Answers

All exam-style questions and sample answers in this title were written by the authors.
In examinations, the way marks are awarded may be different.

Chapter 1

Practice question 1

The time taken to travel down the ramp: s
The length of the ramp: m
The mass of the trolley: kg

Practice question 2

$$\text{cross-sectional area} = \frac{50}{10\,000}\,\text{m}^2$$

$$\text{volume} = \frac{50}{10\,000}\,\text{m}^2 \times 3000\,\text{m}$$
$$= 15\,\text{m}^3$$

Practice question 3

Variable	Symbol for the variable	Name of unit	Symbol for unit
resistance	R	ohm	Ω
potential difference	V	volt	V
current	I	amp (or ampere)	A

Practice question 4

Row A
[v is the symbol for speed; centimetres are a sensible unit of measurement when using a ruler; d is a symbol for distance; t is the symbol for time.]

Practice question 5

a

Variable	Symbol for the variable	Name of unit	Symbol of unit
potential difference	V	volt	V
number of primary turns	N_1 or N_p	none	–
number of secondary turns	N_2 or N_s	none	–
power	P	watt	W
current	I	amp (or ampere)	A
energy	E	joule	J

b The expression for efficiency is a ratio of two values of power, so there are no units for efficiency. The % sign shows that the answer is a number of parts in one hundred.

Practice question 6

a 5
b 8
c 9
d 0
(Thousandths are the third figure after the decimal point.)

Practice question 7

a Line B
Arranging the numbers like this makes the sequence more obvious.

		6	.	0	1	5	4
		6	.	1	0	6	
	6	6	.	8	5	1	
	6	8	.	1	0	5	
6	6	0	.	8	5		
6	8	6	.	5	0	1	

b 660.85 W 686.501 W Microwaves cookers use significant amounts of energy.
c 6.0154 W 6.106 W Mobile phones use a small amount of energy.

Practice question 8

$$\text{to } \frac{1}{10\,000}\text{th of a degree Celsius}$$

Practice question 9

C
[A shows 4 sf. B shows 2 sf. D shows 2 sf.]

Practice question 10

a 9.8 m/s^2
b 10 m/s^2
[These values are often used in physics calculations when you see the symbol g. Normally you will be advised how many significant figures to use.]

Practice question 11

D
[The number has been rounded using the rounding rules shown in the flow chart.]

Practice question 12

a 5.6752×10^4
b $2.533\,12 \times 10^2$
c 1.0005×10^3
d 6×10^{-2}
e 4.46×10^{-4}

Practice question 13

a 8850 m
b 0.000 84 m
c 0.000 000 000 065 m
d 1 496 000 km

Practice question 14

1.20×10^6 V

Practice question 15

$1\,\mu m = 10^{-6}$ m
$1\,nm = 10^{-9}$ m
Therefore there are 1000 or 10^3 nm in 1 µm.

Practice question 16

a $5\,kW = 5 \times 10^3$ W
b $12\,ms = 1.2 \times 10^{-2}$ s
c $23\,M\Omega = 2.3 \times 10^7\,\Omega$
d $0.8\,\mu C = 8 \times 10^{-7}$ C
e $475\,nm = 4.75 \times 10^{-7}$ m

Practice question 17

1 mm is 1.0×10^{-3}.
As mm^3 is in three dimensions, the conversion factor needs to be applied three times, i.e. $10^{-3} \times 10^{-3} \times 10^{-3}$.
Therefore 1 mm^3 is 1.0×10^{-9} m^3.
35 mm^3 is 35×10^{-9} m^3.
Change to standard form:
$35\,mm^3 = 3.5 \times 10^{-8}\,m^3$

Practice question 18

$1500\,mA = 1.5\,A$
$V = 1.5\,A \times 2.0 \times 10^2\,\Omega$
$V = 3 \times 10^2$ V

Practice question 19

$$\text{Wavelength} = \frac{3.0 \times 10^8\,\text{m/s}}{500 \times 10^6\,\text{Hz}}$$
$$= \frac{3.0 \times 10^8\,\text{m/s}}{5.0 \times 10^8\,\text{Hz}}$$
$$= 0.6\,\text{m}$$
$$= 6.0 \times 10^{-1}\,\text{m}$$

Practice question 20

B [Picture each distance in your head and imagine the cheetah travelling this distance in one second. A cheetah can cover 30 metres every second. The other values are unrealistic for a maximum.]

Practice question 21

Round mass to: 1×10^4 kg
Convert mass to weight, giving: force = 10×10^4 N
Round 1490 cm^2 to 1500 cm^2.
1500 $cm^2 = 1.5 \times 10^3$ cm^2
Convert 1.5×10^3 cm^2 to m^2 (because Pa = N/m^2).
1 $cm^2 = 1.0 \times 10^{-4}$ m^2
Therefore 1.5×10^3 cm^2 is $1.5 \times 10^3 \times 1.0 \times 10^{-4}$ m^2,
i.e. 0.15 m^2.
Applying this to the formula:

$$\text{Pressure} = \frac{10 \times 10^4}{0.15}$$

$= 6.66\ldots \times 10^5$ Pa
which is of order of magnitude 10^6 Pa.

Practice question 22

Approximating the given values to 1 sf:

$$800\,\text{km/hour} = \frac{\text{distance (km)}}{20\ \text{hours}}$$

distance = 800 km/h × 20 hours
= 16 000 km or 2×10^4 km (1 sf)

Further questions

1 A
2 **a** $10\,000\,\Omega + 200\,\Omega + 30\,000\,\Omega = 40\,200\,\Omega$
Total resistance = $4.02 \times 10^4\ \Omega$
b $V = IR$
$V = 2 \times 10^{-2} \times 10^{-3}\,A \times 4.02 \times 10^4\,\Omega$
$V = 0.80$ V

Chapter 2

Practice question 1

Independent variable: distance – continuous, quantitative
Dependent variable: time – continuous, quantitative
Distance: a trundle wheel (a distance measuring wheel) or a long tape measure
Time: a stopwatch

Practice question 2

Independent variable: core material – qualitative
Dependent variable: strength – quantitative, continuous
Control variable: current

Practice question 3

a B
b Make the tube containing the coloured liquid thinner.

Practice question 4

a Read the value when no weight added, from the first diagram, then deduct this value from the reading from the second diagram.
b 1.6 N – 0.2 N = 1.4 N
c Adjust the barrel of the newtonmeter first, so that the reading on the scale is zero with no force applied.

Practice question 5

a 0.72 V **b** 0.2 V **c** 0.16 V **d** 0.96 V

Practice question 6

a

Time / m	Temperature of black can / ° C	Temperature of shiny can / ° C
0		
4		
8		
12		
16		
20		

[Accept 2-minute intervals.]
[Note: maintaining a constant ambient temperature while repeating the experiment would be challenging for this length of time, so repeating this experiment would probably be impracticable.]

b The temperature of the surroundings is a variable that needs to be controlled.

Practice question 7

[Note that the current value is only given to show that it was controlled, i.e. kept constant. If it is not shown in the results table it needs to be recorded somewhere in the results section of the experimental write up.]

Current / A	Number of coils	First reading force / N	Second reading force / N	Third reading force / N	Mean (average) reading force / N
	0				
	5				
	10				
	15				
	20				

[Number of coils could be 0, 4, 8, 12, 16, 20.]

Practice question 8

p.d. V / V	First current reading I / A	Second current reading I / A	Third current reading I / A	Mean (average) current reading I / A	Resistance $R = \frac{V}{I}$ / Ω
0.5	0.08	0.09	0.08	0.09	5.6
1.0	0.19	0.19	0.20	0.19	5.3
1.5	0.29	0.27	0.28	0.28	5.4

The best value of the resistance is the mean value of $R = \frac{5.6 + 5.3 + 5.4}{3} = 5.4\,\Omega$

Practice question 9

Time / hours	Activity counts/minute	Background count counts/minute	Net activity counts/minute
1	560	16	560
2	290	16	274
3	152	16	136
4	82	16	66
5	50	16	34

Practice question 10

Mass / kg of A	0.75	0.75
Velocity / m/s of A	2.30	1.80
Momentum / kg m/s of A	1.73	1.35
Mass/ kg of B	0.75	0.75
Velocity / m/s of B	−2.40	−1.70
Momentum / kg m/s of B	−1.80	−1.28
Momentum / kg m/s of A + B	−0.07	+0.07

Conclusion
Within the tolerances of the readings taken:
total momentum before the collision = total momentum after the collision (= 0)

Practice question 11

D [This statement is related to the timing of the release of the ball. When the ruler is not vertical the height is too large. Parallax errors are caused when the eye is not directly opposite the reading. Balls bounce very quickly making it difficult to judge precisely the height reached. Therefore, in these circumstances, the metre rule can only be used to measure to the nearest centimetre.]

Practice question 12

The half-life, the time taken for half of the material to decay, should be consistent throughout the curve.
For the solid curve, the half-life can be estimated as follows:

- Time taken for 100 counts / minute to become 50 is 25 – 18.5 = 6.5 hours
- Time taken for 50 counts / minute to become 25 is 30 – 25 = 5 hours
- Time taken for 25 counts/ minute to become 12.5 is 36 – 30 = 6 hours

The mean (average) half-life is 7 hours.
Using the curve through point A, the time taken for the count rate to change from 250 counts / minute to 125 counts / minute is: 16 – 6 = 10 hours
Using the curve through point B, the time taken for the count rate to change from 200 to 100 is: 18.5 – 12.0 = 6.5 hours
Therefore, the curve through B is the correct curve and point A is an outlier.
Possible reason: First readings should always be treated with caution, as often the experimenters have not practised taking readings and so errors occur. This is especially noticeable when timing is involved.

Further questions

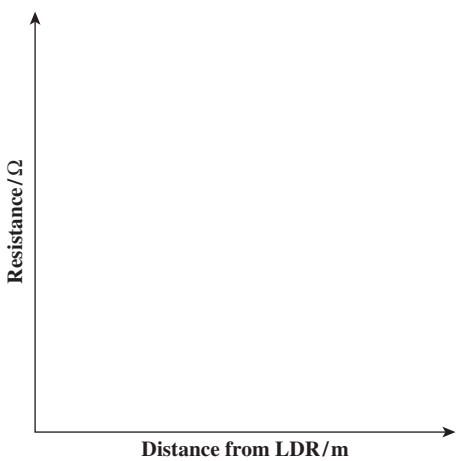
1 The first reading is anomalous and can be ignored. No one has ever run 100 m in 8 seconds. It is likely that the student was late pressing the start button on the stopwatch.
The mean (or average) value of the other readings is 10.8 s.

2 **B**

Chapter 3

Practice question 1

a

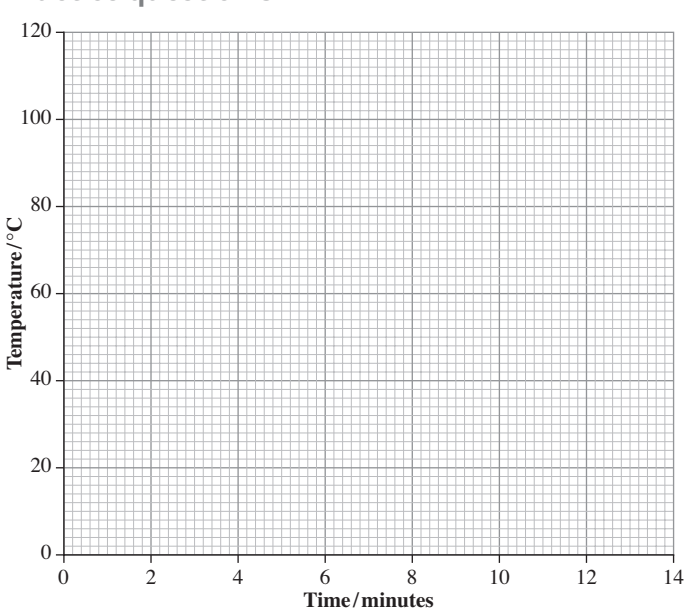


b The distance from the light source is the independent variable and therefore plotted on the *x*-axis.
The resistance is the dependent variable and hence plotted on the *y*-axis. Units need to be added to each variable.

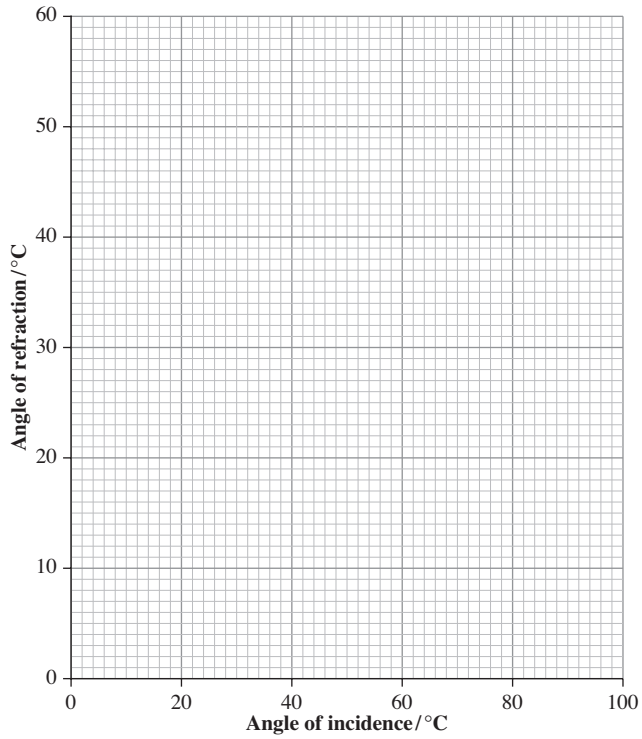
Practice question 2

A [The passage of time is the independent variable.]

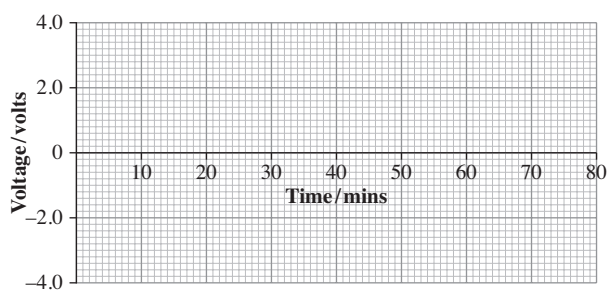
Practice question 3



Practice question 4

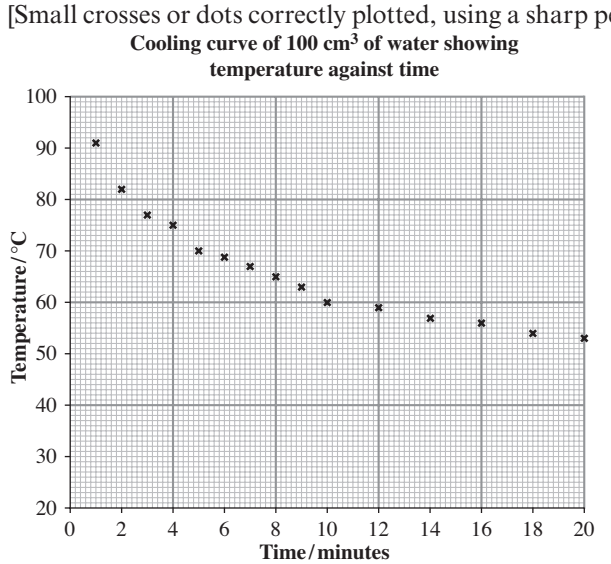


Practice question 5



Practice question 6

[Small crosses or dots correctly plotted, using a sharp pencil]



Practice question 7

Examples:
Should the line go through the origin?
Do the data points seem to form a curve or a straight line?
Are there any outliers that I should ignore?
If I draw the line or curve like this, are there as many points below the line as above it?
Are the points that are above and below the line roughly evenly spaced along the line?
Am I sure this is the best estimate of the trend?

Practice question 8

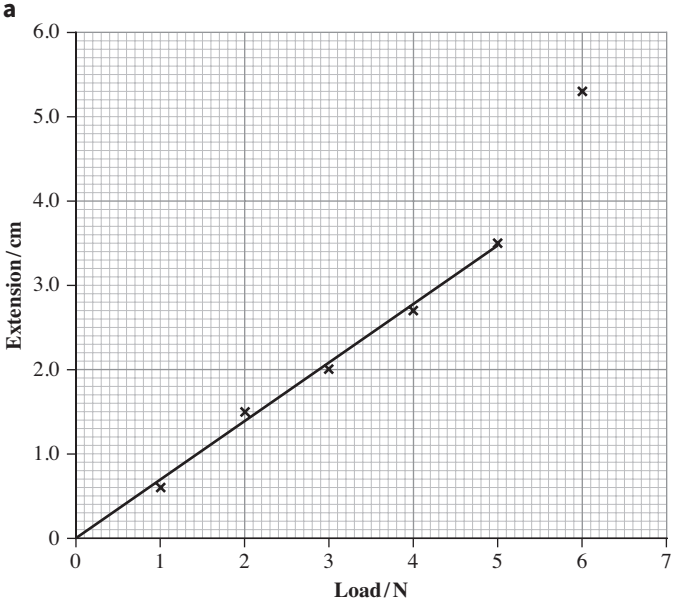
a B [Although the curve does not touch every data point this is the best estimate. In A the drawn line is not smooth. Unless there is a reason to believe otherwise, in physics it is best to assume that changes are gradual and curves should be smoothly drawn. In C there is no evidence for the rise at the end of the curve. In D the feathering of the lines leads to uncertainty and so to inaccuracies.]

b C

Reason: In this region (low volume, high pressure) the data is changing rapidly as shown by the steeply falling graph. More readings would improve the accuracy of the data plot.

Practice question 9

a

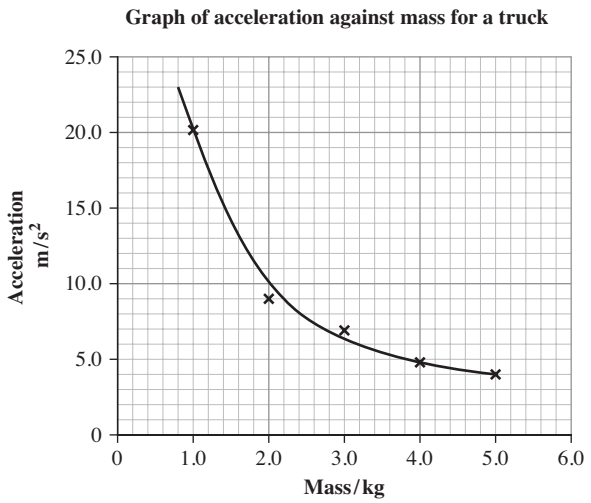


[The graph is a straight line and should pass through the origin, demonstrating Hooke's law.]

b The final point shows the spring has been stretched beyond its elastic limit.
Or, the final point could be an outlier and some repeat data should be taken to check.
In either case, the point should be ignored when determining the position of the straight line.

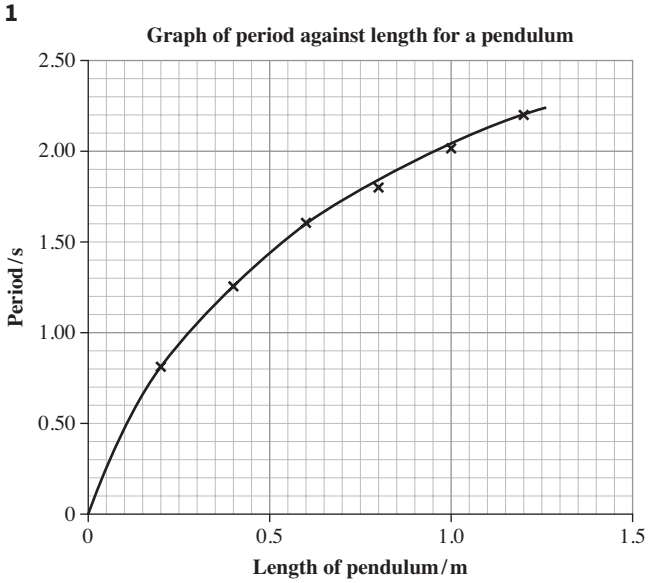
Practice question 10

[The line should be a curve, smoothly drawn, with equal number of points above and below the curve.]



Further questions

1



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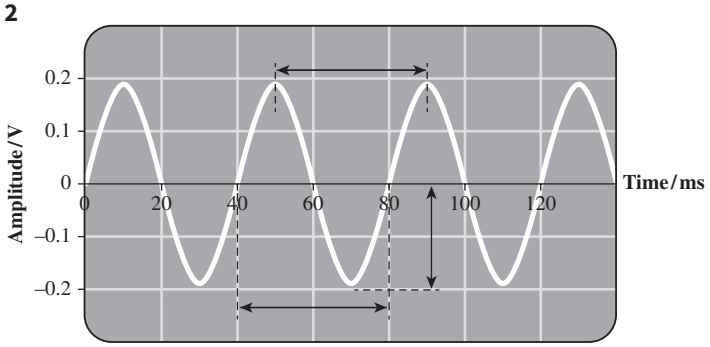


Chapter 4

Practice question 1

2.9 s [allow 2.8 s or 3.0 s; this is the point at which the graph becomes linear.]

Practice question 2

18.4 m/s

Practice question 3

24.9 mph (accept 25 mph)

Practice question 4

4600 Pa

Practice question 5

The speed is directly proportional to time. (For each period of time passing, the speed increases evenly and the line goes through the origin.)

Practice question 6

C

Practice question 7

a gradient, $m = \frac{(8 - 0) \times 10^{-3}}{2 - 0}$ A/V

$m = \frac{8 \times 10^{-3}}{2}$ A/V

$m = 4 \times 10^{-3}$ A/V

b intercept, $c = 0$

c Use $y = mx + c$, giving $I = 4 \times 10^{-3}V$, where I is in A and V is in V.

Practice question 8

a gradient $m = \frac{300 - 100}{60 - 0}$ m/s

$m = \frac{200}{60}$ m/s

$= 3.3$ m/s

intercept $c = 100$ m

equation, using $y = mx + c$, is $d = 3.3\ t + 100$, where d is in m and t is in s

b The value of the gradient tells us that the speed of the object was 3.3 m/s, constant for the journey.

c The value of the intercept tells us the object was 100 m from the start position when timing started.

Practice question 9

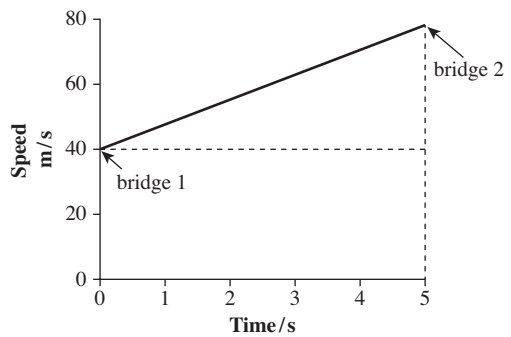
a The new station needs to be 6.5 m from station A.

b The faster train is Q; it covers 20 km in $\frac{1}{2}$ an hour (speed 40 km/h), whereas train P covers 20 km in 1 hour (speed 20 km/h).

Practice question 10

27 N

Practice question 11



area of rectangle = 40 m/s × 5 s
= 200 m

area of triangle = $\frac{1}{2}$ × 5 s × (80 – 40) m/s
= $\frac{1}{2}$ × 5 s × 40 m/s
= 100 m

total distance between bridges = 200 m + 100 m
= 300 m

Practice question 12

'Accelerates uniformly' means that the line on the speed–time graph is straight with a constant gradient.
distance travelled = area under line
distance travelled = $\frac{1}{2}$ × base × height
100 m = $\frac{1}{2}$ × 20 s × final speed
100 m = 10 s × final speed
final speed = 10 m/s

Practice question 13

i B [When braking the speed decreases slowly at the beginning and then very quickly.]

ii D [The graph shows that the speed is zero at the start (as the car is parked). The final speed is a horizontal line indicating a constant speed has been reached.]

iii A [Uniform deceleration means the speed goes down evenly.]

iv C [The horizontal line going through the velocity axis shows at the start the rocket is travelling at speed. The upward slope indicates acceleration.]

Practice question 14

a As the cross-sectional area *increases* the resistance of the wire *decreases.*
As $\frac{1}{\text{cross-sectional area}}$ *increases* the resistance of the wire *increases.*

b The graph in Figure 4.31 has a straight line which goes through the origin. There is sufficient evidence.

c The gradient k of the graph in Figure 4.31 is found by taking two convenient numbers as far apart as possible.
gradient = $\frac{\text{change in } y}{\text{change in } x}$
gradient = $\frac{7.8 - 2.6}{30 - 10}\ \Omega\,\text{mm}^2$
= $0.26\ \Omega\,\text{mm}^2$
Therefore by comparing to $y = mx + c$:
resistance = $\frac{0.26}{\text{cross-sectional area}}$
where resistance is in Ω and cross-sectional area is in mm^2.

Practice question 15

a 2.2 m

b 2.2 m

c Point labelled F near 9 hours or 21 hours

d Point labelled S at any peak or trough

Practice question 16

Gas: 75.5 TWh × (41.3/100) = 31.2 TWh to 3 sf
Renewables: 75.5 TWh × (29.8/100) = 22.5 TWh to 3 sf

Practice question 17

Material	Density / g/cm³	Mass / g = Density / g/cm³ × volume / cm³
mercury	13.6	**4760**
copper	9.0	**3150**
iron	8.0	**2800**
aluminium	2.6	**910**

Further questions

1 B

2 **a** power = 2700 × length , or $P = 2700l$, where power P is in W and length l is in metres

b 1350 W [accept 1300 to 1400 W]

c Any straight line with a lower gradient

3 A; The outside air has the biggest temperature range.
C; High thermal capacity materials either limit the temperature range or cause the biggest time lag.
[Accept either.]
44 °C – –6 °C = 50 °C

Chapter 5

Practice question 1

a distance = 85 m × 2 = 170 m

b $\text{speed} = \frac{\text{distance}}{\text{time}}$

$\text{speed} = \frac{85\,\text{m} \times 2}{0.5\,\text{s}}$

speed = 340 m/s

Practice question 2

a volume = 2 cm × 3 cm × 5 cm
= 30 cm^3

$\text{density} = \frac{\text{mass}}{\text{volume}}$

$\text{density} = \frac{270\,\text{g}}{30\,\text{cm}^3}$

= 9 g/cm^3

b The object will sink, because the density of water is 1 g/cm^3.

Practice question 3

a $\text{KE} = \frac{1}{2}mv^2$

$\text{KE} = \frac{1}{2}$ 8000 kg × 33 m/s × 33 m/s

= 4 356 000 J
= 4.4 × 10^6 J to 2 sf

b 1.7 × 10^7 J [When the speed is doubled, the kinetic energy is quadrupled.]

Practice question 4

	Percentage	Decimal
4 m as a percentage of 20 m	$\frac{4}{20} \times 100 = 20\,\%$	0.2
12 minutes as a percentage of 60 minutes	$\frac{12}{60} \times 100 = 20\,\%$	0.2
1250 cm^3 of a liquid as a percentage of 2000 cm^3 of liquid	$\frac{1250}{2000} \times 100 = 62.5\,\%$	0.625
35 g as a percentage of 805 g	$\frac{35}{805} \times 100 = 4.3\,\%$	0.043

Practice question 5

87.5 %

Find the % of useful energy first. $\frac{45\,\text{J}}{360\,\text{J}} \times 100 = 12.5\,\%$

Subtract this value from 100% to find the wasted percentage: 100 % − 12.5 % = 87.5 %

Practice question 6

The weight is the downward force: $W = mg$

$W = 60\,\text{kg} \times 10\,\text{N/kg}$

$W = 600\,\text{N}$

$P = \frac{F}{A}$

$P = \frac{600\,N}{2.5\,\text{m}^2}$

$P = 240\,\text{Pa}$ $\quad (1\,\text{N/m}^2 = 1\,\text{Pa})$

Practice question 7

a $P = IV$

$P = 20\,000\,\text{A} \times 25\,000\,\text{V}$

$P = 500\,000\,000\,\text{W}$ or 500 MW

b $\frac{\text{power out}}{\text{power in}} \times 100$ = efficiency as a percentage

$\frac{500\,\text{MW}}{\text{power in}} \times 100 = 37\,\%$

$\text{power in} = \frac{500\,\text{MW} \times 100}{37}$

power in = 1350 MW to 3 sf

Practice question 8

$\frac{V_\text{p}}{V_\text{s}} = \frac{N_\text{p}}{N_\text{s}}$

$\frac{11\,000\,V}{132\,000\,V} = \frac{1000}{N_\text{s}}$

$N_\text{s} = \frac{132\,000\,\text{V} \times 1000}{11\,000\,\text{V}}$

$N_\text{s} = 12\,000$

Practice question 9

Refractive index, $n = \frac{\sin i}{\sin r}$

For diamond, $n = \frac{\sin 20.0}{\sin 8.2}$

= 2.398

If the crystal is diamond, $\sin A = \frac{\sin 10}{2.398}$

$\sin A = 0.0724$

$A = \sin^{-1} 0.0724$

$A = 4.15°$

$A = 4.2°$ to 2 sf

Practice question 10

a $W = mg$

$W = 95\,\text{kg} \times 10\ \text{N/kg}$

$W = 950\,\text{N}$

b $W = 95\,\text{kg} \times 0.6\,\text{N/kg}$

$W = 57\,\text{N}$

c $1235\,\text{N} = 75\,\text{kg} \times g$

$g = 13\,\text{N/kg}$

Practice question 11

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

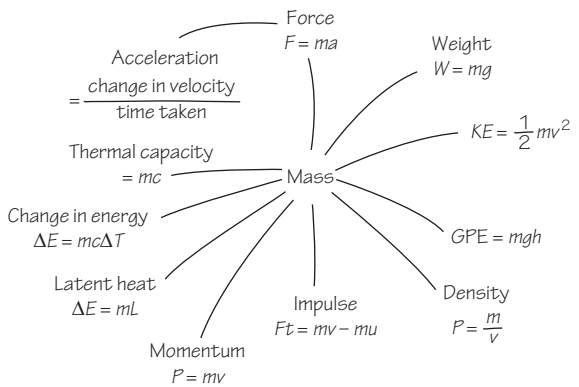
$R = \frac{12\,\text{V}}{0.4 \times 10^{-3}\,\text{A}}$

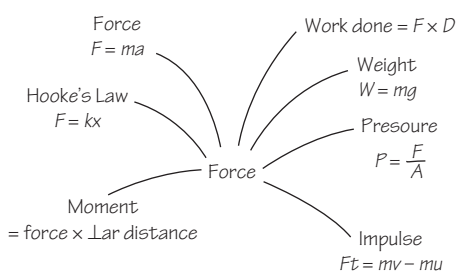
$R = 30\,000\,\Omega$ or $30\,\text{k}\Omega$

The information is correct.

Practice question 12

Possible diagrams:





Practice question 13

a $P = IV$

$1.0 \times 10^{-4}\,\text{W} = \text{I} \times 1.5\,\text{V}$

$I = \frac{1.0 \times 10^{-4}\,\text{W}}{1.5\,\text{V}}$

$I = 6.6 \times 10^{-5}\,\text{A}$

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

$R = \frac{1.5\,\text{V}}{6.6 \times 10^{-5}\,\text{A}}$

$R = 2.3 \times 10^{-4}\,\Omega$

c $P = \frac{\Delta E}{t}$

$1.0 \times 10^{-4}\,\text{W} = \frac{\Delta E}{2.6 \times 10^{-7}}$

$\Delta E = 1.0 \times 10^{-4}\,\text{W} \times 2.6 \times 10^{-7}\,\text{s}$

$\Delta E = 2.6 \times 10^{-11}\,\text{J}$

Practice question 14

$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_{12}} = \frac{1}{5\,\Omega} + \frac{1}{10\,\Omega}$

$\frac{1}{R_{12}} = \frac{15}{50\,\Omega}$

$R_{12} = \frac{50}{15\,\Omega}$

$R_{12} = 3.3\Omega$

$\frac{1}{R_{34}} = \frac{1}{R_3} + \frac{1}{R_4}$

$\frac{1}{R_{34}} = \frac{1}{20\,\Omega} + \frac{1}{5\,\Omega}$

$\frac{1}{R_{34}} = \frac{5}{20\,\Omega}$

$R_{34} = 4\Omega$

$R_\text{T} = R_{12} + R_{34}$

$R_\text{T} = 7.3\,\Omega$

Practice question 15

D

$R_\text{T} = \frac{V}{I}$

$R_\text{T} = \frac{36\,\text{V}}{4 \times 10^{-3}\,\text{A}}$

$R_\text{T} = 9000\,\Omega$

$\frac{1}{R_\text{T}} = \frac{1}{R_\text{A}} + \frac{1}{R_\text{B}}$

$\frac{1}{9000\,\Omega} = \frac{1}{90\,000\,\Omega} + \frac{1}{R_\text{B}}$

$R_\text{B} = \frac{10^{-1}}{90\,000}\Omega$

Practice question 16

anticlockwise moment = clockwise moment

$10\,000 \times 5 =$ force $\times 25$

force = 2000 N

[This is the maximum weight that can be lifted (because the balancing weight is at the end of the jib).]

Practice question 17

a Momentum before = momentum after
$m_1u_1 + m_2u_2 = (m_1 + m_2)v_{1+2}$
$10\,\text{kg} \times 20\,\text{m/s} + -11\,\text{kg} \times 5\,\text{m/s} = 31\,\text{kg} \times v_{1+2}$
$v_{1+2} = \frac{145}{3}\,\text{m/s}$
$v_{1+2} = 4.7\,\text{m/s}$

b They move in the direction of the 10 kg mass.

Practice question 18

$Ft = mv$
$F \times 2\,\text{s} = 1.6 \times 10^{-3}\,\text{kg} \times 5.0\,\text{m/s}$
$F = 4 \times 10^{-3}\,\text{N}$

Practice question 19

$^{222}_{86}\text{Rn} \rightarrow {}^{218}_{84}\text{Po} + {}^{4}_{2}\text{He}$

Practice question 20

$^{14}_{6}\text{C} \rightarrow {}^{14}_{7}\text{N} + {}^{0}_{-1}\text{e}$

Practice question 21

a $^{94}_{50}\text{S}$

b $^{99}_{51}\text{T}$

c $^{98}_{52}\text{P} \rightarrow {}^{94}_{50}\text{S} + {}^{4}_{2}\text{He}$

d $^{99}_{51}\text{T} \rightarrow {}^{99}_{52}\text{Q} + {}^{0}_{-1}\text{e}$

Practice question 22

A

Practice question 23

The time between 7.00 am and 7 pm is 2 half-lives. Each half-life going back from 7.00 pm to 7.00 am doubles the count rate. 30 doubled twice is 120 counts/s.

Practice question 24

C
[Reduced by 50% after 7.5 h; reduced by 50% of this, or by a further 25% of the original, after 2 × 7.5 = 15 h]

Further questions

1 $2.3 \times 10^{-23}\,\text{N}$
$F = ma \quad F = 9.1 \times 10^{-31}\,\text{kg} \times \frac{2.3 \times 10^{-3}\,\text{m/s}}{1.0 \times 10^{-14}\,\text{s}}$

2 199 m/s
2 bullets each have the same kinetic energy
Total KE = $2 \times \frac{1}{2}mv^2$
Thermal energy = mcT =
KE lost = thermal energy gained
$2 \times \frac{1}{2}mv^2 = mcT$
$v^2 = cT \qquad T = 327 - 23 = 304$
$v = \sqrt{(130 \times 304)}\,\text{m/s}$
v= 199 m/s

3 In equilibrium $F_1 + F_2 = 15\,\text{N} \qquad F_1 = 15\,\text{N} - F_2$
Choose which pivot to take moments about.
Anticlockwise moment = $F_2 \times 0.45$
Clockwise moment = $F_1 \times 0.5\,\text{m}$
$F_2 \times 0.45\,\text{m} = F_1 \times 0.5\,\text{m}$
$F_2 \times 0.45\,\text{m} = (15\,\text{N} - F_2) \times 0.5\,\text{m}$
$F_2 = \frac{0.5\,\text{m} \times (15\,\text{N} - 0.5F_2)}{0.45\,\text{m}}$
$F_2 = \frac{7.5\,\text{Nm}}{0.45\,\text{m}} - \frac{0.5\,\text{m}\,F_2}{0.45\,\text{m}}$
$F_2 = 16.7\,\text{N} - 1.11\,F_2$
$1.11\,F_2 = 16.7\,\text{N}$
$F_2 = 7.9\,\text{N}$
$15 = F_1 + F_2$
$F_1 = 7.1\,\text{N}$

4 $2.3 \times 10^{-23}\,\text{N}$

5 $3.9 \times 10^{5}\,\text{Pa}$

6 420 Ns

Chapter 6

Practice question 1

B
[Diagonals are straight lines joining two opposite corners of a square, rectangle, or other straight-sided shape.]

Practice question 2

The picture shows a sideways version of the wheel rolling. The dotted circle shows the wheel after the first revolution. This diagram is read from left to right. The total distance for two circumferences is 12 – 1 cm = 11 cm. Therefore one circumference is 11 cm.

Practice question 3

a volume = length × breadth × height
$2.5\,\text{m} \times 2.0\,\text{m} \times 3.0\,\text{m} = 15\,\text{m}^3$

b B
[Heat is lost from the surface. So it is the largest surface ($2.5\,\text{m} \times 3.0\,\text{m} = 7.5\,\text{m}^2$) that will lose the most heat.]

Practice question 4

B

A: area of contact = 3.0 cm × 4.0 cm
= 12.0 cm²

$$\rho = \frac{F}{A}$$

$$\rho = \frac{240}{12}$$

$\rho = 20\ \text{g/cm}^2$

B: area of contact = 3.14 × 4.0 cm²
= 12.6 cm²

$$\rho = \frac{240}{12.6}$$

$\rho = 19\ \text{g/cm}^2$

C: area of contact = $\frac{1}{2}$ × 4.0 cm × 6.0 cm
=12 cm²

$$\rho = \frac{240}{12}$$

$\rho = 20\ \text{g/cm}^2$

Practice question 5

Normal line added at 90° to mirror, labelled N; angle of reflection drawn at 20°, correct to ±1°

Practice question 6

B

Practice question 7

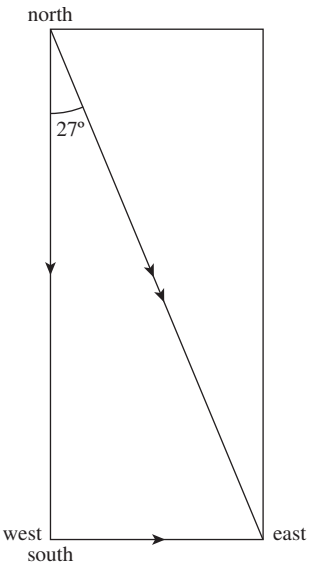
Physical quantity	Vector or scalar
Time taken for a ball to bounce	Scalar
Distance travelled by a car on a journey	Scalar
The change in velocity of a person on a zip wire	Vector
The pressure inside a bicycle inner tube	Scalar
The acceleration of free fall	Vector
The kinetic energy of an aeroplane	Scalar

Practice question 8

C

Practice question 9

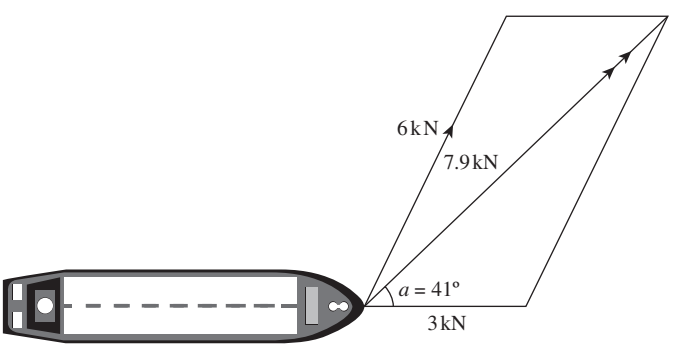
A suitable scale is 1 cm = 1000 N. The resultant line is 13 cm long.
Resultant force = 13 000 N in a direction
180° – 27° = 153° (±1°) from north, or north 153° (±1°) south



Further questions

1 volume of a cylinder = $\pi r^2 h$
volume of space = 3.14 × (1.8 m)² × 1.75 m
= 17.8 m³

2



Resultant force = 7.9 (±1) kN at an angle of 41 (±1)° to the original forward direction

Additional questions involving several maths skills

1 C

2 **a**

$$P = \frac{F}{A}$$

$F = mg$

$F = (4\ \text{kg} + 41\ \text{kg}) \times 10\ \text{N/kg}$

$F = 450\ \text{N}$

Area = 2.5 cm² × 3

Area = 7.5 cm²

$$P = \frac{F}{A}$$

$$P = \frac{450\ \text{N}}{7.5\ \text{cm}^2}$$

$P = 60\ \text{N/cm}^2$

b New area = $2 \times 2.5\,\text{cm}^2$

New area = $5\,\text{cm}^2$

$$\text{New pressure} = \frac{450\,\text{N}}{5\,\text{cm}^2}$$

New pressure = $90\,\text{N/cm}^2$

3 A is correct.

When balanced: anticlockwise moment = clockwise moment

Anticlockwise moment = force × perpendicular distance from pivot

= $30\,\text{N} \times 0.4\,\text{m}$

= $12\,\text{Nm}$

Clockwise moment = $15\,\text{N} \times 0.2\,\text{m}$

= $3\,\text{Nm}$

Therefore an additional moment of 9 Nm is needed in the clockwise direction to balance.

Answer A gives a 9 Nm anticlockwise moment ($20\,\text{N} \times 0.45\,\text{m}$)

4 $$\text{Efficiency} = \frac{\text{output energy /second}}{\text{input energy /second}} \times 100\,\%$$

$$\text{Efficiency} = \frac{15\,\text{J/s}}{60\,\text{J/s}} \times 100\,\%$$

= 25 %

5 Using the Gas law

$p_1V_1 = p_2V_2$

$1.5 \times 10^5\,\text{Pa} \times 300\,\text{cm}^3 = 0.8 \times 10^5\,\text{Pa} \times V_2$

$$V_2 = \frac{1.5 \times 10^5\,\text{Pa} \times 300\,\text{cm}^3}{0.8 \times 10^5\,\text{Pa}}$$

$V_2 = 562.5\,\text{cm}^3$

6 **a** $$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

$$25\,\text{m/s} = \frac{160\,\text{m}}{\text{time}}$$

Time = 6.4 s

b Convert 192 kJ of energy into joules = 192 000 J

$$P = \frac{E}{t}$$

$$= \frac{192\,000\,\text{J}}{6.4\,\text{s}}$$

= 30 000 W