Torquay Girls' Grammar School

Transition Pack for A Level Physics

Get ready for A-level!

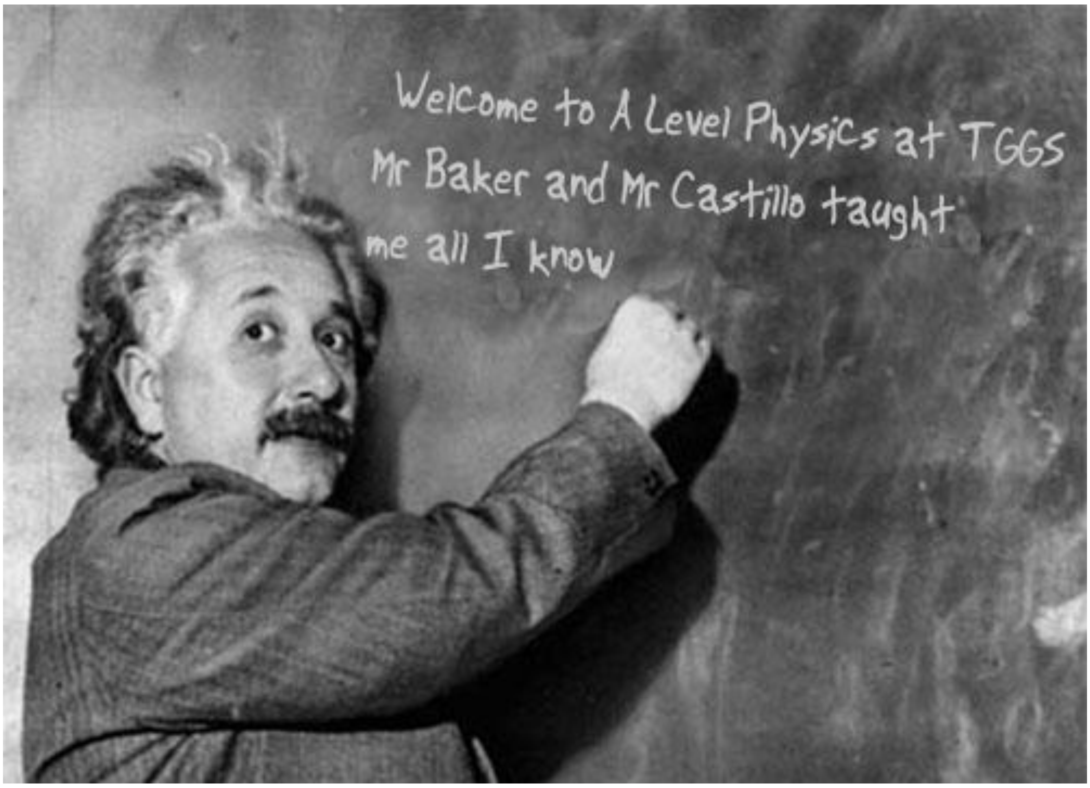
A guide to help you get ready for A-level Physics, including everything from topic guides to online learning courses.

So, you're thinking of doing A Level Physics?

This pack contains activities and resources to prepare you to start A Level Physics. It's aimed to be completed after your GCSEs.

You should aim to complete a selection of the work over about 5 weeks. Between 15-25 hours of work.

Good Luck! Have Fun!



TRANSITION TASKS

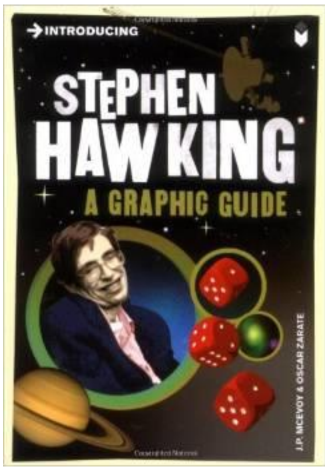
There are 4 specific tasks I would like you to complete before September.
You can use this checklist to log your progress.

Page	Task	Completed? (✓ / x)
4	1: **Write a review.**	
7	2: **Research and note taking task.**	
9	3: **Transition Questions.**	
26	4: **Isaac Physics.**	

Task 1: Write a review Maximum 1 A4 page: of a book, movie or lecture about Physics. Here are some ideas of things to read and watch but you can choose anything you like.

Book Recommendations

Here is a small selection of books that will appeal to any true physicist. Or for anybody who wants to try and understand the universe around us all.

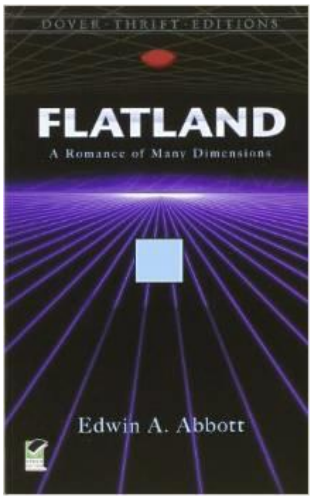


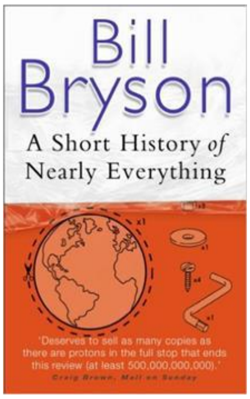
Stephen Hawking A Graphic Guide

This book introduces Hawking in a concise, easy to read form. It's a cross between a popular science book and a graphic novel, so it's really easy to visualise the concepts. This book is really good as a simple primer to Hawking's work, so I'd recommend reading it before tackling *A Brief History of Time.* It doesn't go into as much detail, but it gives you the general idea of Hawking's research, so when you come to read it in Hawking's own words it seems less daunting.

Flatland

A clever and humourous mathematical essay that tells the story of a square living in a two dimensional land. In a dream he is transported to Lineland where inhabitants exist in one dimension. On his return to Flatland he is visited by a strange visitor called a Sphere!

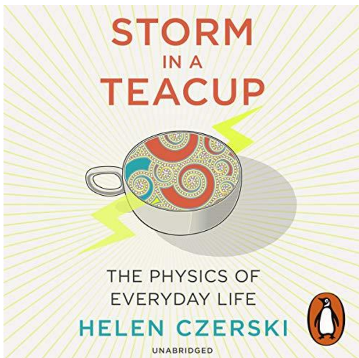




A Short History of Nearly Everything

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.

In **Storm in a Teacup**, Helen Czerski links the little things we see every day with the big world we live in. Each chapter begins with something small popcorn, coffee stains and refrigerator magnets and uses it to explain some of the most important science and technology of our time.



<u>Movie Recommendations</u>

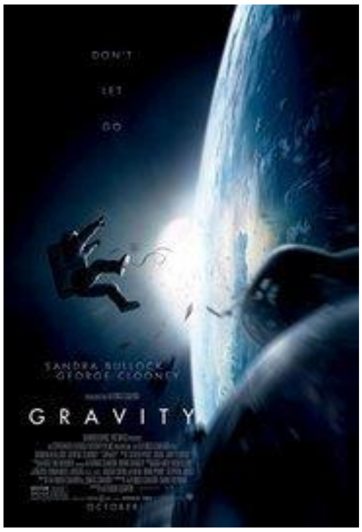
How about some popcorn? Here are some of Mr Castillo's favourite movies of all time (probably – I haven't actually checked with him, but I'm sure he'd love them…)

Martian

Six days ago, astronaut Mark Watney became one of the first people to walk on Mars.

Now, he's sure he'll be the first person to die there.

After a dust storm nearly kills him and forces his crew to evacuate while thinking him dead, Mark finds himself stranded and completely alone with no way to even signal Earth that he's alive—and even if he could get word out, his supplies would be gone long before a rescue could arrive.



Gravity

Sandra Bullock plays an astronaut whose spaceship is damaged by meteorites, leaving her in a desperate race adrift in space as she attempts to reach safety and find a way home. The film is visually stunning and her movement in space and the planning she has to make to get from point to point is well worth it from a science standpoint.

October Sky

The film is based on a true story and is about a teenager (played by Jake Gyllenhaal) who becomes fascinated with rocketry. Against all odds, he becomes an inspiration for his small mining town by going on to win a national science fair.

Check out some of these lectures from leading scientists and researchers. Really thought provoking.

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

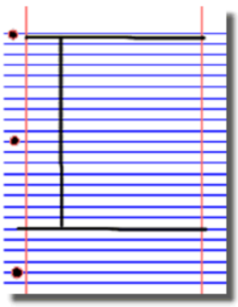
Joe Lassiter is focused on developing clean, secure and carbon-neutral supplies of reliable, low-cost energy. His analysis of the world's energy realities puts a powerful lens on the touchy issue of nuclear power.

1. https://www.ted.com/talks/regina_dugan_from_mach_20_glider_to_humming_bird_drone/up-next?language=en
2. https://www.ted.com/talks/brian_greene_why_is_our_universe_fine_tuned_for_life?language=en
3. https://www.ted.com/talks/helen_czerski_fun_home_experiments_that_teach_you_physics?language=en
4. https://www.ted.com/talks/joe_lassiter_we_need_nuclear_power_to_solve_climate_change?language=en

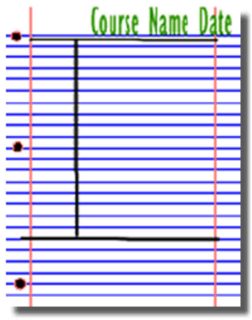
Task 2: Research and note taking task. (5 hours max) You will research one of the research topics on the next page and create a 3 page (maximum) report. It can include images and diagrams if you wish. You can use other sources if you like and should keep all your rough notes to hand in with your project. These must be in the style of Cornell Notes, see below:

We will be using a new note taking technique with you at A Level which I'd like you to start practising during this task. It's called Cornell Note Taking: https://www.youtube.com/watch?v=ErSjc1PEGKE

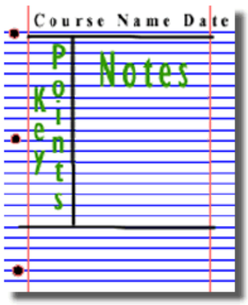
1. Divide your page into three sections like this



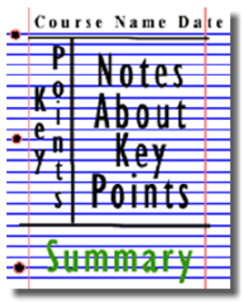
2. Write the name, date and topic at the top of the page



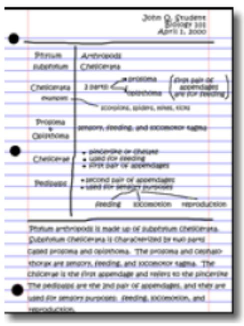
3. Use the large box to make notes. Leave a space between separate idea. Abbreviate where possible.



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 Topics

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.

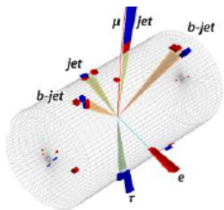
For each of the following topics, you are going to use the resources to produce one page of Cornell style notes.

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

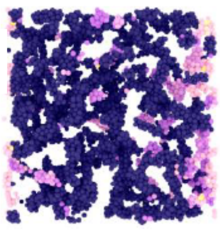
A proton collision experiment at CERN provides a new handle on the Higgs boson's interaction with the heaviest of the quarks.



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.

Task 3: Transition Questions.

You should already have a login to kerboodle. Try it and access the A Level Physics textbook. Read through the next few

Moving from GCSE Science to A Level can be a daunting leap. You'll be expected to remember a lot more facts, equations, and definitions, and you will need to learn new maths skills and develop confidence in applying what you already know to unfamiliar situations.

This worksheet aims to give you a head start by helping you:

- to pre-learn some useful knowledge from the first chapters of your A Level course
- understand and practice of some of the maths skills you'll need.

Learning objectives

After completing the worksheet you should be able to:

- define practical science key terms
- recall the answers to the retrieval questions
- perform maths skills including:
    - unit conversions
    - uncertainties
    - using standard form and significant figures
    - resolving vectors
    - rearranging equations
    - equations of work, power, and efficiency

Retrieval questions

You need to be confident about the definitions of terms that describe measurements and results in A Level Physics.
Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

Practical science key terms

When is a measurement valid?	when it measures what it is supposed to be measuring
When is a result accurate?	when it is close to the true value
What are precise results?	when repeat measurements are consistent/agree closely with each other
What is repeatability?	how precise repeated measurements are when they are taken by the *same* person, using the *same* equipment, under the *same* conditions
What is reproducibility?	how precise repeated measurements are when they are taken by *different* people, using *different* equipment
What is the uncertainty of a measurement?	the interval within which the true value is expected to lie
Define measurement error	the difference between a measured value and the true value
What type of error is caused by results varying around the true value in an unpredictable way?	random error
What is a systematic error?	a consistent difference between the measured values and true values
What does zero error mean?	a measuring instrument gives a false reading when the true value should be zero
Which variable is changed or selected by the investigator?	independent variable
What is a dependent variable?	a variable that is measured every time the independent variable is changed
Define a fair test	a test in which only the independent variable is allowed to affect the dependent variable
What are control variables?	variables that should be kept constant to avoid them affecting the dependent variable

Foundations of Physics

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

What is a physical quantity?	a property of an object or of a phenomenon that can be measured
What are the S.I. units of mass, length, and time?	kilogram (kg), metre (m), second (s)
What base quantities do the S.I. units A, K, and mol represent?	current, temperature, amount of substance
List the prefixes, their symbols and their multiplication factors from pico to tera (in order of increasing magnitude)	pico (p) 10^{-12}, nano (n) 10^{-9}, micro (µ) 10^{-6}, milli (m) 10^{-3}, centi (c) 10^{-2}, deci (d) 10^{-1}, kilo (k) 10^{3}, mega (M) 10^{6}, giga (G) 10^{9}, tera (T) 10^{12}
What is a scalar quantity?	a quantity that has magnitude (size) but *no* direction
What is a vector quantity?	a quantity that has magnitude (size) *and* direction
What are the equations to resolve a force, *F*, into two perpendicular components, F_x and F_y?	$F_x = F\cos\theta$ $F_y = F\sin\theta$
What is the difference between distance and displacement?	distance is a scalar quantity displacement is a vector quantity
What does the Greek capital letter Δ (delta) mean?	'change in'
What is the equation for average speed in algebraic form?	$v = \frac{\Delta x}{\Delta t}$
What is instantaneous speed?	the speed of an object over a very short period of time
What does the gradient of a displacement–time graph tell you?	velocity
How can you calculate acceleration and displacement from a velocity–time graph?	acceleration is the gradient displacement is the area under the graph
Write the equation for acceleration in algebraic form.	$a = \frac{\Delta v}{\Delta t}$
What do the letters *suvat* stand for in the equations of motion?	s = displacement, u = initial velocity, v = final velocity, a = acceleration, t = time taken
Write the four *suvat* equations.	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $s = \frac{1}{2}(u+v)t$ $v^2 = u^2 + 2as$
Define *stopping distance*	the total distance travelled from when the driver first sees a reason to stop, to when the vehicle stops
Define *thinking distance*	the distance travelled between the moment when you first see a reason to stop to the moment when you use the brake
Define *braking distance*	the distance travelled from the time the brake is applied until the vehicle stops
What does *free fall* mean?	when an object is accelerating under gravity with no other force acting on it

Maths skills

1 Measurements

1.1 Base and derived SI units

Units are defined so that, for example, every scientist who measures a mass in kilograms uses the same size for the kilogram and gets the same value for the mass. Scientific measurement depends on standard units – most are *Système International* (SI) units. Every measurement must give the unit to have any meaning. You should know the correct unit for physical quantities.

Base units

Physical quantity	Unit	Symbol
length	metre	m
mass	kilogram	kg
time	second	s

Physical quantity	Unit	Symbol
electric current	ampere	A
temperature difference	Kelvin	K
amount of substance	mole	mol

Derived units

Example:

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

If a car travels 2 metres in 2 seconds:

$$\text{speed} = \frac{2\,\text{metres}}{2\,\text{seconds}} = 1\frac{\text{m}}{\text{s}} = 1\text{m/s}$$

This defines the SI unit of speed to be 1 metre per second (m/s), or 1 m s^{-1} ($s^{-1} = \frac{1}{s}$).

Practice questions

1 Complete this table by filling in the missing units and symbols.

Physical quantity	Equation used to derive unit	Unit	Symbol and name (if there is one)
frequency	period^{-1}	s^{-1}	Hz, hertz
volume	length^{3}		–
density	mass ÷ volume		–
acceleration	velocity ÷ time		–
force	mass × acceleration		
work and energy	force × distance		

1.2 Significant figures

When you use a calculator to work out a numerical answer, you know that this often results in a large number of decimal places and, in most cases, the final few digits are 'not significant'. It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, too few and you are not showing the precision and care required in scientific analysis.

Numbers to 3 significant figures (3 s.f.):

3.62   25.4   271   0.0147   0.245   39 400

(notice that the zeros before the figures and after the figures are *not* significant – they just show you how large the number is by the position of the decimal point).

Numbers to 3 significant figures where the zeros *are* significant:

207   4050   1.01 (any zeros between the other significant figures *are* significant).

Standard form numbers with 3 significant figures:

9.42×10^{-5} 1.56×10^{8}

If the value you wanted to write to 3.s.f. was 590, then to show the zero was significant you would have to write:

590 (to 3.s.f.) or 5.90×10^2

Practice questions

2 Give these measurements to 2 significant figures:

a 19.47 m   **b** 21.0 s   **c** 1.673×10^{-27} kg **d** 5 s

3 Use the equation:

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

to calculate the resistance of a circuit when the potential difference is 12 V and the current is 1.8 mA. Write your answer in kΩ to 3 s.f.

1.3 Uncertainties

When a physical quantity is measured there will always be a small difference between the measured value and the true value. How important the difference is depends on the size of the measurement and the size of the uncertainty, so it is important to know this information when using data.

There are several possible reasons for uncertainty in measurements, including the difficulty of taking the measurement and the resolution of the measuring instrument (i.e. the size of the scale divisions).

For example, a length of 6.5 m measured with great care using a 10 m tape measure marked in mm would have an uncertainty of 2 mm and would be recorded as 6.500 ± 0.002 m.

It is useful to quote these uncertainties as percentages.

For the above length, for example,

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{measurement}} \times 100$$

$\text{percentage uncertainty} = \dfrac{0.002}{6.500}$ × 100% = 0.03%. The measurement is 6.500 m ± 0.03%.

Values may also be quoted with absolute error rather than percentage uncertainty, for example, if the 6.5 m length is measured with a 5% error,

the absolute error = 5/100 × 6.5 m = ±0.325 m.

Practice questions

4 Give these measurements with the uncertainty shown as a percentage (to 1 significant figure):

a 5.7 ± 0.1 cm **b** 450 ± 2 kg **c** 10.60 ± 0.05 s **d** 366 000 ± 1000 J

5 Give these measurements with the error shown as an absolute value:

a 1200 W ± 10% **b** 330 000 Ω ± 0.5%

6 Identify the measurement with the smallest percentage error. Show your working.

A 9 ± 5 mm **B** 26 ± 5 mm **C** 516 ± 5 mm **D** 1400 ± 5 mm

2 Standard form and prefixes

When describing the structure of the Universe you have to use very large numbers. There are billions of galaxies and their average separation is about a million light years (ly). The Big Bang theory says that the Universe began expanding about 14 billion years ago. The Sun formed about 5 billion years ago. These numbers and larger numbers can be expressed in standard form and by using prefixes.

2.1 Standard form for large numbers

In standard form, the number is written with one digit in front of the decimal point and multiplied by the appropriate power of 10. For example:

- The diameter of the Earth, for example, is 13 000 km.

  13 000 km = 1.3 × 10 000 km = 1.3×10^4 km.
- The distance to the Andromeda galaxy is 2 200 000 light years = 2.2 × 1 000 000 ly = 2.2×10^6 ly.

2.2 Prefixes for large numbers

Prefixes are used with SI units (see Topic 1.1) when the value is very large or very small. They can be used instead of writing the number in standard form. For example:

- A kilowatt (1 kW) is a thousand watts, that is 1000 W or 10^3 W.
- A megawatt (1 MW) is a million watts, that is 1 000 000 W or 10^6 W.
- A gigawatt (1 GW) is a billion watts, that is 1 000 000 000 W or 10^9 W.

Prefix	Symbol	Value
kilo	k	10^3
mega	M	10^6

Prefix	Symbol	Value
giga	G	10^9
tera	T	10^{12}

For example, Gansu Wind Farm in China has an output of 6.8×10^9 W. This can be written as 6800 MW or 6.8 GW.

Practice questions

1 Give these measurements in standard form:

a 1350 W **b** 130 000 Pa **c** 696×10^6 s **d** 0.176×10^{12} C kg^{-1}

2 The latent heat of vaporisation of water is 2 260 000 J/kg. Write this in:

a J/g **b** kJ/kg **c** MJ/kg

2.3 Standard form and prefixes for small numbers

At the other end of the scale, the diameter of an atom is about a tenth of a billionth of a metre. The particles that make up an atomic nucleus are much smaller. These measurements are represented using negative powers of ten and more prefixes. For example:

- The charge on an electron = 1.6×10^{-19} C.
- The mass of a neutron = $0.016\,75 \times 10^{-25}$ kg = 1.675×10^{-27} kg (the decimal point has moved 2 places to the right).
- There are a billion nanometres in a metre, that is 1 000 000 000 nm = 1 m.
- There are a million micrometres in a metre, that is 1 000 000 µm = 1 m.

Prefix	Symbol	Value
centi	c	10^{-2}
milli	m	10^{-3}
micro	µ	10^{-6}

Prefix	Symbol	Value
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

Practice questions

3 Give these measurements in standard form:

a 0.0025 m **b** 160×10^{-17} m **c** 0.01×10^{-6} J **d** 0.005×10^6 m **e** 0.00062×10^3 N

4 Write the measurements for question 3a, c, and d above using suitable prefixes.

5 Write the following measurements using suitable prefixes.

a a microwave wavelength = 0.009 m

b a wavelength of infrared = 1×10^{-5} m

c a wavelength of blue light = 4.7×10^{-7} m

2.4 Powers of ten

When multiplying powers of ten, you must *add* the indices.

So 100 × 1000 = 100 000 is the same as $10^2 \times 10^3 = 10^{2+3} = 10^5$

When dividing powers of ten, you must *subtract* the indices.

So $\frac{100}{1000} = \frac{1}{10} = 10^{-1}$ is the same as $\frac{10^2}{10^3} = 10^{2-3} = 10^{-1}$

But you can only do this when the numbers with the indices are the same.

So $10^2 \times 2^3 = 100 \times 8 = 800$

And you can't do this when adding or subtracting.

$10^2 + 10^3 = 100 + 1000 = 1100$

$10^2 - 10^3 = 100 - 1000 = -900$

Remember: You can only add and subtract the indices when you are multiplying or dividing the numbers, not adding or subtracting them.

Practice questions

6 Calculate the following values – read the questions very carefully!

a $20^6 + 10^{-3}$

b $10^2 - 10^{-2}$

c $2^3 \times 10^2$

d $10^5 \div 10^2$

7 The speed of light is 3.0×10^8 m s^{-1}. Use the equation $v = f\lambda$ (where λ is wavelength) to calculate the frequency of:

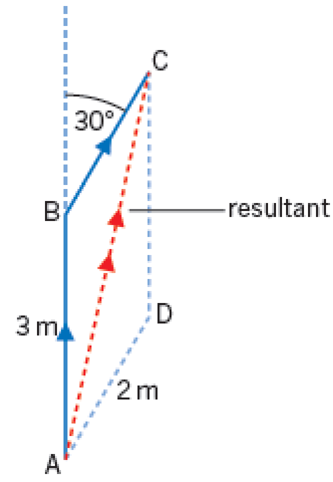
a ultraviolet, wavelength 3.0×10^{-7} m

b radio waves, wavelength 1000 m

c X-rays, wavelength 1.0×10^{-10} m.

3 Resolving vectors

3.1 Vectors and scalars



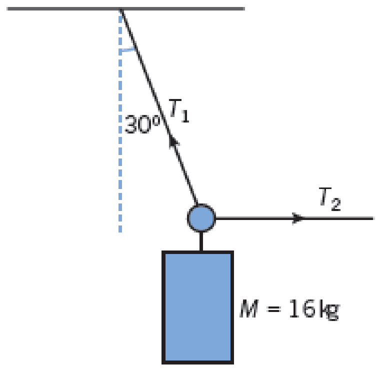
Vectors have a magnitude (size) and a direction. Directions can be given as points of the compass, angles or words such as forwards, left or right. For example, 30 mph east and 50 km/h north-west are velocities.

Scalars have a magnitude, but no direction. For example, 10 m/s is a speed.

Practice questions

1 State whether each of these terms is a vector quantity or a scalar quantity: density, temperature, electrical resistance, energy, field strength, force, friction, frequency, mass, momentum, power, voltage, volume, weight, work done.

2 For the following data, state whether each is a vector or a scalar: 3 ms^{-1}, +20 ms^{-1}, 100 m NE, 50 km, −5 cm, 10 km S 30° W, 3×10^8 ms^{-1} upwards, 273 °C, 50 kg, 3 A.



3.2 Drawing vectors

Vectors are shown on drawings by a straight arrow. The arrow starts from the point where the vector is acting and shows its direction. The length of the vector represents the magnitude.

When you add vectors, for example two velocities or three forces, you must take the direction into account.

The combined effect of the vectors is called the resultant.

This diagram shows that walking 3 m from A to B and then turning through 30° and walking 2 m to C has the same effect as walking directly from A to C. AC is the resultant vector, denoted by the double arrowhead.

A careful drawing of a scale diagram allows us to measure these. Notice that if the vectors are combined by drawing them in the opposite order, AD and DC, these are the other two sides of the parallelogram and give the same resultant.

Practice question

3 Two tractors are pulling a log across a field. Tractor 1 is pulling north with force 1 = 5 kN and tractor 2 is pulling east with force 2 = 12 kN. By scale drawing, determine the resultant force.

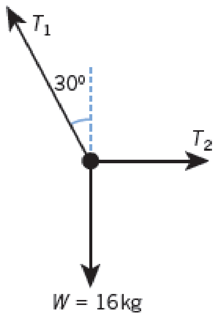
3.3 Free body force diagrams

To combine forces, you can draw a similar diagram to the one above, where the lengths of the sides represent the magnitude of the force (e.g., 30 N and 20 N). The third side of the triangle shows us the magnitude and direction of the resultant force.

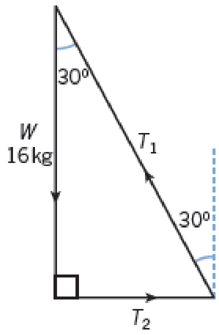
When solving problems, start by drawing a free body force diagram. The object is a small dot and the forces are shown as arrows that start on the dot and are drawn in the direction of the force. They don't have to be to scale, but it helps if the larger forces are shown to be larger. Look at this example.

A 16 kg mass is suspended from a hook in the ceiling and pulled to one side with a rope, as shown on the right. Sketch a free body force diagram for the mass and draw a triangle of forces.

Free body force diagram



Triangle of forces



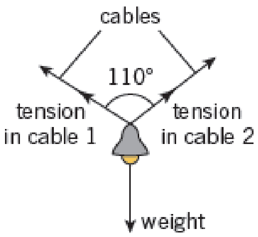
Notice that each force starts from where the previous one ended and they join up to form a triangle with no resultant because the mass is in equilibrium (balanced).

Practice questions

4 Sketch a free body force diagram for the lamp (**Figure 1**, below) and draw a triangle of forces.

5 There are three forces on the jib of a tower crane (**Figure 2**, below). The tension in the cable *T*, the weight *W*, and a third force *P* acting at X.

The crane is in equilibrium. Sketch the triangle of forces.



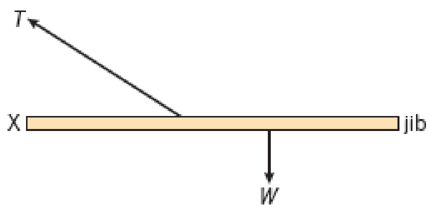


Figure 1 **Figure 2**

3.4 Calculating resultants

When two forces are acting at right angles, the resultant can be calculated using Pythagoras's theorem and the trig functions: sine, cosine, and tangent.

For a right-angled triangle as shown:

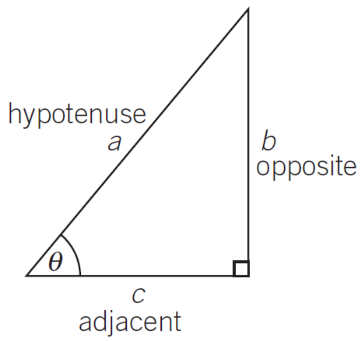
$h^2 = o^2 + a^2$

$\sin \vartheta = \dfrac{o}{h}$

$\cos \vartheta = \dfrac{a}{h}$

$\tan \vartheta = \dfrac{o}{a}$

(soh-cah-toa).



Practice questions

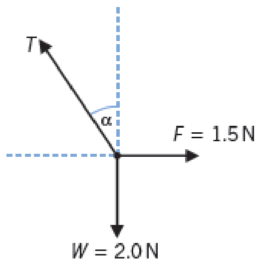
6 **Figure 3** shows three forces in equilibrium.

Draw a triangle of forces to find T and α.

7 Find the resultant force for the following pairs of forces at right angles to each other:

a 3.0 N and 4.0 N **b** 5.0 N and 12.0 N

Figure 3



4 Rearranging equations

Sometimes you will need to rearrange an equation to calculate the answer to a question. For example, if you want to calculate the resistance R, the equation:

potential difference (V) = current (A) × resistance (Ω) or $V = I\,R$

must be rearranged to make R the subject of the equation:

$$R = \frac{V}{I}$$

When you are solving a problem:

- Write down the values you know and the ones you want to calculate.
- you can rearrange the equation first, and then substitute the values

  or

- substitute the values and then rearrange the equation

4.1 Substitute and rearrange

A student throws a ball vertically upwards at 5 m s^{-1}. When it comes down, she catches it at the same point. Calculate how high it goes.

step 1: Known values are:

- initial velocity u = 5.0 m s^{-1}
- final velocity v = 0 (you know this because as it rises it will slow down, until it comes to a stop, and then it will start falling downwards)
- acceleration $a = g$ = −9.81 m s^{-2}
- distance s = ?

Step 2: Equation:

(final velocity)^2 − (initial velocity)^2 = 2 × acceleration × distance

or $v^2 - u^2 = 2 \times g \times s$

Substituting: $(0)^2 - (5.0\ \text{m s}^{-1})^2 = 2 \times -9.81\ \text{m s}^{-2} \times s$

$0 - 25 = 2 \times -9.81 \times s$

Step 3: Rearranging:

$-19.62\,s = -25$

$$s = \frac{-25}{-19.62} = 1.27\ \text{m} = 1.3\ \text{m (2 s.f.)}$$

Practice questions

1 The potential difference across a resistor is 12 V and the current through it is 0.25 A. Calculate its resistance.

2 Red light has a wavelength of 650 nm. Calculate its frequency. Write your answer in standard form.

(Speed of light = $3.0 \times 10^8\ \text{m s}^{-1}$)

4.2 Rearrange and substitute

A 57 kg block falls from a height of 68 m. By considering the energy transferred, calculate its speed when it reaches the ground.

(Gravitational field strength = $10\ \text{N kg}^{-1}$)

Step 1: $m = 57$ kg $h = 68$ m $g = 10\ \text{N kg}^{-1}$ $v = ?$

Step 2: There are three equations:

PE = $m\,g\,h$ KE gained = PE lost KE = $0.5\,m\,v^2$

Step 3: Rearrange the equations before substituting into it.

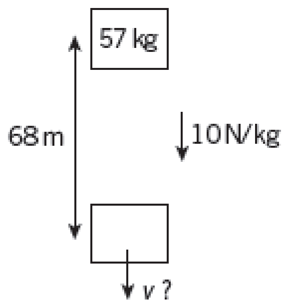
As KE gained = PE lost, $m\,g\,h = 0.5\,m\,v^2$

You want to find v. Divide both sides of the equation by $0.5\,m$:

$$\frac{mgh}{0.5m} = \frac{0.5mv^2}{0.5m}$$

$2\,g\,h = v^2$

To get v, take the square root of both sides: $v = \sqrt{2gh}$



Step 4: Substitute into the equation:

$v = \sqrt{2 \times 10 \times 68}$

$v = \sqrt{1360} = 37\ \text{m s}^{-1}$

Practice question

3 Calculate the specific latent heat of fusion for water from this data:

4.03×10^4 J of energy melted 120 g of ice.

Use the equation:

thermal energy for a change in state (J) = mass (kg) × specific latent heat (J kg^{-1})

Give your answer in J kg^{-1} in standard form.

5 Work done, power, and efficiency

5.1 Work done

Work is done when energy is transferred. Work is done when a force makes something move. If work is done *by* an object its energy decreases and if work is done *on* an object its energy increases.

work done = energy transferred = force × distance

Work and energy are measured in joules (J) and are scalar quantities (see Topic 3.1).

Practice question

1 Calculate the work done when the resultant force on a car is 22 kN and it travels 2.0 km.

2 Calculate the distance travelled when 62.5 kJ of work is done applying a force of 500 N to an object.

5.2 Power

Power is the rate of work done.

It is measured in watts (W) where 1 watt = 1 joule per second.

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}} \quad \textit{or} \quad \text{power} = \frac{\text{work done}}{\text{time taken}}$$

$P = \Delta W / \Delta t$ *Δ is the symbol 'delta' and is used to mean a 'change in'*

Look at this worked example, which uses the equation for potential energy gained.

A motor lifts a mass m of 12 kg through a height Δh of 25 m in 6.0 s.

Gravitational potential energy gained:

$\Delta PE = mg\Delta h = (12 \text{ kg}) \times (9.81 \text{ m s}^{-2}) \times (25 \text{ m}) = 2943 \text{ J}$

$$\text{Power} = \frac{2943 \text{ J}}{6.0 \text{ s}} = 490 \text{ W (2 s.f.)}$$

Practice questions

3 Calculate the power of a crane motor that lifts a weight of 260 000 N through 25 m in 48 s.

4 A motor rated at 8.0 kW lifts a 2500 N load 15 m in 5.0 s. Calculate the output power.

5.3 Efficiency

Whenever work is done, energy is transferred and some energy is transferred to other forms, for example, heat or sound. The efficiency is a measure of how much of the energy is transferred usefully.

Efficiency is a ratio and is given as a decimal fraction between 0 (all the energy is wasted) and 1 (all the energy is usefully transferred) or as a percentage between 0 and 100%. It is not possible for anything to be 100% efficient: some energy is always lost to the surroundings.

Efficiency = $\frac{\text{useful energy output}}{\text{total energy input}}$ or Efficiency = $\frac{\text{useful power output}}{\text{total power input}}$

(multiply by 100% for a percentage)

Look at this worked example.

A thermal power station uses 11 600 kWh of energy from fuel to generate electricity. A total of 4500 kWh of energy is output as electricity. Calculate the percentage of energy 'wasted' (dissipated in heating the surroundings).

You must calculate the energy wasted using the value for useful energy output:

percentage energy wasted = $\frac{\text{(total energy input - energy output as electricity)}}{\text{total energy input}} \times 100$

percentage energy wasted = $\frac{(11600 - 4500)}{11600} \times 100$ = 61.2% = 61% (2 s.f.)

Practice questions

5 Calculate the percentage efficiency of a motor that does 8400 J of work to lift a load.

The electrical energy supplied is 11 200 J.

6 An 850 W microwave oven has a power consumption of 1.2 kW.

Calculate the efficiency, as a percentage.

7 Use your answer to question 4 above to calculate the percentage efficiency of the motor. (The motor, rated at 8.0 kW, lifts a 2500 N load 15 m in 5.0 s.)

8 Determine the time it takes for a 92% efficient 55 W electric motor take to lift a 15 N weight 2.5 m.

Assess your understanding by marking your answers using this mark scheme. Make a note of any difficulties you had and what you have tried to do to improve.

Maths skills

1 Measurements

Practice questions

1

Physical quantity	Equation used to derive unit	Unit	Symbol and name (if there is one)
frequency	period^{-1}	s^{-1}	Hz, hertz
volume	length^3	m^3	–
density	mass ÷ volume	$kg\ m^{-3}$	–
acceleration	velocity ÷ time	$m\ s^{-2}$	–
force	mass × acceleration	$kg\ m\ s^{-2}$	N newton
work and energy	force × distance	N m (or $kg\ m^2\ s^{-2}$)	J joule

2 **a** 19 m **b** 21 s
c 1.7×10^{-27} kg **d** 5.0 s

3 Resistance $= \dfrac{12\text{ V}}{1.8\text{ mA}} = \dfrac{12\text{ V}}{0.0018\text{ A}} = 6666.666...\Omega = 6.66666...\text{k}\Omega = 6.67\Omega$

4 **a** 5.7 cm ± 2% **b** 450 kg ± 0.4%
c 10.6 s ± 0.5% **d** 366 000 J ± 0.3%

5 **a** 1200 ± 120 W **b** 330 000 ± 1650 Ω

6 **D** 1400 ± 5 mm (Did you calculate them all? The same absolute error means the percentage error will be smallest in the largest measurement, so no need to calculate.)

2 Standard form and prefixes

Practice questions

3 **a** 1.35×10^3 W (or 1.350×10^3 W to 4 s.f.) **b** 1.3×10^5 Pa
c 6.96×10^8 s **d** 1.76×10^{11} C kg^{-1}

4 **a** 2 260 000 J in 1 kg, so there will be 1000 times fewer J in 1 g: $\dfrac{2\,260\,000}{1000} = 2260\text{ J/g}$

b 1 kJ = 1000 J, $2\,260\,000\text{ J/kg} = \dfrac{2\,260\,000}{1000}\text{kJ/kg} = 2260\text{ kJ/kg}$

c 1 MJ = 1000 kJ, so $2260\text{ kJ/kg} = \dfrac{2260}{1000}\text{MJ/kg} = 2.26\text{ MJ/kg}$

5 **a** 2.5×10^{-3} m **b** 1.60×10^{-15} m
c 1×10^{-8} J **d** 5×10^3 m
e 6.2×10^{-1} N

6 **a** 2.5 µm **b** 1.60 f m

c 10 nJ **or** 0.01 µJ **d** 5 km

e 0.62 N **or** 62 cN

7 **a** 0.009 m = 9×10^{-3} m = 9 mm

b 1×10^{-5} m = $1 \times 10 \times 10^{-6}$ m = 10×10^{-6} m = 10 µm

c 4.7×10^{-7} m = $4.7 \times 100 \times 10^{-9}$ m = 470×10^{-9} m = 470 nm

8 **a** 64000000 **or** 6.4×10^7 **b** 99.99

c 800 **d** 10^3

9 **a** 3.0×10^8 m s^{-1} ÷ 3.03×10^{-7} m = 1.0×10^{15} Hz

b 3.0×10^8 m s^{-1} ÷ 1000 m = 3.0×10^5 Hz

c 3.0×10^8 m s^{-1} ÷ 1.0×10^{-10} m = 3.0×10^{18} Hz

3 Resolving vectors

Practice questions

1 **Scalars:** density, electric charge, electrical resistance, energy, frequency, mass, power, temperature, voltage, volume, work done

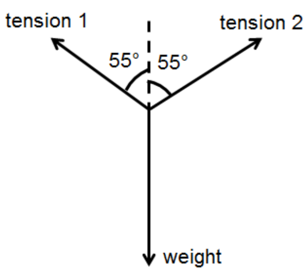
Vectors: field strength, force, friction, momentum, weight

2 **Scalars:** 3 ms^{-1}, 50 km, 273 °C, 50 kg, 3 A

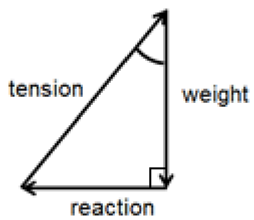
Vectors: +20 ms^{-1}, 100 m NE, −5 cm, 10 km S 30°W, 3×10^8 m/s upwards

3 13 kN

4 **Free body force diagram:**



Triangle of forces:



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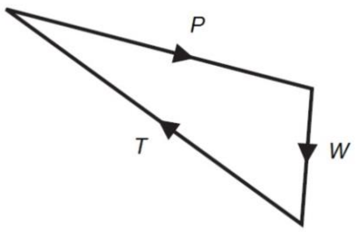

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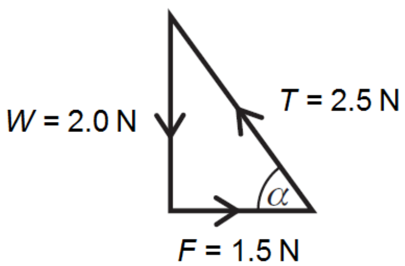

7 **a** 5.0 N at 37° to the 4.0 N force **b** 13 N at 23° to the 12.0 N force

4 Rearranging equations

Practice questions

1 V = 12 V and I = 0.25 A

$V = I R$ so $12 = 0.25 \times R$

$R = \frac{V}{I} = \frac{12}{0.25} = 48\ \Omega$

2 λ = 650 nm = 650×10^{-9} m and v = 3.0×10^{8} m/s

$v = f\lambda$ so $3.0\times10^{8} = f \times 650\times10^{-9}$

$f = \frac{v}{\lambda} = \frac{3.0\times10^{8}}{650\times10^{-9}} = 0.00462\times10^{17} = 4.62\times10^{14}$ Hz

3 E = 4.01×10^{4} J and m = 0.120 g = 0.120 kg

$E = mL$ so $4.01\times10^{4} = 0.120 \times L$

$L = \frac{E}{m} = \frac{4.01\times10^{4}}{0.120}$ = 334 166 J/kg = 3.34×10^{5} J/kg in standard form

5 Work done, power, and efficiency

Practice questions

1 22×10^{3} N × 2×10^{3} m = 44 000 000 J = 44 MJ

2 $\frac{62.5\times10^{3}\ \text{J}}{500\ \text{N}}$ = 125 m

3 $\frac{260\ 000\ \text{N}\times 25\ \text{m}}{48\ \text{s}}$ = 13 541.6 W = 14 000 W or 14 kW (2 s.f.)

4 $\frac{2500\ \text{N}\times 15\ \text{m}}{5\ \text{s}}$ = 7500 W = 7.5 kW

5 $\frac{8400}{11200} \times 100$ = 75%

6 $\frac{850}{1.2\times10^{3}} \times 100$ = 71%

7 $\frac{7.5}{8.0} \times 100$ = 94%

8 0.74 s

Task 4: Isaac Physics

You have just completed some retrieval practice and transition questions to get a really good idea of what the start of the A Level will be like. Over the course of the next few years we will be using isaacphysics.org to help to assess you and provide specific feedback. You will need to click on this link and set up an account:

https://isaacphysics.org/account?authToken=Q9W6ZN

You will see that Assignments have been set up for you that you will need to complete before September 6th. Read on to find out how I would like you to attempt completing the assignments fully.

This transition work will help develop essential skills you will need to be successful in physics. Watch the clips, take some notes (try practising using Cornell notes again – hand these in in the first lesson) and then try the Isaacphysics questions.

Assignments:

1) **Units**
https://www.alevelphysicsonline.com/quantities-and-units

2) **A Level transition – skills**
This assignment tests the following:
a) Rearranging equations
https://www.youtube.com/watch?v=HyH9-5tnS0A
b) Standard form and prefixes
https://www.youtube.com/watch?v=RMmuVrUfaWU
c) Converting units
https://www.youtube.com/watch?v=dzR7rcO2-fI
d) Gradients and Intercepts of Graphs
e) Equations of Graphs
https://www.youtube.com/watch?v=SDOelTzW_MA
f) Area Under the Line on a Graph
https://www.youtube.com/watch?v=d-_eqgj5-K8

3) **Getting to grips with Significant Figures**
https://www.youtube.com/watch?v=Pml4Z4BJibc

But wait, there's more?

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!