

Urmston Grammar Physics Transition 11 to 12

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

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

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

Recommended reading

CGP New Head start to A level Physics (£5 a copy) Bridging GCSE to A level physics. It recaps all the crucial topics you will need to remember from GCSE, with clear study notes and examples, plus practice questions to test your understanding. Included there is also an introduction to some of the key topics you'll meet at A-Level.

Head First Physics, nice and entertaining, download for free at:

<http://www.ebook777.com/head-first-physics/>

Metric system to get a grasp of units and conversions from the start which will provide you with a really good head start.

https://simple.wikipedia.org/w/index.php?title=Metric_system&oldid=4754036

Further Reading

Superstrings and other things – a great read

Cartoon Guide to Physics – key ideas presented with humour

Surely you're joking Mr Feynmann – another great read

On-line

Minute Physics

Wonders of the Universe (Netflix)

Shock and Awe

The Fantastic Mr Feynmann

Research

CERN

Phet.colorado

Resources to help

AQA website is a great place to start.

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

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

Institute of Physics (IOP)

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

SI units

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

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

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

The seven SI base units are:

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

All other units can be derived from the SI base units. For example, area is measured in square metres (written as m²) and speed is measured in metres per second (written as ms⁻¹).

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

quantity	Usual quantity symbol	Unit	Abbreviation	SI unit
Force	<i>F</i>	newton	N	kg m s ⁻²
Energy	<i>E or W</i>	joule	J	kg m ² s ⁻²
Frequency	<i>f</i>	hertz	Hz	s ⁻¹

It is not always appropriate to use a full unit. For example, measuring the width of a hair or the distance from Manchester to London in metres would cause the numbers to be difficult to work with. Prefixes are used to multiply each of the units. You will be familiar with centi (meaning 1/100), kilo (1000) and milli (1/1000) from centimetres, kilometres and millimetres.

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

Basic Mathematical Skills.

1: How to use and convert prefixes

Mathematical Prefixes

How a prefix works.

Example: 5×10^3 is equivalent to writing 5000 (where $\times 10^3$ is replaced by 3 zeros)

5×10^{-3} however become 0.005 (because it is -3 , three zeros are added before the value, one before the decimal place.)

Another way to think about it is the decimal place moving back spaces (ie for $\times 10^3$) forwards 3 spaces (for $\times 10^{-3}$), it moves forward or back the same number of spaces as the multiplier.

Prefix	Symbol	Name	Multiplier
femto	f	quadrillionth	10^{-15}
pico	p	trillionth	10^{-12}
nano	n	billionth	10^{-9}
micro	μ	millionth	10^{-6}
milli	m	thousandth	10^{-3}
centi	c	hundredth	10^{-2}
deci	d	tenth	10^{-1}
deka	da	ten	10^1
hecto	h	hundred	10^2
kilo	k	thousand	10^3
mega	M	million	10^6
giga	G	billion [†]	10^9
tera	T	trillion [†]	10^{12}
peta	P	quadrillion	10^{15}

Don't learn all the names, but DO learn the **prefix**, its **symbol** and the **multiplier**.

IMPORTANT IDEA: When you are given a variable with a prefix you must convert it into its numerical equivalent in standard form before you use it in an equation.

FOLLOW THIS!

Always start by replacing the prefix symbol with its equivalent multiplier. Then write it as a number without a multiplier.

For example: $0.16 \mu\text{A} = 0.16 \times 10^{-6} \text{ A} (= 0.00000016 \text{ A}$, avoid writing numbers like this - we don't want to spend our time counting zeroes!)

$$3 \text{ km} = 3 \times 10^3 \text{ m} = 3000 \text{ m}$$

$$10 \text{ ns} = 10 \times 10^{-9} \text{ s} = (0.000000010 \text{ s}) - \text{AVOID writing all the zeroes}$$

DO NOT get tempted to follow this further (for example: $0.16 \times 10^{-6} \text{ A} = 1.6 \times 10^{-7} \text{ A}$ and also $10 \times 10^{-9} \text{ s} = 10^{-8} \text{ s}$) unless you are absolutely confident that you will do it correctly. It is always safer to stop at the first step ($10 \times 10^{-9} \text{ s}$) and type it like this into your calculator.

NOW TRY THIS!

Replace the prefix with standard form.

Example: $1.4 \text{ kW} = 1.4 \times 10^3 \text{ W}$

$10 \mu\text{C} =$

$24 \text{ cm} =$

$340 \text{ MW} =$

$46 \text{ pF} =$

$27 \text{ Ps} =$

$0.03 \text{ mA} =$

$52 \text{ Gm} =$

$43 \text{ k}\Omega =$

$0.03 \text{ MN} =$

$34 \text{ nm} =$

$0.05 \text{ kV} =$

Rewrite the number with a more appropriate standard form then its prefix.

Example: $0.004 \text{ N} = 4 \times 10^{-3} \text{ N} = 4 \text{ mN}$

$0.000035 \text{ A} =$

$0.000703 \text{ C} =$

$25000 \text{ W} =$

$5430000 \text{ J} =$

$938400 \text{ m} =$

Convert these so they are in proper standard form (ie: $35000 = 3.5 \times 10^4$)

$1750.3 \times 10^6 =$

$0.0000036 =$

$375000000 =$

$0.000234 =$

2: Rearranging equations

The first step in learning to manipulate an equation is your ability to see how it is done once and then repeat the process again and again until it becomes second nature to you.

In order to show the process once I will be using letters rather than physical concepts.

You can rearrange an equation $a = b \times c$

In order to rearrange the equation for b, c must be moved to the other side. As it is b multiplied by c it can be removed by dividing the equation by c, but this must be done on both sides of the equals sign. On one side this cancels out the c's on the other side it leaves a / c .

So:

$a = b \times c$ moving c \rightarrow $\frac{a}{c} = \frac{b \times \cancel{c}}{\cancel{c}}$ both sides divided by c.
The c's on the right side of the equation cancel out.

$$b = \frac{a}{c}$$

So with b as the subject the equation becomes

Just remember in order to move a value the opposite function must be done to it (Multiplied \rightarrow Divided, Added \rightarrow Subtracted or Squared \rightarrow Square rooted.).

Some examples

Equation	First Rearrangement	Second Rearrangement
$v = f \times \lambda$	$f = \frac{v}{\lambda}$	$\lambda = \frac{v}{f}$
$T = \frac{1}{f}$	$1 = T \times f$	$f = \frac{1}{T}$
$\frac{1}{v} = \frac{1}{u} + \frac{1}{f}$	$1 = v \times \left(\frac{1}{u} + \frac{1}{f} \right)$	$v = \frac{1}{\frac{1}{u} + \frac{1}{f}}$

For more complicated formula start with the letters that are the most distant from the one you want to make the subject.

NOW TRY THIS!

From now on the multiplication sign will not be shown, so $a = b \times c$ will be simply written as $a = bc$

Fill in the blank spaces with each possible rearrangement for the equations given.

Equation	First Rearrangement	Second Rearrangement
(Magnification of lens) $m = \frac{v}{u}$	$v =$	$u =$
(refractive index) $n = \frac{c}{v}$	$c =$	$v =$
(current) $I = \frac{\Delta Q}{\Delta t}$		
(electric potential) $V = \frac{\Delta E}{\Delta Q}$		
(power) $P = \frac{\Delta E}{\Delta t}$		
(power) $P = VI$		
(resistance) $R = \frac{V}{I}$		
(power) $P = I^2 R$		
(power) $P = \frac{V^2}{R}$		
(Kinetic energy) $E_K = \frac{1}{2} m v^2$		
(conductance) $G = \frac{\sigma A}{L}$		
(resistance) $R = \frac{\rho L}{A}$		

How to solve a lengthy problem

Problems in physics can appear to be difficult at first sight. However, once you analyse the problem in well-defined steps you should be able to solve it without any difficulty. The steps you need to follow are:

1. **Identify the variables** you are given and the ones you are asked to find and label them with their symbols. Also think of variables that are not stated, but implied (Like gravity or the rest speed = 0).
2. **Convert all units** given to SI units
3. **Recognise which equation/s** to use. You do this by looking at what variables are available to you and what variables you are asked to find. This is a critical stage; experience is the most important factor here. This is why you need to practise again and again... This is also why you need to KNOW ALL YOUR EQUATIONS VERY WELL!
4. **Find the logical sequence** for using these equations in order to reach the desirable outcome. Again, experience is very important here!
5. Write the final answer and **add the correct units.**

EXAMPLE

A car of mass 600 kg is travelling at 10 ms⁻¹. When the brakes are applied, it comes to rest in 0.01 km. What is the average force exerted by the brakes? [3]

STEP 1. Mass (m) = 600 kg
initial velocity (u) = 10 m s⁻¹
final velocity (v) = 0 m s⁻¹
stopping distance (s) = 0.01 km
force (F) = ?

STEP 2. Are they all in SI units? No. So ...
stopping distance = 0.01 km = 0.01 × 10³ m = 10 m

STEP 3. $\Delta E = W$ (Change in energy = work done)
 $W = Fs$ (Work done = force × distance in the direction of the force)
 $E_K = \frac{1}{2}mv^2$ (Kinetic energy = 0.5 × mass × speed × speed)

STEP 4. Find the initial kinetic energy:
 $E_K = \frac{1}{2}mu^2 = \frac{1}{2} \times 600 \times 10^2 = 30000$
Find the final kinetic energy:
 $E_K' = \frac{1}{2}mv^2 = \frac{1}{2} \times 600 \times 0^2 = 0$

Find the change in kinetic energy: $\Delta E = E_K' - E_K = 0 - 30000 = -30000$
Equalize the change in kinetic energy with the work done and rearrange to find the force:
 $\Delta E = W \Rightarrow \Delta E = Fs \Rightarrow F = \frac{\Delta E}{s} \Rightarrow F = \frac{-30000}{10} \Rightarrow F = -3000$

STEP 5. The final answer is $F = -3000 \text{ N}$
The negative sign shows that the force is in opposite direction to the velocity, i.e. it is the frictional force that stops the car.

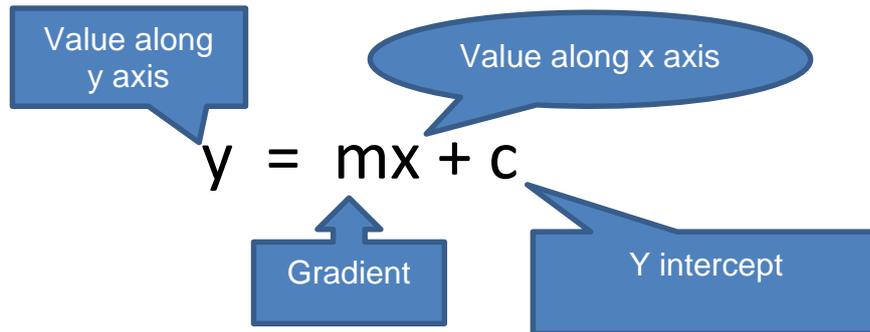
NOW TRY THIS!

A girl diving from a 15 m platform wishes to know how fast she enters the water. She is in the air for 1.75 s and dives from rest (with an initial speed of zero). What can you tell her about her entry speed? ($g = 9.8 \text{ m s}^{-2}$) [7]

REMEMBER! Follow all steps! Do not try to rush through!**STEP 1.****STEP 2.****STEP 3.****STEP 4.****STEP 5.**

4. Straight Line Graphs

If a graph is a straight line, then there is a formula that will describe it.



Using Straight Line Graphs in Physics

If asked to plot a graph of experimental data at GCSE, you would plot the *independent variable* along the x-axis and the *dependent variable* up the y-axis. Then you might be able to say something about how the two variables are related.

At A-Level, we need to be cleverer about our choice of axes. Often we will need to find a value which is not easy to measure. We take a relationship and manipulate it into the form $y = mx + c$ to make this possible.

Example: $R = \rho L/A$ is the relationship between the resistance R of a conductor, the resistivity ρ of the material which it is made of, its length L , and its area A .

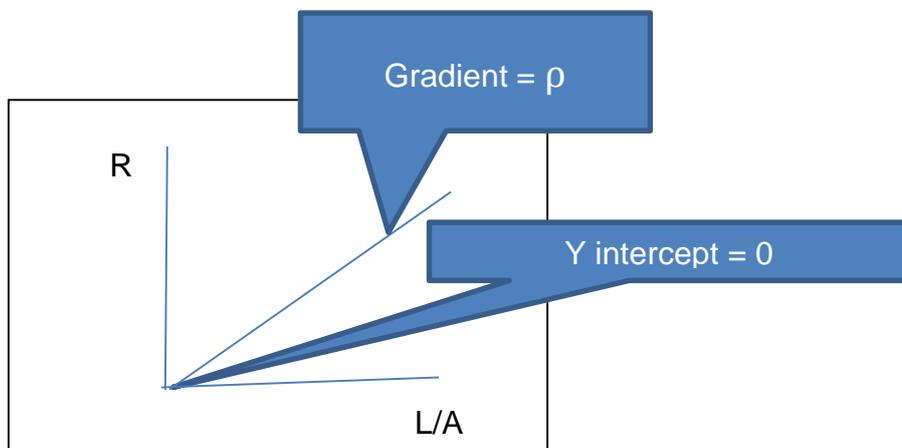
We do an experiment to find R , L and A , which are all easy to measure.

We want to find the resistivity ρ , which is harder.

This example doesn't need rearranging,

Just rewriting $R = \rho L/A$ into the shape $y = mx + c$:

$R = \rho L/A$
Plotting R on y axis and L/A on the x axis, gives a straight line through the origin with a gradient = ρ



Straight Line Graphs - Questions

1) For each of the following equations that represent straight line graphs, write down the gradient and the y intercept:

a) $y = 5x + 6$

b) $y = -8x + 2$

c) $y = 7 - x$

d) $2y = 8x - 3$

e) $y + 4x = 10$

f) $3x = 5(1-y)$

g) $5x - 3 = 8y$

Which career appeals to you?

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

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

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