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.
A good textbook which breaks down content into manageable chunks to help students with the transition from GCSE to A Level study: Advanced Physics For You

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

Magazines

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

On-line

Minute Physics
Wonders of the Universe (Netflix)
Shock and Awe
The Fantastic Mr Feynmann

Research

CERN
Phet.colarado

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 ºC). 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 given in column 3 of the table:

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

All other units can be derived from the SI base units. For example, area is measured in square metres (written as m^2) and speed is measured in metres per second (written as ms^{-1}).
Some derived units have their own unit names and abbreviations, often when the combination of SI units becomes complicated. Some common derived units are:

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 33km. The most common prefixes you will encounter are mentioned on the next page.

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)
7×10^{-3} however becomes 0.007 (because the index 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 forward or back spaces.
(ie for $\times 10^3$) forwards 3 spaces
(for $\times 10^{-3}$), it moves back 3 spaces.

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**.

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

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 µA = 0.16 x 10^{-6} A (= 0.00000016 A, avoid writing numbers like this – we don't want to spend our time counting zeroes)!

3 km = 3 x 10^{3} m = 3000 m

10 ns = 10 x 10^{-9} s [= (0.000000010 s) – AVOID all of the zeroes]

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

NOW TRY THIS!

Replace the prefix with the right number.	**Rewrite the number more sensibly using an appropriate prefix.**
Example: 1.4 kW = 1.4 x 10^3 W	Example: 0.004 N = 4 x 10^{-3} N = 4 mN
10 μC =	0.000035 A =
24 cm =	0.000703 C =
340 MW =	25000 W =
46 pF =	5430000 J =
27 Ts =	938400 m =
0.03 mA =	**Convert these so they are in proper standard form (ie: 35000 = 3.5 x 10^4)**
52 Gm =	1750.3 x 10^6 =
43 kΩ =	0.0000036 =
0.03 MN =	375000000 =
34 nm =	0.000234 =
0.05 kV =	

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

So with b as the subject the equation becomes $b = \frac{a}{c}$

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

<u>Some examples</u>

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 a 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) $E = ½ m v^2$		
(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 is 9.81N/kg or the speed at rest = 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 value and **add the correct units,** because the unit is part of the answer.

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 x 10^3 m = 10 m

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

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

Find the change in kinetic energy: $\Delta E = E_K' - E_K = 0 - 30000 = -30000$
Equalise the change in kinetic energy with the work done and rearrange to find the force:

$$\Delta E = W \Rightarrow \Delta E = Fs \Rightarrow F = \frac{\Delta E}{s} \Rightarrow \quad F = \frac{-30000}{10} \Rightarrow F = -3000$$

STEP 5. The final answer is $F = -3000N$

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? ($g = 9.8\ m\ s^{-2}$)

REMEMBER! Follow all steps! Do not try to rush through!

STEP 1.

STEP 2.

STEP 3.

STEP 4.

STEP 5.

Further Problems

Activity 1

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

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

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

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

Activity 2

Re-write the following in SI units.

1. 1 minute

2. 1 hour

3. 1 tonne

Activity 3

Re-write the following quantities:

1. 1502 metres in kilometres

2. 0.000 45 grams in micrograms

The delta symbol Δ

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

speed = $^{distance}/_{time}$ which can be written, simply, as $v = {}^{s}/_{t}$

What you often measure is the change in the distance of the car from a particular point, and the change in time from the beginning of your measurement to the end of it.
Because of the fact that the distance and the speed are changing, you use the delta symbol to emphasise this. The A-level version of the above formula becomes:

velocity = *displacement / time*, which can be written as $v = {}^{\Delta s}/_{\Delta t}$

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 4

Research exercise

1. Find out the difference between:

    speed and velocity

    distance and displacement

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

Activity 5: Standard form

1. Write in standard form

    (a) 379.4

    (b) 0.0712

2. Write as ordinary numbers:

    (a) The speed of light

    (b) The charge on an electron

3. Write one quarter of a million in standard form.

Activity 6: Decimal places, significant figures and rounding

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

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

   Work out the efficiency of the power station.

   Give your answer as a percentage to one decimal place.

3. A radioactive source produces 17 804 beta particles in 1 hour.

   Calculate the mean number of beta particles produced in 1 minute.

   Give your answer to one significant figure.

Activity 7: 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?

Activity 8: Arithmetic means

1. The mean weight of 9 people is 79 kg

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

   How heavy is the 10th person?

2. A pendulum completes 12 swings in 150 s.

   Work out the mean swing time.

Activity 9: Rearranging formulas

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

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

3. Rearrange $E = 1/2mv^2$ to make v the subject.

4. Rearrange $s = ut + 1/2at^2$ to make u the subject.

5. Rearrange $s = ut + 1/2at^2$ to make a the subject.

6. Rearrange $\omega = v/r$ to make r the subject.

7. Rearrange $T = 2\pi\sqrt{L/g}$ to make g the subject.

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.