \frac{F}{k} = \frac{378}{84.0} = \mathbf{4.50 \text{ m}}$
- a) $F = m \times g = 7.4 \times 9.81 = 72.594 \text{ N}$
 $k = \frac{F}{\Delta l} = \frac{72.594}{0.084} = 864.214... = \mathbf{860 \text{ Nm}^{-1}}$ (to 2 s.f.)
b) $F = k \times \Delta l = 864.214... \times 0.095 = 82.100... \text{ N}$
 $m = \frac{F}{g} = \frac{82.100...}{9.81} = 8.369... = \mathbf{8.4 \text{ kg}}$ (to 2 s.f.)
Yes, the bag can be taken on the flight.
- a) The maximum force at which an object's extension is still proportional to the force applied to it.
b) It could have been stretched beyond its elastic limit.

Answers

Section 4 — Electricity

Page 25 — Current and Potential Difference

- $I = \frac{Q}{t}$, so $t = \frac{Q}{I} = \frac{12}{3.0} = 4.0 \text{ s}$
- $V = \frac{W}{Q}$, so $W = V \times Q = 1.5 \times 9.2 = 13.8 \text{ V}$
- $I = \frac{Q}{t}$, so $Q = I \times t = 3.80 \times 275 = 1045 \text{ C}$
 $V = \frac{W}{Q} = \frac{9540}{1045} = 9.129\dots = 9.13 \text{ V (to 3 s.f.)}$

Page 26 — Current in Electric Circuits

- $0.5 = I_1 + 0.2 + 0.05$
 $0.5 = I_1 + 0.25$
 $I_1 = 0.5 - 0.25$
 $I_1 = 0.25 \text{ A}$
- $0.4 + 0.3 + I_2 = 1.3$
 $0.7 + I_2 = 1.3$
 $I_2 = 1.3 - 0.7$
 $I_2 = 0.6 \text{ A}$

Page 27 — Potential Difference in Electric Circuits

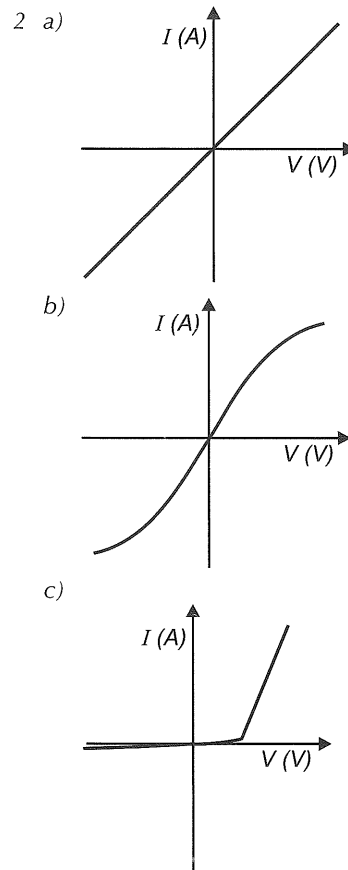
- a) $12 = V_M + 3$
 $V_M = 12 - 3$
 $= 9 \text{ V}$
 b) $12 = 6 + 2 + V_S$
 $V_S = 12 - 6 - 2$
 $= 4 \text{ V}$
- 12 V

Page 28 — Resistance

- $V = I \times R$, so $V = 2.5 \times 15 = 37.5 = 38 \text{ V (to 2 s.f.)}$
- $I = \frac{V}{R} = \frac{6.0}{2500} = 0.0024 \text{ A (or 2.4 mA)}$
- $R = \frac{V}{I} = \frac{1.5}{0.024} = 62.5 = 63 \Omega \text{ (to 2 s.f.)}$

Page 29 — I-V Graphs

- Provided the temperature is constant, the current through an ohmic component is directly proportional to the potential difference across it ($V = IR$).



Page 30 — Power in Circuits

- $P = V \times I = 6.5 \times 0.12 = 0.78 \text{ W}$
- a) $I = \frac{P}{V} = \frac{45}{14} = 3.214\dots = 3.2 \text{ A (to 2 s.f.)}$
 b) $W = P \times t = 45 \times 12 = 540 \text{ J}$

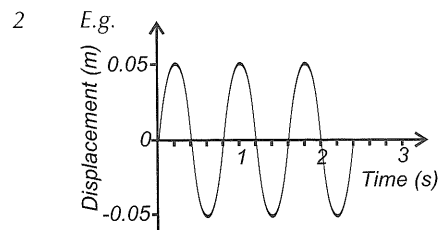
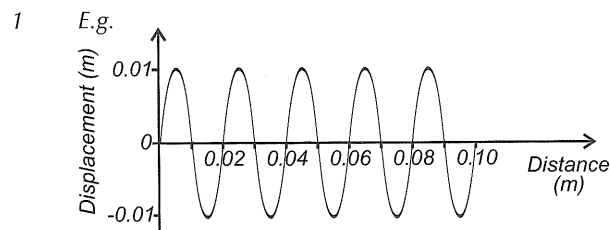
Page 31 — Power in Circuits

- $P = I^2 R = 1.2^2 \times 2400 = 3456 = 3500 \text{ W (to 2 s.f.)}$
- $P = \frac{V^2}{R} = \frac{6^2}{100} = \frac{36}{100} = 0.36 \text{ W}$
 $W = P \times t = 0.36 \times 60 = 21.6 = 20 \text{ J (to 1 s.f.)}$
- $R = \frac{P}{I^2} = \frac{6.0}{0.50^2} = 24 \Omega$

Answers

Section 5 — Waves

Page 32 — Waves



Page 33 — Frequency and the Wave Equation

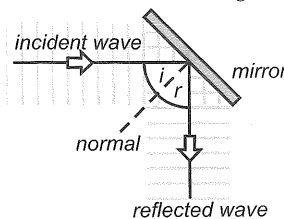
- $T = \frac{1}{f} = \frac{1}{6.25 \times 10^5} = 1.60 \times 10^{-6} \text{ s}$
- $f = \frac{1}{T} = \frac{1}{0.0012} = 833.33... = 833 \text{ Hz (to 2 s.f.)}$
- $v = f \times \lambda = 3.5 \times 1.4 = 4.9 \text{ ms}^{-1}$
- a) $f = \frac{1}{T} = \frac{1}{7.1} = 0.1408... = 0.14 \text{ Hz (to 2 s.f.)}$
 b) $v = f \times \lambda$, so $\lambda = \frac{v}{f} = \frac{180}{0.1408...} = 1278 = 1300 \text{ m (to 2 s.f.)}$

Page 34 — Superposition of Waves

- a) If two waves meet they will briefly combine and become one single wave, with a displacement equal to the displacement of each individual wave added together.
 b) When the amplitude of the combined wave is larger than the amplitude of the individual waves.
 c) When the amplitude of the combined wave is smaller than the amplitude of the individual waves.
- Amplitude = $0.67 + 0.67 = 1.34 \text{ mm}$
- The waves will cancel each other out completely, so the amplitude will be **0 m**.
- Amplitude = $35 + 41 = 76 \text{ cm}$

Page 35 — Reflection and Diffraction

- Angle of incidence (i) = angle of reflection (r)
- E.g.



- When the gap is about the same size as the wavelength, there will be a lot of diffraction. When the gap is made slightly larger, the amount of diffraction will decrease.
- Light diffracts as it passes through the slit and forms a diffraction pattern of light and dark fringes.

Page 36 — Refraction

- The wave slows down without changing direction.
- The wave slows down and changes direction.
- $n = \frac{\sin i}{\sin r} = \frac{\sin 72}{\sin 39} = 1.511... = 1.5$
- $n = \frac{\sin i}{\sin r}$ so $\sin r = \frac{\sin i}{n} = \frac{\sin 23}{1.3} = 0.3005...$
 so $r = \sin^{-1} 0.3005... = 17.49... = 17^\circ \text{ (to 2 s.f.)}$

Section 6 — Atoms and Radioactivity

Page 37 — Atomic Structure

- a) 95 protons, 146 neutrons
 b) 94 protons, 145 neutrons
 c) 38 protons, 52 neutrons
 d) 27 protons, 33 neutrons
 e) 88 protons, 138 neutrons
- An isotope is a different form of the same element. It has the same number of protons but a different number of neutrons.

Page 38 — Nuclear Radiation

- An alpha particle is made up of two protons and two neutrons.
- In beta radiation a neutron in the nucleus turns into a proton and an electron. The electron is emitted from the nucleus.
 In gamma radiation high-energy electromagnetic radiation is emitted from the nucleus. There is no change to the number of protons and neutrons.
- a) ${}_{94}^{242}\text{Pu} \rightarrow {}_{92}^{238}\text{U} + 2\alpha$
 b) ${}_{19}^{40}\text{K} \rightarrow {}_{20}^{40}\text{Ca} + {}_{-1}^0\beta$
 c) ${}_{86}^{222}\text{Rn} \rightarrow {}_{84}^{218}\text{Po} + 2\alpha$
 d) ${}_{6}^{14}\text{C} \rightarrow {}_{7}^{14}\text{N} + {}_{-1}^0\beta$

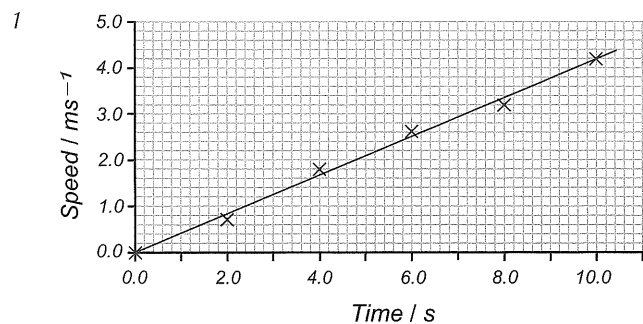
Answers

Section 7 – Investigating and Interpreting

Page 39 – Planning an Experiment and Collecting Data

- 1 a) Independent variable: potential difference across the component.
Dependent variable: current through the component.
- b) $(0.13 + 0.17 + 0.12) \div 3 = 0.14 \text{ A}$

Page 40 – Analysing Your Data

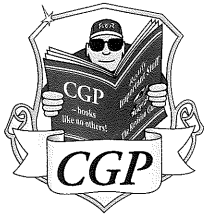


Page 41 – Conclusions and Uncertainty

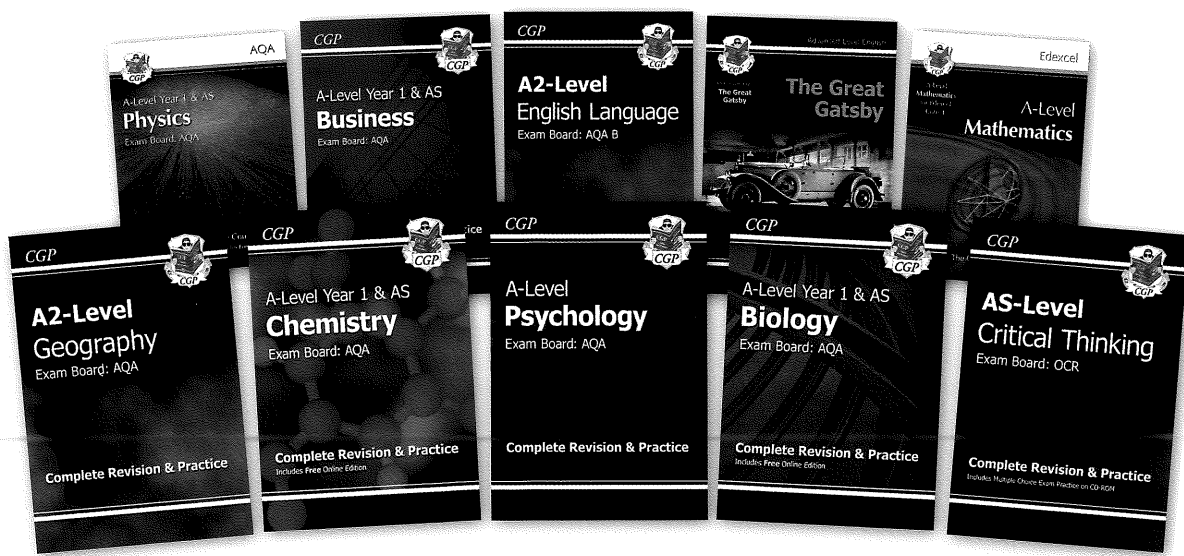
- 1 a) 0.001 s (or 1 ms)
- b) No. There will be some human error in the result caused by the student's reaction time.

Index

- A**
 acceleration 6–11, 13, 14
 due to gravity 7
 alpha decay 38
 amplitude 32
 anomalous results 40
 atomic structure 37
 atoms 37, 38
 averages 39
- B**
 beta decay 38
- C**
 charge 25, 26
 circuits 25–27, 30, 31
 combining vectors 4
 conclusions 41
 conservation of charge 26
 conservation of energy 17, 27
 constructive interference 34, 35
 control variables 39
 conventional current 25
 correlation 40
 current 25, 26, 28, 29, 31
- D**
 dependent variables 39
 destructive interference 34, 35
 diffraction 35
 diodes 29
 displacement 2–4, 8, 9
 combining displacements 4
 waves 32
 displacement-time graphs 8, 9
 distance 2, 9, 10
- E**
 efficiency 22
 elastic limit 24
 elastic strain energy 24
 electricity 25–31
 circuits 25–27, 30, 31
 current 25, 26, 28, 29, 31
 I-V graphs 29
 potential difference 25, 27–31
 power 30, 31
 resistance 28, 29, 31
 electrons 37
 as current 25
 beta decay 38
 energy 15–22
 conservation of energy 17, 27
 efficiency 22
 elastic strain energy 24
 gravitational potential energy 16
 in circuits 27
 kinetic energy 15
 power 20, 21
 work 18–21
 errors 39, 41
- F**
 filament lamps 29
 forces 12–14, 18, 19, 21
 on springs 23, 24
 resolving forces 12
 resultant forces 12–14
 frequency 33
- G**
 gamma decay 38
 graphs 40
 displacement-time graphs 8, 9
 force-extension graphs 24
 I-V graphs 29
 velocity-time graphs 10, 11
 gravitational potential energy 16
 gravity 7
- H**
 Hooke's law 23, 24
 hypotheses 39
- I**
 independent variables 39
 index notation 1
 interference
 constructive 34, 35
 destructive 34, 35
 isotopes 37
 I-V graphs 29
- K**
 kinetic energy 15
 Kirchoff's laws 26, 27
- L**
 limit of proportionality 24
 lines of best fit 40
 longitudinal waves 32
- N**
 negative correlation 40
 neutrons 37
 Newton's laws of motion 13, 14
 nuclear radiation 38
 nucleon numbers 37, 38
 nucleons 37
 nuclide notation 37
- O**
 Ohm's law 29
- P**
 phase 34
 planning experiments 39
 plastic deformation 24
 positive correlation 40
 potential difference 25, 27–31
 power 20, 21, 30, 31
 proton numbers 37, 38
 protons 37
 Pythagoras' theorem 4
- R**
 radiation 38
 radioactive decay 38
 random errors 39
 reflection 35
 refraction 36
 refractive indices 36
 resistance 28, 29, 31
 resultant forces 12–14
 resultant vectors 4
- S**
 scale drawings 3
 significant figures 1, 41
 Snell's law 36
 speed 2
 of a wave 33
 spring constants 23
 springs 23, 24
 standard form 1
 superposition 34
 symbols 1
- T**
 time period 32, 33
 transverse waves 32
 trigonometry 5, 18, 36
- U**
 uncertainties 41
 units 1
- V**
 variables 39
 vectors 2–5, 12
 resolving 5, 12
 resultant 4
 velocity 2–6, 8–11
 combining velocities 4
 velocity-time graphs 10
 voltage 25, 27–31
- W**
 wavelength 32, 33, 35
 waves 32–36
 diffraction 35
 frequency 33
 graphs 32
 longitudinal 32
 reflection 35
 refraction 36
 speed 33
 superposition 34
 time period 32, 33
 transverse 32
 wave equation 33
 work 18–21



Even more brilliant CGP books that might just save your life...



To find out more (or place an order with fantastic next-day delivery), just visit our website or give our friendly team a call:

www.cgpbooks.co.uk • 0800 1712 712

And of course, our books are available from all good booksellers, including:

Waterstones

WHSmith

amazon.co.uk