The Transition from GCSE to A Level Physics

Welcome to A Level Physics!

We follow the Edexcel Physics (2015) specification and many of the details of this course can be found on the Edexcel Website below:

http://qualifications.pearson.com/en/qualifications/edexcel-a-levels/physics-2015.html

The aim of this guide is to provide you with some important information about the course and give you practice of some of the skills that you will need whilst studying physics at A Level. At the end is a list of suggestions of things you could do to 'become a better physicist'.

How much of the booklet you do is up to you…but remember; the more you do, the easier you will find the transition to A Level Physics.

See you in September!

Miss A Kent, Mr S Rowe and Miss S Fenner

<u>Symbols and SI Units</u>

One of the biggest jumps between GCSE and A Level Physics is the way things are written down. At A Level, you are expected to start using standard scientific notation. This includes:

- Using the conventional symbols for quantities (see below)
- Writing quantities in terms of SI units
- Using standard form to write very large or very small numbers

The table below lists some of the different quantities you will need to know for next year, with their symbols and units. This list is not extensive, but gives you an idea of some of the more common units that you will need to use frequently. The quicker you learn these, the easier you will find the year!

Quantity	**Symbol**	**Unit**
Displacement	s	m
Time	t	S
Velocity	v	ms^{-1}
Acceleration	a	ms^{-2}
Mass	m	kg
Force	F	N
Gravitational Field Strength	g	Nkg^{-1}
Energy	E	J
Power	P	W
Frequency	f	Hz
Wavelength	λ	m
Temperature	T	K
Charge	Q	C
Electric Current	I	A
Potential Difference	V	V
Resistance	R	Ω
Density	ρ	kgm^{-3}

<u>TASKS:</u>

1. Find out what the difference between a base unit and a derived unit is. Find the 7 base quantities, their unit names and symbols.
2. Find out what formally defines 2 of the base units above.
3. Write the following derived units in their base unit equivalent:
   (a) Newton
   (b) Joule,
   (c) Coulomb,
   (d) Hertz,
   (e) Watt

Power Prefixes

Sometimes the values we have to work with for some quantities mean that the numbers involved are extremely large or small. For example, the average distance from the Earth to the Sun, measured in metres, is 150 000 000 000 m. Scientists have developed a system for abbreviating such large values by adding a prefix to the unit which tells us that it has been multiplied by a very large or very small amount. In our Earth orbit example, the distance is equivalent to 150 billion metres, and the prefix gigameans multiply by a billion. So the Earth–Sun distance becomes 150 gigametres, or 150 Gm.

The table below shows the prefixes often used by Physicists. You will need to know these and use them in calculation questions in your exams. Again, if you spend some time learning the factors and the symbols, you will find it a lot easier throughout the year!

Factor	Name	Symbol	Factor	Name	Symbol
10^{1}	deca-	da	10^{-1}	deci-	d
10^{2}	hecto-	h	10^{-2}	centi-	c
10^{3}	kilo-	k	10^{-3}	milli-	m
10^{6}	mega-	M	10^{-6}	micro-	µ
10^{9}	giga-	G	10^{-9}	nano-	n
10^{12}	tera-	T	10^{-12}	pico-	p
10^{15}	peta-	P	10^{-15}	femto-	f
10^{18}	exa-	E	10^{-18}	atto-	a
10^{21}	zetta-	Z	10^{-21}	zepto-	z
10^{24}	yotta-	Y	10^{-24}	yocto-	y

TASKS:

1. Using the table above, write the following in standard form:
   - (a) 9.2 GW
   - (b) 43 mm
   - (c) 6400 km
   - (d) 44 ns.

2. Write the following using an appropriate prefix and unit symbol:
   - (a) 3 600 000 joules
   - (b) 31 536 000 seconds
   - (c) 10 millionths of an ampere
   - (d) 105 000 hertz.

Estimation

In physics it can be very helpful to be able to make approximate estimates of values to within an order of magnitude. This means that the power of ten of your estimate is the same as the true value.

In many situations, physicists are not interested in specific answers, as circumstances can vary slightly and then the specific answer is incorrect. An order of magnitude answer will always be correct, unless you change the initial conditions by more than an order of magnitude.
By estimating important quantities, like a typical mass for cars, we can get an approximate – order of magnitude – answer. The reason for doing so would be that it allows us to develop ideas as possible or impossible, and focus on developing the ideas along lines that will eventually be feasible when we get to developing a specific solution. This reduces time and money wasted by pursuing ideas that can never be realised.

It is also vital in quickly spotting when we have miscalculated the answer to a question. If we used a sophisticated equation to calculate the answer to the top speed of a particular car in particular conditions, and the answer came out as 300 000 metres per second, we should immediately know that the answer is incorrect, and re-check the calculation.

TASKS

1. Give an order of magnitude estimate for the following quantities:
   (a) the height of a giraffe
   (b) the mass of an apple
   (c) the reaction time of a human
   (d) the diameter of a planet
   (e) the temperature in this room.

2. Answer the following estimation questions, showing all the steps and the assumptions and estimates you make.
   (a) How many ping pong balls can fit into a Boeing 747?
   (b) How many atoms are there in your body?
   (c) How many heartbeats are there in a year for the entire world's population?
   (d) In your lifetime, how much will you earn in total?

Rearranging Formulae

The ability to rearrange formula or rewrite them in different ways is a very important skill which will be used frequently in Physics. Overall, a minimum of 40% of your marks across Physics A Level will be awarded for mathematical competency.

You will meet the equations below in your first month of studying A Level Physics. They are often referred to as the 'SUVAT' equations.

Kinematic equations of motion

$$v = u + at$$
$$s = ut + \tfrac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

TASKS

1. Using the table on the first page, work out what v, a, t and s stand for. Write down the quantities and their units. Remember from GCSE that u stands for 'initial velocity'.

2. Rearrange the formula given to make the letter in brackets the subject of the equation:
   (a) $v=u+at$ (a)
   (b) $s=ut + \frac{1}{2} at^2$ (a)
   (c) $s=ut + \frac{1}{2} at^2$ (u)
   (d) $v^2=u^2+2as$ (s)
   (e) $v^2=u^2+2as$ (u)

3. A particle is accelerated uniformly from rest, so that after 10 seconds it has achieved a speed of 15 m/s. Find its acceleration and the distance it has covered?

4. A car accelerates uniformly from rest and after 12 seconds has covered 40m. What are its acceleration and its final velocity?

5. A train decelerates from 35m/s to 21m/s over a distance of 350m. Calculate the deceleration and the time taken to come to rest from the 35m/s.

6. A particle is accelerated from 1m/s to 5m/s over a distance of 15m. Find the acceleration and the time taken.

<u>Becoming a better Physicist</u>

Here are some ideas of things you might want to do in order to advance your physics knowledge and deepen your understanding of key concepts before September. You don't have to do them all. Pick something you are interested in and start there. Trying to complete at least one task from each section would be a good starting point.

Keep this list and refer back to it throughout the year. It's a good list to refer to for extension activities should you finish all your homework!

Join the Institute of Physics

It is completely free for A-level students, although if you want to receive paper copies of the monthly 'Physics World' magazine then there is an annual fee. At the very least you can get a monthly update on the latest physics news, and also read in-depth articles about current cutting-edge physics topics. The direct link is:
http://members.iop.org/16-19.asp

In the 'school details' section you need to enter :
School name & Address: Salesian College Farnborough, 119 Reading Road, Farnborough, GU14 6PA, Telephone: 01252 893000, Physics Teacher Name: Miss A Kent

To read:

- **New Scientist** - available from the library
- **Physics in the news** - http://www.sciencedaily.com

Physics books – some of these may be available from the library:
Quantum: a guide for the perplex, Jim Al-Khalili
Flatland*:* A Romance of Many Dimensions by Edwin Abbott Abbott
13 Things That Don't Make Sense: The Most Intriguing Scientific Mysteries of Our Time by Michael Brooks
A Short History of Nearly Everything by Bill Bryson
The Particle at the End of the Universe by Sean Carroll
Particle Physics: A very short introduction, Frank Close
Carrying the Fire: An Astronaut's Journeys by Michael Collins (the Apollo 11 astronaut).
Surely you're joking Mr Feynman by Richard P Feynman and Ralph Leighton.
Six Easy Pieces: Fundamentals of Physics Explained by Richard P Feynman (or any other book by the same author)
Why does $E=mc^2$ – Brian Cox & Jeff Forshaw
A Brief History of Time by Stephen Hawking
The Universe in a Nutshell by Stephen Hawking
The Making of the Atomic Bomb by Richard Rhodes
Big Bang: The Most Important Scientific Discovery of All Time and Why You Need to Know About It by Simon Singh

To do:

- ➔ **Physics Problems.** Support and activities in physics problem solving: https://isaacphysics.org/ and its sister site: http://i-want-to-study-engineering.org/
- ➔ **SETI@home** is a scientific experiment that uses Internet-connected computers in the Search for Extraterrestrial Intelligence (SETI). You can participate by running a free program that downloads and analyzes radio telescope data. http://setiathome.berkeley.edu/
- ➔ **Asteroid watch.** Search for Near Earth Objects (i.e. asteroids) in observations that have taken, and report back their positions. http://www.schoolsobservatory.org.uk/activ/asteroidwatch
- ➔ **Galaxy zoo.** To understand how galaxies, and our own, formed we need your help to classify them according to their shapes — a task at which your brain is better than even the most advanced computer. If you're quick, you may even be the first person in history to see each of the galaxies you're asked to classify. http://www.galaxyzoo.org/
- ➔ **Zooniverse**. Many other projects similar to galaxy zoo: solar stormwatch, planet hunters, the Milky Way project. https://www.zooniverse.org/

To Listen:

- ➔ **In Our Time** - Melvyn Bragg and guests discuss the history of ideas. Examples of relevant episodes: The Age of the Universe, Radiation, The Vacuum of Space, The Measurement Problem in Physics, The Multiverse, Gravitational Waves, The Speed of Light...
- ➔ **The Life Scientific** - Professor Jim Al-Khalili talks to leading scientists about their life and work, finding out what inspires and motivates them and asking what their discoveries might do for mankind.
- ➔ **Frontiers** - Programme exploring new ideas in science and meeting the scientists and researchers responsible for them, as well as hearing from their critics.

To Watch:

- ➔ https://www.khanacademy.org/science/physics
- ➔ http://www.youtube.com/user/minutephysics
- ➔ http://research.microsoft.com/apps/tools/tuva/
- ➔ http://video.mit.edu/channel/physics/

Answers

Symbols and SI Units

1. Length (m), Mass (kg), Time (s), Electric Current (A), Temperature (K), Amount of substance (mol), Lumnious Intensity (Cd)

3. (a) $kgms^{-2}$
   (b) $kgm^{2}s^{-2}$
   (c) As
   (d) s^{-1}
   (e) $kgm^{2}s^{-3}$

Power Prefixes

1. (a) $9.2x10^{9}$W
   (b) $4.3x10^{-2}$m
   (c) $6.4x10^{6}$ m
   (d) $4.4x10^{-8}$s.

2. (a) 3.6MJ
   (b) 31,536ks or 31.536Ms
   (c) 10 µA
   (d) 105kHz.

Estimation

1. (a)5m
   (b) 0.1kg
   (c) 0.3ms
   (d) 13,000km
   (e)Normally around 20^{o}C (293K)

2. (a)10^{8} ping pong balls
   (b) 10^{27} atoms
   (c) 10^{17} heartbeats
   (d) £10^{6}

Rearranging Formulae

1. s- displacement (m),
   u – initial velocity (ms^{-1}),
   v – final velocity (ms^{-1})
   a – acceleration (ms^{-2})
   t – time (s)

2. (a) a = (v-u)/t
   (b) a = 2(s-ut)/t^2
   (c) u = (s – ½ at^2) /t
   (d) s = (v^2-u^2)/2a
   (e) u = $\sqrt{v^2 - 2as}$

3. 1.5 ms^{-2}, 75m
4. 0.55 ms^{-2}, 6.67 ms^{-1}
5. -1.12 ms^{-2}, 31.25s
6. 5s, 0.8 ms^{-2}