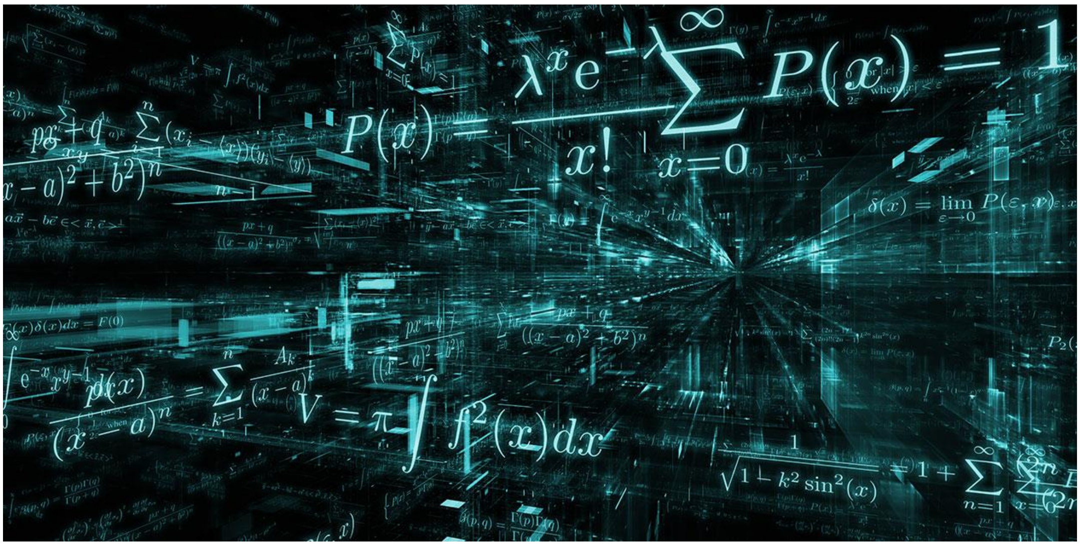
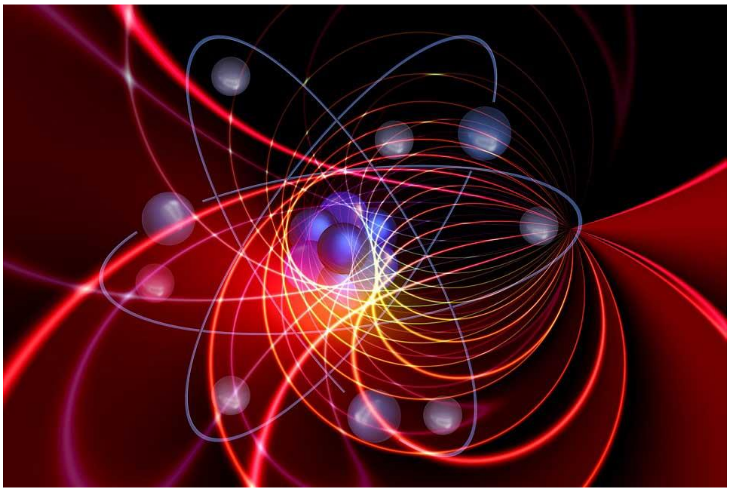
2023 Entry

HILLCREST SIXTH FORM





Physics Summer Bridging Work

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 the Physics Welcome Pack, you’ll soon adapt. I recommend you consult the **Physics Welcome Pack** before you start the course and keep it somewhere safe, as you may like to refer to the information inside throughout your studies.

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.

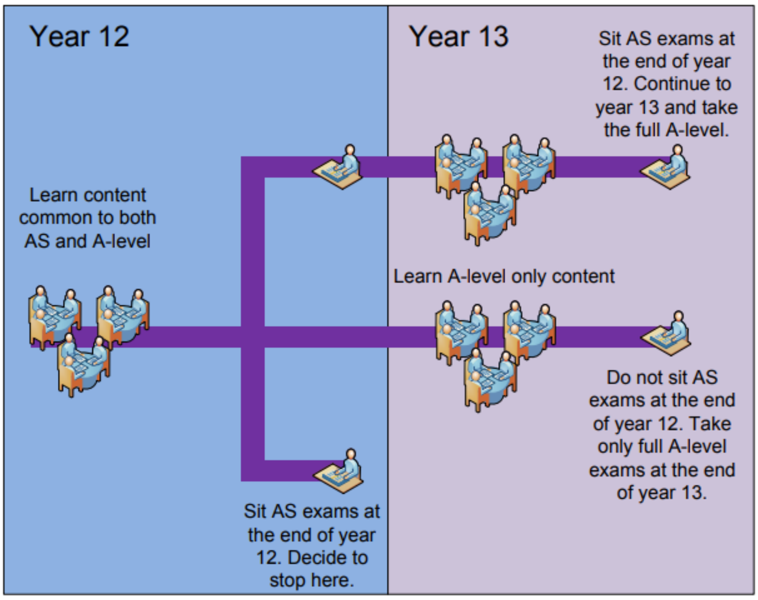
A-level only:

- 6. Further mechanics and thermal physics;
- 7. Fields and their consequences;
- 8. Nuclear physics;
- 9. Optional module (TBC in summer 2021). Options include astrophysics, medical physics, engineering physics, turning points in physics or electronics.

Studying 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. I 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.



Mr Squires tsquires@hillcrest.bham.sch.uk

Assessment

The assessment for AS consists of two examinations:

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 examinations:

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.

As well as written examinations at the end of the course, your practical work will be continuously assessed using the Common Practical Assessment Criteria (CPAC). Upon completion of the course, alongside your grade you will receive a practical endorsement. The practical endorsement is given as a pass or fail on your qualification certificate. See the **Physics practical handbook** for more information.

Bridging work

Although A-level Mathematics is not an absolute requirement to study A-level Physics, it is strongly advised that those studying A-level Physics also study A-level Mathematics. It is crucial for your success in A-level Physics that you are confident with the mathematical skills and techniques in this booklet. Completing this booklet is a prerequisite before starting the A-level Physics course in September.

During your first week in Year 12 at Hillcrest you will be given a 'Benchmark Physics' test, which will test your mathematic understanding and will include topics such as rearranging equations, trigonometry, rounding, SI units, standard form, significant figures, substituting numbers into formulae, prefixes (e.g. kilo, mega etc) and graphs. Completing this booklet will help you prepare for the test. I have provided a lot of additional detail and useful information to help you complete the activities. I have also attached the A-level Physics equation sheet to the conclusion of this booklet for your reference.

Your tasks

1. Read through the whole booklet.
2. Read through the booklet again, completing the activities as you go.
3. If there are any sections you do not understand then you need to research them and then seek help if you still don't understand (consult the 'resources to help' section of the **Physics Welcome Pack**).
4. Revise using the booklet for the Benchmark Physics test in the first week of the course.
5. Write a one page A4 letter, addressed to Mr Squires and Mr Gale, about the areas of Physics which you most enjoy, are most looking forward to studying at A-level and any interesting recent Physics news and developments which you have researched and would like to share. Also include any hesitations or concerns about starting the course, if you have any. This letter provides an opportunity for me to get to know you and your interests in greater detail.

Please be prepared to hand in the following completed activities and your letter to me in your first lesson.

Please work hard at mastering the techniques in this booklet, as experience has shown that students who struggle with these concepts tend to find Physics A-level very difficult.

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

Mr Squires tsquires@hillcrest.bham.sch.uk

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	$kg\ m\ s^{-2}$
Energy	E or W	joule	J	$kg\ m^2\ s^{-2}$
Frequency	f	hertz	Hz	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

Mr Squires tsquires@hillcrest.bham.sch.uk

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

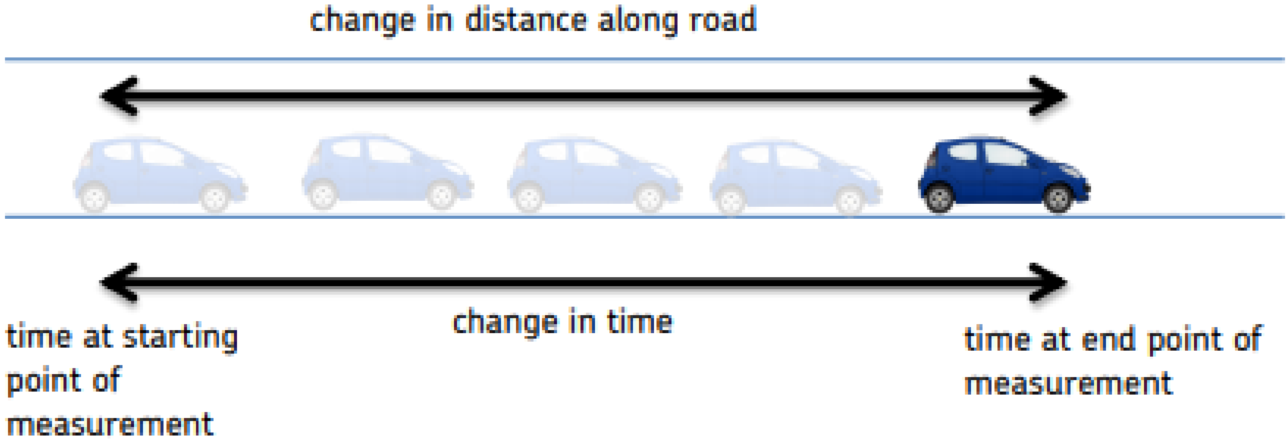
Mr Squires tsquires@hillcrest.bham.sch.uk

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.

Mr Squires tsquires@hillcrest.bham.sch.uk

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.

Mr Squires tsquires@hillcrest.bham.sch.uk

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.

Mr Squires tsquires@hillcrest.bham.sch.uk

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.

Mr Squires tsquires@hillcrest.bham.sch.uk

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.

Mr Squires tsquires@hillcrest.bham.sch.uk

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.

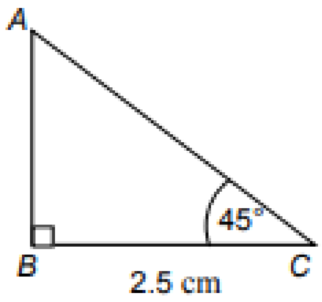
   Power station B was online $\frac{8}{9}$ of the 9720 days it worked for.

   Which power station was offline for longer?

Mr Squires tsquires@hillcrest.bham.sch.uk

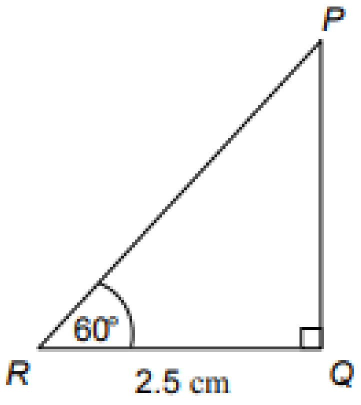
Activity 10: Use sine, cosine and tangent

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



(Not drawn accurately)

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

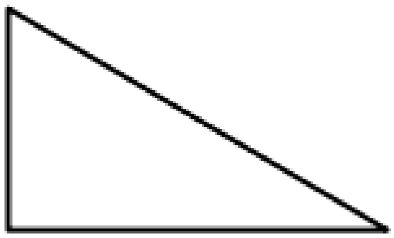


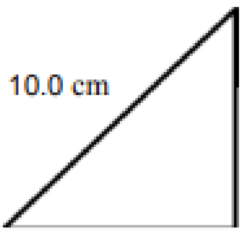
(Not drawn accurately)

Mr Squires tsquires@hillcrest.bham.sch.uk

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.

Mr Squires tsquires@hillcrest.bham.sch.uk

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.

Mr Squires tsquires@hillcrest.bham.sch.uk

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.

Mr Squires tsquires@hillcrest.bham.sch.uk

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.

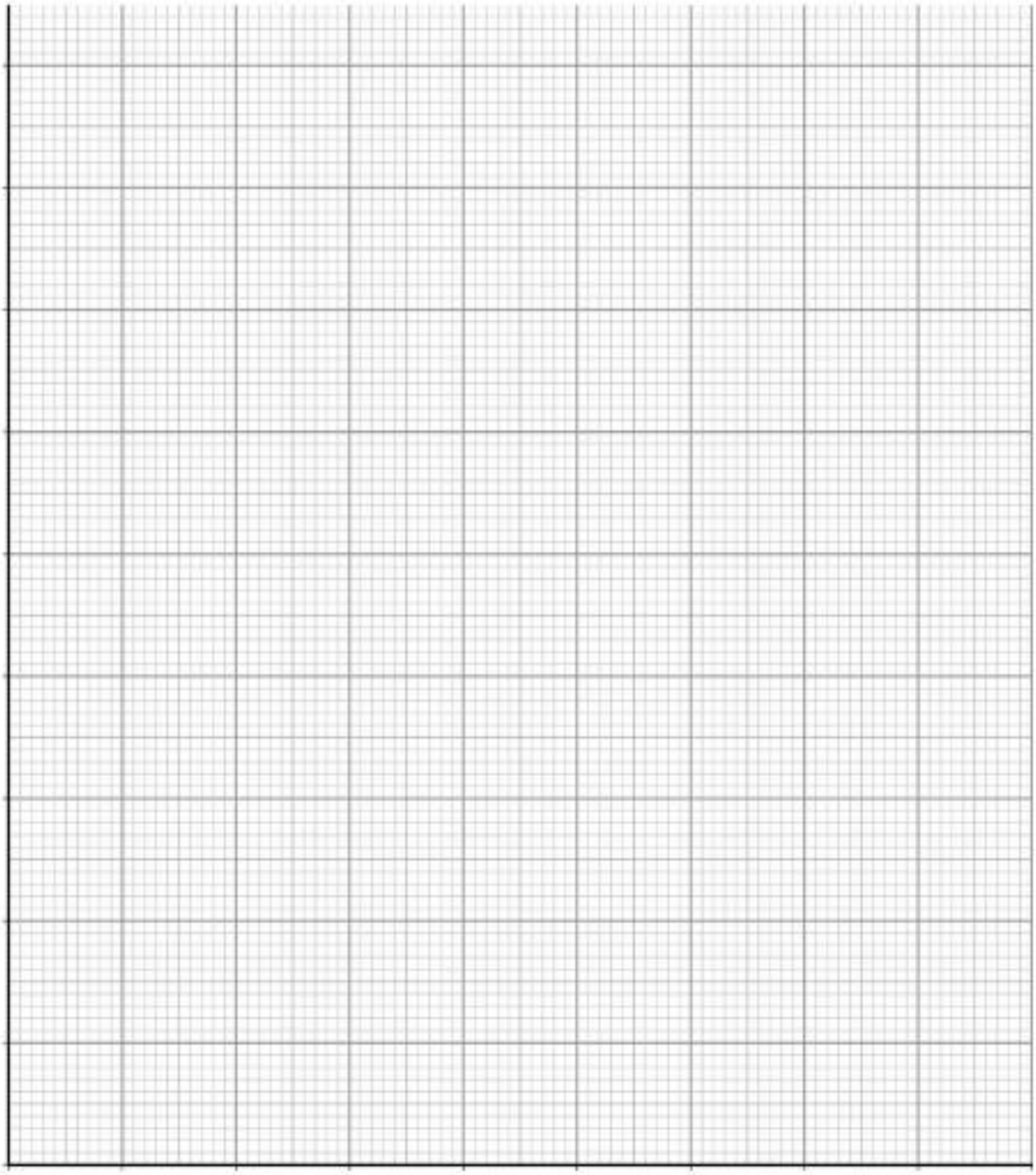
Mr Squires tsquires@hillcrest.bham.sch.uk

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 .



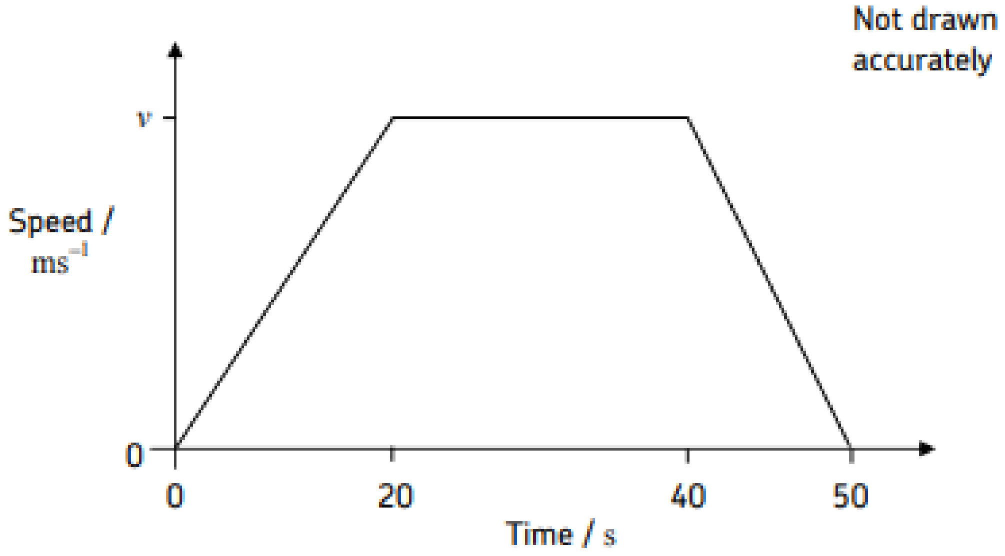
Activity 15: Gradients and areas

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.

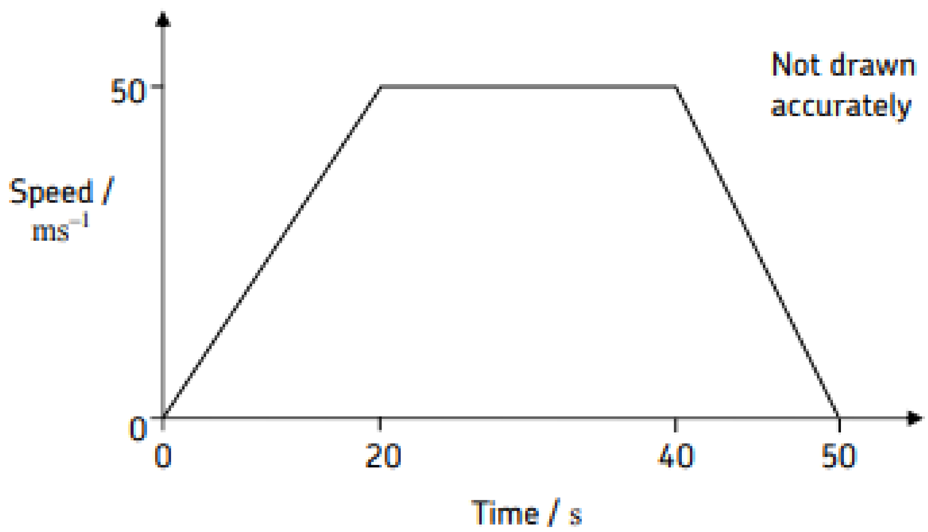
   It travels for 50 seconds.

   The distance between the traffic lights is 625 metres.



   Calculate the value of v

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

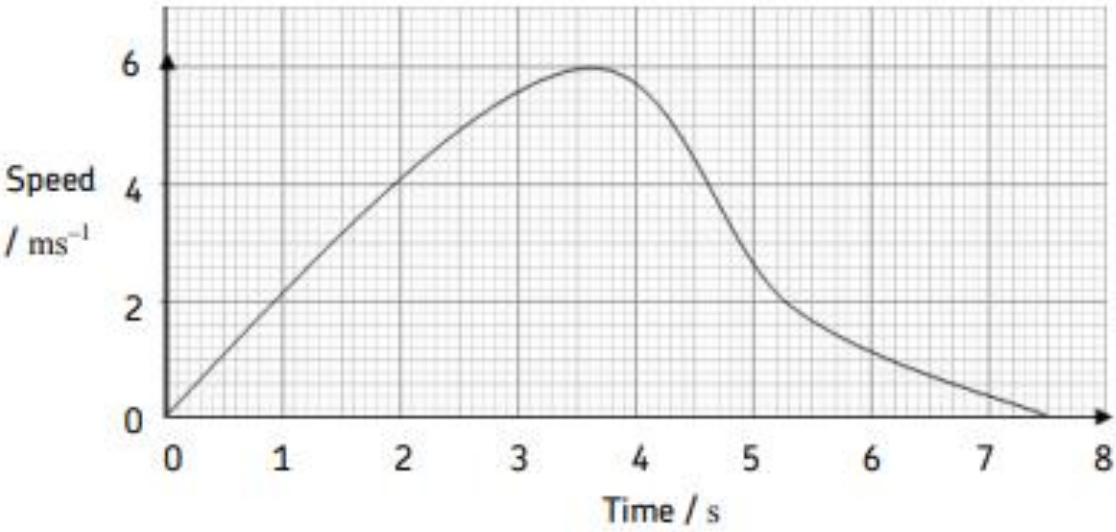


   Calculate the distance between the stations.

Mr Squires tsquires@hillcrest.bham.sch.uk

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.

Mr Squires tsquires@hillcrest.bham.sch.uk

Equation sheet

You will need to learn to love your equation sheet – every physicist's best friend.

Equations… learn, love and live them.

Quantity	Symbol	Value	Units
speed of light in vacuo	c	3.00×10^{8}	$m\ s^{-1}$
permeability of free space	μ_0	$4\pi \times 10^{-7}$	$H\ m^{-1}$
permittivity of free space	ε_0	8.85×10^{-12}	$F\ m^{-1}$
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}	$N\ m^{2}\ kg^{-2}$
the Avogadro constant	N_A	6.02×10^{23}	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	$N\ kg^{-1}$
acceleration due to gravity	g	9.81	$m\ s^{-2}$
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

Particle Physics

Class	Name	Symbol	Rest energy/MeV
photon	photon	γ	0
lepton	neutrino	ν_e	0
		ν_μ	0
	electron	$e^\pm$	0.510999
	muon	$\mu^\pm$	105.659
mesons	π meson	$\pi^\pm$	139.576
		π^0	134.972
	K meson	$K^\pm$	493.821
		K^0	497.762
baryons	proton	p	938.257
	neutron	n	939.551

Properties of quarks

antiquarks have opposite signs

Type	Charge	Baryon number	Strangeness
u	$+\frac{2}{3}e$	$+\frac{1}{3}$	0
d	$-\frac{1}{3}e$	$+\frac{1}{3}$	0
s	$-\frac{1}{3}e$	$+\frac{1}{3}$	-1

Properties of Leptons

		Lepton number
Particles:	$e^-, \nu_e; \mu^-, \nu_\mu$	$+1$
Antiparticles:	$e^+, \overline{\nu_e}, \mu^+, \overline{\nu_\mu}$	-1

Photons and energy levels

photon energy $E = hf = \frac{hc}{\lambda}$

photoelectricity $hf = \phi + E_{k\,(max)}$

energy levels $hf = E_1 - E_2$

de Broglie wavelength $\lambda = \frac{h}{p} = \frac{h}{mv}$

Waves

wave speed $c = f\lambda$ *period* $f = \frac{1}{T}$

first harmonic $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

fringe spacing $w = \frac{\lambda D}{s}$ *diffraction grating* $d \sin\theta = n\lambda$

refractive index of a substance s, $n = \frac{c}{c_s}$

for two different substances of refractive indices n_1 and n_2,

law of refraction $n_1 \sin\theta_1 = n_2 \sin\theta_2$

critical angle $\sin\theta_c = \frac{n_2}{n_1}$ for $n_1 > n_2$

Mechanics

moments moment $= Fd$

velocity and acceleration $v = \frac{\Delta s}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$

equations of motion $v = u + at$ $s = \left(\frac{u+v}{2}\right)t$

$v^2 = u^2 + 2as$ $s = ut + \frac{at^2}{2}$

force $F = ma$

force $F = \frac{\Delta(mv)}{\Delta t}$

impulse $F\,\Delta t = \Delta(mv)$

work, energy and power $W = F\,s\cos\theta$

$E_k = \frac{1}{2}mv^2$ $\Delta E_p = mg\Delta h$

$P = \frac{\Delta W}{\Delta t}$, $P = Fv$

$efficiency = \frac{useful\ output\ power}{input\ power}$

Materials

density $\rho = \frac{m}{V}$ *Hooke's law* $F = k\,\Delta L$

Young modulus $= \frac{tensile\ stress}{tensile\ strain}$ *tensile stress* $= \frac{F}{A}$ *tensile strain* $= \frac{\Delta L}{L}$

energy stored $E = \frac{1}{2}F\Delta L$

Mr Squires tsquires@hillcrest.bham.sch.uk

Electricity

current and pd	$I = \frac{\Delta Q}{\Delta t}$ $\quad V = \frac{W}{Q}$ $\quad R = \frac{V}{I}$
resistivity	$\rho = \frac{RA}{L}$
resistors in series	$R_T = R_1 + R_2 + R_3 + \ldots$
resistors in parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$
power	$P = VI = I^2R = \frac{V^2}{R}$
emf	$\varepsilon = \frac{E}{Q}$ $\quad \varepsilon = I(R + r)$

Circular motion

magnitude of angular speed	$\omega = \frac{v}{r}$
	$\omega = 2\pi f$
centripetal acceleration	$a = \frac{v^2}{r} = \omega^2 r$
centripetal force	$F = \frac{mv^2}{r} = m\omega^2 r$

Simple harmonic motion

acceleration	$a = -\omega^2 x$
displacement	$x = A\cos(\omega t)$
speed	$v = \pm\omega\sqrt{(A^2 - x^2)}$
maximum speed	$v_{max} = \omega A$
maximum acceleration	$a_{max} = \omega^2 A$
for a mass-spring system	$T = 2\pi\sqrt{\frac{m}{k}}$
for a simple pendulum	$T = 2\pi\sqrt{\frac{l}{g}}$

Thermal physics

energy to change temperature	$Q = mc\Delta\theta$
energy to change state	$Q = ml$
gas law	$pV = nRT$ $pV = NkT$
kinetic theory model	$pV = \frac{1}{3}Nm(c_{rms})^2$
kinetic energy of gas molecule	$\frac{1}{2}m(c_{rms})^2 = \frac{3}{2}kT = \frac{3RT}{2N_A}$

Gravitational fields

force between two masses	$F = \frac{Gm_1m_2}{r^2}$
gravitational field strength	$g = \frac{F}{m}$
magnitude of gravitational field strength in a radial field	$g = \frac{GM}{r^2}$
work done	$\Delta W = m\Delta V$
gravitational potential	$V = -\frac{GM}{r}$
	$g = -\frac{\Delta V}{\Delta r}$

Electric fields and capacitors

force between two point charges	$F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1Q_2}{r^2}$
force on a charge	$F = EQ$
field strength for a uniform field	$E = \frac{V}{d}$
work done	$\Delta W = Q\Delta V$
field strength for a radial field	$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$
electric potential	$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$
field strength	$E = \frac{\Delta V}{\Delta r}$
capacitance	$C = \frac{Q}{V}$
	$C = \frac{A\varepsilon_0\varepsilon_r}{d}$
capacitor energy stored	$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$
capacitor charging	$Q = Q_0(1 - e^{-\frac{t}{RC}})$
decay of charge	$Q = Q_0 e^{-\frac{t}{RC}}$
time constant	RC

Mr Squires tsquires@hillcrest.bham.sch.uk

Magnetic fields

force on a current	$F = BIl$
force on a moving charge	$F = BQv$
magnetic flux	$\Phi = BA$
magnetic flux linkage	$N\Phi = BAN\cos\theta$
magnitude of induced emf	$\varepsilon = N\dfrac{\Delta\Phi}{\Delta t}$
	$N\Phi = BAN\cos\theta$
emf induced in a rotating coil	$\varepsilon = BAN\omega \sin \omega t$
alternating current	$I_{rms} = \dfrac{I_0}{\sqrt{2}}$ $V_{rms} = \dfrac{V_0}{\sqrt{2}}$
transformer equations	$\dfrac{N_s}{N_p} = \dfrac{V_s}{V_p}$
	$efficiency = \dfrac{I_s V_s}{I_p V_p}$

Nuclear physics

inverse square law for γ radiation	$I = \dfrac{k}{x^2}$
radioactive decay	$\dfrac{\Delta N}{\Delta t} = -\lambda N$, $N = N_0 e^{-\lambda t}$
activity	$A = \lambda N$
half-life	$T_{½} = \dfrac{\ln 2}{\lambda}$
nuclear radius	$R = R_0 A^{1/3}$
energy-mass equation	$E = mc^2$

Mr Squires tsquires@hillcrest.bham.sch.uk