Transition Activities GCSE → A Level

The following activities cover some of the key skills from GCSE science that will be relevant at AS and A-level. They include the vocabulary used when working scientifically and some maths and practical skills.

You can do these activities independently or in class. The booklet has been produced so you can complete it electronically or print it out and do the activities on paper.

The activities are **not a test**. Try the activities first and see what you remember and then use textbooks or other resources to answer the questions. **Don't** just go to Google for the answers, as actively engaging with your notes and resources from GCSE will make this learning experience much more worthwhile.

The answer booklet guides you through each answer. It is not set out like an exam mark scheme but is to help you get the most out of the activities.

Understanding and using scientific vocabulary

Understanding and applying the correct terms are key for practical science. Much of the vocabulary you have used at GCSE for practical work will not change but some terms are dealt with in more detail at A-level so are more complex.

Activity 1 Scientific vocabulary: Designing an investigation

Link each term on the left to the correct definition on the right.

Hypothesis	The maximum and minimum values of the independent or dependent variable
Dependent variable	A variable that is kept constant during an experiment
Independent variable	The quantity between readings, eg a set of 11 readings equally spaced over a distance of 1 metre would give an interval of 10 centimetres
Control variable	A proposal intended to explain certain facts or observations
Range	A variable that is measured as the outcome of an experiment
Interval	A variable selected by the investigator and whose values are changed during the investigation

Activity 2 Scientific vocabulary: Making measurements

Link each term on the left to the correct definition on the right.

Term	Definition
True value	The range within which you would expect the true value to lie
Accurate	A measurement that is close to the true value
Resolution	Repeated measurements that are very similar to the calculated mean value
Precise	The value that would be obtained in an ideal measurement where there were no errors of any kind
Uncertainty	The smallest change that can be measured using the measuring instrument that gives a readable change in the reading

Activity 3 Scientific vocabulary: Errors

Link each term on the left to the correct definition on the right.

Random error	Causes readings to differ from the true value by a consistent amount each time a measurement is made
Systematic error	When there is an indication that a measuring system gives a false reading when the true value of a measured quantity is zero
Zero error	Causes readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next

Understanding and using SI units

All measurements have a size (eg 2.7) and a unit (eg metres or kilograms). Sometimes, there are different units available for the same type of measurement. For example, milligram, gram, kilogram and tonne are all units used for mass. Some values like strain and refractive index are not followed by a unit.

To reduce confusion, and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes.

These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China.

There are seven SI base units, which are given in the table.

Physical quantity	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
luminous intensity	candela	cd

All other units can be derived from the SI base units. For example, area is measured in metres square (written as m^2) and speed is measured in metres per second (written as $m\ s^{-1}$ this is a change from GCSE, where it would be written as m/s).

Some derived units have their own unit names and abbreviations, often when the combination of SI units becomes complicated. Some common derived units are given in the table below.

Physical quantity	Unit	Abbreviation	SI unit
Force	newton	N	$kg\ m\ s^{-2}$
Energy	joule	J	$kg\ m^2\ s^{-2}$
Frequency	hertz	Hz	s^{-1}

Using prefixes and powers of ten

Very large and very small numbers can be complicated to work with if written out in full with their SI unit. For example, measuring the width of a hair or the distance from Manchester to London in metres (the SI unit for length) would give numbers with a lot of zeros before or after the decimal point, which would be difficult to work with.

So, we use prefixes that multiply or divide the numbers by different powers of ten to give numbers that are easier to work with. You will be familiar with the prefixes milli (meaning 1/1000), centi (1/100), and kilo (1 × 1000) from millimetres, centimetres and kilometres.

There is a wide range of prefixes. Most of the quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, we would quote a distance of 33 000 m as 33 km.

Kg is the only base unit with a prefix.

The most common prefixes you will encounter are given in the table.

Prefix	Symbol	Power of 10	Multiplication factor	
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	µ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Activity 4 SI units and prefixes

1. Re-write the following quantities using the correct SI units.

   a. 1 minute
   b. 1 milliamp
   c. 1 tonne

2. What would be the most appropriate unit to use for the following measurements?

   a. The wavelength of a wave in a ripple tank
   b. The temperature of a thermistor used in hair straighteners
   c. The half-life of a source of radiation used as a tracer in medical imaging
   d. The diameter of an atom
   e. The mass of a metal block used to determine its specific heat capacity
   f. The current in a simple circuit using a 1.5 V battery and bulb

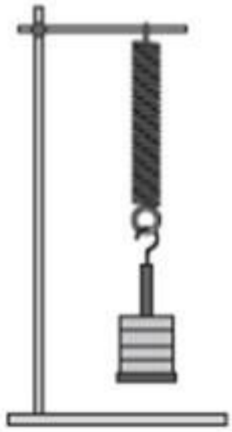
Activity 5 Converting data

Re-write the following quantities.

1. 1.5 kilometres in metres
2. 450 milligrams in kilograms
3. 96.7 megahertz in hertz
4. 5 nanometers in metres
5. 3.9 gigawatts in watts

Activity 6 Investigating springs

A group of students investigated how the extension of a spring varied with the force applied. They did this by hanging different weights from the end of the spring and measuring the extension of the spring for each weight.



The results are below.

Weight added to the spring / N	Extension of spring / cm			
	Trial 1	Trial 2	Trial 3	Mean
2	3.0	3.1	3.2	
4	6.0	5.9	5.8	
6	9.1	7.9	9.2	
8	12.0	11.9	12.1	
10	15.0	15.1	15.12	

1. What do you predict the result of this investigation will be?
2. What are the independent, dependent and control variables in this investigation?
3. What is the difference between repeatable and reproducible?
4. What would be the most likely resolution of the ruler you would use in this investigation?
5. Suggest how the student could reduce parallax errors when taking her readings.
6. Random errors cause readings to be spread about the true value.

   What else has the student done in order to reduce the effect of random errors and make the results more precise?

7. Another student tries the experiment but uses a ruler which has worn away at the end by 0.5 cm. What type of error would this lead to in his results?

8. Calculate the mean extension for each weight.

9. A graph is plotted with force on the *y* axis and extension on the *x* axis. What quantity does the gradient of the graph represent?

Greek letters

Greek letters are used often in science. They can be used:

- as symbols for numbers (such as $\pi = 3.14\ldots$)
- as prefixes for units to make them smaller (eg μm = 0.000 000 001 m)
- as symbols for particular quantities.

The Greek alphabet is shown below.

Capital letter	Lower case letter	Name
Α	α	alpha
Β	β	beta
Γ	γ	gamma
Δ	δ	delta
Ε	ε	epsilon
Ζ	ζ	zeta
Η	η	eta
Θ	θ	theta

Capital letter	Lower case letter	Name
Ι	ι	iota
Κ	κ	kappa
Λ	λ	lambda
Μ	μ	mu
Ν	ν	nu
Ξ	ξ	ksi
Ο	ο	omicron
Π	π	pi

Capital letter	Lower case letter	Name
Ρ	ρ	rho
Σ	ς or σ	sigma
Τ	τ	tau
Υ	υ	upsilon
Φ	φ	phi
Χ	χ	chi
Ψ	ψ	psi
Ω	ω	omega

Activity 7 Using Greek letters

Use your knowledge from GCSE to complete the table. The first line has been completed for you.

Object or quantity represented by the Greek letter	Greek letter
Wavelength	λ
Type of ionising radiation which cannot pass through paper and is used in smoke detectors	
	Ω
Type of ionising radiation which is an electron ejected from the nucleus. Can be used to monitor paper thickness	
Very short wavelength electromagnetic wave	

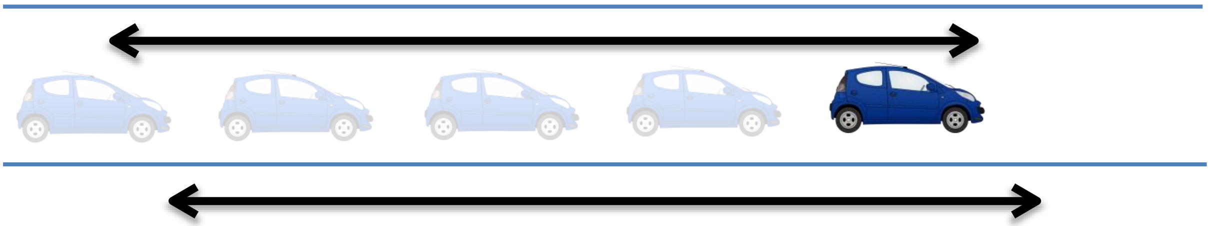
The delta symbol (Δ)

The delta symbol (Δ) is used to mean ‘change in’. For example, at GCSE, you would have learned the formula:

$$\text{speed} = \frac{\text{distance}}{\text{time}} \quad \text{which can be written as} \quad s = \frac{d}{t}$$

What you often measure is the **change** in the distance of the car from a particular point, and the **change** in time from the beginning of your measurement to the end of it.

change in distance along road



change in time

time at starting point of measurement

time at end point of measurement

As the distance and the speed are changing, you use the delta symbol to emphasise this. The A-level version of the above formula becomes:

$$\text{velocity} = \frac{\text{displacement}}{\text{time}} \quad \text{which can be written as} \quad v = \frac{\Delta s}{\Delta t}$$

Note: the delta symbol is a property of the quantity it is with, so you treat ‘Δs’ as one thing when rearranging, and you cannot cancel the delta symbols in the equation above

Rearranging formulas

Activity 8 Rearranging formulas
1. Rearrange $c = f\lambda$ to make f the subject. 2. Rearrange $\rho = \frac{m}{V}$ to make m the subject. 3. Rearrange $w = \frac{\lambda D}{s}$ to make s the subject 4. Rearrange $P = I^2 R$ to make I the subject 5. Rearrange $E = ½ m v^2$ to make v the subject. 6. Rearrange $h f = \varphi + E_k$ to make φ the subject 7. Rearrange $v = u + a t$ to make a the subject. 8. Rearrange $s = u t + ½ a t^2$ to make a the subject. 9. Rearrange $\varepsilon = I(R + r)$ to make r the subject. 10. Rearrange $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$ to make T the subject.

Using maths skills

Physics uses the language of mathematics to make sense of the world. It is important that you are able to apply maths skills in Physics. The maths skills you learnt and applied at GCSE are used and developed further at A-level.

Activity 9 Standard form

1. Write the following numbers in standard form.

   a. 379 4
   b. 0.0712

2. Use the data sheet to write the following as ordinary numbers.

   a. The speed of light
   b. The charge on an electron

3. Write one quarter of a million in standard form.

4. Write these constants in ascending order (ignoring units).

   Permeability of free space
   The Avogadro constant
   Proton rest mass
   Acceleration due to gravity
   Mass of the Sun

Activity 10 Significant figures and rounding

1. A rocket can hold 7 tonnes of material.

   Calculate how many rockets would be needed to deliver 30 tonnes of material to a space station.

2. A power station has an output of 3.5 MW.

   The coal used had a potential output of 9.8 MW.

   Calculate the efficiency of the power station.

   Give your answer as a percentage to an appropriate number of significant figures.

3. A radioactive source produces 17 804 beta particles in 1 hour.

   Calculate the mean number of beta particles produced in 1 minute.

   Give your answer to one significant figure.

Activity 11 Fractions, ratios and percentages

1. The ratio of turns of wire on a transformer is 350 : 7000 (input : output)

   What fraction of the turns are on the input side?

2. A bag of electrical components contains resistors, capacitors and diodes.

   $^{2}/_{5}$ of the components are resistors.

   The ratio of capacitors to diodes in a bag is 1 : 5. There are 100 components in total.

   How many components are diodes?

3. The number of coins in two piles are in the ratio 5 : 3. The coins in the first pile are all 50p coins. The coins in the second pile are all £1 coins.

   Which pile has the most money?

4. A rectangle measures 3.2 cm by 6.8 cm. It is cut into four equal sized smaller rectangles.

   Work out the area of a small rectangle.

5. Small cubes of edge length 1 cm are put into a box. The box is a cuboid of length 5 cm, width 4 cm and height 2 cm.

   How many cubes are in the box if it is half full?

6. In a circuit there are 600 resistors and 50 capacitors. 1.5% of the resistors are faulty. 2% of the capacitors are faulty.

   How many faulty components are there altogether?

7. How far would you have to drill in order to drill down 2% of the radius of the Earth?

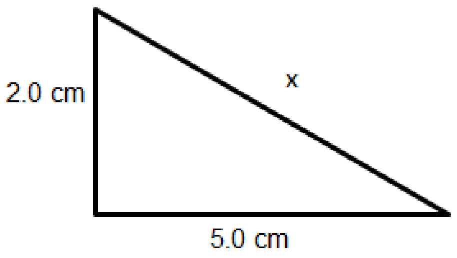
8. Power station A was online 94% of the 7500 days it worked for.

   Power station B was online $^{8}/_{9}$ of the 9720 days it worked for.

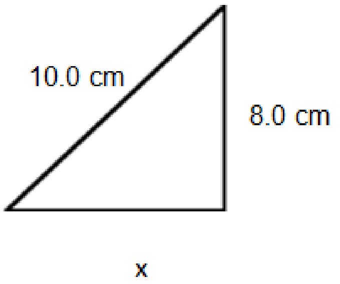
   Which power station was offline for longer?

Activity 12 Pythagoras' theorem

1. Calculate the length of side x.

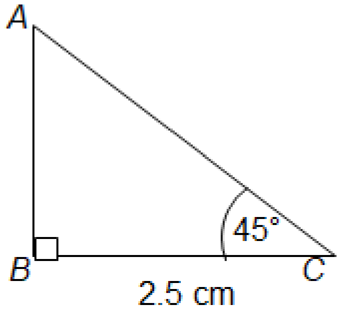


2. Calculate the length of side x.



Activity 13 Using sine, cosine and tangent

1. Calculate length AB



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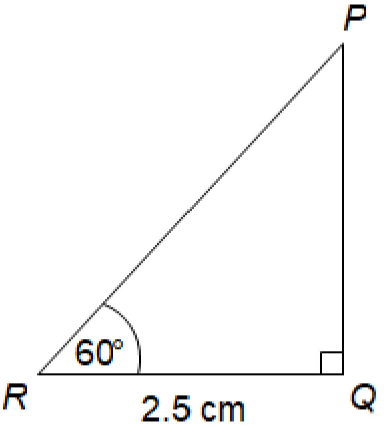
2. Calculate length PR



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Activity 14 Arithmetic means

1. The mean mass of 9 people is 79 kg.

   A 10th person is such that the mean mass increases by 1 kg

   What is the mass of the 10th person?

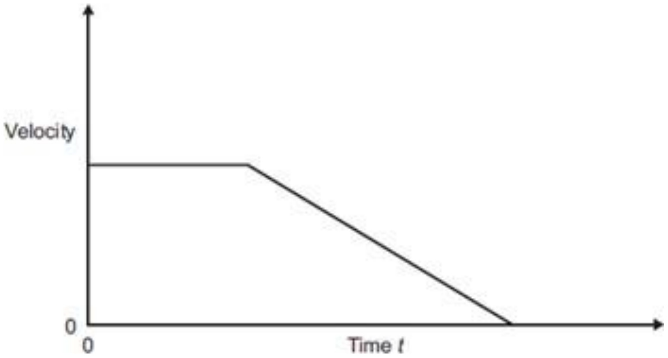
2. A pendulum completes 12 swings in 150 s.

   Calculate the mean swing time.

Activity 15 Gradients and areas

1. A car is moving along a road. The driver sees an obstacle in the road at time $t = 0$ and applies the brakes until the car stops.

   The graph shows how the velocity of the car changes with time.

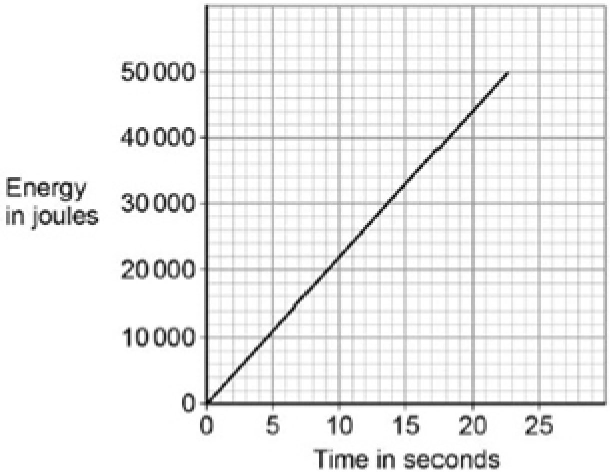


   From the list below, which letter represents:

   - the negative acceleration of the car
   - the distance travelled by the car?

   a. The area under the graph
   b. The gradient of the sloping line
   c. The intercept on the y axis

2. The graph shows how the amount of energy transferred by a kettle varies with time.



   The power output of the kettle is given by the gradient of the graph.

   Calculate the power output of the kettle.

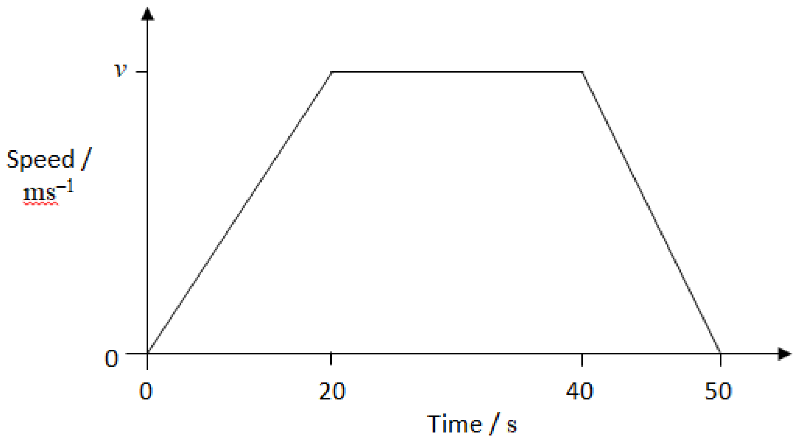
Activity 16 Gradients and areas

3. The graph shows the speed of a car between two sets of traffic lights.

   It achieves a maximum speed of *v* metres.

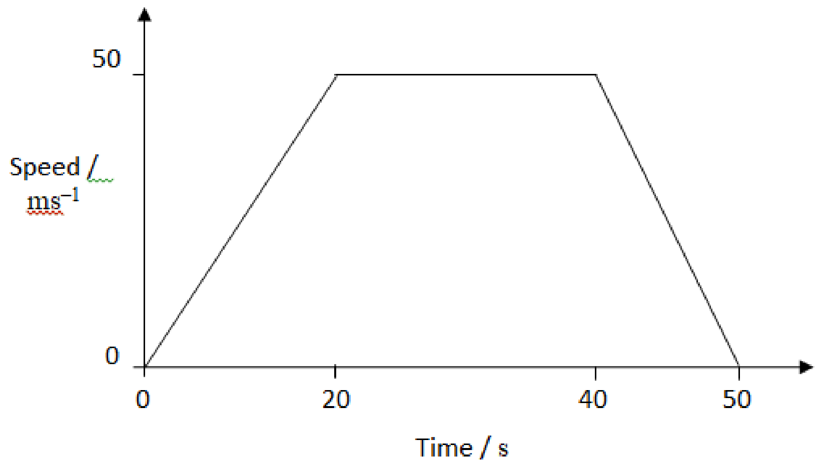
   per second. It travels for 50 seconds.

   The distance between the traffic lights is 625 metres.



   Calculate the value of v.

4. The graph shows the speed of a train between two stations.



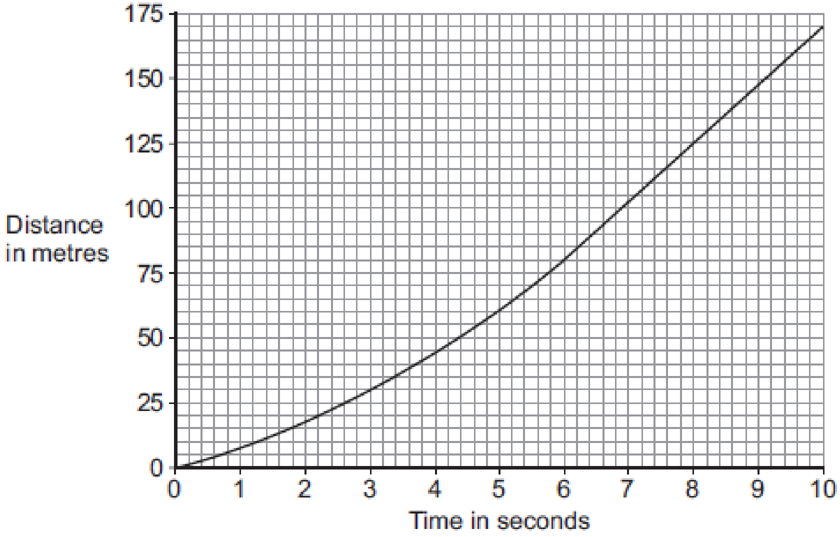
   (not drawn accurately)

   Calculate the distance between the stations.

Activity 17 Using and interpreting data in tables and graphs

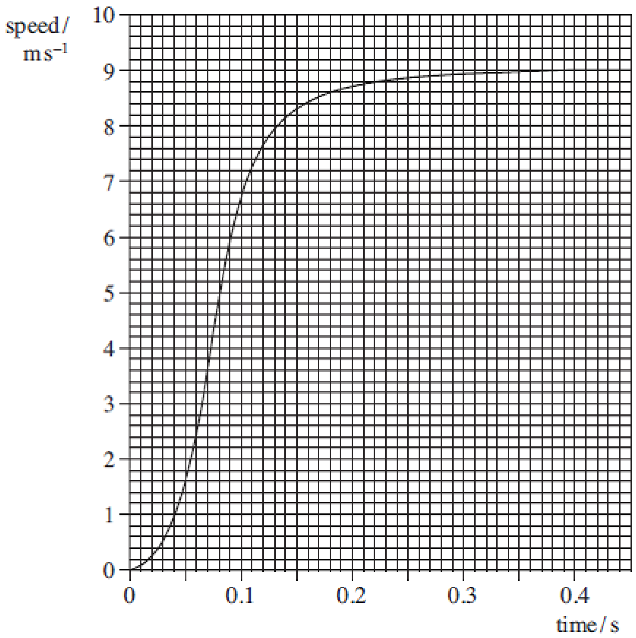
1. The graph shows the motion of a car in the first 10 seconds of its journey.

Figure 1



Use the graph to calculate the maximum speed the car was travelling at.

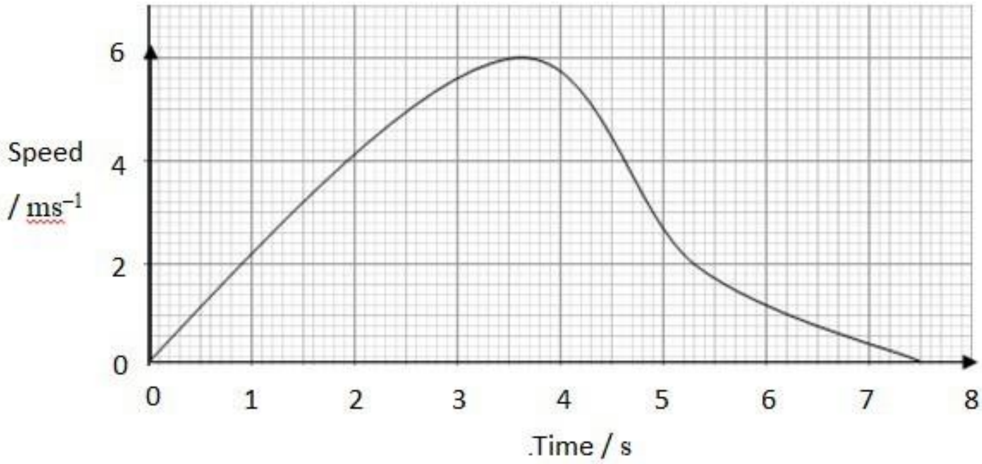
2. The figure below is a speed–time graph for a sprinter at the start of a race.



Determine the distance covered by the sprinter in the first 0.3 s of the race.

Activity 17 Using and interpreting data in tables and graphs

3. The graph shows the speed–time graph of a car.

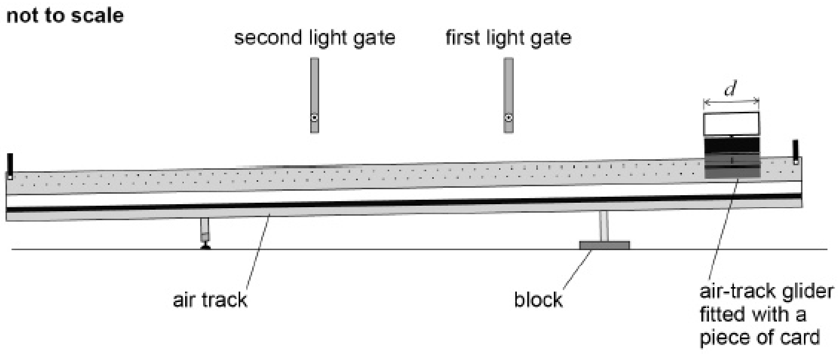


Use the graph to determine:

a. the maximum speed of the car
b. the total distance travelled
c. the average speed for the journey.

Activity 17 Using and interpreting data in tables and graphs

4. The diagram shows the apparatus used by a student to measure the acceleration due to gravity (g).



In the experiment:

- a block is used to raise one end of the air track
- an air-track glider is released from rest near the raised end of the air track and passes through the first light gate and then through the second light gate
- a piece of card of length *d* fitted to the air-track glider interrupts a light beam as the air-track glider passes through each light gate
- a data logger records the time taken by the piece of card to pass through each light gate and also the time for the piece of card to travel from one light gate to the other.

a. The table gives measurements recorded by the data logger.

Time to pass through first light gate / s	Time to pass through second light gate / s	Time to travel from first to second light gate / s
0.50	0.40	1.19

The length *d* of the piece of card is 10.0 cm.

Assume there is negligible change in velocity while the air-track glider passes through a light gate.

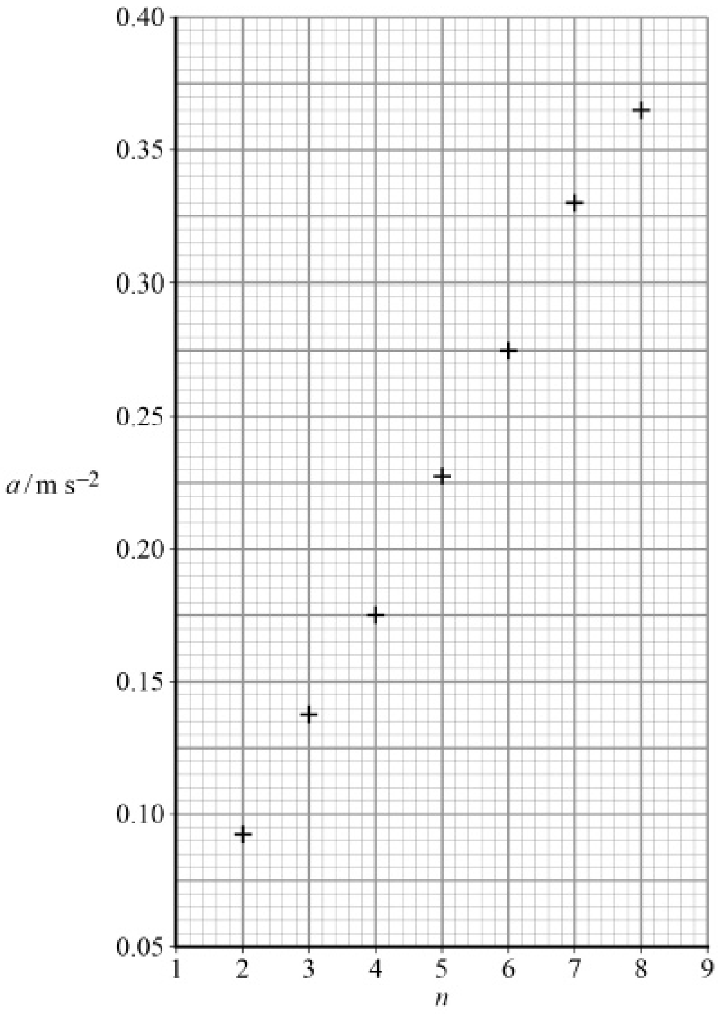
Determine the acceleration *a* of the air-track glider.

b. Additional values for the acceleration of the air-track glider are obtained by further raising the end of the air track by using a stack consisting of identical blocks.

Adding each block to the stack raises the end of the air track by the same distance.

Activity 17 Using and interpreting data in tables and graphs

Below is a graph of these results showing how *a* varies with *n*, the number of blocks in the stack.



Draw a line of best fit and then determine the gradient of your line (A).

c. It can be shown that, for the apparatus used by the student, *g* is equal to $\frac{2A}{h}$ where *h* is the thickness of each block used in the experiment.

The student obtains a value for *g* of 9.8 m s^{-2}

Calculate *h*.

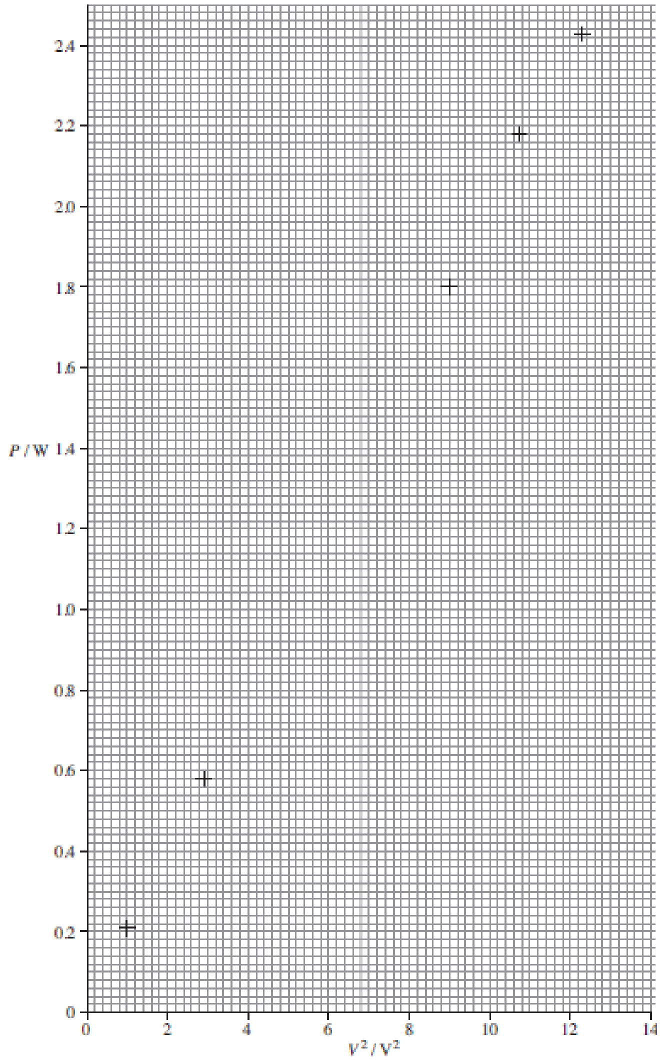
Activity 17 Using and interpreting data in tables and graphs

5. The power *P* dissipated in a resistor of resistance *R* is measured for a range of values of the potential difference *V* across it. The results are shown in the table.

V / V	V^2 / V^2	P / W
1.00	1.0	0.21
1.71	2.9	0.58
2.25		1.01
2.67		1.43
3.00	9.0	1.80
3.27	10.7	2.18
3.50	12.3	2.43

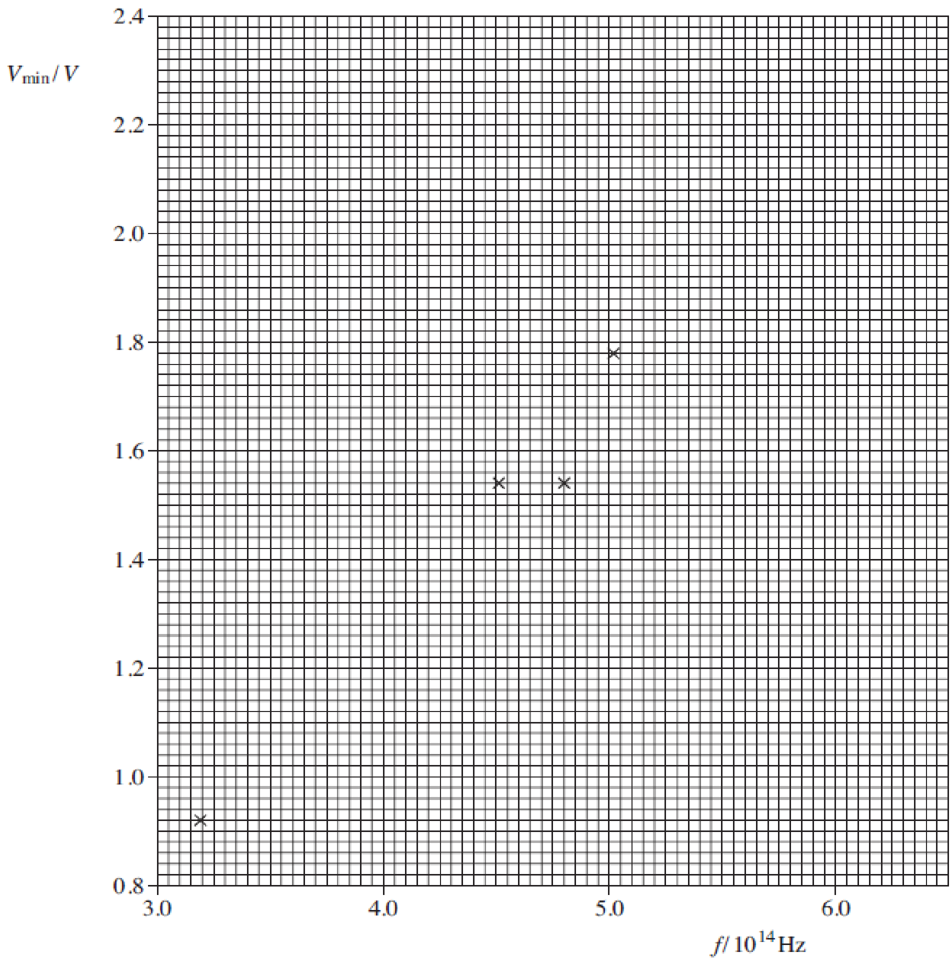
a. Complete the table.

b. Complete the graph below, and draw a line of best fit.



Activity 17 Using and interpreting data in tables and graphs
c. Determine the gradient of the graph. d. Use the gradient of the graph to obtain a value for *R*. The relationship is power = potential difference ^{2} / resistance

Activity 17 Using and interpreting data in tables and graphs



c. Determine the gradient of the graph.

d. Theory predicts that the energy lost by the electron in passing through the LED is the energy of the emitted photon. Hence

$eV_{min} = hf$,

where h is the Planck constant and $e = 1.60 \times 10^{-19}$ C.

Find a value for h by using the general equation of a straight line, $y = mx + c$, and your answer to part (c).

e. The accepted value for $h = 6.63 \times 10^{-34}$ J s. Calculate the percentage difference between the value calculated in part (d) and the accepted value.