Wearing safety glasses, measure out some hydrochloric acid in a measuring cylinder and transfer it to a beaker. Add some copper oxide / copper carbonate to the acid and mix well. Heat gently until no more solid dissolves.

Fold a piece of filter paper and place it in a filter funnel in the top of a conical flask or beaker. Filter the hot mixture through the funnel. Pour the filtrate into an evaporating basin and gently warm over a water bath until the volume has reduced by about half. Remove the evaporating basin from the heat and leave the concentrated solution to cool and the copper chloride crystals to form. Finally dry the crystals by dabbing them on a piece of filter paper.

Page 112

1 Answer could include the following points in a logical order for 6 marks:

Diamond and graphite are allotropes of carbon. They are both covalent, giant molecular structures with very high melting points. This is because of the strong covalent bonds between the carbon atoms which need to be broken to change them from a solid to a liquid.

However, the structural arrangements of the carbon atoms are different, which explains the differences in their properties and uses.

Diamond has a tetrahedral arrangement of carbon atoms, which makes it very hard and rigid. It is used as a drilling and cutting tool because of this. This shape also means that diamond can be cut with very flat sides that reflect light so it sparkles, which can be used in jewellery.

Graphite is softer than diamond because it has a layered structure. Each carbon atom is covalently bonded to three others forming layers containing hexagonal rings. There are weak intermolecular forces between the layers, which allow them to slide over each other. This makes graphite a useful lubricant for moving parts. There are also delocalised electrons, which are free to move as they are not all held in the covalent bonds like diamond. This means that graphite conducts electricity but diamond does not. Graphite can be used as electrodes for electrolysis, which is useful as it is not very reactive.

2 Answer could include the following points in a logical order for 6 marks:

copper carbonate + hydrochloric acid → copper chloride + water + carbon dioxide.

As carbon dioxide is given off, the reaction can be followed by measuring the volume of gas produced using a gas syringe attached to the top of a conical flask.

Wear safety glasses throughout the experiment and wipe up any spillages immediately.

For each experiment, use the same:

- mass of copper carbonate (2 g measured on a balance);
- volume of dilute hydrochloric acid (50 cm^3 measured in a measuring cylinder);
- time to collect the carbon dioxide gas (30 seconds measured using a stop watch).

Temperature is the only variable to be changed. This can be done using a large beaker containing five different temperatures of water to get a good range of results. Ice can be used to cool the water bath below room temperature. Different amounts of water from a boiled kettle can be used for the higher temperatures. (Take care with hot water.)

Put a conical flask containing 50 cm^3 dilute HCl into the water bath to give it time to warm up or cool down. Record the temperature of the acid. Add the copper carbonate and seal the gas syringe onto the top of the conical flask. Start timing and measure the volume of gas collected after 30 seconds.

Record the results in a table with these headings.

Temperature of hydrochloric acid in °C	Volume of gas produced in 30 seconds in cm^3

Ideally the whole experiment should be repeated to confirm the trend. A graph of volume of carbon dioxide produced (cm^3) against temperature can be drawn to show the effect of temperature on this reaction.

Physics

Unit 1

Page 114

1 a Work done by a force. b Heating. c Work done by an electrical current.

2 an electric current; a force; heating

3 From top: gravitational store of the object; elastic store of the spring in the watch; thermal store of the water (and surroundings); elastic store of the bow and bow string [decreases]; kinetic store of the arrow [increases]

4 a 500 (J) b 2.5 (kJ)

Page 115

1

Energy store	Equation
gravitational potential energy store *	$\Delta Q = m \times c \times \Delta\theta$
kinetic energy store *	$E = \frac{1}{2} \times k \times x^2$
elastic potential energy store	$Q = m \times L$
energy change during a change of state (e.g. melting)	$KE = \frac{1}{2} \times m \times v^2$
energy change when an object changes temperature	$\Delta GPE = m \times g \times \Delta h$

2

Select the correct energy equation	$KE = \frac{1}{2} \times m \times v^2$
Substitute in the correct values from the question using your highlighted values	$KE = 0.5 \times 3.0 \times (2.0 - 0)^2$
Calculate the answer	$KE = 6.0$
Choose the correct number of significant figures and add the units	$KE = 6.0$ J

Page 116

1 a Circled: 200 N/m and 0.50 m; underlined: 0.90

b $E = \frac{1}{2} \times k \times x^2$

c $E = \frac{1}{2} \times k \times x^2 = 0.5 \times 200 \times 0.502 = 25$ J d Method 1

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

$$0.9 = \frac{\text{useful energy transferred by the device}}{2.5}$$

$$2.5 \times 0.9 = \frac{\text{useful energy transferred by the device}}{\cancel{2.5}} \times \cancel{2.5}$$

2.25 J = useful energy transferred by the device

Method 2

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

useful energy transferred by the device = total energy supplied to the device × efficiency

$= 2.5 \times 0.90 = 2.25$ J

Page 117

1. $\Delta GPE = m \times g \times \Delta h$
2. $\Delta GPE = m \times g \times \Delta h = 0.15 \times 10 \times 2.5 = 3.75$ J
3. As the apple falls, its gravitational potential energy decreases but its kinetic energy increases.
4. 3.75 J
5. $KE = \frac{1}{2} \times m \times v^2$
6. $KE = \frac{1}{2} \times m \times v^2$

   $v^2 = \frac{2 \times KE}{m} = \frac{2 \times 3.75}{0.15} = 50$
7. $v^2 = \sqrt{50}$, $v = 7.1$ m/s (to 2 sf)

Page 118

1. Gravitational potential energy $\Delta GPE = m \times g \times h$ $= 1.0 \times 10 \times 3.6 = 36$ J
2. The student has written v instead of v^2.
3. $v = \sqrt{\frac{2 \times KE}{m}} = \sqrt{\frac{2 \times 36}{1.0}} = 8.5$ m/s
4. a 27 000 J b $\frac{\Delta Q}{mc}$ c °C d 12.9 °C

Page 119

1 (a) There is a transfer from the elastic store of the spring (elastic potential energy) **(1)** to the kinetic store of the toy (kinetic energy) **(1)** and then to the gravitational store (gravitational potential energy) **(1)** of the toy.

(b) $E = \frac{1}{2} \times k \times x^2$ **(1)** $= 0.5 \times 50.0 \times (0.10)^2$

$= 0.25$ J **(1)**

(c) $\Delta GPE = m \times g \times \Delta h$ **(1)**; maximum height at efficiency of 1 = 0.42 m **(1)**; actual height at efficiency of 0.9 = 0.42 × 0.9 = 0.38 m **(1)**

Page 120

1 (a) $\Delta GPE = m \times g \times \Delta h$ **(1)** $= 0.40 \times 10 \times 2.0$ $= 8.0$ J **(1)**

(b) $KE = \frac{1}{2} \times m \times v^2$ **(1)**, $\sqrt{\frac{2 \times KE}{m}}$ **(1)** $= 6.3$ m/s **(1)** (Allow error carried forwards from (a).)

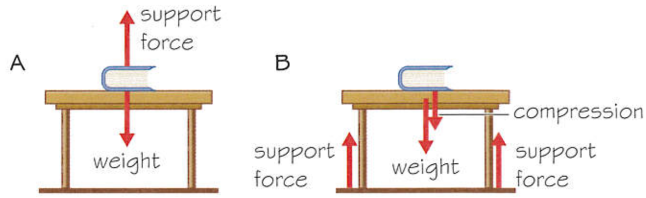
(c) As the ball hits the ground it deforms so kinetic → elastic **(1)**; as the ball rebounds elastic → kinetic **(1)**.

(d) Calculation of gravitational potential energy after bounce (5.6 J) **(1)**, use of efficiency = $\frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$ **(1)** to give efficiency of 0.70 **(1)**. (Allow use of ratio of heights to reach efficiency.)

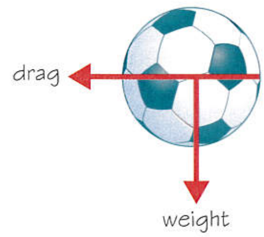
Unit 2

Page 122

1. A, e; B, f; C, a; D, g; E, d; F, h; G, c; H, b
2. a and b



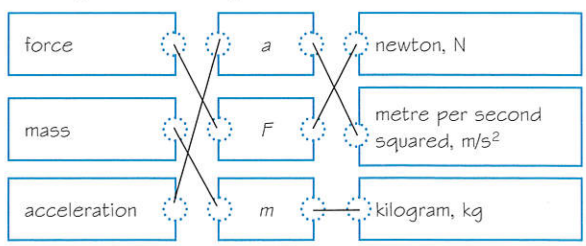
3. a



b The weight would be the same but the drag (air resistance) would be larger.

Page 123

1.



2.

	A	B	C
Resultant force	↓ 6.0 N	→ 2.0 N	↓ 120 N
Acceleration	$a = \frac{F}{m} = \frac{6.0}{3.0}$ $a = 2.0$ m/s²	$a = \frac{F}{m} = \frac{2.0}{0.2}$ $a = 10$ m/s²	$a = \frac{F}{m} = \frac{120}{6.0}$ $a = 20$ m/s²

Page 124

1. first row: change in velocity = 4 m/s

   second row: end velocity = −3; change in velocity = −3 −9 = −12 m/s
2.

Stage	Your try
Scenario	A car has a mass of 1200 kg. Calculate the force needed to accelerate it from 0 m/s to 5.0 m/s in 5.0 s.
Find the change in velocity	0 to 5.0 m/s change in velocity = 5.0 − 0 = 5.0 m/s
Find the acceleration $a = \frac{\text{change in velocity}}{t}$	$a = \frac{\text{change in velocity}}{t}$ $= \frac{5.0}{5.0}$ $a = 1.0$ m/s
Size of the forces involved $F = m \times a$	$F = m \times a$ $F = 1200 \times 1.0$ $F = 1200$ N

Page 125

1. a A, B, D, E b A, D c A, D
2. b $p = m \times v$; $p = 5000 \times 8.5$; 42 500 (or 4.25×10^4) kg m/s to the right
3. $p = m \times v$; $4.0 \times 1.5 = 6.0$ to the right; $3.0 \times 2.0 = 6.0$ to the right; $6.0 + 6.0 = +12.0$ kg m/s to the right

Page 126

1. a $m = \frac{p}{v}$ b $\frac{0.3}{2.5} = 0.12$ kg
   c The student has used too many significant figures. The data in the question has only two sf and so the answer should have the same number.
   d The student has used the correct form of the equation ($p = m \times v$).
   e The student has not found the change in velocity. They have subtracted the numbers but not taken into account the direction. The real change in velocity is 4.50 m/s. The student would get marks even though they used the wrong mass, as they did not score the mark for the calculation earlier.
   f change in momentum = change in velocity × mass = $4.50 \times 0.12 = 0.54$ kg m/s

Page 127

1 (a) 0 m/s² (1)
(b) $p = m \times v = 0.045 \times 80 = 3.6$ (1) kg m/s (1)
(c) [–]3.6 kg m/s (1) (Allow error carried forward from part (b).)
(d) $a = \frac{\Delta v}{t} = \frac{(80-0)}{0.02} = 4000$ (1) m/s² (1)
(e) $F = m \times a = 0.045 \times 4000 = 180$ N (1) (Allow error carried forward from part (d).)

Page 128

1 (a) $a = \frac{\text{change in velocity}}{t} = \frac{(11-5)}{1.5} = 4.0$ (1) m/s² (1)
(b) $F = m \times a = 60 \times 4 = 240$ N (1)
(c) (–)240 N (1)
(d) $p = m \times v = 60 \times 5 = 300$ kg m/s (1) (accept N s)

Unit 3

Page 130

1. proton: positive; in the nucleus
   neutron: neutral; in the nucleus
   electron: negative; in orbit around the nucleus
2. a protons b protons; neutrons
   c mass number; atomic number
   d electrons; nucleus
3. a All of the chlorine isotopes have the same number of protons (17).
   b All of the chlorine isotopes have different numbers of neutrons (18, 19 and 20).
4.

Isotope and chemical symbol	Protons (from atomic number)	Neutrons (mass number – atomic number)	Electrons (same as protons)	Atomic notation
carbon-14 C	6	14 – 6 = 8 8	6	${}^{14}_{6}C$
carbon-12 C	6	6	6	${}^{12}_{6}C$
uranium-238 U	92	146	92	${}^{238}_{92}O$
oxygen-17 O	8	9	8	${}^{17}_{8}O$

Page 131

1. a protons b 2 c ${}^{4}_{2}He$
2. a negative charge b ${}^{0}_{-1}e$
3. a positive charge b ${}^{0}_{+1}e$
4.

Radiation	α (alpha)	β⁻ (beta minus)	β⁺ (positron)	γ (gamma)
Symbol for radiation in equations	${}^{4}_{2}He$	${}^{0}_{-1}e$	${}^{0}_{+1}e$	γ
Radiation consists of	two protons and two neutrons	a fast-moving electron ejected from the nucleus	a fast-moving positron ejected from the nucleus	electromagnetic radiation emitted from the nucleus

Page 132

1. ${}^{4}_{2}He$ 2. 219, 4 3. 219 = 215 + 4
4. 86 = 84 + 2 5. ${}^{218}_{86}Rn$; ${}^{204}_{82}Pb$
6. 79 = 80 + –1 7. ${}^{0}_{-1}e$; ${}^{14}_{7}N$
8.

Decay type	Equation	Decay type	Equation
alpha	${}^{185}_{79}Au \rightarrow {}^{181}_{77}Ir + {}^{4}_{2}He$	alpha	${}^{231}_{91}Pa \rightarrow {}^{227}_{89}Ac + {}^{4}_{2}He$
beta	${}^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}C$	beta	${}^{8}_{3}Li \rightarrow {}^{8}_{4}Be + {}^{0}_{-1}e$

Page 133

1. a 1800 Bq b 5 hours c 5 hours
2. $\frac{1}{16}$
3.

Time in hours	0	→ 1st half-life	5	→ 2nd half-life	10	→ 3rd half-life	15
Activity in Bq	1800		900		450		225
Fraction remaining	$\frac{1}{1}$		$\frac{1}{2}$		$\frac{1}{4}$		$\frac{1}{8}$

Page 134

1. It means one half-life has passed.
2. a Four. There are four arrows.
   b 16 000 Bq → 8000 Bq → 4000 Bq → 2000 Bq → 1000 (the answer is 1000 Bq)
3. a 90; 0; e b ${}^{90}_{38}Sr \rightarrow {}^{90}_{39}Y + {}^{0}_{-1}e$

Page 135

1 (a) Atoms of the same element (atoms with the same number of protons) (1) with different mass numbers/numbers of neutrons (1).
(b) Source A (1) (c) Source B (1)

(d) 4.5 days (1)

(e) $^{131}_{53}\text{I} \rightarrow {}^{131}_{54}\text{Xe} + {}^{0}_{-1}\text{e}$

(1 mark for 131, 1 mark for 54 and 1 mark for −1)

Page 136

1 (a) $^{226}_{88}\text{Ra} \rightarrow {}^{222}_{86}\text{Rn} + {}^{4}_{2}\text{He}$

(1 mark for 222, 1 mark for 86 and 1 mark for the whole helium nucleus)

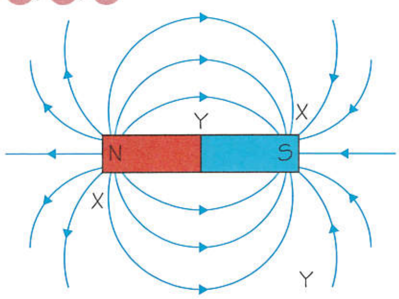
(b) (i) The time it takes for the activity of a sample to fall to half of its original value **(1)**. (Accept half of mass/sample/count rate.)

(ii) One-eighth/$\frac{1}{8}$ **(1)**

Unit 4

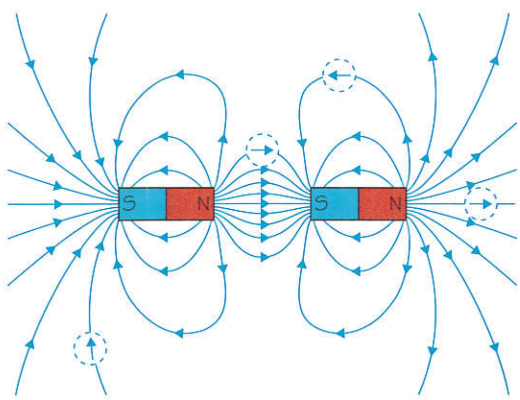
Page 138

1 a, b, c



Other places for X and Y can be chosen. X should be where the magnetic field lines are close together and Y should be where they are far apart.

2



3 strong; uniform

Page 139

1 current; magnetic field

2 The current is moving upwards.

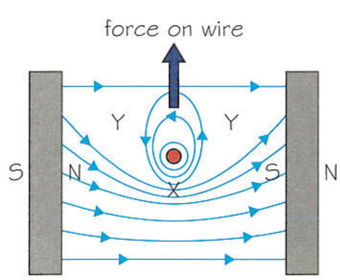
3 strongest; weaker; stronger

4 three upward arrows, one on each wire

5 True; False; True

Page 140

1 a, b, c

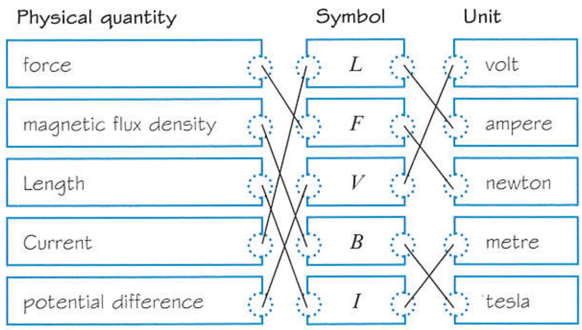


d opposite; the same as

2 left: up middle: left right: no force

Page 141

1



2 a magnetic field is pointing upwards

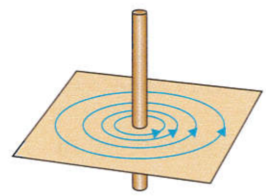
b force on the wire shown by an arrow pointing to the right

c force on the yoke is an arrow pointing to the left

3 $F = B \times I \times l = 0.2 \times 1.5 \times 0.12 = 0.036$ N

Page 142

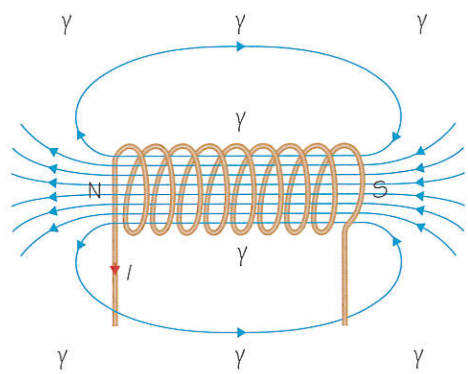
1 a



b You should explain that the spacing between circles increases with distance from the wire because the magnetic flux density decreases with distance from the wire. You should explain that the field lines need arrows to show the direction of the magnetic field. In this case, the field is anticlockwise as predicted by the right-hand grip rule.

2 a The letter X would have been better in the middle of the solenoid where the field lines are closest together and not diverging.

b Other places of low magnetic flux density are shown on the diagram:



c The magnetic field is **strong** because the lines are close together and **uniform** because the lines are straight, parallel and evenly spaced.

Page 143

1 (a) A force acts on the wire because the current in the wire and the magnetic field from the magnets are at right angles to each other. **(1)** The magnetic field around the wire interacts with the magnetic field between the magnets **(1)** to create a force between the wire and magnets. **(1)**

(b) There should be an upward arrow on the wire between X and Y (The battery shows that the current is moving around the circuit in a clockwise direction. Fleming's left-hand rule allows us to predict the direction of the force on the wire.)

(c) force on a conductor at right angles to a magnetic field carrying a current = magnetic flux density × current × length ($F = B \times I \times l$)

(d) increase the magnetic flux density (allow magnetic field strength) **(1)**; increase the current; increase the length of wire in the magnetic field **(1)**

Page 144

1 (a) $F = m \times g = 0.016 \times 10$ **(1)**

$F = 0.16$ **(1)** N **(1)**

(b) $F = B \times I \times l$ **(1)**

$B = \frac{F}{I} \times l = \frac{0.16}{3.2} \times 0.1$ **(1)**

$B = 0.5$ **(1)** T **(1)**

(c) (i) The balance reading would change by more than 16.0 g.

(ii) Placing the magnets closer together would increase the magnetic flux density, B, **(1)** which would increase the force of the wire acting on the yoke. **(1)**

Unit 5

Page 146

1 P represents the physical quantities of pressure and power.

V represents the physical quantities of volume, potential difference, and the unit, volt.

2

Distance/length metre	Time second	Energy joule
Power watt	Mass kilogram	Current ampere
Force newton	Potential difference volt	Pressure pascal

3 kg m/s (the unit of mass multiplied by the unit of velocity)

4 $a = \frac{F}{m}$

Page 147

1 a and b

A lamp has a current of 1.6 A flowing through it.

Calculate the charge that passes through the lamp in 25 s.

c I, Q, t d $Q = I \times t$ circled

e $Q = I \times t = 1.6 \times 25 = 40$ C

2 a $I = \frac{P}{V}$

b $I = \frac{P}{V} = \frac{2.4}{12} = 0.2$ A

Page 148

1 a volume = $0.1 \times 0.1 \times 0\ 1 = 0.001\ m^3$

b $D = \frac{m}{V} = \frac{2.7}{0.001} = \frac{2700\ kg}{m^3}$

2

Prefix name and symbol	Multiplier	Multiplier (standard form)
mega (M)	1000000	10^6
kilo (k)	1000	10^3
centi (c)	$\frac{1}{100}$	10^{-2}
milli (m)	$\frac{1}{1000}$	10^{-3}
micro (μ)	$\frac{1}{1000000}$	10^{-6}
nano (n)	$\frac{1}{1000000000}$	10^{-9}

3

145 m = 0.145 km	145 m = 14 500 cm	2440 mm = 2.44 m
97.7 MHz = 97 700 000 Hz	48 mV = 0.048 V	101 300 Pa = 101.3 kPa
2300 W = 2.3 kW		

4

Object	Distance	Time	Average speed
car	240 m	40 s	6 m/s
lizard	300 cm	15 s	20 cm/s
rocket	480 km	64 s	7.5 km/s

Page 149

1 B Choose the right equation and write it down.

E Calculate the answer and give the unit.

A Identify the physical quantities, making sure the units are SI units if needed.

D Put the numbers in.

C Rearrange the equation if needed.

2

Step	Calculation
Identify the physical quantities, making sure the units are SI units if needed	$\Delta Q = 6.25$ kJ = 6250 J; change in temperature ($\Delta\theta$) = 16 °C, specific heat capacity (c) = ?
Choose the right equation and write it down	$\Delta Q = m \times c \times \Delta\theta$
Rearrange the equation if needed	$c = \frac{\Delta Q}{m \times \Delta\theta}$
Put the numbers in	$c = \frac{6250}{1} \times 16$
Calculate the answer and give the unit	$c = 391$ J/kg °C

3 $u = 18$ m/s; $v = 28$ m/s; distance (s) = 1.15 km = 1150 m; acceleration = ?

$v^2 - u^2 = 2as$

$a = \frac{(v^2 - u^2)}{2s} = \frac{(28^2 - 18^2)}{(2 \times 1150)}$

$a = \frac{(784 - 324)}{2300} = 0.2\ m/s^2$

Page 150

1 a 0.50 kg; 50 W; 45 °C b 3 minutes

2 a Did not convert the time in minutes to seconds. Gave the answer without a unit.

b $E = P \times t = 50 \times (3 \times 60)$

$E = 9000\ J = \Delta Q$

c Although the student used the incorrect value for ΔQ, they chose the correct equation, rearranged it correctly, and calculated the answer correctly.

d $\Delta Q = m \times c \times \Delta\theta$

$c = \frac{\Delta Q}{m\ \Delta\theta} = \frac{9000}{0.5 \times 45} = 400$ J/kg °C

Page 151

1 (a) $E = I \times V \times t = 4 \times 8 \times 300$

$E = 9600$ J

(b) $\Delta Q = m \times L$

$L = \frac{\Delta Q}{m} = \frac{9600}{0.0343} = \frac{280000\ J}{kg}$

Page 152

1 (a) $P = I^2 R$

(b) $P = 5000^2 \times 2.7 = 25\,000\,000 \times 2.7$

$P = 67\,500\,000\,W = 67.5\,MW$

(c) $P = 2500^2 \times 2.7 = 6\,250\,000 \times 2.7$

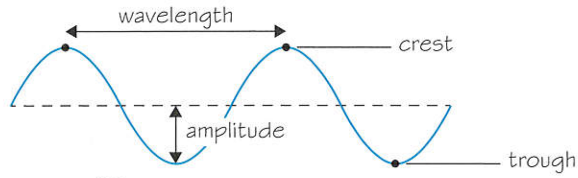
$P = 16\,875\,000 = 19.9\,MW$

The power loss in the second power line is one-quarter of the loss in the first power line.

Unit 6

Page 154

1



2 $v = \frac{x}{t} = \frac{0.5}{0.8} = 0.63\,m/s$

3 $v = f \times \lambda = 165 \times 2.0 = 330\,m/s$

4 a true b true c true d true e false

Page 155

1 incident; refracted; reflected; absorbed

2 B, D

3 reflected; refracted; absorbed; transmitted

Page 156

1 a true b true c false d true e false

2

	Gamma ray	X-ray	Ultra-violet	Visible light	Infrared	Micro-wave	Radio wave
filament lamp				✓	✓		
mobile phone						✓	(✓)
neon light				✓			
radioactive tracer	✓						

Note that satellite TV transmitters use microwaves, terrestrial (Earth-bound) TV transmitters use radio waves. Most modern mobile phones use microwaves, but some use radio waves.

3 refracted; reflected; absorbed

Page 157

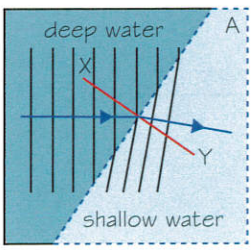
1 Deep water:

$\lambda = \frac{v}{f} = \frac{0.50}{2} = 0.25\,m$

Shallow water:

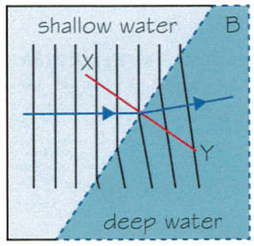
$\lambda = \frac{v}{f} = \frac{0.40}{2} = 0.20\,m$

2



3 a increase; normal

b and c



4 a true b false c true d true

Page 158

1 The amplitude should be measured from a crest or trough to the centre of the wave.

The wavelength has been measured from the top of the crest to the top of the next crest, but not accurately enough.

2 There are eleven crests so there are ten waves. The student has calculated the answer with eleven waves instead of ten.

3 a Stating the correct equation and putting the numbers in (even though the answer for the wavelength was calculated incorrectly in part (b)). Calculating the answer correctly using those numbers.

b No mark was given for the unit because the speed would be calculated in cm/s not m/s.

Page 159

1 (a) normal line

(b) The wavelength decreases.

The frequency stays the same.

The wave speed decreases.

(c) Some energy from the light ray is reflected away from the block at A.

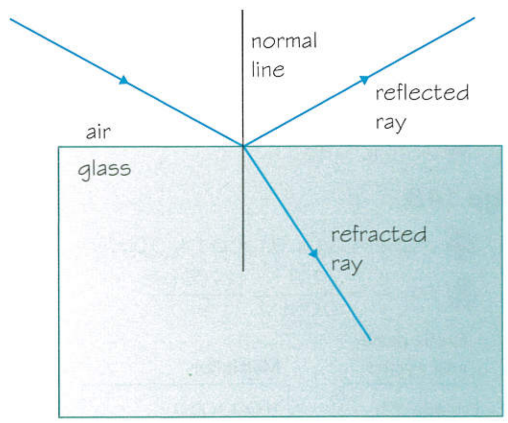
Some energy from the light ray is refracted inside the block at B.

Some energy from the light ray is absorbed by the glass.

Page 160

1 (a) Some energy is absorbed by the glass, the rest is transmitted by the glass.

(b)



(c) Snow absorbs very little / reflects most of the light energy from the Sun making it very bright to look at; the sunglasses or goggles absorb most of the energy from the reflected light making it much less bright for the skier.

Unit 7

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(1) (a) and (b)

Question parts

- Explain why this circuit could be used to measure resistance …
- Evaluate the use of radioisotopes such as iodine-131 …
- Describe an investigation a student …
- Compare and contrast the properties of water waves and sound waves.
- The current in the wire starts to slowly decrease when the circuit is left on. Suggest an explanation for why this reading changes.

Meaning

- Apply your knowledge and understanding to a new situation.
- Give similarities and differences between several things, not just one.
- Look at the information in the question and bring it together to make a decision and come to a conclusion with evidence from the question.
- Give an account of something, or link facts, information, events or processes in a logical order.
- Say how or why something happens – 'because' will be an important part of your answer.

Style of answer

- The current in the wire is causing it to heat up and so its resistance is increasing.
- Both water waves and sound waves need a medium to travel through. Water waves are transverse and sound waves are longitudinal.
- This circuit can be used to measure resistance because …
- Radioisotopes, such as iodine-131, may emit harmful gamma radiation but …
- Record the readings in a clear table and then plot a graph.

(2) 1, 4, 5; 2, 6, 3

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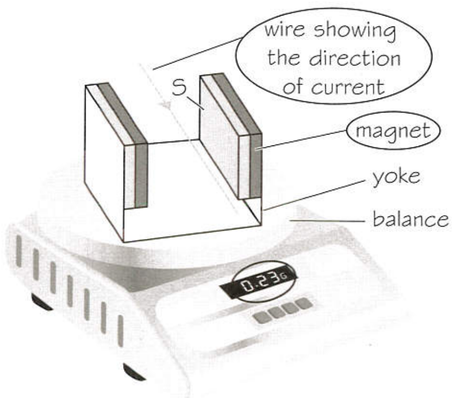
(1) (a) Explain. Say how or why something happens.

(b) A student placed two magnets with opposite poles facing on a top-pan balance. She zeroed the balance.

She clamped a horizontal wire between the poles of the magnets, so the wire could not move.

She passed an electric current through the wire.

She observed that the top-pan balance reading changes.



(c) why a force acts on the balance; how the force can be changed

(2) A, b; B, d; C, a; D, c; E, f; F, g; G, e

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(1) The motor effect

(2) 7, 5, 11, 4, 6, 9, 3, 8, 2, 10, 1

(3) There is a magnetic field created around the wire because there is an electric current in the wire.

There is a uniform magnetic field created between the magnets because the magnets have opposite poles facing. A force acts on the wire because the magnetic field from the wire interacts with the magnetic field from the magnets.

There is a force acting downwards on the magnets because there is a force acting upwards on the wire from Fleming's left-hand rule.

The force increases if the current in the wire increases because the force exerted by the magnetic field on the wire is directly proportional to the current in the wire.

The force increases if the magnets are placed closer together because the strength of the magnetic field increases and the force acting on the wire is directly proportional to the strength of the magnetic field.

The force changes direction if the current in the wire changes direction because the direction of the force depends on the direction of the current and the magnetic field. It can be predicted by Fleming's left-hand rule.

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(1) (a) air-glass boundary; inside the glass block; glass-air boundary

(b) reflection; refraction; absorption; transmission

(2) Reflection and refraction; Absorption and emission of wave energy; The law of conservation of energy

(3) (a)

Region	Reflection	Refraction	Absorption	Transmission
air-glass boundary	some energy is reflected	most energy is refracted		
inside the glass block			some energy is absorbed	most energy is transmitted
glass-air boundary	some energy is reflected	most energy is refracted		

(b) As the ray of light passes through the glass block, some light energy is absorbed but the remaining light energy is transmitted by the block because all energy from the ray inside the block must be absorbed or transmitted.

As the ray of light reaches the glass-air boundary, some light energy is reflected internally but the remaining light energy is refracted at the surface and leaves the block because all energy from the ray must be refracted or reflected.

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1. These ideas are **not** needed: Which materials are good electrical conductors and which are insulators; The factors which affect the size of the force on a current-carrying wire; Which materials are magnetic and which are not.
2. This information is **not** relevant to the question: Copper is a good conductor but is not normally magnetic; If you make the current in the rod larger then the reading on the balance will change more because there will be an even larger force because of the equation $F = B \times I \times l$.
3. a This magnetic rod is then affecting the magnets because there is a force whenever two magnets are placed near to each other because of their magnetic fields.

   The magnets act to repel each other so the rod is pushed away from the permanent magnets.

   b When magnets put a force on the rod it is the same force that pushes back on the magnets and then the top-pan balance.
4. The current in the rod creates a circular magnetic field around it. This field interacts with the field from the magnets to produce a pair of forces acting in opposite directions on the rod and the magnets. The direction of the force from the frame on the rod is determined using Fleming's left-hand rule and is downwards. The rod is prevented from moving as it is clamped, so it exerts an equal and opposite upward force on the frame holding the magnets. There is a reduced resultant force on the balance from the frame, which decreases the balance reading.

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1. Explain
2. very high potential differences are used to transfer electrical power in overhead power cables; lower potential differences are used in houses
3. To transmit a large power, the current must be high or the voltage must be high (or both).
4. Use low resistances or low currents (or both).
5. A high voltage will allow a large power without a large heating effect in the overhead cable.
6. Explain power losses in cables using $P = I^2 \times R$.

   Need for transmission at high voltage.

   Need for lower voltage in homes for safety reasons.
7. Answer could include the following points in a logical order for 6 marks:

   The overhead power cables waste power because of electrical heating. To reduce this waste, a high voltage can be used because this allows the same power to be transmitted with a much lower current (from $P = I \times V$). This lower current means there is a lot less power wasted due to electrical heating in the cable (from $P = I^2 \times R$).

   High potential differences are very dangerous as they can cause a current to pass through you and electrocute you from a distance. A much lower p.d. of 230 V is a lot safer.

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1 Answer could include the following points in a logical order for 6 marks:

Both electromagnetic waves and sound waves transfer energy from the wave source to the surroundings. Both can be reflected or absorbed by a surface. Both electromagnetic waves and sound waves can be refracted at a boundary if they change speed. They both have different wavelengths and frequencies, which are related by wave speed = frequency × wavelength.

Electromagnetic waves can travel through a vacuum, but sound waves need a material to travel through. Electromagnetic waves are transverse waves, but sound waves are longitudinal waves. Electromagnetic waves are very fast, but sound waves are about a million times slower. Some electromagnetic waves can cause ionisation, but sound waves cannot.