Multiple choice questions

The equation used to determine displacement is $s = ut + \frac{1}{2}at^2$
where in this case
initial velocity (u) = 3.75 m s^{-1} acceleration (a) = 0.3 m s^{-2} time (t) = 5.0×10^2 s

Example 1 QLD 2017 Question 1, 1 mark

How many significant figures should be present in the answer?

A one

B two

C three

D four

A pendulum is used to determine the value of acceleration due to gravity. The length of the pendulum is varied, and the time taken for the same number of oscillations is recorded.

Example 2 NSW 2014 Question 3, 1 mark

Which of the following could increase the reliability of the results?

A Changing the mass of the pendulum

B Identifying the independent and dependent variables

C Recording all measurements to at least four significant figures

D Repeating each measurement several times and recording the average

---

A series of measurements were recorded as:

a = 3.67, b = 0.21, c = 2.301

Example 3 QLD 2013 Question 1, 1 mark

For the equation x = b (a + c), how many significant figures should be present in the answer?

A 1

B 2

C 3

D 4

How many significant figures are in the answer to the following calculation?

$$\cos A = \frac{a^2 - b^2 - c^2}{2bc} \quad \text{where } a = 3.070,\ b = 5.20 \text{ and } c = 0.082$$

Example 4 QLD 2012 Question 1, 1 mark

A One

B Two

C Three

D Four

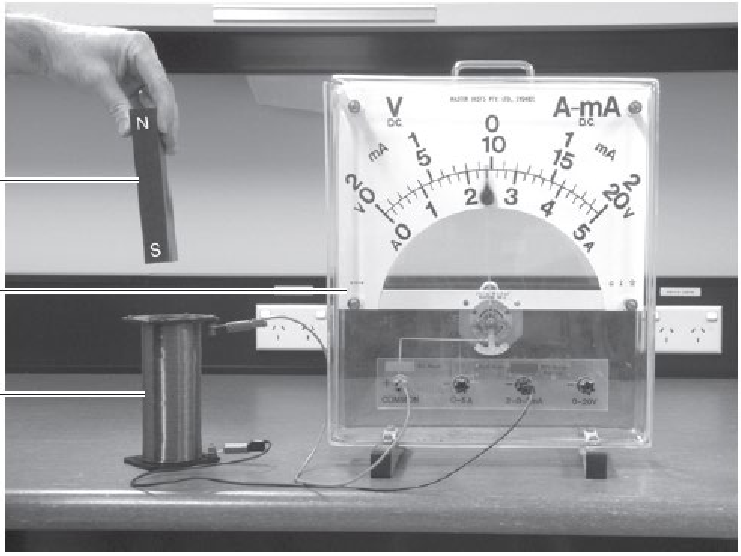
Example 5 NSW 2011 Question 11, 1 mark

A student set up the equipment shown to carry out a first-hand investigation.

Magnet

Galvanometer

Coil



What was the student investigating?

A Gravity

B The motor effect

C Magnetic levitation

D Electromagnetic induction

Example 6 QLD 2009 Question 1, 1 mark

The density of silver is known to be 10.490 g cm^{-3}. When expressed in kg m^{-3} and correctly rounded to three significant digits, the density is

A 1.05×10^3.

B 1.05×10^4.

C 1.04×10^3.

D 1.05×10^6.

Example 7 Qld 2016 Question 1, 1 mark

A series of measurements were taken during an experiment to determine the acceleration experienced by a body. The equation used to determine acceleration is

$$a = \frac{v - u}{t}$$

where, in this case
acceleration (a) = ?
final velocity (v) = 9.35 m s^{-1}
initial velocity (u) = 2.71 m s^{-1}
time (t) = 3.0×10^{-2} s

How many significant figures should be present in the answer?

A one

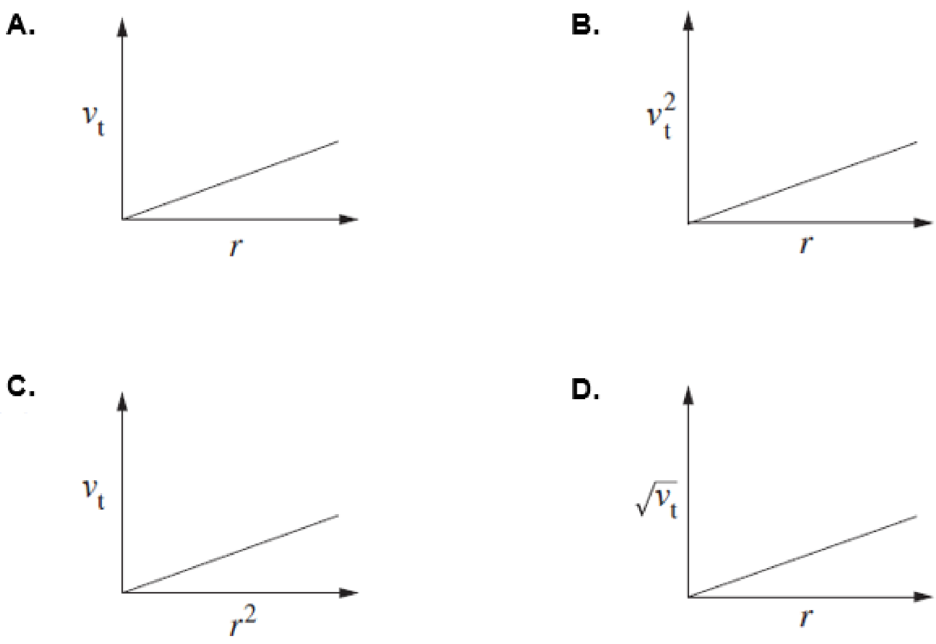
B two

C three

D four

Example 8 NSW 2010 Question 12, 1 mark

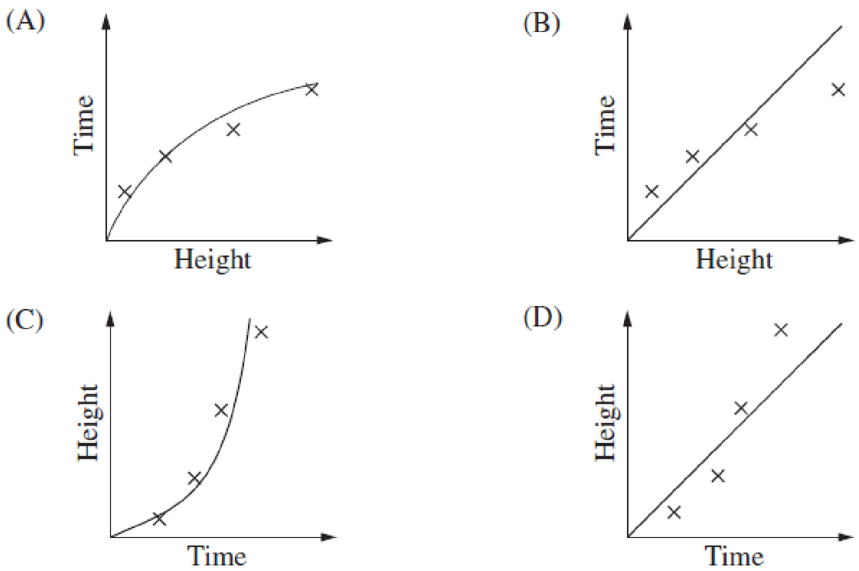
The terminal velocity (v) of a spherical object in Earth's atmosphere is proportional to the square root of its radius (r). Which graph correctly shows this relationship?

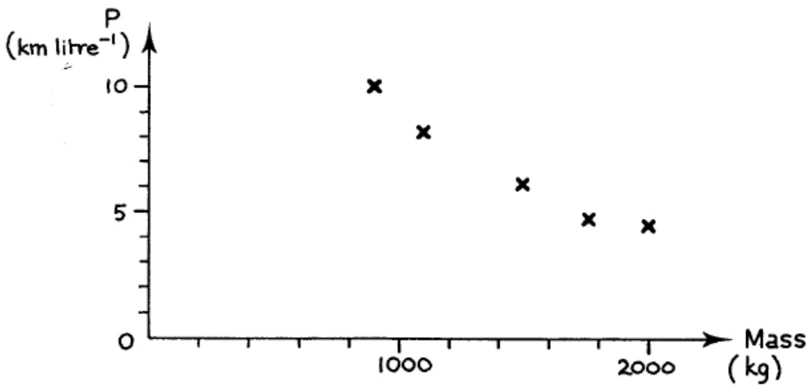


An investigation was performed to determine the acceleration due to gravity. A ball was dropped from various heights and the time it took to reach the ground from each height was measured. The results were graphed with the independent variable on the horizontal axis.

Example 9 NSW 2008 Question 4, 1 mark

Which graph best represents the relationship between the variables?





The petrol consumption of a number of different cars is measured. The points on the graph represent typical values of the distance travelled per unit volume of petrol, P km l^{-1}, for various values of the mass of the car, m kg.

Example 10 1979 Question 23, 1 mark

Which of the following best represents the relationship between P and M?

A. $P\ \alpha\ M$

B. $P\ \alpha\ M^2$

C. $P\ \alpha\ \frac{1}{M}$

D. $P\ \alpha\ \frac{1}{M^2}$

Example 11 1977 Question 29, 1 mark

Only one of the formulae given below correctly gives the radius, R, of the circular flight path of a thrown boomerang in terms of the following quantities:

M, the mass of the boomerang, expressed in kg, L, the length of its blades, expressed in m,

C, the lift-constant of the boomerang, expressed in kg m^{-2}.

Basing your answer only on the units associated with the quantities given, which of these formulae is the correct one?

A. $R = \frac{M^2}{4LC}$

B. $R = \frac{M}{4LC}$

C. $R = \frac{L}{4MC}$

D. $R = \sqrt{\frac{M}{4LC}}$

E. $R = \frac{MC}{4L}$

Water is kept at a constant height in a tank. Water flows from the tank through a number of horizontal tubes of different lengths and cross-sectional areas. These tubes are all attached to the tank at the same level. The volume of water that flows from each of these tubes in 1 minute (the flow rate) is recorded in the following table.

Length of tube L (cm)	Cross-sectional area of tube S (cm^2)	Flow rate V (cm^3/min)
10	0.010	90
20	0.010	45
30	0.010	30
30	0.020	120
30	0.030	270

Example 12 1966 Question 44, 1 mark

Which of the following graphs would be the most useful in predicting the flow rates from tubes of various lengths, all of cross-sectional area 0·010 cm, and all at this same level in the tank?

A. V against L

B. V against $\frac{1}{L}$

C. V against L^2

D. V against $\frac{1}{L^2}$

Example 13 1966 Question 45, 1 mark

Which of following graphs would be the most useful in predicting the flow rates from tubes of different cross-sectional areas, all of length 30 cm, and all at this same level in the tank?

A. V against S

B. V against $\frac{1}{S}$

C. V against S^2

D. V against $\frac{1}{S^2}$

Example 14 1966 Question 46, 1 mark

To which of the following is the flow rate directly proportional?

A. S^2L

B. $\frac{S^2}{L}$

C. $\frac{L}{S^2}$

D. L^2S

E. $\frac{L^2}{S}$

F. $\frac{L^2}{S^2}$

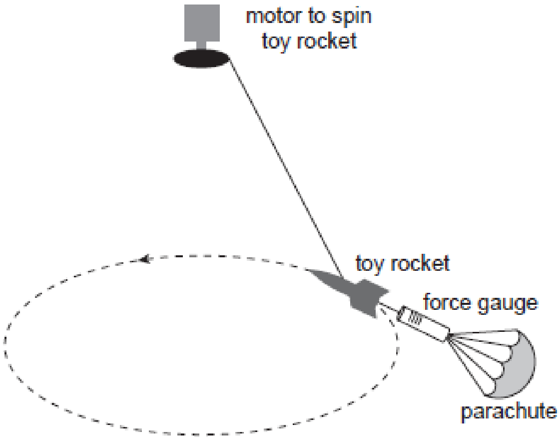
G. None of the above.

Short answer questions

Example 15 QLD 2017 Question 2, 1 mark

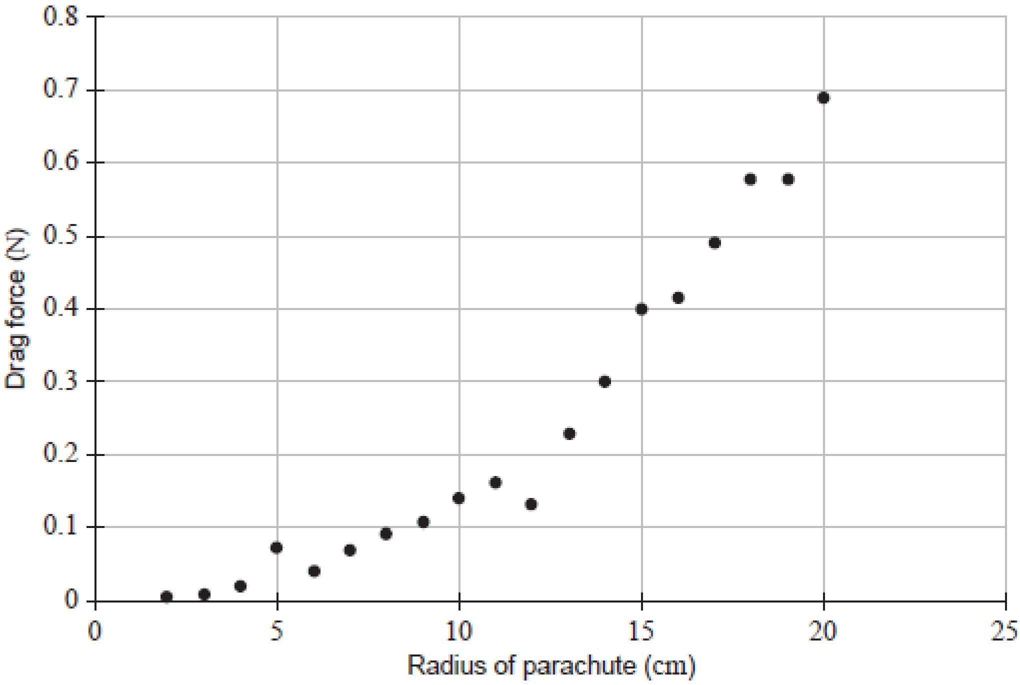
Convert the percentage error into an absolute error.
52.5 ± 2 %

A group of students investigated the relationship between the radius, *r*, of a circular parachute and the drag force due to the air resistance that the parachute creates.
The students attached a parachute and a force gauge to a toy rocket, as shown in the diagram below. An adjustable electric motor was used to spin the toy rocket in a horizontal circular path.



[*This diagram is not drawn to scale.*]

The force gauge was used to measure the drag force.
The students used other parachutes of different radii and repeated the measurement of the drag force. The motor was adjusted to try to keep the toy rocket travelling at the same speed in each test.
The data collected in the investigation are shown in the graph below.



Example 16 QLD 2019 Question 6a, 1 mark

State how the graph shows that the drag force was ***not*** directly proportional to the radius of the parachute.

Example 17 QLD 2019 Question 6b i, 1 mark

State the type of error evident in the graph.

Example 18 QLD 2019 Question 6b ii, 1 mark

Identify *one* possible source of this type of error in this investigation.

Example 19 QLD 2019 Question 6c, 1 mark

Describe how the students could use the data collected in the investigation to show a linear relationship.

The table below contains temperature data for an experiment measuring coffee temperature versus time. Trials 1 and 2 involved adding milk to the coffee at different times as indicated by the double asterisk.

	Temperature (°C)	
Time (min)	**Trial 1**	**Trial 2**
0	67	67
1	64	65
2	63**	64
3	54	63
4	53	62
5	52	60
6	51	59
7	50	58
8	49	57
9	48	56
10	48	55
11	48	54
12	47	53**
13	47	45
14	45	45
15	45	43

Example 20 QLD 2018 Question 4a, 4 marks

Plot the data in the table. Include a key to indicate which lines represent which trials.

Example 21 QLD 2018 Question 4b, 2 marks

Suggest from this data whether it is better to place milk in coffee earlier or later to keep the temperature as high as possible for drinking immediately after the experiment.

Example 22 QLD 2018 Question 5, 6 marks

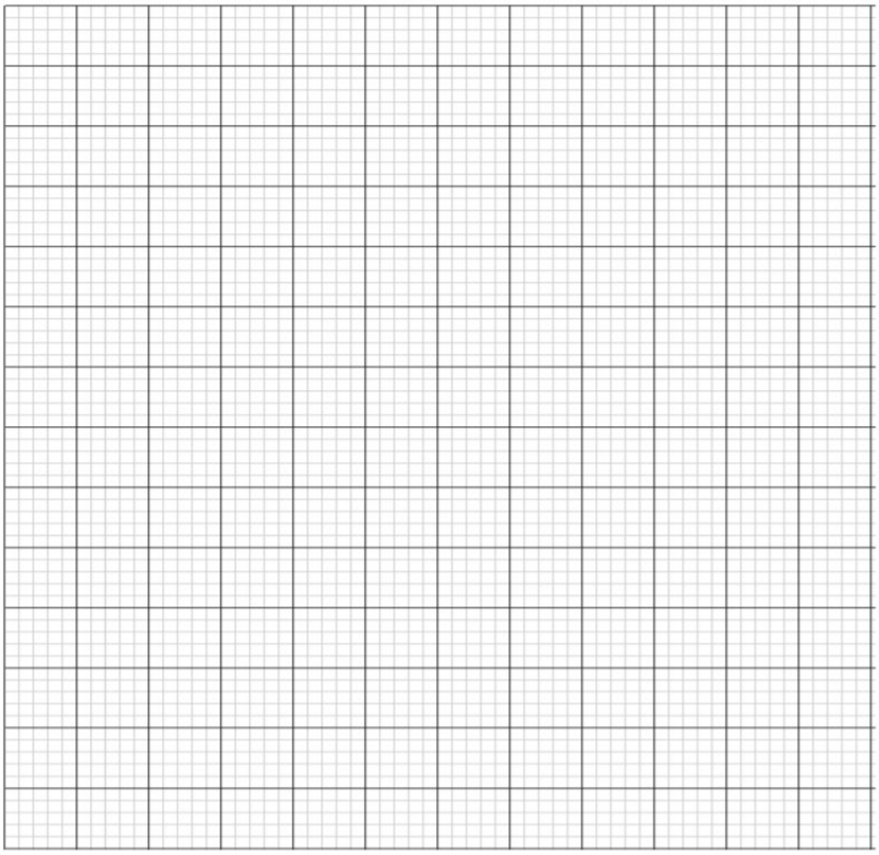
Two students are arguing about whether a person would get wetter by running across a given uncovered length of ground if it is raining or by walking at a normal pace. They are also concerned that the length that has to be traversed is an important factor to consider.
Design an experiment that will address these issues.

The table below contains temperature data for an experiment measuring temperature vs height in the Earth's atmosphere.

Height h (metres)	Temperature T (°C)
0	15
500	11.8
1000	8.5
1500	5.3
2000	2
2500	–1.3
3000	–4.5
3500	–7.8
4000	–11
4500	–14.3
5000	–17.5
5500	–20.8
6000	–24

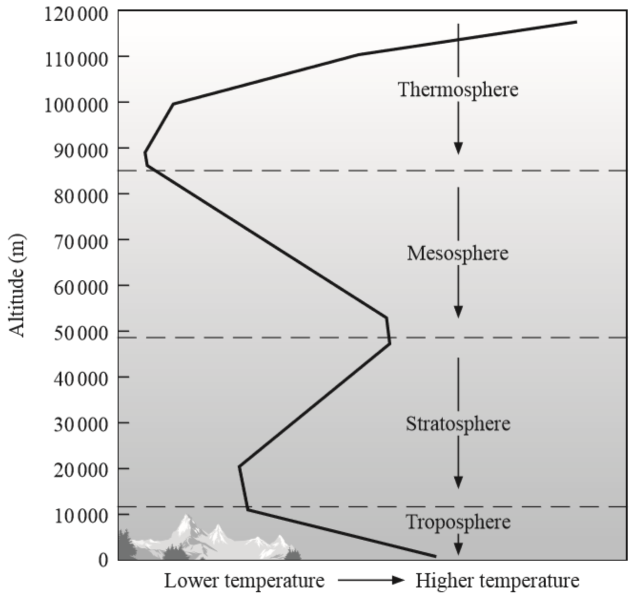
Example 23 QLD 2017 Question 4a, 4 marks

Plot this information on the axes provided.



Example 24 QLD 2017 Question 4b, 1 mark

Using the data from part a and the graph below, estimate the lowest temperature in the atmosphere and state in which atmospheric layer it occurs.

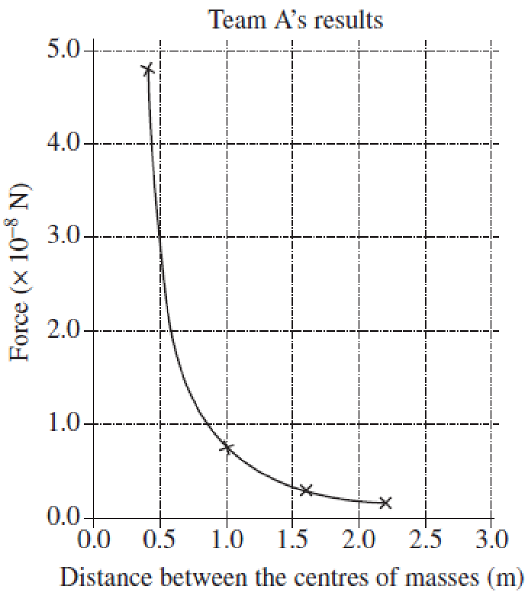


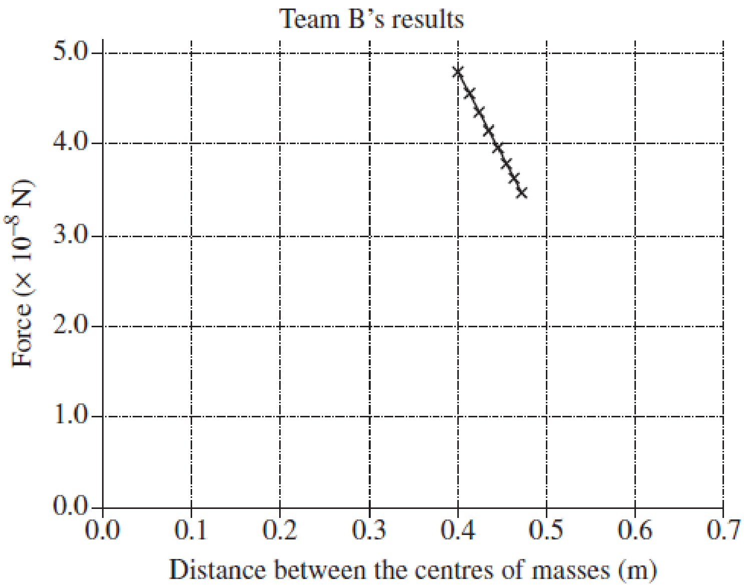
Two housemates are discussing how best to dry clothes as they share the job of hanging washing on a line. One says that the most important factor is wind, while the other maintains it is direct exposure to sunlight.

Example 25 QLD 2017 Question 5, 5 marks

Design an experiment that determines which, if either, housemate is correct.

Two teams carried out independent experiments with the purpose of investigating Newton's Law of Universal Gravitation. Each team used the same procedure to accurately measure the gravitational force acting between two spherical masses over a range of distances. The following graphs show the data collected by each team.





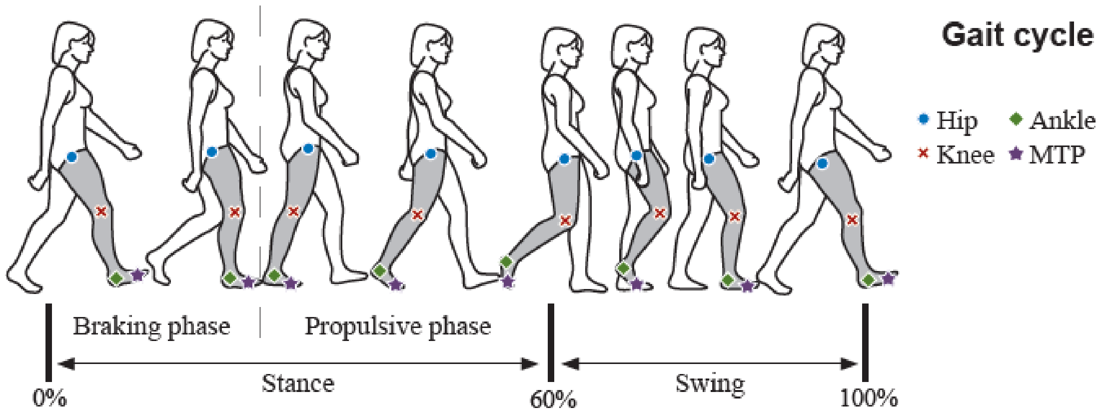
Example 26 NSW 2016 Question 25a 2 marks

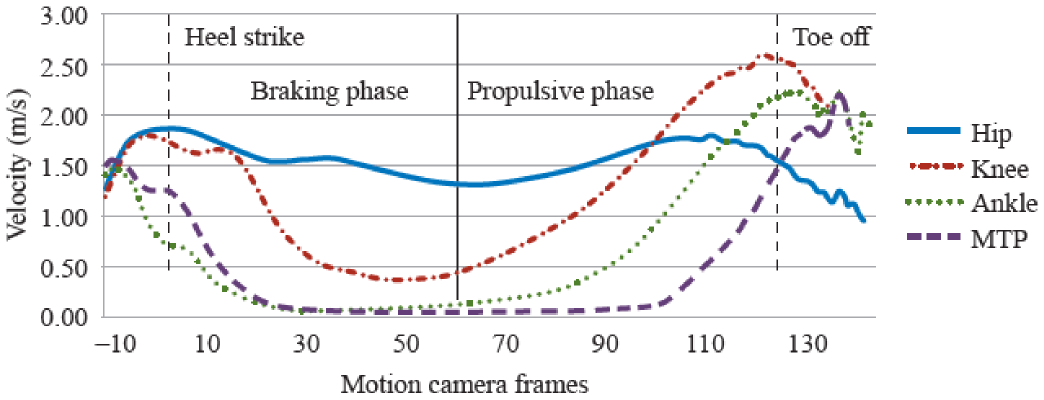
Compare qualitatively the relationship between force and distance in the graphs.

Example 27 NSW 2016 Question 25b 3 marks

Assess the appropriateness of Team A's data and Team B's data in achieving the purpose of the experiments.

The diagrams below refer to the gait cycle, which describes a cycle of human walking. The four points of reference given are the hip, knee, ankle and metatarsophalangeal (MTP) joints.





Example 28 QLD 2016 Question 1 2 marks

Label the statements below as supported (S) or unsupported (U) by the data in the second diagram.

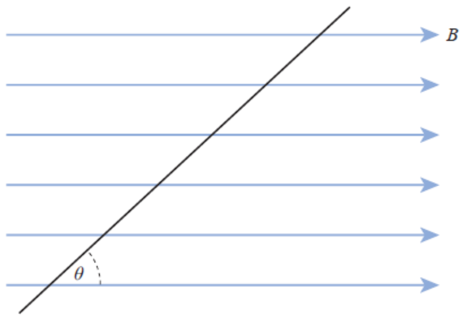
a. At the end of the propulsive phase, the MTP and hip are moving with the same velocity.

b. The ankle experiences its largest acceleration at 'toe off' point.

c. The hip experiences the smallest change in velocity.

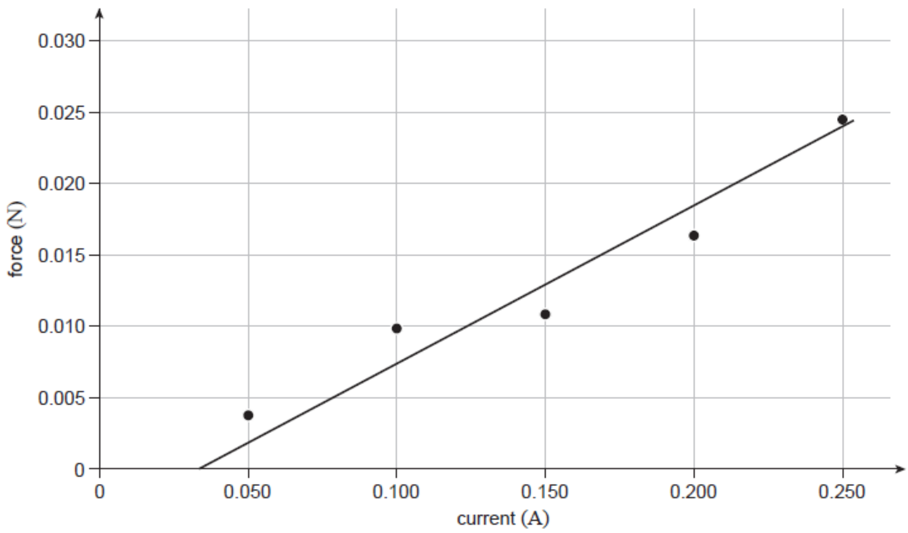
d. The change in velocity of the four points of reference is generally larger in the braking phase than the propulsive phase.

An experiment was conducted to investigate the force on a current-carrying conductor in a magnetic field. The diagram below shows the conductor in the magnetic field of magnitude B = 0.30 T, which is directed to the right of the page:



[*This diagram is not drawn to scale.*]

The conductor was then placed so that it was perpendicular to the magnetic field. The force on the conductor was measured for currents of different magnitudes.
The graph below shows the data collected:



Example 29 SA 2014 Question 11b 2 marks

Explain why the graph shows the presence of a systematic error.

Terminal velocity' is the speed reached by a falling object when its motion is such that the net upward force of resistance is equal in size and opposite in direction to the downward force of gravity.

Students conducted an experiment to determine the terminal velocity of a small sphere that was dropped into a container of oil.

A multi-image photograph recorded the distance fallen every 0.10 s. After initially accelerating downwards, the sphere reached its terminal velocity.

Research by the students indicated that the sphere should reach a terminal velocity of v_t = 0.25 m s^{-1}.

The students conducted the experiment three times. The table below shows the data they recorded:

Time	Distance Fallen			
	Experiment 1	Experiment 2	Experiment 3	Average
0.10 s	1 cm	1 cm	1 cm	
0.20 s	2.4 cm	2.7 cm	2.4 cm	
0.30 s	5 cm	5 cm	5 cm	
0.40 s	7.8 cm	7.6 cm	8 cm	
0.50 s	10.6 cm	10.6 cm	10.6 cm	
0.60 s	13.4 cm	13.1 cm	13.7 cm	
0.70 s	16.2 cm	16.3 cm	16.1 cm	
0.80 s	19 cm	19 cm	19 cm	

Example 30 SA 2014 Question 25a 2 marks

Complete the table above, calculating the average distance fallen for each time.

Example 31 SA 2014 Question 25b 1 mark

Suggest one way of improving the presentation of the data in the table above.

Example 32 SA 2014 Question 25c 6 marks

Plot a graph of average distance fallen against time. Draw a line of best fit for the values *when the sphere had reached its terminal velocity*.

Example 33 SA 2014 Question 25d 3 marks

Determine the gradient of your line of best fit. Include the units of the gradient.

Example 34 SA 2014 Question 25e 1 mark

State why the gradient of your line of best fit represents the terminal velocity.

Example 35 SA 2014 Question 25f (i) 1 mark

Comment on the accuracy of the experiment.

Example 36 SA 2014 Question 25f (ii) 1 mark

Comment on the precision of the experiment.

Example 37 SA 2014 Question 25g 3 marks

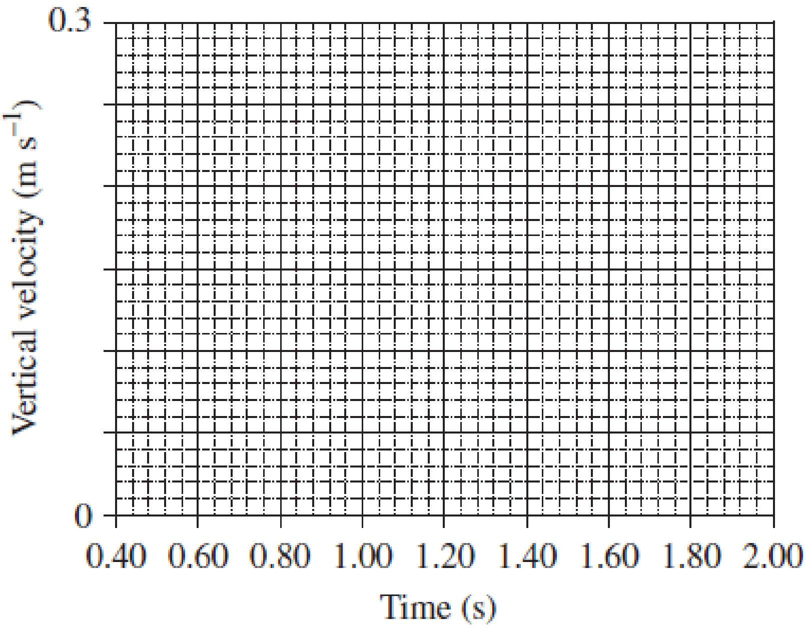
The experiment was repeated with a sphere of the same mass but smaller area of cross section. Predict, giving reasons, how the motion of this sphere would be different.

This set of data was obtained from a motion investigation to determine the acceleration due to gravity on a planet other than Earth.

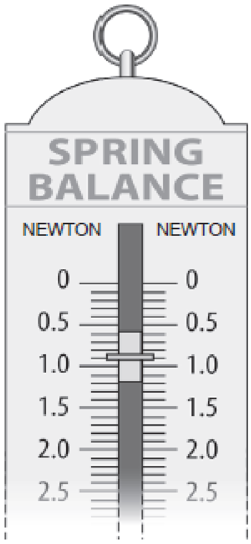
Time (s)	Vertical velocity (m s^{-1})
0.60	0.02
1.00	0.09
1.20	0.12
1.40	0.17
1.80	0.23

Example 38 NSW 2013 Question 22 3 marks

Plot the data from the table, and then calculate the acceleration.

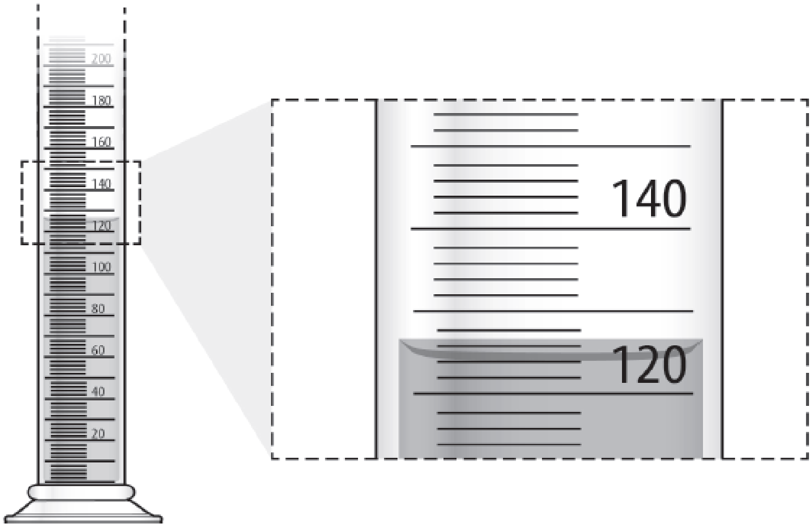


Example 39 WA 2012 Question 2, 4 marks
For the following pictures read the scale, record the measurement and determine the uncertainty
of the measurement.



The force measured by the spring balance is ___________N.

The uncertainty is _________



The volume of the liquid in the graduated cylinder is _______mL.

The uncertainty is _________.

Example 40 QLD 2012 Question 1a, 2 marks

State the number of significant figures in the following measurements.

i. 25.9 km

ii. 8.030×10^3 g

iii. 0.062 mm

iv. 0.05130 L

Example 41 QLD 2012 Question 1b, 2 marks

Convert the following percentage errors into absolute errors.

i. 10.35 ± 0.6%

ii. 247 ± 5.2%

Example 42 NSW 2012 Question 21a, 3 marks

Outline a first-hand investigation that could be performed to measure a value for acceleration due to gravity.

Example 43 NSW 2012 Question 21b, 1 mark

How would you assess the accuracy of the result of the investigation?

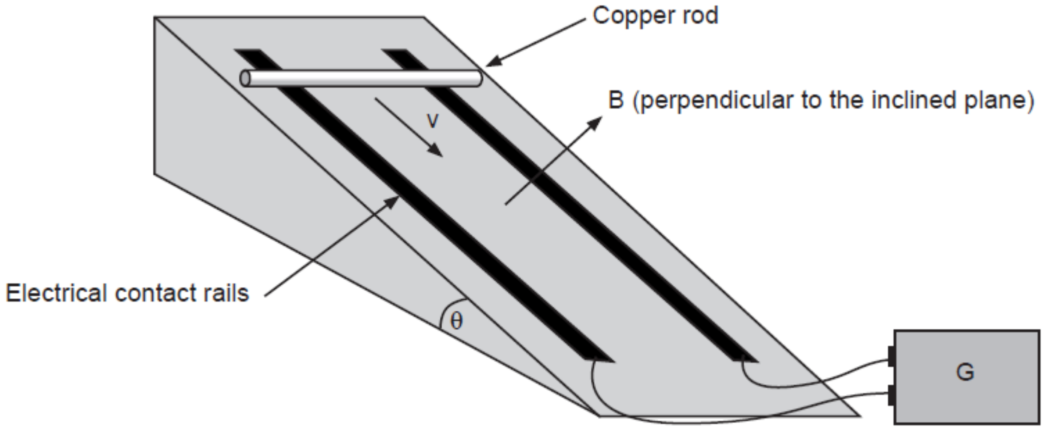
Example 44 NSW 2012 Question 21c, 1 mark

How would you increase the reliability of the data collected?

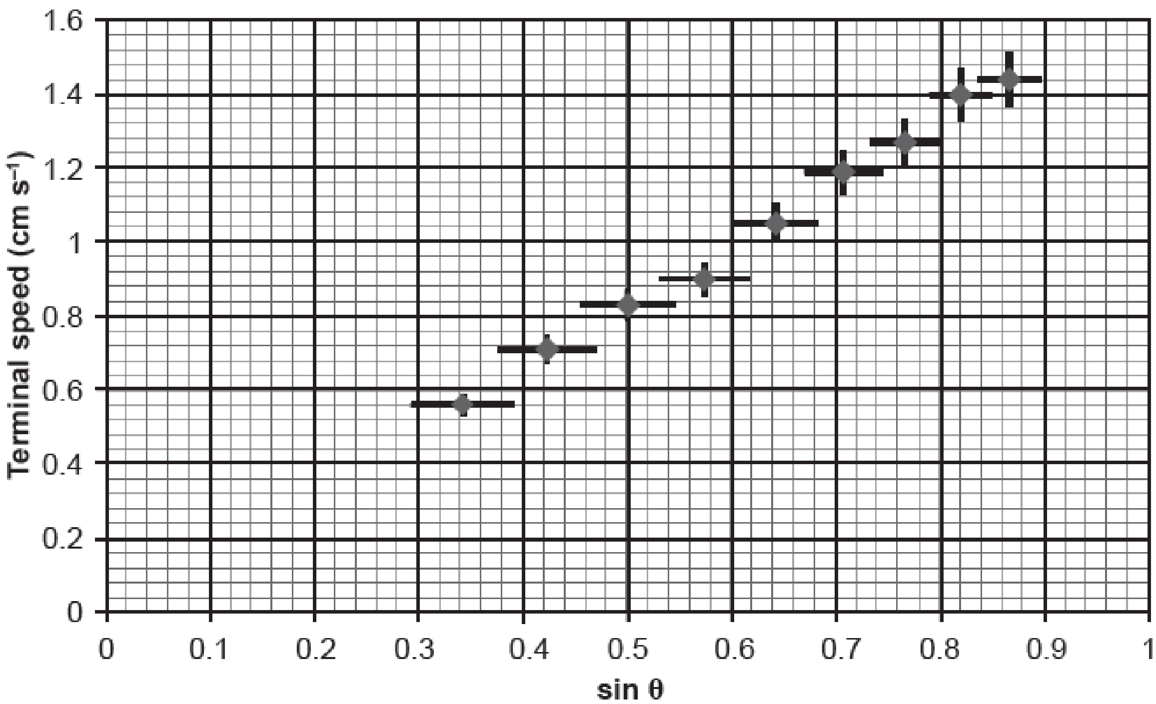
Example 45 NSW 2012 Question 21d 1 mark

How would you assess the reliability of the data collected?

In the diagram below a copper rod is free to slide down two parallel electrical contact rails which are mounted on an inclined plane. The inclined plane is a strong magnet. The angle, θ, between the inclined plane and the horizontal can be changed. The electrical contact rails are connected to a galvanometer.



A group of students investigate the relationship between the terminal speed of the rod and the angle of inclination. They measure the terminal speed of the rod using data logging equipment and the angle of inclination with a protractor. They plot their data on a graph. This graph is reproduced below.



Example 46 WA 2012 Question 18c 2 marks

Express the value of terminal speed, when sin θ = 0.5 in the form y ± Δy, where y is the value of terminal speed and Δy is the uncertainty in the measurement.

Example 47 WA 2012 Question 18d 4 marks

Describe the trend in uncertainty for the terminal speed and for the sin of the angle θ.

Example 48 WA 2012 Question 18e 3 marks

When drawing the line of best fit the students chose not to include the two largest terminal speed measurements from their data because they thought these two measurements were less reliable. Refer to the graph to explain why they thought this.

Example 49 WA 2012 Question 18f 3 marks

Draw a line of best fit onto the graph and determine the gradient of the line.

Example 50 QLD 2011 Question 1, 3 marks

The measurements below were taken during an experiment.

L = 26.5 ± 0.4 cm

W = 18.7 ± 0.4 cm

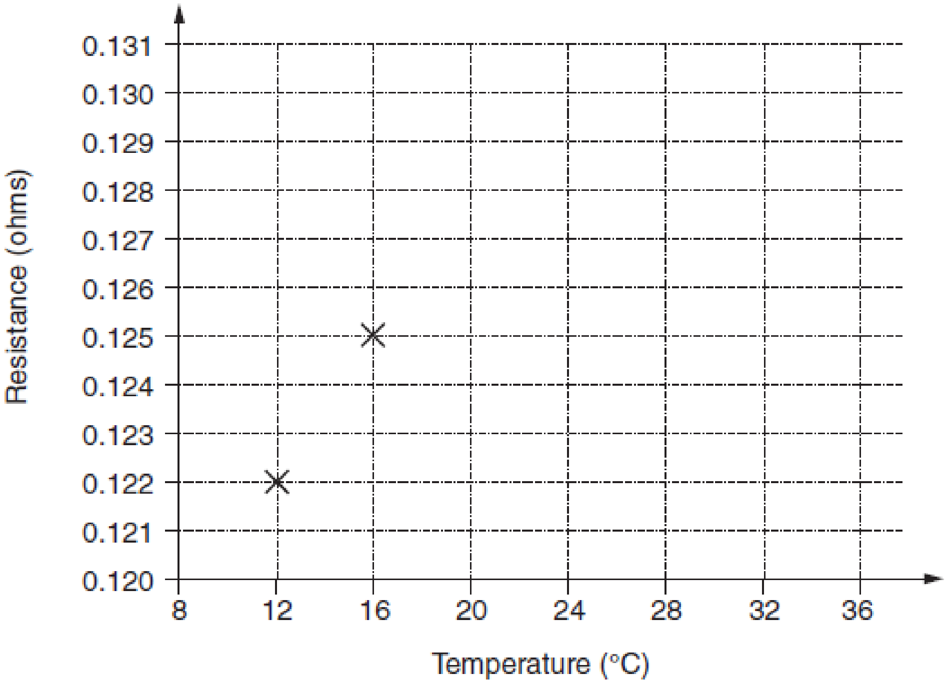
Calculate the following, expressing the correct uncertainty in each response

a L + W

b L - W

The electrical resistance, R, of a piece of wire was measured at different temperatures, T.
Near room temperature, the resistance of the wire can be modelled by the equation $R = mT + b$.

Temperature (°C)	*Resistance (ohms)*
12	0.122
16	0.125
32	0.129
36	0.131



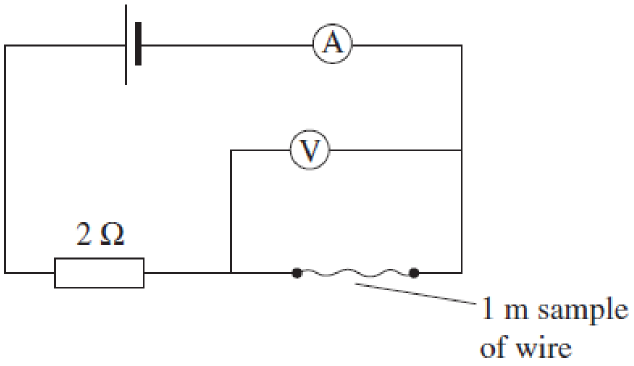
Example 51 NSW 2011 Question 21a, 3 marks

Plot the TWO remaining data points on the graph provided. Draw a line of best fit on the graph and use it to estimate the electrical resistance of the wire at 24°C.

Example 52 NSW 2011 Question 21b, 2 marks

Assess the validity of using the data from this experiment to estimate the electrical resistance at –100°C.

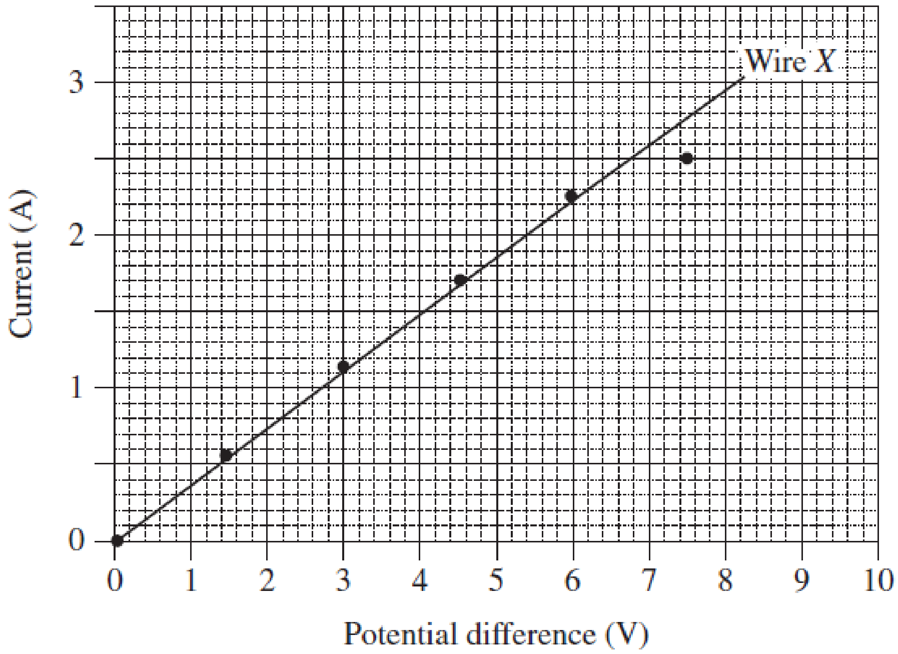
A student was given a sample of wire *X* and a sample of wire *Y*. The wires looked identical. However, one was pure chromium and the other was nichrome, an alloy containing chromium and nickel. To differentiate between the two wires, the student set up the circuit below and obtained the results shown in the table.



Potential difference (V)	*Current* (A)	
	Wire X	*Wire Y*
0	0	0
1.5	0.57	0.20
3.0	1.14	0.39
4.5	1.71	0.59
6.0	2.28	0.79
7.5	2.50	0.99

Example 53 NSW 2008 Question 27a, 2 marks

The data for wire *X* has been plotted on the graph below. Plot the data, including a trend line, for wire *Y* on the same graph.



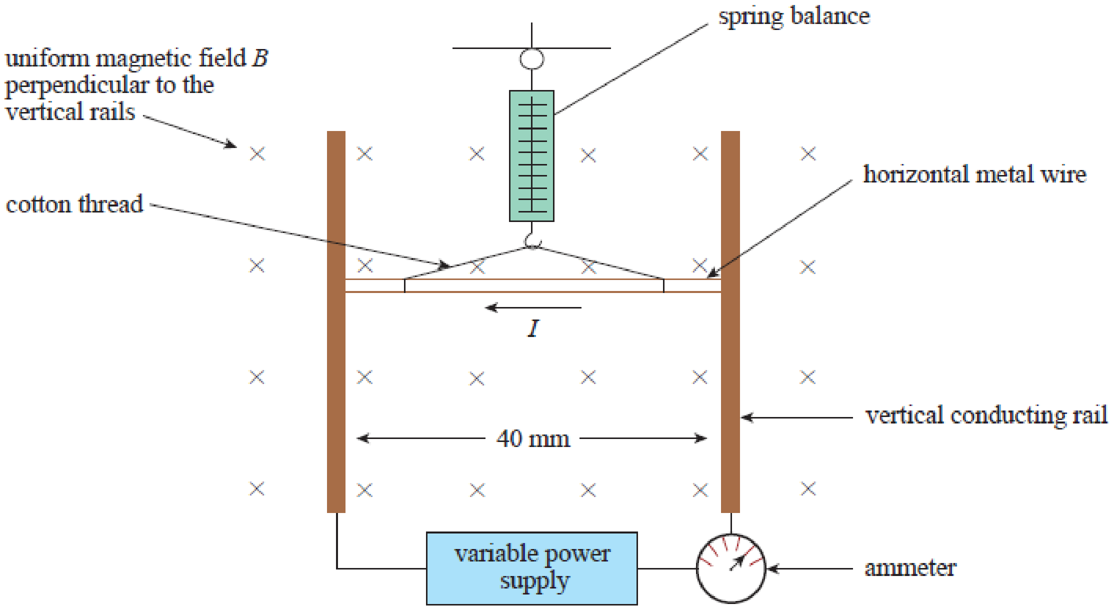
Example 54 NSW 2008 Question 27b, 1 mark

Calculate the resistance of wire *Y*.

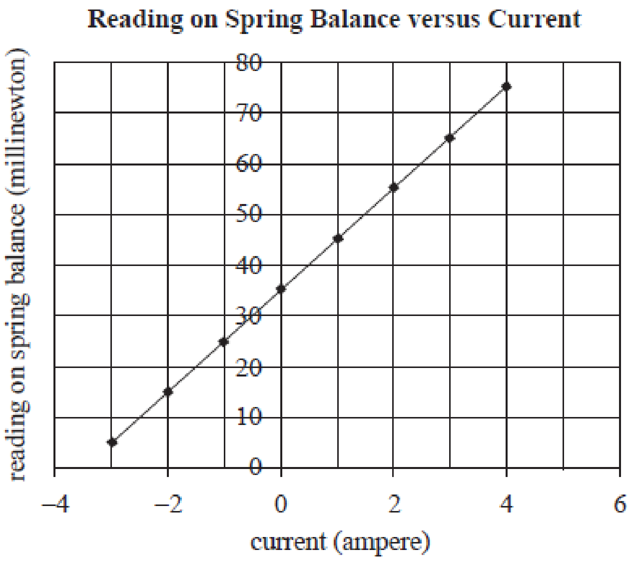
Example 55 NSW 2008 Question 27d, 1 mark

When the data for wire *X* was plotted, one data point was considered inconsistent and was disregarded when drawing the trend line for calculating its resistance. Suggest a physical reason why this data point is inconsistent with the trend line.

A student conducts an experiment to investigate the relationship between the current flowing in a horizontal metal wire and the magnetic force acting on the wire when it is placed in a uniform magnetic field *B*. The experimental arrangement is shown in the diagram below.
The horizontal metal wire has a good electrical contact with two vertical conducting rails, which are connected to a variable power supply that can provide current *I* in either direction.
The horizontal metal wire is attached to a spring balance by a cotton thread of negligible mass.
The horizontal metal wire is free to move up and down in a vertical direction and remains in contact with the vertical conducting rails. The spring balance is calibrated in millinewtons and is set to read zero when supporting no load.



The student changes the current flowing in the horizontal metal wire by varying the power supply, and records the new readings on the spring balance. The results are shown in the following graph:



Example 56 SA 2008 Question 12b 1 mark

State the dependent variable in this experiment.

Example 57 SA 2008 Question 12c 1 mark

Using the graph above, state the value of the current flowing in the horizontal metal wire when the reading on the spring balance is zero.

Example 58 SA 2008 Question 12d 3 marks

Using the graph above, determine the mass of the horizontal metal wire.

An excited form of barium (barium-137) releases gamma radiation as its nucleus undergoes a transition to its ground state.

The activity of a sample of excited barium-137 was investigated by using a gamma counter to measure the number of gamma rays detected at various distances from the sample. The sample of barium-137 was placed in a thick lead container with a small opening. The gamma counter was aligned with the small opening, as shown in the diagram below:

The distance *d* from the sample to the gamma counter was varied and the number *N* of gamma rays detected at each distance during equal time intervals was recorded, as shown in the table below:

Distance d from sample to gamma counter (cm)	Number N of gamma rays detected during equal time intervals	Inverse square of distance $\frac{1}{d^2}$ (cm^{-2})
10.4	133	
14.4	80	
20.0	35	
25.0	24	

Example 59 SA 2008 Question 23a 3 marks

Complete the table above by calculating each of the values of $\frac{1}{d^2}$ to the correct number of significant figures.

Example 60 SA 2008 Question 23b 5 marks

Plot the number *N* of gamma rays detected against $\frac{1}{d^2}$ and draw a line of best fit.

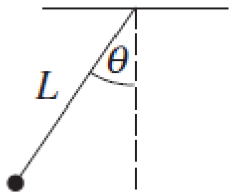
Example 61 SA 2008 Question 23c 3 marks

State and explain the relationship between the variables you have plotted.

Example 62 SA 2008 Question 23d 2 marks

Explain how the effect of random errors may be minimised.

Two students, Kim and Ali, performed an experiment to determine the acceleration due to gravity (*g*) using a simple pendulum consisting of a small mass hanging from a light string.



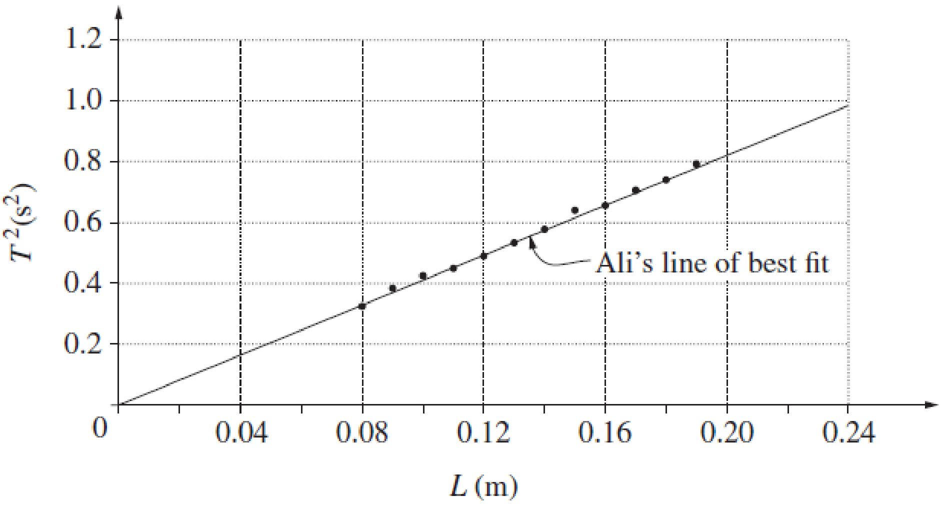
Their procedure was as follows:

1. Adjust the length of the string (*L*) to measure 0.08 m.
2. Hold the mass to the side to give a small angular displacement, θ.
3. Release the mass and measure the time for one period (*T*).
4. Record the result in a table.
5. Repeat using a string length (*L*) of 0.09 m and continue until the string length is 0.19 m (going up in 0.01 m increments, using the same initial angular displacement each time).
6. Calculate *g* using the relationship .$T = 2\pi\sqrt{\frac{l}{g}}$

The results are shown in the table:

L (m)	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19
T (s)	0.57	0.62	0.65	0.67	0.70	0.73	0.76	0.80	0.81	0.84	0.86	0.89

Kim used the data in the table to obtain a mean value for *g*. Kim's result was $g = 9.3$ m s^{-2}.
Ali used the results to produce the following graph. Ali's line of best fit was used to calculate *g*.



Example 63 NSW 2002 Question 16a, 2 marks

Outline TWO changes that could be made to the experimental procedure that would improve its accuracy.

Example 64 NSW 2002 Question 16b, 3 marks

Compare Kim's and Ali's methods of calculating *g* and identify the better approach.

Example 65 NSW 2002 Question 16c, 3 marks

Calculate the value of *g* from the line of best fit on Ali's graph.

The correct use of *units, standard form* (i.e. powers-of-ten notation) and *significant figures* is being tested in Questions 29 and 30.

Example 66 1968 Question 29, 1 mark

A metal rod, of length 7.6039 cm, is heated and expands to 7.6052 cm. What was its change in length **in *metres?***
Express your answer in *standard form,* to an appropriate number of significant figures.

In a Young's double slit experiment, a student takes the following measurements :

distance between slits = 0 021 cm.

distance between slits and screen = 1.34 m.

distance between successive black bars on screen = 3.2 mm.

He uses these figures, and his logarithm tables, and then records the wavelength of the light as 5014 Å. (Use 1 Å = 1 × 10^{-10} m)

Example 67 1968 Question 30, 1 mark

Express this result in *metres,* in *standard form,* to the appropriate number of *significant figures.*
