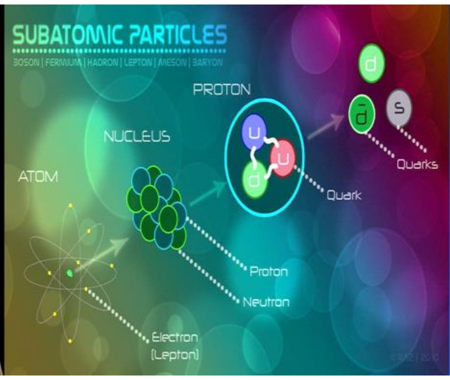
AQA PHYSICS

Achieving Excellence Together



Transition Induction Pack

Table of Contents

Course Structure - Theory

The course is made up for nine units:

Unit 1 – Measurements and their errors

Content in this section is a continuing study for a student of physics. A working knowledge of the specified fundamental (base) units of measurement is vital. Likewise, practical work in the subject needs to be underpinned by an awareness of the nature of measurement errors and of their numerical treatment. The ability to carry through reasonable estimations is a skill that is required throughout the course and beyond.

Unit 2 – Particles and radiation

This section introduces students both to the fundamental properties of matter, and to electromagnetic radiation and quantum phenomena. Teachers may wish to begin with this topic to provide a new interest and knowledge dimension beyond GCSE. Through a study of these topics, students become aware of the way ideas develop and evolve in physics. They will appreciate the importance of international collaboration in the development of new experiments and theories in this area of fundamental research.

Unit 3 – Waves

GCSE studies of wave phenomena are extended through a development of knowledge of the characteristics, properties, and applications of travelling waves and stationary waves. Topics treated include refraction, diffraction, superposition and interference.

Unit 4 – Mechanics and materials

Vectors and their treatment are introduced followed by development of the student's knowledge and understanding of forces, energy and momentum. The section continues with a study of materials considered in terms of their bulk properties and tensile strength. As with earlier topics, this section and also the following section Electricity would provide a good starting point for students who prefer to begin by consolidating work.

Unit 5 – Electricity

This section builds on and develops earlier study of these phenomena from GCSE. It provides opportunities for the development of practical skills at an early stage in the course and lays the groundwork for later study of the many electrical applications that are important to society.

Unit 6 – Further mechanics and thermal physics

The earlier study of mechanics is further advanced through a consideration of circular motion and simple harmonic motion (the harmonic oscillator). A further section allows the thermal properties of materials, the properties and nature of ideal gases, and the molecular kinetic theory to be studied in depth.

Unit 7 – Fields and their consequences

The concept of field is one of the great unifying ideas in physics. The ideas of gravitation, electrostatics and magnetic field theory are developed within the topic to emphasise this unification. Many ideas from mechanics and electricity from earlier in the course support this and are further developed. Practical applications considered include planetary and satellite orbits, capacitance and capacitors, their charge and discharge through resistors, and electromagnetic induction. These topics have considerable impact on modern society.

Unit 8 – Nuclear Physics

This section builds on the work of Particles and radiation to link the properties of the nucleus to the production of nuclear power through the characteristics of the nucleus, the properties of unstable nuclei, and the link between energy and mass. Students should become aware of the physics that underpins nuclear energy production and also of the impact that it can have on society.

Unit 9 – Astrophysics (Option A)

Fundamental physical principles are applied to the study and interpretation of the Universe. Students gain deeper insight into the behaviour of objects at great distances from Earth and discover the ways in which information from these objects can be gathered. The underlying physical principles of the devices used are covered and some indication is given of the new information gained by the use of radio astronomy. The discovery of exoplanets is an example of the way in which new information is gained by astronomers.

The specification is a useful reference document for you. You can download a copy from the AQA Website (follow the QR Code)

- Each section of the content begins with an overview, which describes the broader context and encourages an understanding of the place each section has within the subject. This overview will not be directly assessed.
- The specification is presented in a two-column format. The left-hand column contains the specification content that you must cover, and that can be assessed in the written papers.
- The right-hand column exemplifies the opportunities for Maths and practical skills to be developed throughout the course. These skills can be assessed through any of the content on the written papers, not necessarily in the topics we have signposted.

Course Structure – Required Practicals

Practical work is at the heart of physics. Practical assessments have been divided into those that can be assessed in written exams and those that can only be directly assessed whilst students are carrying out experiments.
A-level grades will be based only on marks from written exams.
A separate endorsement (CPAC) of practical skills will be taken alongside the A-level. This will be assessed by teachers and will be based on direct observation of students' competency in a range of skills that are not assessable in written exams.

This course has 12 required practicals

1. Investigation into the variation of the frequency of stationary waves on a string with length, tension and mass per unit length of the string.
2. Investigation of interference effects to include the Young's slit experiment and interference by a diffraction grating.
3. Determination of g by a free-fall method
4. Determination of the Young modulus by a simple method.
5. Determination of resistivity of a wire using a micrometer, ammeter and voltmeter.
6. Investigation of the emf and internal resistance of electric cells and batteries by measuring the variation of the terminal pd of the cell with current in it.
7. Investigation into simple harmonic motion using a mass-spring system and a simple pendulum.
8. Investigation of Boyle's (constant temperature) law and Charles's (constant pressure) law for a gas.
9. Investigation of the charge and discharge of capacitors. Analysis techniques should include log-linear plotting leading to a determination of the time constant RC.
10. Investigate how the force on a wire varies with flux density, current and length of wire using a top pan balance.
11. Investigate, using a search coil and oscilloscope, the effect on magnetic flux linkage of varying the angle between a search coil and magnetic field direction.
12. Investigation of the inverse-square law for gamma radiation.

Assessment in the course

The assessment for the A-level consists of three exams, which you will take at the end of the course.

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 1–6.1	**What's assessed** Section A: Compulsory section: Practical skills and data analysis Section B: Students enter for **one** of sections 9, 10,11,12 or 13
How it's assessed Written exam: 2 hours 85 marks 34% of the A-level	**How it's assessed** Written exam: 2 hours 85 marks 34% of the A-level	**How it's assessed** Written exam: 2 hours 80 marks 32% of the A-level
Questions 60 marks of short and long answer questions 25 multiple choice questions on content.	**Questions** 60 marks of short and long answer questions 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 question on optional topic

Assessment objective

As you know from GCSE, we have to write exam questions that address the Assessment objectives (AOs). It is important you understand what these AOs are, so you are well prepared. In Physics there are three AOs.

- AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques, and procedures (A-level about 30% of the marks).

- AO2: Apply knowledge and understanding of scientific ideas, processes, techniques, and procedures:
  - in a theoretical context
  - in a practical context
  - when handling qualitative data
  - when handling quantitative data

  (A-level about 45% of the marks).

- AO3: Analyse, interpret, and evaluate scientific information, ideas, and evidence, including in relation to:
    - make judgements and reach conclusions
    - develop and refine practical design and procedures

  (A-level about 25% of the marks).

Other assessment criteria

At least 40% of the marks for AS and A-level Physics will assess mathematical skills, which will be equivalent to Level 2 (Higher Tier GCSE Mathematics) or above.

At least 15% of the overall assessment of AS and A-level Physics will assess knowledge, skills and understanding in relation to practical work.

Command words

Command words are used in questions to tell you what is required when answering the question. You can find definitions of the command words used in Physics assessments on the AQA website (follow the QR code) They are very similar to the command words used at GCSE.

Post-18 Progression

University

A-Level Physics provides students with a comprehensive understanding of the fundamental principles that govern the physical world. This knowledge enhances critical thinking, problem-solving skills, and the ability to make informed decisions.
A-Level Physics is highly regarded by universities and can open doors to a variety of science and engineering-related courses. Students who excel in A-Level Physics often gain access to prestigious institutions and competitive degree programs. The subject provides a solid foundation for further studies in physics, engineering, astrophysics, and other scientific disciplines.

Grade	UCAS Points
A*	56
A	48
B	40
C	32
D	24
E	16

Employability

A-Level Physics equips students with valuable skills sought after by employers in various sectors. Graduates often pursue careers in engineering, research and development, renewable energy, telecommunications, aerospace, and other technological fields. The demand for skilled physicists and engineers remains high, offering attractive job prospects and potential for career advancement.
Physics cultivates a logical and analytical mindset, enabling students to approach problems from multiple perspectives. A-Level Physics teaches students to break down complex challenges into manageable components, fostering creativity and innovation. These problem-solving skills are transferrable and applicable to diverse career paths.

Pre-Course induction work

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.

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.

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.

Term	Definition
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.

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 (e.g. 2.7) and a unit (e.g. 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

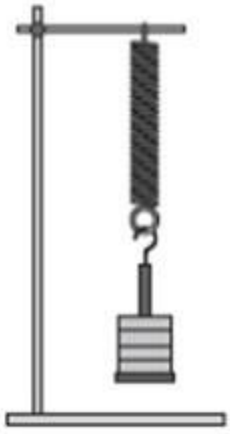
Practical skills

The practical skills you learnt at GCSE will be further developed through the practicals you undertake at A-level. Your teacher will explain in more detail the requirements for practical work in Physics.

There is a practical handbook for AS and A-level Physics, which has lots of very useful information to support you in developing these important skills. You can download a copy using the QR code

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 π = 3.14…)
- as prefixes for units to make them smaller (e.g. µm = 0.000 000 001 m)
- as symbols for particular quantities.

The Greek alphabet is shown below.

Capital letter	Lower case letter	Name	Capital letter	Lower case letter	Name	Capital letter	Lower case letter	Name
Α	α	alpha	Ι	ι	iota	Ρ	ρ	rho
Β	β	beta	Κ	κ	kappa	Σ	ς or σ	sigma
Γ	γ	gamma	Λ	λ	lambda	Τ	τ	tau
Δ	δ	delta	Μ	µ	mu	Υ	υ	upsilon
Ε	ε	epsilon	Ν	ν	nu	Φ	ϕ	phi
Ζ	ζ	zeta	Ξ	ξ	ksi	Χ	χ	chi
Η	η	eta	Ο	ο	omicron	Ψ	ψ	psi
Θ	θ	theta	Π	π	pi	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 Physics formula and data sheet

You will need to use the AQA Physics formula and data sheet in your exams.

You can download a copy using the QR code

Activity 8 Using the Physics formula and data sheet

1. Use the sheet to find the symbols used to represent the following particles. (You will learn about these particles when you study particle physics.)

   a. Photon
   b. Neutrino
   c. Muon
   d. Meson (two letters used depending on type of meson)

2. Look through the Electricity and Materials formula sections on the data sheet.

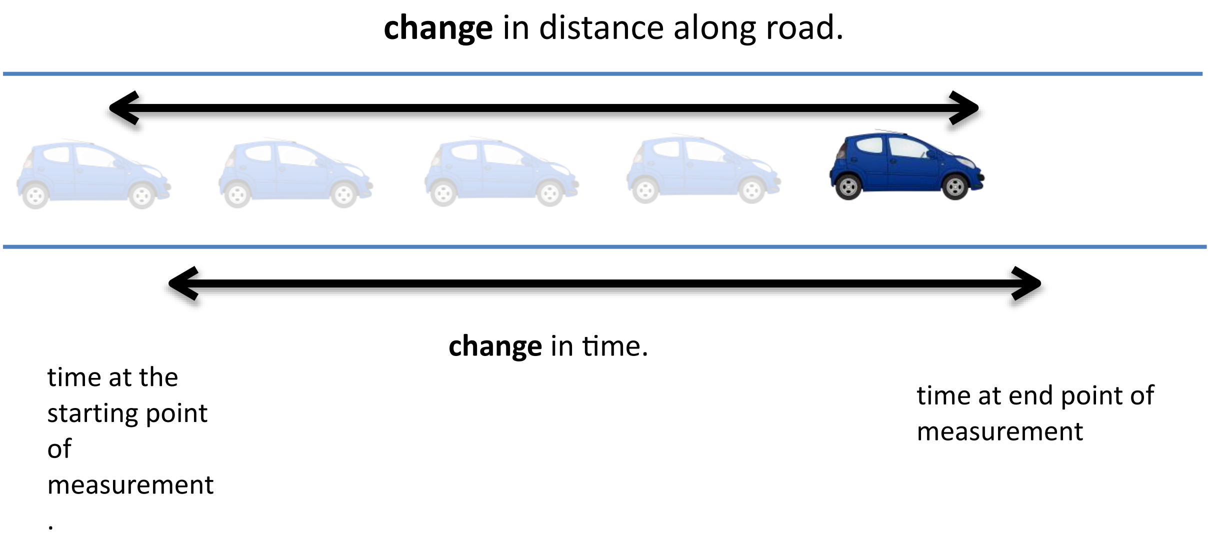
   There is one Greek letter that is used to represent two different quantities. Give the letter and the quantities is it used to represent.

The delta symbol (Δ)

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

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

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.



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:

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

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 9 Using the delta symbol

1. What is the difference between:

   a. speed and **velocity**
   b. distance and **displacement**

2. Look at the A-level Physics formula and data sheet*.*

   Which equations look similar to ones you used at GCSE, but now include the delta symbol?

3. A coffee machine heats water from 20 °C to 90 °C. The power output of the coffee

   machine is 2.53 kW. The specific heat capacity of water is 4200 J/kg °C

   Calculate the mass of water that the coffee machine can heat in 20 s.

4. An unused pencil has a length of 86.0 mm.

   A student uses the pencil to draw 20 lines on a piece of paper.

   Each line has a length of 25 cm.

   The length of the pencil has changed to 84.5 mm.

   Calculate the length of line that would need to be drawn for the original length to be halved.

Rearranging formulas

Activity 10 Rearranging formulas

1. Rearrange $c = f\lambda$ to make f the subject.
2. Rearrange $p = \frac{m}{V}$ 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 $E = \frac{1}{2} m v^2$ to make v the subject.
6. Rearrange $h f = \phi + E_k$ to make ϕ the subject
7. Rearrange $v = u + a t$ to make a the subject.
8. Rearrange $s = u t + \frac{1}{2} a t^2$ to make a the subject.
9. Rearrange $\varepsilon = I(R + r)$ to make r the subject.
10. Rearrange $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$ o 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 11 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 12 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 13 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?

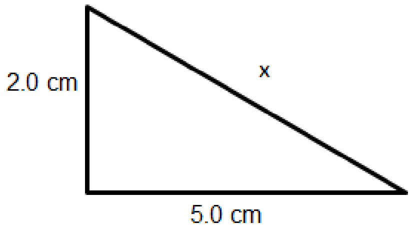
8. Power station A was online 94% of the 7500 days it worked for.

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

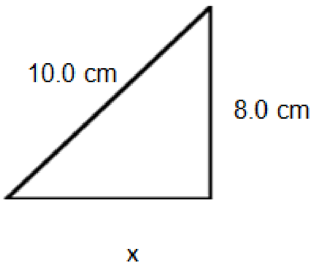
   Which power station was offline for longer?

Activity 14 Pythagoras' theorem

1. Calculate the length of side x.

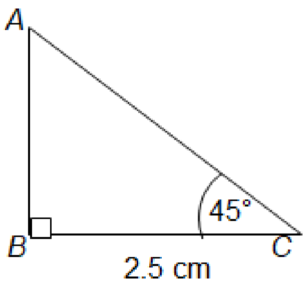


2. Calculate the length of side x.

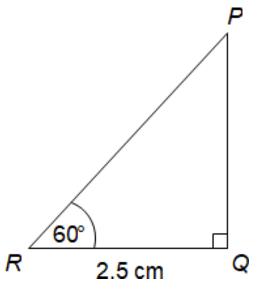


Activity 15 Using sine, cosine and tangent

1. Calculate length AB (Not drawn to scale)



2. Calculate length PR (Not drawn to scale



Activity 16 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?

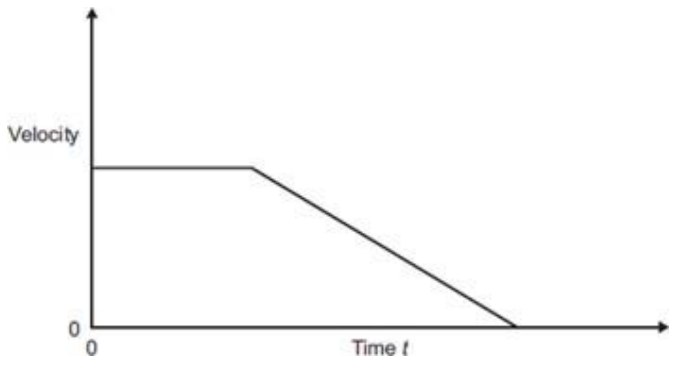
2. A pendulum completes 12 swings in 150 s.

   Calculate the mean swing time.

Activity 17 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.

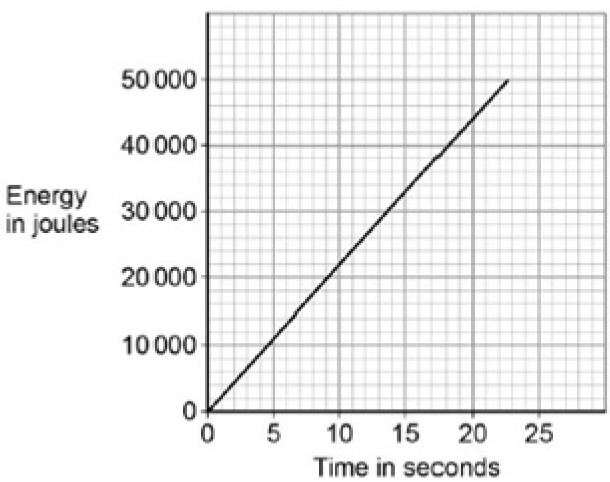


From the list below, which letter represents:

- 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.

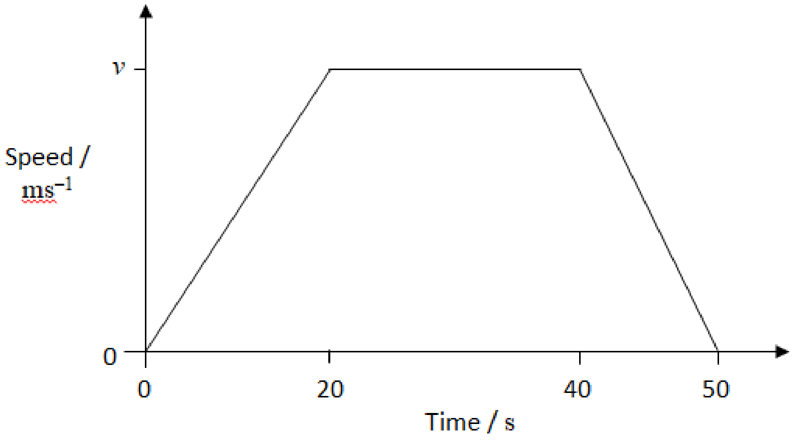


The power output of the kettle is given by the gradient of the graph. Calculate the power output of the kettle.

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

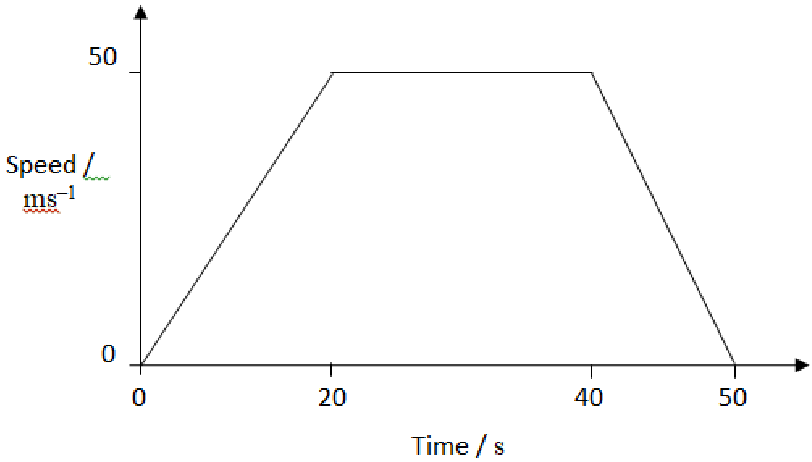
   It achieves a maximum speed of *v* metres. per second. It travels for 50 seconds.

   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.



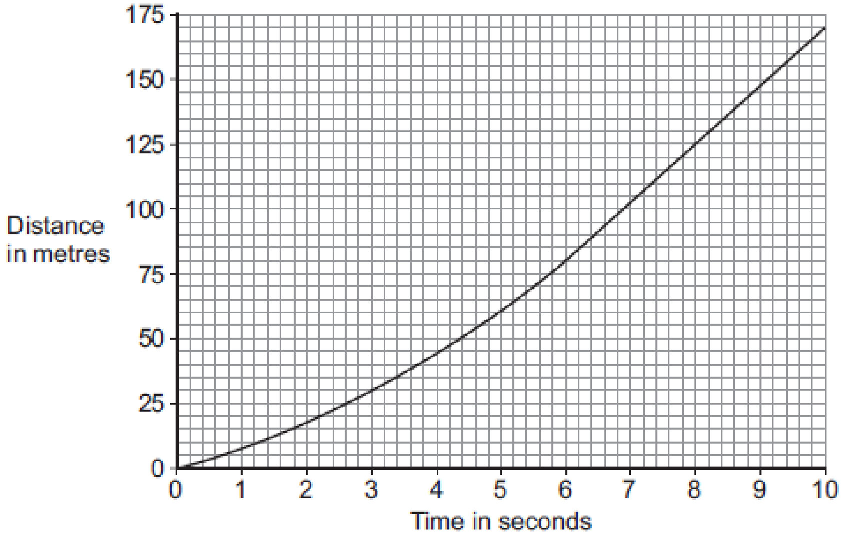
   (not drawn accurately)

   Calculate the distance between the stations.

Activity 18 Using and interpreting data in tables and graphs

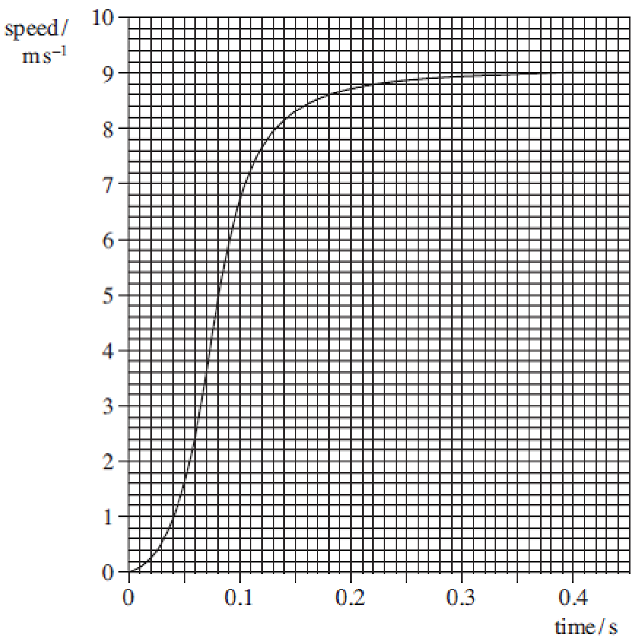
1. The graph shows the motion of a car in the first 10 seconds of its journey.

Figure 1



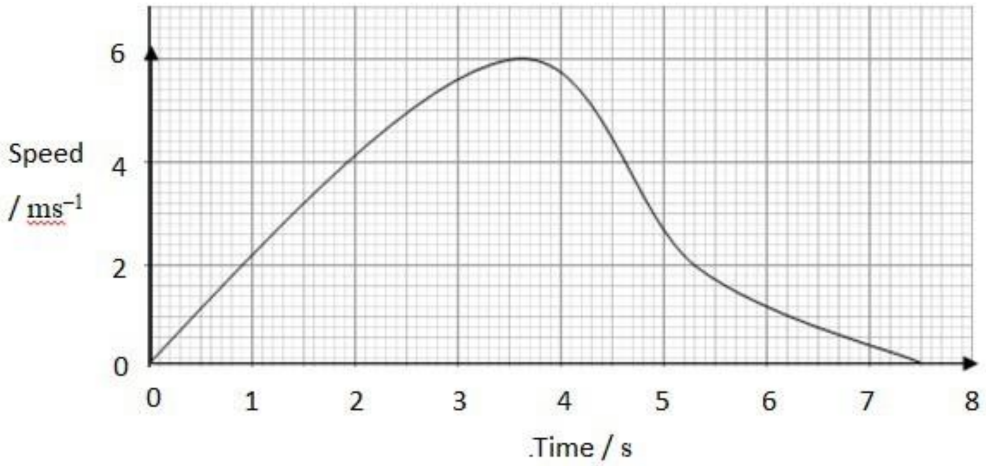
Use the graph to calculate the maximum speed the car was travelling at.

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.

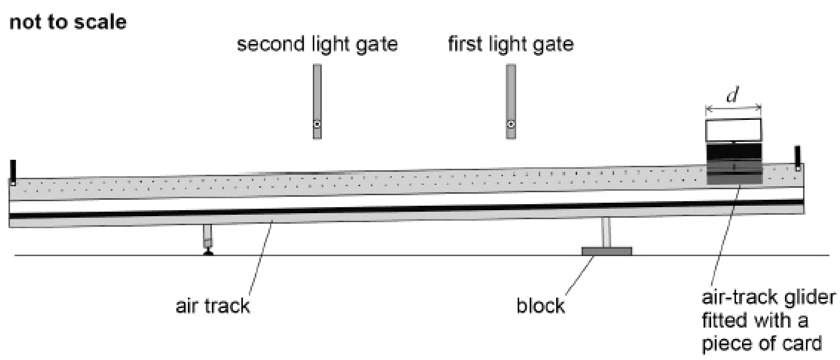
3. The graph shows the speed–time graph of a car.



Use the graph to determine:

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

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.

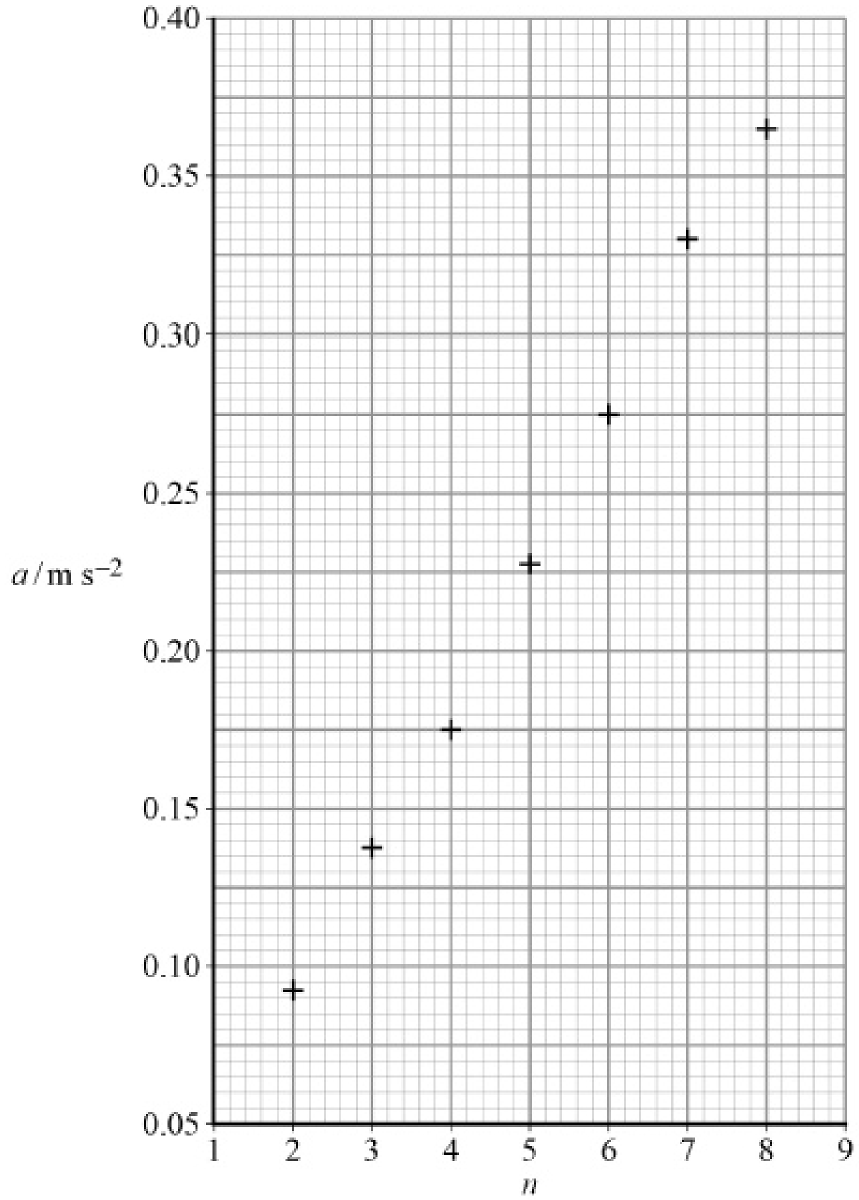
Assume there is negligible change in velocity while the air-track glider passes through a light gate.

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.

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}

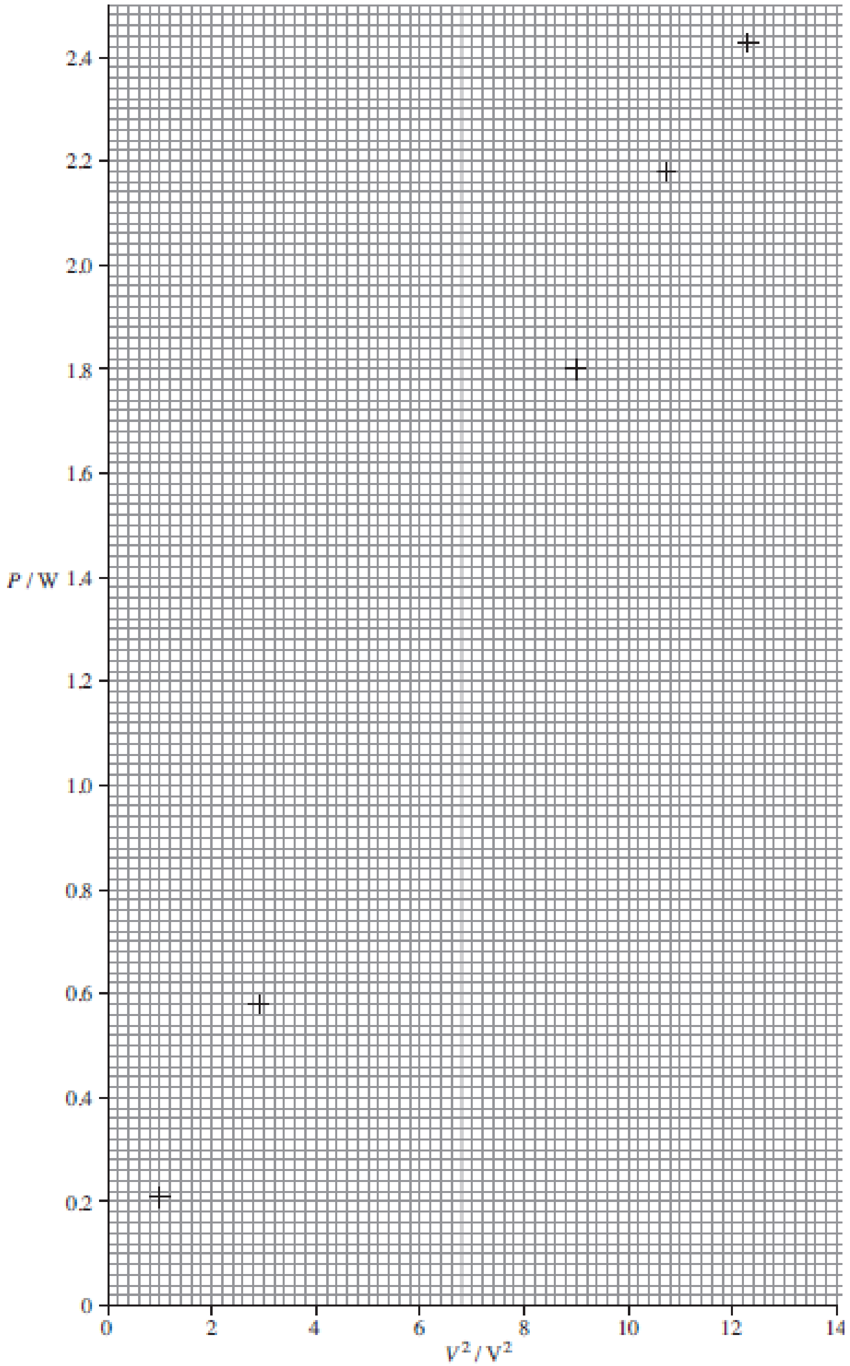
Calculate *h*.

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.



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

6. To answer these questions, you will need a copy of the A-level Physics formula sheet.

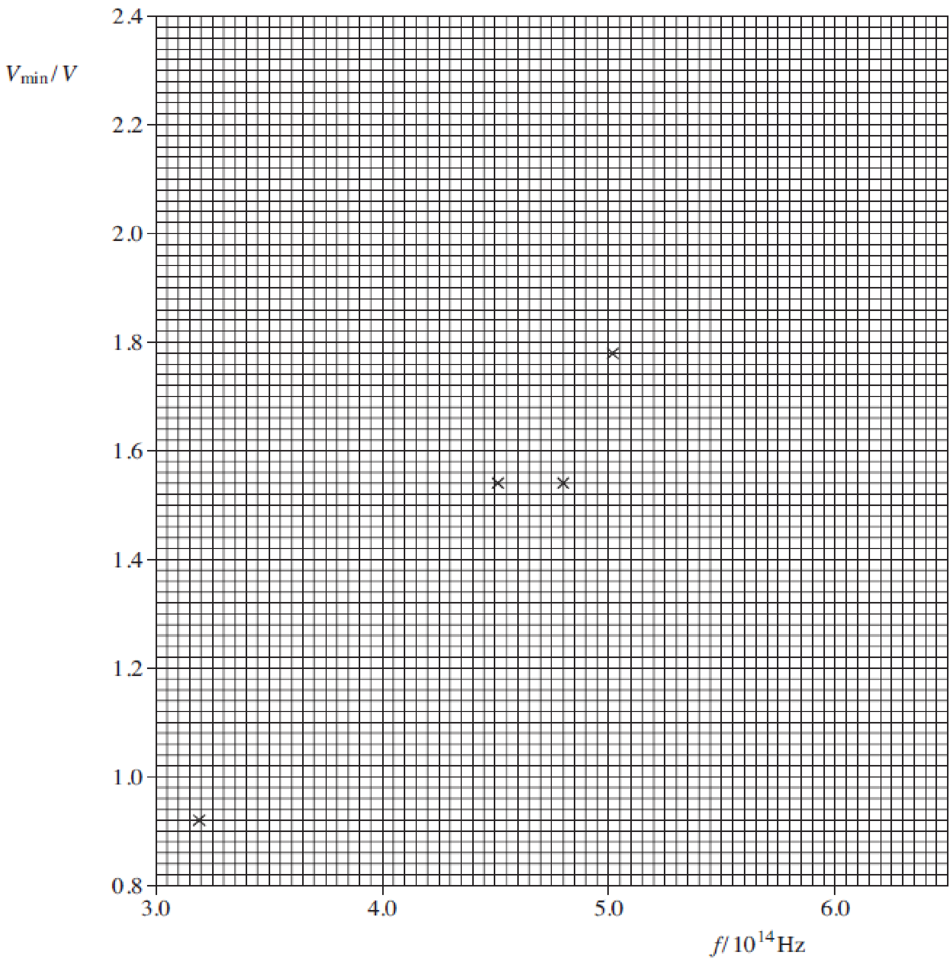
In an experiment, a set of LEDs that emitted light of different colours was used.

The table below shows the data collected.

Colour	**Wavelength** λ / nm	**Frequency** f / 10^{14} Hz	**Minimum pd** V_{min} / V
Infrared	940	3.19	0.92
Red	665	4.51	1.54
Orange	625	4.80	1.54
Yellow	595	5.04	1.78
Green	565		1.87
Blue	470		2.37

a. Complete the missing values for frequency.

b. Complete the graph by plotting the missing two points and drawing a line of best fit.



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.

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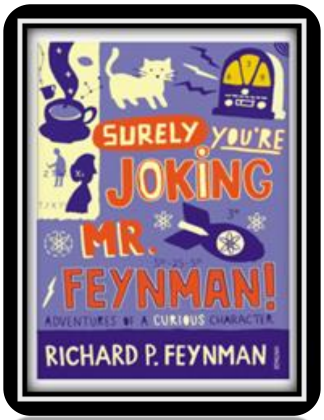
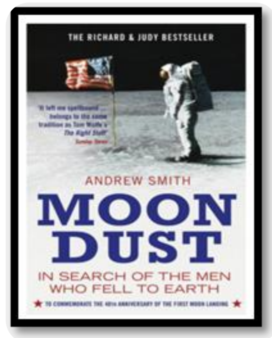
Book Recommendations

Below is a selection of books that should appeal to a physicist – someone with an enquiring mind who wants to understand the universe around us.



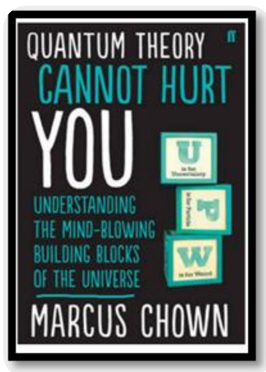
Moondust: In Search of the Men Who Fell to Earth

This book uses the personal accounts of 9 astronauts and many others involved in the space program, looking at the whole space-race era.



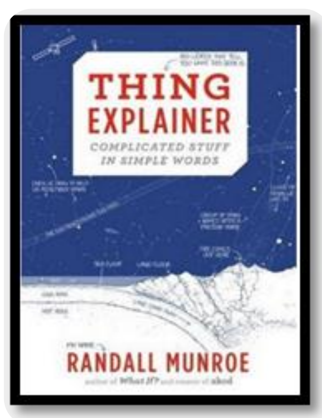
Surely You're Joking Mr Feynman: Adventures of a Curious Character

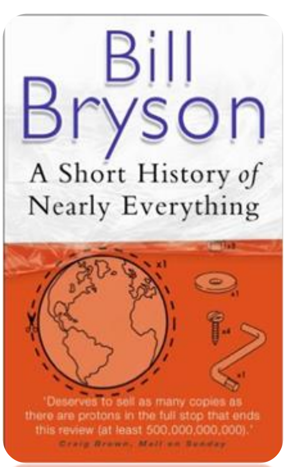
By reading this book you will get insight into his life's work including the creation of the first atomic bomb and his work in the field of particle physics.



Quantum Theory Cannot Hurt You: Understanding the Mind-Blowing Building Blocks of the Universe

Any physics book by Marcus Chown is an excellent insight into some of the more exotic areas of physics that require no prior knowledge.





A Short History of Nearly Everything

A whistle-stop tour through many aspects of history from the Big Bang to now. This is a really accessible read that will re-familiarise you with common concepts and introduce you to some of the more colourful characters from the history of science.

Thing Explainer: Complicated Stuff in Simple Words

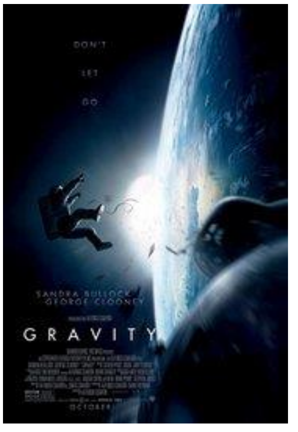
Written by the creator of online comic XTCD (a great source of science humour) is a book of blueprints from everyday objects such as a biro to the Saturn V rocket and an atom bomb.

Movie Recommendations

Everyone loves a good story and everyone loves some great science. Here are some picks of the best films based on real life scientists and discoveries. You wont find Jurassic Park on this list! We've looked back over the last 30 years to give you our top 5 films you might not have seen before. Great watching for a rainy day.

Moon (2009)

With only three weeks left in his three year contract, Sam Bell is getting anxious to finally return to Earth. He is the only occupant of a Moon-based manufacturing facility along with his computer and assistant, GERTY. When he has an accident however, he wakens to find that he is not alone.

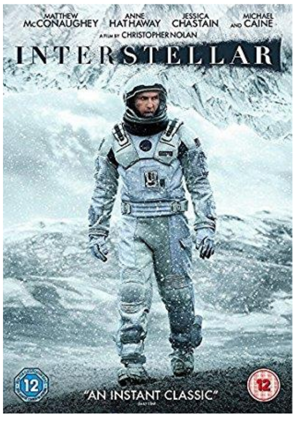


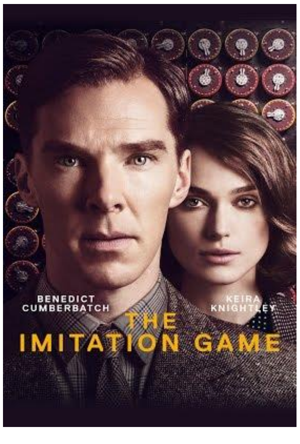
Gravity (2013)

Two astronauts work together to survive after an accident which leaves them stranded in space.

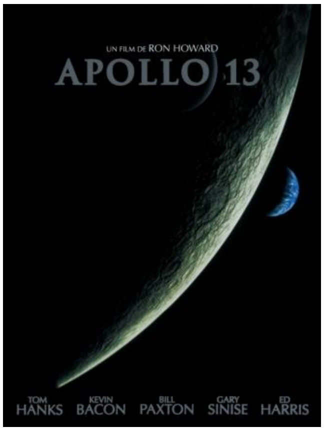
Interstellar (2014)

A team of explorers travel through a wormhole in space in an attempt to ensure humanity's survival.





The Imitation Game (2014)
Based on a true story. During World War II, the English mathematical genius Alan Turing tries to crack the German Enigma code with help from fellow mathematicians.



Apollo 13 (1995)

Based on a true story. NASA must devise a strategy to return Apollo 13 to Earth safely after the spacecraft undergoes massive internal damage putting the lives of the three astronauts on board in jeopardy.

There are some great TV series and box sets available too! You might want to check out: Blue Planet, Planet Earth, Wonders of the Universe, Wonders of the Solar System, NASA TV and Shock & Awe – The Story of Electricity.

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Movie Recommendations

If you have 30 minutes to spare, here are some great presentations (and free!) from world leading scientists and researchers on a variety of topics. They provide some interesting answers and ask some thought-provoking questions. Use the link or scan the QR code to view:

From mach-20 glider to hummingbird drone
Available at:
https://www.ted.com/talks/regina_dugan_from_mach_20_glider_to_humming_bird_drone/up-next?language=en
"What would you attempt to do if you knew you could not fail?" asks Regina Dugan, then director of DARPA, the Defense Advanced Research Projects Agency. In this talk, she describes some of the extraordinary projects that her agency has created.

Is our universe the only universe?
Available at:
https://www.ted.com/talks/brian_greene_why_is_our_universe_fine_tuned_for_life?language=en
Brian Greene shows how the unanswered questions of physics (starting with a big one: What caused the Big Bang?) have led to the theory that our own universe is just one of many in the "multiverse."

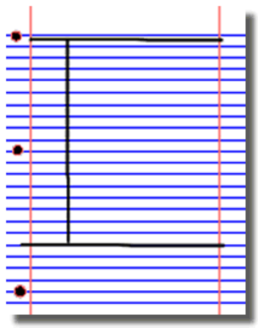
The fascinating physics of everyday life
Available at :
https://www.ted.com/talks/helen_czerski_fun_home_experiments_that_teach_you_physics?language=en
Physicist Helen Czerski presents various concepts in physics you can become familiar with using everyday things found in your kitchen.

We need nuclear power to solve climate change
Available at :
https://www.ted.com/talks/joe_lassiter_we_need_nuclear_power_to_solve_climate_change?language=en
Joe Lassiter is focused on developing clean, secure and carbon-neutral supplies of reliable, low-cost energy. His analysis of the world's energy realities puts a powerful lens on the touchy issue of nuclear power.

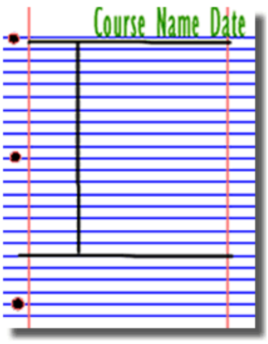
Research Activities

Research, reading and note making are essential skills for A level Physics study. For the following task you are going to produce 'Cornell Notes' to summarise your reading.

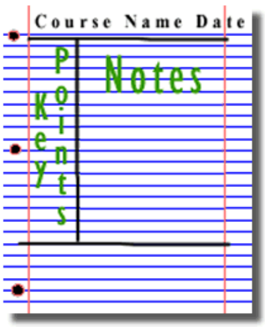
1. Divide your page into three sections like this



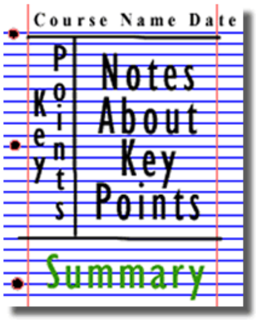
2. Write the name, date and topic at the top of the page



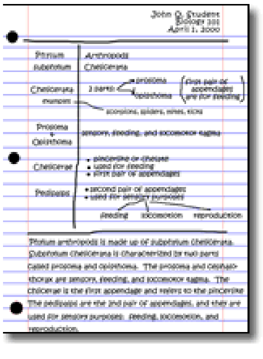
3. Use the large box to make notes. Leave a space between separate idea. Abbreviate where possible.



4. Review and identify the key points in the left hand box



5. Write a summary of the main ideas in the bottom space



Images taken from http://coe.jmu.edu/learningtoolbox/cornellnotes.html

Research Activities

Physics provides daily online-only news and commentary about a selection of papers from the APS journal collection. The website is aimed at the reader who wants to keep up with highlights of physics research with explanations that don't rely on jargon and technical detail.

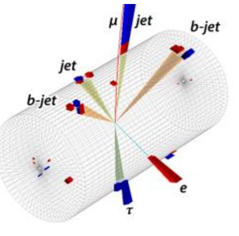
For each of the following topics, you are going to use the resources to produce one page of Cornell style notes.

Use the links or scan the QR code to take you to the resources.

Topic 1: **Sizing up the top quarks interaction with the Higgs**

Available at: https://physics.aps.org/articles/v11/56

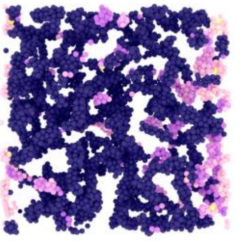
A proton collision experiment at CERN provides a new handle on the Higgs boson's interaction with the heaviest of the quarks.



Topic 2: **Why soft solids get softer**

Available at: https://physics.aps.org/articles/v11/50

Soft materials like gels and creams exhibit fatigue resulting from the stretching of their constituent fibres, according to experiments and simulations.



Topic 3: **Listening for the cosmic hum of black holes**

Available at: https://physics.aps.org/articles/v11/36

A new analysis technique would allow the gravitational-wave "background" from distant black hole mergers to be detected in days instead of years.

Ideas for Day Trips

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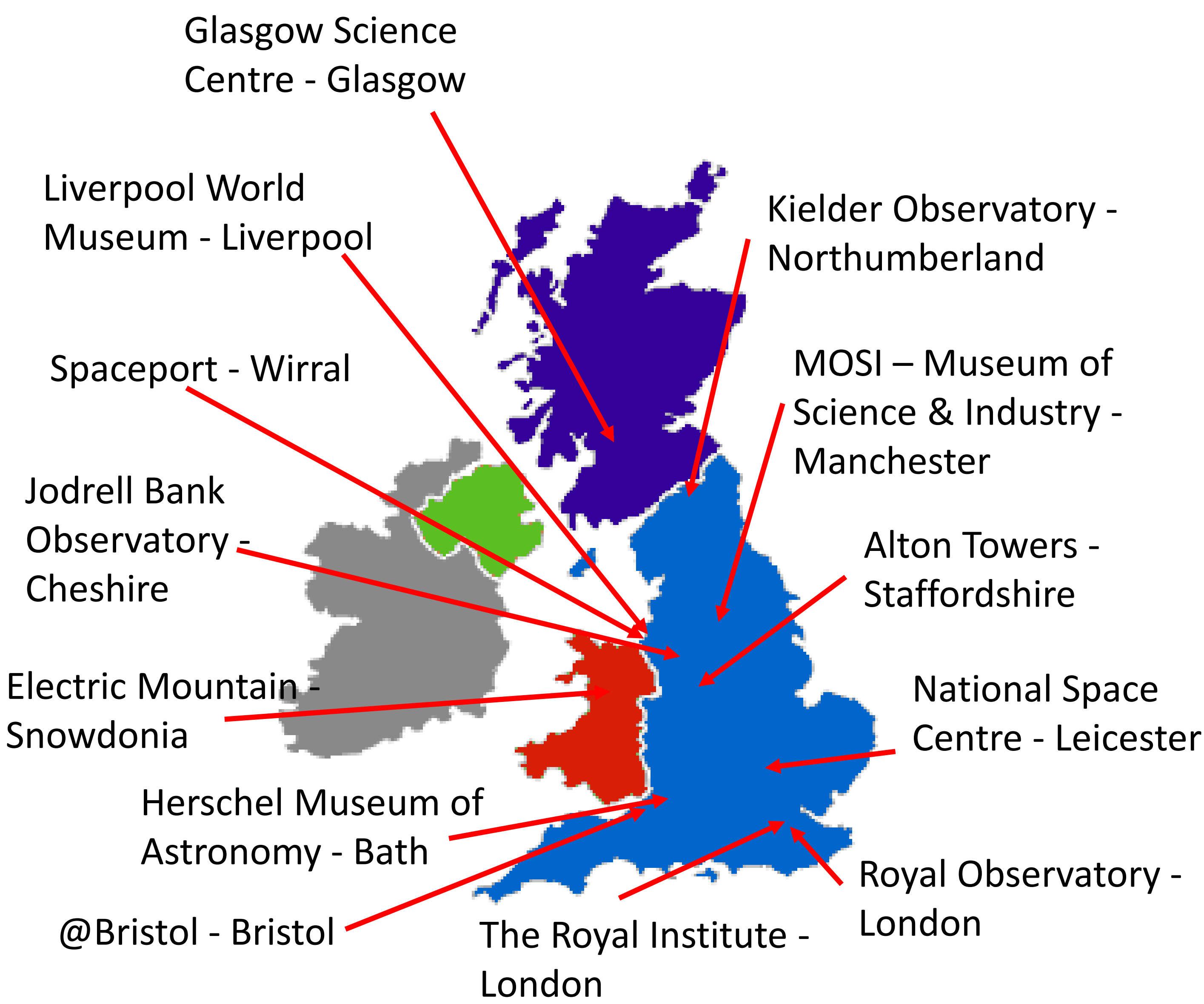
If you are on holiday in the UK, or on a staycation at home, why not plan a day trip to one of these :



Ideas for Day Trips

If you are on holiday in the UK, or on a staycation at home, why not plan a day trip to one of these :

Northern England and Scotland

1. **Jodrell Bank Observatory** – Cheshire – one of the largest moveable radio telescopes in the world and the location of the filming of the BBC's Stargazing Live. The site has both indoor and outdoor activities.
2. **MOSI** – Manchester – Massive free museum showing how science helped Britain lead the way through the industrial revolution. Contains hands on exhibits and displays and often host regular travelling exhibitions.
3. **Liverpool World Museum** / **Spaceport –** Liverpool/Wirral – Start the day off at an excellent family science museum with a top floor dedicated to astronomy including a planetarium. Take the ferry across the Mersey to another family friendly museum dedicated to spaceflight.
4. **Kielder Observatory** – Northumberland – Book ahead at this popular observatory in the midst of the darkest night skies the UK has to offer. Regular tours and opportunities to view the stars through professional telescopes take place on a nightly basis.
5. **Glasgow Science Centre** - The Centre is home to hundreds of interactive exhibits throughout the three engaging floors.

The Midlands and Wales

1. **Electric Mountain** – Snowdonia – Set against a mountainous backdrop is a working pumped storage power station. Take a tour deep into the heart of the mountain and see the turbines spring into action to meet our ever increasing demand for electricity. Take a stroll up on of the UKs highest peaks in the afternoon.
2. **National Space Centre** – Leicester - With six interactive galleries, the UK's largest planetarium, unique 3D simulator experience, the award-winning National Space Centre in Leicester is an out of this world visitor attraction.
3. **Alton Towers** – Staffordshire – Treat yourself to a go on a few rollercoasters whilst discussing Newton's Laws. You may want to download and take these handy rollercoaster physics notes with you http://www.explainthatstuff.com/rollercoasters.html

Southern England

1. **Royal Observatory** – London - Visit the Royal Observatory Greenwich to stand on the historic Prime Meridian of the World, see the home of Greenwich Mean Time (GMT), and explore your place in the universe at London's only planetarium.
2. **Herschel Museum of Astronomy –** Bath – As you walk around the picturesque Roman city – take an hour or two out at the home of one of the great scientists – discoverer of Infra-red radiation and Uranus.
3. **@Bristol –** Bristol - home to the UK's only 3D Planetarium and one of the biggest science centres.
4. **The Royal Institution –** London – The birthplace of many important ideas of modern physics, including Michael Faraday's lectures on electricity. Now home to the RI Christmas lectures and many exhibits of science history.

Science on Social Media

Science communication is essential in the modern world and all the big scientific companies, researchers and institutions have their own social media accounts. Here are some of our top tips to keep up to date with developing news or interesting stories:

Follow on Twitter:

Commander Chris Hadfield – former resident aboard the International Space Station
@cmdrhadfield

NASA's Voyager 2 – a satellite launched nearly 40 years ago that is now travelling beyond our solar system
@NSFVoyager2

Neil deGrasse Tyson – Director of the Hayden Planetarium in New York
@neiltyson

The SETI Institute – The Search for Extra Terrestrial Intelligence, be the first to know what they find!
@setiinstitute

Phil Plait – tweets about astronomy and bad science
@badastronomer

Institute of Physics – The leading scientific membership society for physics
@PhysicsNews

Scientific America – Journal sharing discoveries and insights into science that develops the world
@sciam

SN Students – Science news for students
@SNStudents

Find on Facebook:

National Geographic - since 1888, National Geographic has travelled the Earth, sharing its amazing stories in pictures and words.

Science News Magazine - Science covers important and emerging research in all fields of science.

BBC Science News - The latest BBC Science and Environment News: breaking news, analysis and debate on science and nature around the world.

Institute of Physics - The Institute of Physics is a leading scientific membership society working to advance physics for the benefit of all.

Chandra X-ray Observatory - NASA's Chandra X-ray Observatory is a telescope specially designed to detect X-ray emission from very hot regions of the Universe such as exploded stars, clusters of galaxies, and matter around black holes.

Interesting Engineering - Interesting Engineering is a cutting edge, leading community designed for all lovers of engineering, technology and science.

Science websites

These websites all offer an amazing collection of resources that you should use again and again throughout your course.

At CERN, the European Organization for Nuclear Research, physicists and engineers are probing the fundamental structure of the universe. They use the world's largest and most complex scientific instruments to study the basic constituents of matter – the fundamental particles.
https://home.cern/

physics.org is brought to you by the Physics in Society team at the Institute of Physics. Their aim is to inspire people of all ages about physics. Let them be your guide and show you the best physics places on the web.
http://www.physics.org/aboutus.asp

A website written by James Irvine, a retired teacher from Sheffield. Although the website is primarily written to support AQA, the material is also easily transferable to other exam boards.
http://www.antonine-education.co.uk/

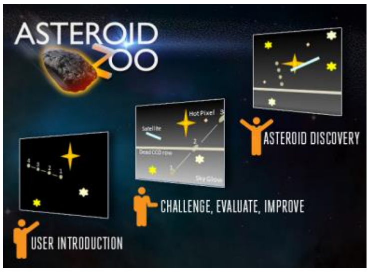
A website written by a practicing physics and maths tutor in London. @physicsandmathstutor is an Oxford physics graduate with a PGCE from Kings College London.

http://www.physicsandmathstutor.com/

Ok, so not a website, but a YouTube channel you definitely want to watch. Y12 or AS Physics content is free to view, you will find hundreds of videos made to help you in your A Level physics studies.
https://www.youtube.com/c/ALevelPhysicsOnline

Science: Things to do!

Day 4 of the holidays and boredom has set in?
There are loads of citizen science projects you can take part in either from the comfort of your bedroom, out and about, or when on holiday. Wikipedia does a comprehensive list of all the current projects taking place. Google ‘citizen science project’



Want to stand above the rest when it comes to UCAS? Now is the time to act.
MOOCs are online courses run by nearly all universities. They are short FREE courses that you take part in. They are usually quite specialist, but aimed at the public, not the genius!
There are lots of websites that help you find a course, such as edX and Future learn.
You can take part in any course, but there are usually start and finish dates. They mostly involve taking part in web chats, watching videos and interactives.

Completing a MOOC will look great on your Personal statement and they are dead easy to take part in!