A Level Physics

A transition guide for Year 11 students

AQA

Transition guide: Physics

We have created this student support resource to help you make the transition from GCSE to AS or A-level Physics.

Contents

You're studying AS or A-level Physics, congratulations!	2
Why study A-level Physics?	2
Possible degree options	2
Which career appeals to you?	3
Specification at a glance	3
Should you study AS or A-level?	4
The assessment for the AS consists of two exams	5
The assessment for the A-level consists of three exams	6
Resources to help	7
Useful information and activities	8
Greek letters	8
SI units	9
The delta symbol Δ	13
Important vocabulary for practical work	14
Maths help	16
Data Sheet	27

You're studying AS or A-level Physics, congratulations!

Studying physics after your GCSEs really develops your practical and mathematical skills. If you enjoy experimenting in the lab, you'll love it.

At first, you may find the jump in demand from GCSE a little daunting, but if you follow the tips and advice in this guide, you'll soon adapt.

We recommend you keep this somewhere safe, as you may like to refer to the information inside throughout your studies.

Why study A-level Physics?

Physicists explore the fundamental nature of almost everything we know of. They study everything from the fundamental particles that build matter, to the galaxies that make up the universe itself. Join them to enter a world deep beneath the surface of normal human experience.

Even if you don't decide to work in physics, studying it still develops useful and transferable skills for other careers. You'll develop research, problem solving and analytical skills, alongside teamwork and communication. Universities and business regard all of these very highly.

Possible degree options

According to bestcourse4me.com the top seven degree courses taken by students who have A-level Physics are:

- mathematics
- physics
- mechanical engineering
- computer science
- civil engineering
- economics
- business.

For more details, go to bestcourse4me.com or UCAS.

Which career appeals to you?

Studying Physics at A-level or degree level opens up all sorts of career opportunities.

- Geophysicist/field seismologist
- Healthcare scientist, medical physics
- Higher education lecturer or secondary school teacher
- Radiation protection practitioner
- Research scientist (physical sciences)
- Scientific laboratory technician
- Meteorologist
- Structural or Acoustic engineer
- Product/process development scientist
- Systems developer
- Technical author.

You can also move into engineering, astrophysics, chemical physics, nanotechnology, renewable energy and more. With physics, the opportunities are endless.

Specification at a glance

AS and A-level

1 Measurements and their errors

2 Particles and radiation

3 Waves

4 Mechanics and materials

5 Electricity

A-level only

6 Further mechanics and thermal physics

7 Fields and their consequences

8 Nuclear physics

9 Optional topics. You will study one of these: Astrophysics, Medical physics, Engineering physics, Turning points in physics or Electronics.

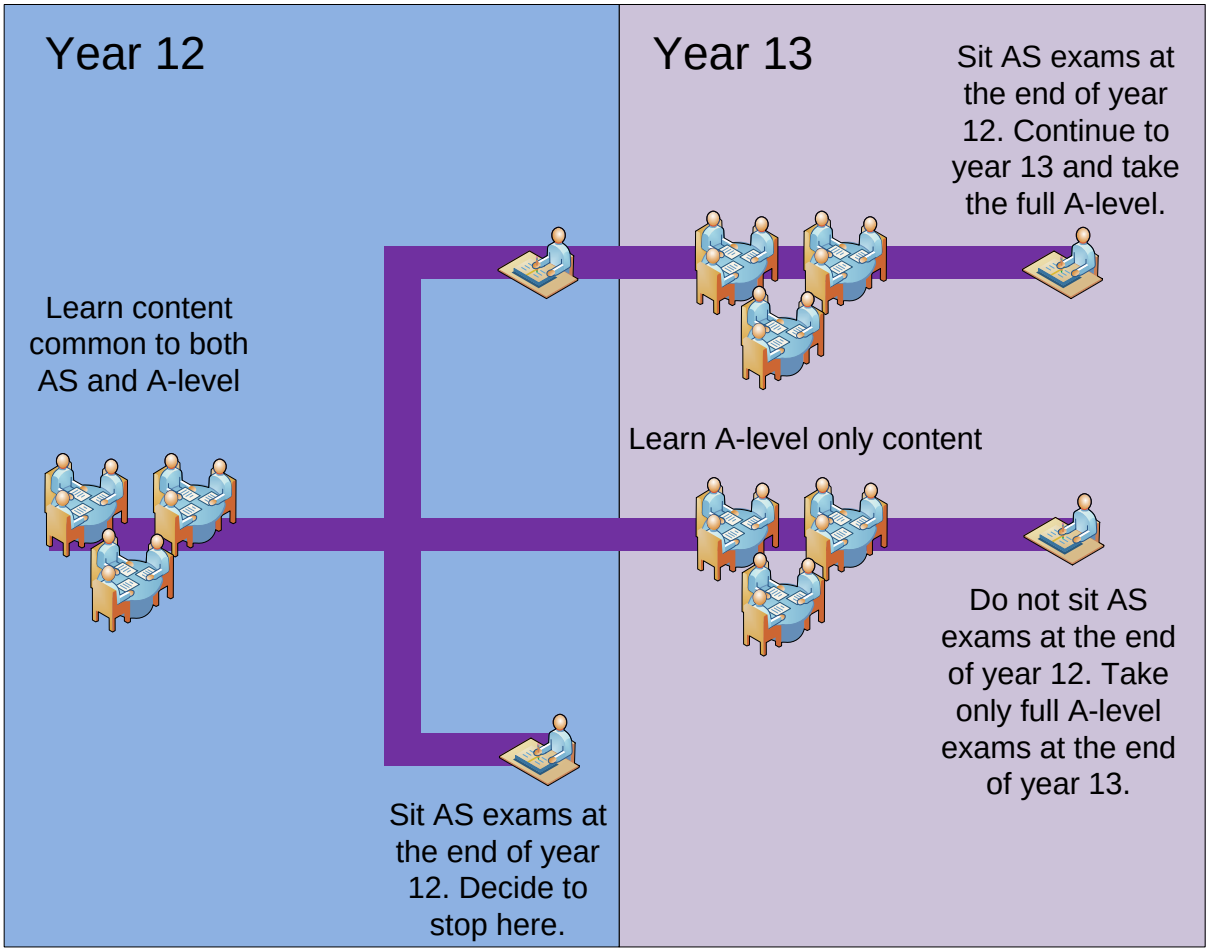
Should you study AS or A-level?

AS and A-level are separate qualifications.

An AS lasts one year. Your exam results don't count towards an A-level, but they're still valuable and AS points are accepted by higher education institutions.

Despite being separate from an A-level, AS course content is the same as the first year of A-level. If you want to switch from an AS to an A-level, you can. Your teacher will help you decide whether it's the right move for you.

All exams for the AS take place at the end of the one-year course. Exams for the A-level take place at the end of the two-year course.



The assessment for the AS consists of two exams

Paper 1	+	Paper 2
What's assessed Sections 1 – 5		What's assessed Sections 1 – 5
Assessed • written exam: 1 hour 30 minutes • 70 marks • 50% of AS		Assessed • written exam: 1 hour 30 minutes • 70 marks • 50% of AS
Questions 70 marks of short and long answer questions split by topic.		Questions Section A: 20 marks of short and long answer questions on practical skills and data analysis. Section B: 20 marks of short and long answer questions from across all areas of AS content. Section C: 30 multiple choice questions

The assessment for the A-level consists of three exams

Paper 1	Paper 2	Paper 3
What's assessed Sections 1 – 5 and 6.1 (Periodic motion)	What's assessed Sections 6.2 (Thermal Physics), 7 and 8 Assumed knowledge from sections 1 to 6.1	What's assessed Section A: Compulsory section: Practical skills and data analysis Section B: Optional topic
Assessed • written exam: 2 hours • 85 marks • 34% of A-level	Assessed • written exam: 2 hours • 85 marks • 34% of A-level	Assessed • written exam: 2 hours • 80 marks • 32% of A-level
Questions 60 marks of short and long answer questions and 25 multiple choice questions on content.	Questions 60 marks of short and long answer questions and 25 multiple choice questions on content.	Questions 45 marks of short and long answer questions on practical experiments and data analysis. 35 marks of short and long answer questions on optional topic.

Resources to help

Our website is a great place to start.

Our Physics webpages are aimed at teachers, but you may find them useful too. Information includes:

- The specification – this explains exactly what you need to learn for your exams.
- Practice exam papers
- Lists of command words and subject specific vocabulary – so you understand the words to use in exams
- Practical handbooks explain the practical work you need to know
- Past papers from the old specification. Some questions won't be relevant to the new AS and A-level, so please check with your teacher.
- Maths skills support.

Institute of Physics (IOP)

The IOP do everything from research like that taking place at CERN to lobbying MPs. You'll find lots of handy resources on their website at iop.org/tailored/students/

The student room

Join the A-level Physics forums and share thoughts and ideas with other students if you're stuck with your homework. Just be very careful not to share any details about your assessments, there are serious consequences if you're caught cheating. Visit thestudentroom.co.uk

Textbooks

Our approved textbooks are published by Collins, Hodder and Oxford University Press. Textbooks from other publishers will also be suitable, but you'll need to double check that the content and formula symbols they use match our specification.

Revision guides

These are great if you want a quick overview of the course when you're revising for your exams. Remember to use other tools as well, as these aren't detailed enough on their own.

YouTube

YouTube has thousands of Physics videos. Just be careful to look at who produced the video and why because some videos distort the facts. Check the author, date and comments – these help indicate whether the clip is reliable. If in doubt, ask your teacher.

Magazines

Focus, New Scientist or Philip Allan updates can help you put the physics you're learning in context.

Useful information and activities

Greek letters

Greek letters are used often in science. They can be used as symbols for numbers (such as π = 3.14...), as prefixes for units to make them smaller (eg μm = 0.000 000 001 m) or as symbols for particular quantities (such as λ which is used for wavelength).

The Greek alphabet is shown below.

Α	α	alpha
Β	β	beta
Γ	γ	gamma
Δ	δ	delta
Ε	ε	epsilon
Ζ	ζ	zeta
Η	η	eta
Θ	θ	theta
Ι	ι	iota
Κ	κ	kappa
Λ	λ	lambda
Μ	μ	mu

Ν	ν	nu
Ξ	ξ	ksi
Ο	ο	omicron
Π	π	pi
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 1

List all of the uses of Greek letters that you have encountered in your GCSE Science and Maths studies.

SI units

Every measurement must have a size (eg 2.7) and a unit (eg metres or °C). Sometimes, there are different units available for the same type of measurement. For example ounces, pounds, kilograms and tonnes are all used as units for mass.

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.

The seven SI base units are:

Physical quantity	Usual quantity symbol	Unit	Abbreviation
mass	m	kilogram	kg
length	l or x	metre	m
time	t	second	s
electric current	I	ampere	A
temperature	T	kelvin	K
amount of substance	N	mole	mol
luminous intensity	(not used at A-level)	candela	cd

All other units can be derived from the SI base units. For example, area is measured in square metres (written as m^2) and speed is measured in metres per second (written as ms^{-1}).

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

Physical quantity	Usual quantity symbol	Unit	Abbreviation	SI unit
Force	F	newton	N	$\mathrm{kg\ m\ s^{-2}}$
Energy	E or W	joule	J	$\mathrm{kg\ m^2\ s^{-2}}$
Frequency	f	hertz	Hz	$\mathrm{S^{-1}}$

It is not always appropriate to use a full unit. For example, measuring the width of a hair or the distance from Manchester to London in metres would cause the numbers to be difficult to work with.

Prefixes are used to multiply each of the units. You will be familiar with centi (meaning 1/100), kilo (1000) and milli (1/1000) from centimetres, kilometres and millimetres.

There is a wide range of prefixes. The majority of quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, a distance of 33 000 m would be quoted as 33 km. The most common prefixes you will encounter are:

Prefix	Symbol	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 2

Which SI unit and prefix would you use for the following quantities?

1. The length of a finger
2. The temperature of boiling water
3. The time between two heart beats
4. The width of an atom
5. The mass of iron in a bowl of cereal
6. The current in a simple circuit using a 1.5 V battery and bulb

Sometimes, there are units that are used that are not combinations of SI units and prefixes.

These are often multiples of units that are helpful to use. For example, a light year is a distance of 9.46×10^{12} km.

Activity 3

Re-write the following in SI units.

1. 1 minute

2. 1 hour

3. 1 tonne

Activity 4

Re-write the following quantities:

1. 1502 metres in kilometres

2. 0.000 45 grams in micrograms

3. 0.000 45 metres in millimetres

4. 1055 kilometres in metres

5. 180 megaseconds in seconds

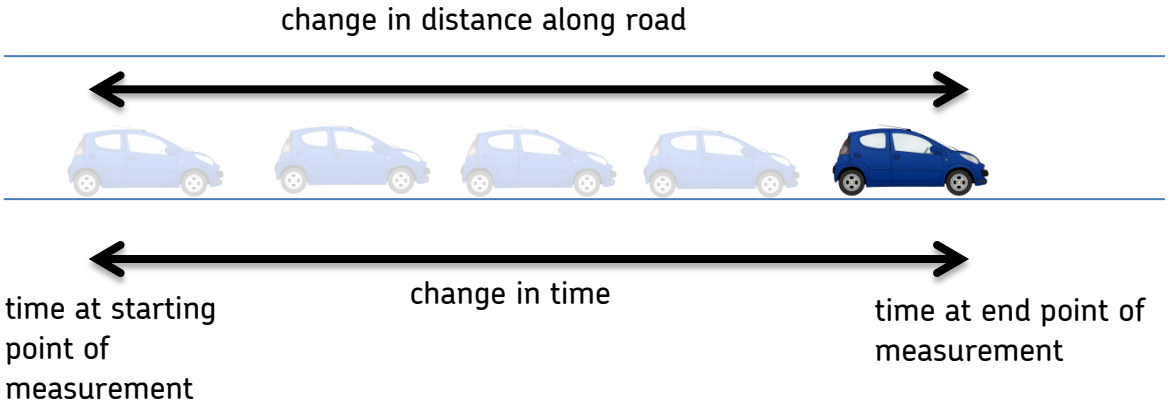
6. 2500 centimetres in millimetres

The delta symbol Δ

The delta symbol is used to mean “change in”. For example, at GCSE, you would have learned the formula:

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

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.



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

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

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.

Activity 5

Research exercise

1. Find out the difference between:

   speed and velocity

   distance and displacement

2. Look at the A-level Physics formula sheet on the AQA website (it's under "assess" on the Physics A-level page). Which equations look similar to ones you've encountered at GCSE, but include the delta symbol?

Important vocabulary for practical work

There are many words used in practical work. You will have come across most of these words in your GCSE studies. It is important that you are using the right definition for each word. The activity on the next page tests your understanding of terms used in practical work.

Activity 6

Join the boxes to link the word to its definition.

Accurate	A statement suggesting what may happen in the future.
Data	An experiment that gives the same results when a different person carries it out, or a different set of equipment or technique is used.
Precise	A measurement that is close to the true value.
Prediction	An experiment that gives the same results when the same experimenter uses the same method and equipment.
Range	Physical, chemical or biological quantities or characteristics.
Repeatable	A variable that is kept constant during an experiment.
Reproducible	A variable that is measured as the outcome of an experiment.
Resolution	This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.
Uncertainty	The interval within the true value can be expected to lie.
Variable	The spread of data, showing the maximum and minimum values of the data.
Control variable	Measurements where repeated measurements show very little spread.
Dependent variable	Information, in any form, that has been collected.

Maths help

Physics uses the language of mathematics to make sense of the world. It is important that you are able to use maths. The following exercises will help you to practise some of the maths you have covered during your GCSE studies to help with your A-level course.

Activity 7: Standard form

1. Write in standard form

   (a) 379.4

   (b) 0.0712

2. Write as ordinary numbers (use the data sheet on the last page of this booklet):

   (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.

5. Work out the value of the following.

   Give your answer in standard form.

   The mass of an electron/the mass of the Earth (use the data sheet).

6. Solve $(2.4 \times 10^{7})x = 1.44 \times 10^{9}$

   Give your answer in standard form.

Activity 8: Decimal places, significant figures and rounding

1. How many rockets would be needed to deliver 30 tonnes of material to a space station, if every rocket could hold 7 tonnes?

2. A power station has an output of 3.5 MW. The coal used had a potential output of 9.8 MW.

   Work out the efficiency of the power station.

   Give your answer as a percentage to one decimal place.

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 9: 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.

   $\frac{2}{5}$ 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?

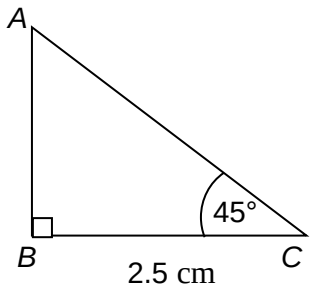
8. Power station A was online 94% of the 7500 days it worked for.

   Power station B was online $\frac{8}{9}$ of the 9720 days it worked for.

   Which power station was offline for longer?

Activity 10: Use sine, cosine and tangent

1 (a) Work out the length of *AB*.



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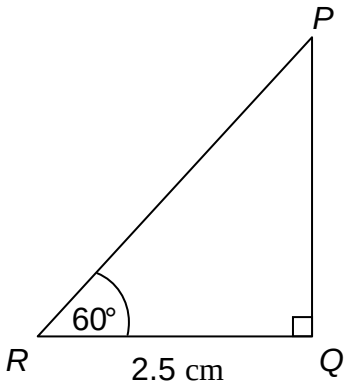
(b) Work out the length of *PR*.



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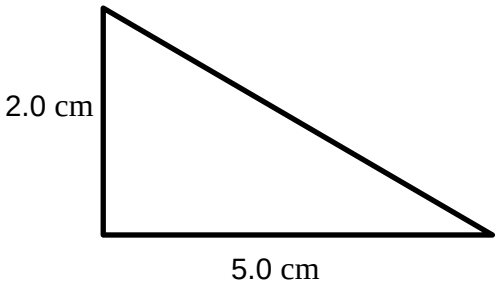
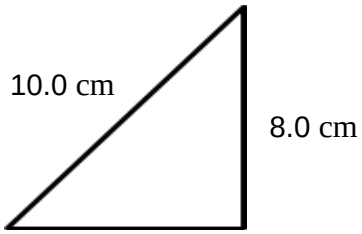
Activity 11: Pythagoras's theorem

Work out the lengths of the unlabelled sides.





Activity 12: Arithmetic means

1. The mean weight of 9 people is 79 kg

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

   How heavy is the 10th person?

2. A pendulum completes 12 swings in 150 s.

   Work out the mean swing time.

Activity 13: Rearranging formulas

1. Rearrange $y = 2x + 3$ to make x the subject.

2. Rearrange $C = 2\pi r$ to make r the subject.

3. Rearrange $E = \frac{1}{2}mv^2$ to make v the subject.

4. Rearrange $s = ut + \frac{1}{2}at^2$ to make u the subject.

5. Rearrange $s = ut + \frac{1}{2}at^2$ to make a the subject.

6. Rearrange $\omega = \frac{v}{r}$ to make r the subject.

7. Rearrange $T = 2\pi\sqrt{\frac{v}{r}}$ to make r the subject.

8. Rearrange $v = \omega\sqrt{A^2 - x^2}$ to make x the subject.

Note: in science, subscripts are often used to label quantities. So in the following two examples, there are two masses, m_1 and m_2. The 1 and 2 are part of the quantity and should be kept with the m.

9. Rearrange $F = \frac{Gm_1m_2}{r^2}$ to make m_2 the subject.

10. Rearrange $F = \frac{Gm_1m_2}{r^2}$ to make r the subject.

Activity 14: Graphs

1. The cost of hiring a piece of equipment is given by the formula $C = 8d + 10$, where d is the number of days for which the equipment is hired and C (£) is the total cost of hire.

   Add a line to the graph to show this equation $C = 8d + 10$

2. For the above graph, what was the deposit required for hiring the equipment?

3. Another shop hires out equipment where the cost of hire is given by the formula $C = 5d + 24$

   Josh says that the first supplier is always cheaper if you want to hire equipment.

   Add this formula to the graph.

   Is he correct? Give reasons for your answer.

Activity 14: Graphs (continued)

4. The cost of hiring a laser is worked out as follows:

   Fixed charge = £28

   Cost per day = £12

   Draw a graph to work out the cost of hiring the laser for 6 days.

5. Another firm hires out a laser machine for £22 fixed charge, plus the cost of the first 2 days at £20 per day, then £8 for each additional day.

   Draw a graph on the same axes as the one above to show the cost of hiring the laser for 6 days.

   Which firm would you use to hire the laser machine for 5 or more days?

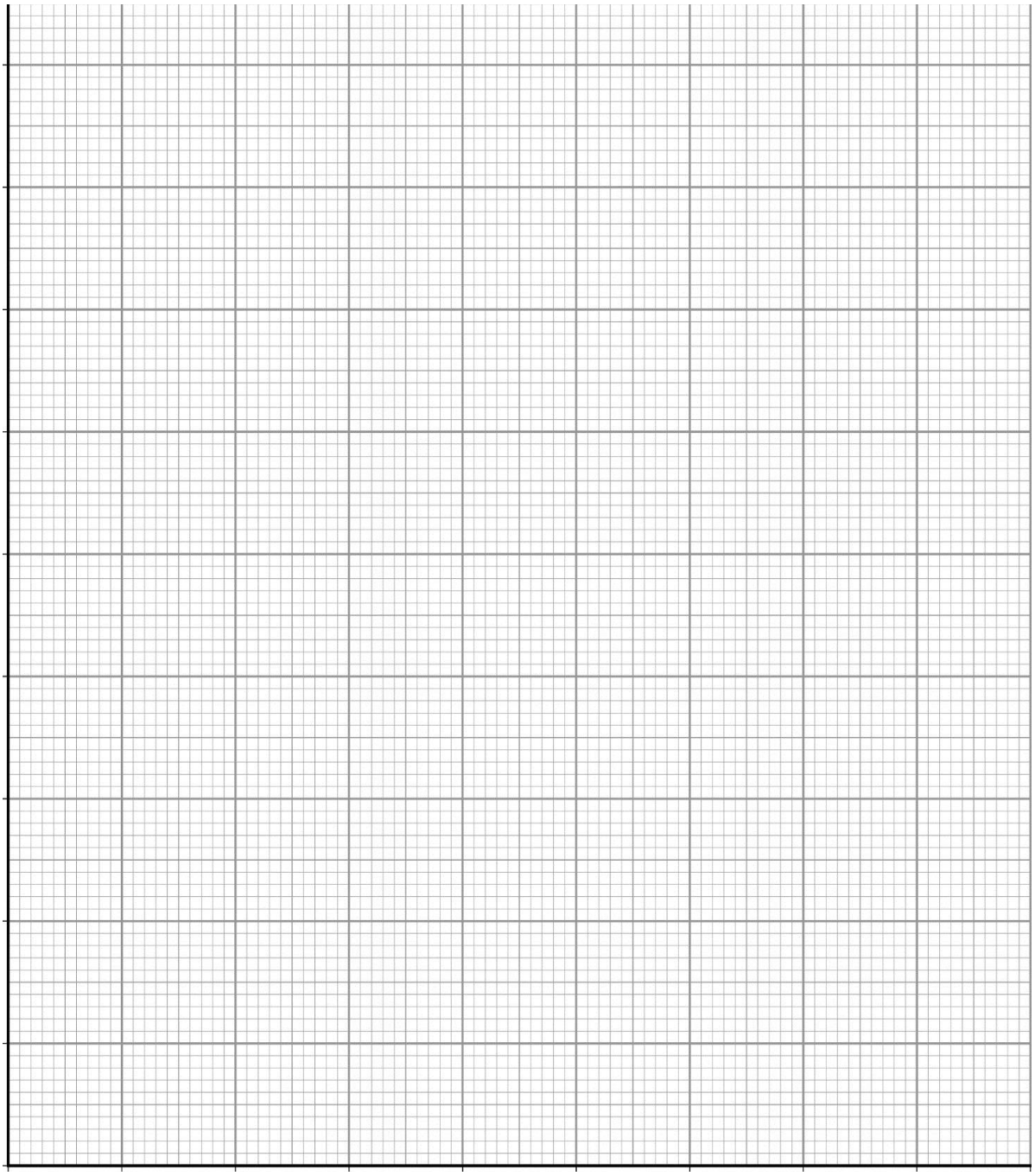
   Give reasons for your answer.

Activity 14: Graphs (continued)

6. Draw graphs of the following functions from $x = -3$ to $x = +3$

   Choose axes that allow all values of all graphs to be shown.

   $y = x^2$, $y = x^3$ and $y = \sqrt{(x)}$ for positive numbers only .



Activity 15: Gradients and areas

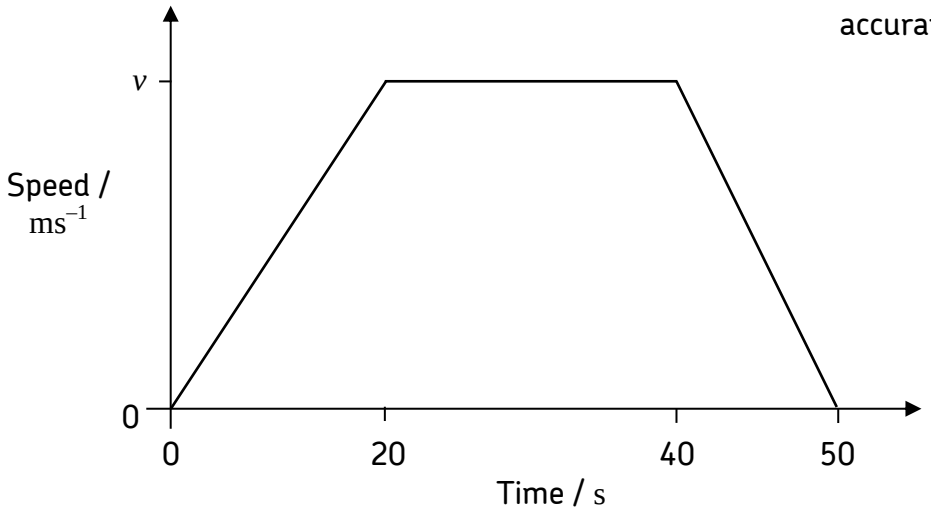
1. The graph shows the speed of a car between two sets of traffic lights.

   It achieves a maximum speed of v metres per second.

   It travels for 50 seconds.

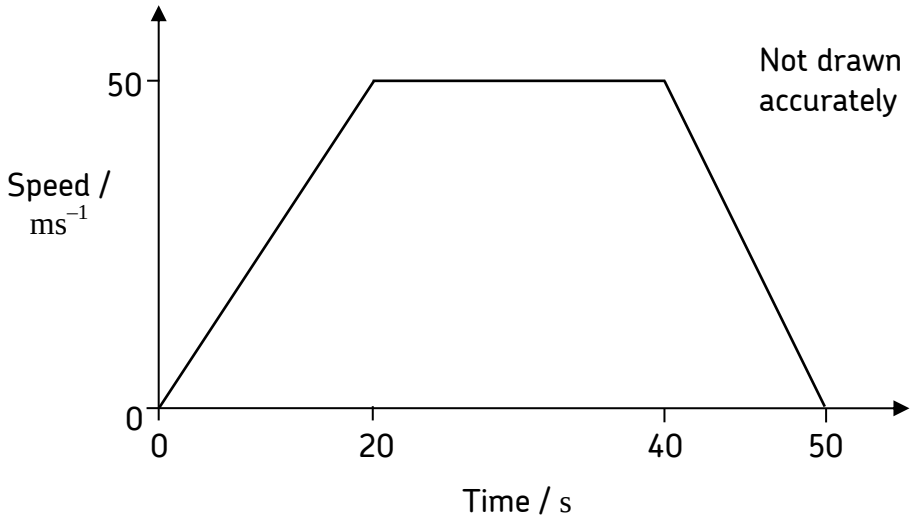
   The distance between the traffic lights is 625 metres.

Not drawn accurately



Calculate the value of v

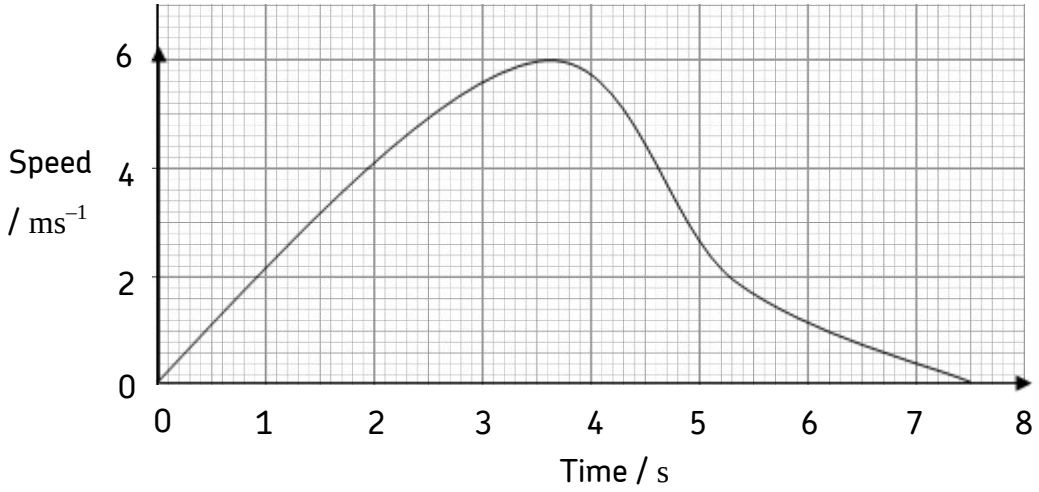
2. The graph shows the speed of a train between two stations.



Calculate the distance between the stations.

Activity 16: Non-linear graphs

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



Use the graph to work out:

a. The maximum speed of the car.

b. The total distance travelled.

c. The average speed for the journey.

d. The deceleration of the car after 8 seconds.

There are a number of activities throughout this resource. The answers to some of the activities are available on our secure website, e-AQA. Your teacher will be able to provide you with these answers.

Data Sheet

Quantity	Symbol	Value	Units
speed of light in vacuo	c	3.00×10^{8}	$\mathrm{m\ s^{-1}}$
permeability of free space	μ_0	$4\pi \times 10^{-7}$	$\mathrm{H\ m^{-1}}$
permittivity of free space	ε_0	8.85×10^{-12}	$\mathrm{F\ m^{-1}}$
magnitude of the charge of electron	e	1.60×10^{-19}	C
the Planck constant	h	6.63×10^{-34}	J s
gravitational constant	G	6.67×10^{-11}	$\mathrm{N\ m^2\ kg^{-2}}$
the Avogadro constant	N_A	6.02×10^{23}	$\mathrm{mol^{-1}}$
electron rest mass	m_e	9.11×10^{-31}	kg
proton rest mass	m_p	$1.67(3) \times 10^{-27}$	kg
neutron rest mass	m_n	$1.67(5) \times 10^{-27}$	kg
gravitational field strength	g	9.81	$\mathrm{N\ kg^{-1}}$
acceleration due to gravity	g	9.81	$\mathrm{m\ s^{-2}}$
atomic mass unit	u	1.661×10^{-27}	kg
mass of the Sun		1.99×10^{30}	kg
mean radius of the Sun		6.96×10^{8}	m
mass of the Earth		5.98×10^{24}	kg
mean radius of the Earth		6.37×10^{6}	m