WORCESTER
SIXTH FORM COLLEGE

Progression - Physics

Contents:

1. Thinking of studying Engineering at Worcester Sixth Form College?

We teach the **Eduqas A-level Physics** specification.

Here is a brief summary of the units we cover over the first year of the two-year course. If you want to find out more about each of these topics, you can find the full specification on the Eduqas website: https://www.eduqas.co.uk/qualifications/physics-as-a-level/#tab_overview

- Fundamental wave properties
- Phase, superposition and standing waves
- Wave phenomena – polarisation, refraction and diffraction
- Optics and optical fibres
- Energy levels, photons and LASERS
- Einstein's photoelectric effect (the quantum nature of light)
- Electrostatics
- Electric current, voltage, resistance and circuit behaviour
- Resistivity
- Particle physics
- Stars
- Kinematics (the physics of motion)
- Dynamics (the physics of forces)
- Density and centres of gravity
- Collisions and momentum (including photon momentum)
- Energy and work principles
- Power and efficiency
- Material physics

The second year of the course expands on these themes, looking at gravitational, electric and magnetic fields, orbits, resonance, particle accelerators, nuclear physics, radioactivity, medical physics and lots more besides. Each of the topics we study contain a huge range of applications from electrical engineering to architecture and from space travel to medicine!

2. Tasks to complete before September

In order to prepare for the course, you need to complete the following 3 tasks.

Task 1) Use the space below to define the following key terms. Do some research when you are unsure. Alongside your definition, draw a diagram to help your explanation.

- Frequency
- Amplitude
- Wavelength
- Peak and trough
- Displacement
- Longitudinal wave
- Transverse wave
- Polarised wave

Task 2) Symbols, Quantities and Prefixes

In Physics, unlike GCSE, you need to remember all symbols and units. Below is a list of quantities you may have already come across and will be using during your Physics course.

1. Complete the gaps in the table. You may need to look up some of the symbols.

Quantity	Symbol	Unit
Wavelength		**m**
Frequency	f	
Wave speed	c	**m/s or ms^{-1}**
Velocity	v	**m/s or ms^{-1}**
Acceleration		**m/s^2 or ms^{-2}**
Time		**s**
	m	**kg**
Force	F	
Distance	x	**m**
	R	**Ω**
Potential difference	V	
	I	**A**
Energy		
Pressure	P	
Momentum		**$kgms^{-1}$**
Power	P	
Density	ρ	
Charge	**Q**	

2. The units in the table above are called SI units. Do some research and find out what SI stands for. Write a few notes in the box space below.

Inevitably, some SI units are too big or too small for certain Physics applications. The

width of this page is about 20 centimeters, it wouldn't necessarily occur to you to describe the width of the page in metres, since a metre is much bigger than the page.

The word 'centi' is called a prefix and it has a mathematical meaning:

20cm = 0.20m so centi must mean x 0.01 or $x10^{-2}$

There are lots of other prexifes, allowing us to use SI units for huge numbers as well as teeny weeny ones.

Prefix	Symbol	Power of ten
nano	n	**x 10^{-9}**
micro	µ	**x 10^{-6}**
milli	m	**x 10^{-3}**
centi	c	**x 10^{-2}**
kilo	k	**x 10^{3}**
mega	M	**x 10^{6}**
giga	**G**	**x 10^{9}**
tera	**T**	**x 10^{12}**

It's helpful to memorise these prefixes. Here's an example of a method you can use to lodge them in your long-term memory:

Step 1) Find a word similar or related to the prefix – the weirder the better!!

Step 2) Visualise your link to the prefix, and find a way to include a visual reminder of the power of ten.

Example: Nano sounds like Nandos. You could visualise the Nando's logo and incorporate the -9 into the design. Alternatively, you could visualise going to Nandos and finding that the little flag in your burger has $x10^{-9}$ written on it – the choice is yours!

3. Come up with visual reminders for each of the prefixes – some of them are trickier than others and it *will*

take some time to come up with some really good memorable ones!!

Draw or describe each of the prefixes in the boxes below:

micro, µ	milli, m	centi, c	kilo, k	Mega, M	Giga, G

Converting Between Units

Prefixes are important because they make it nice and easy to convert back and forth between units. To convert from a prefixed unit into an SI unit all you have to do is replace the prefix symbol with the appropriate power of ten.

Example 1: $100\ km = 100 \times 10^{3}\ m$

Example 2: $3mA = 3 \times 10^{-3}\ A$

4. Convert the following into SI units:

i) 10 cm

ii) 730 nm

iii) 15 ms (milliseconds)

iv) 1 kN

v) 440 MJ

f) 1000 µF

In the previous examples we 'got rid' of the prefix by **multiplying** by the appropriate power of 10. So, to add a prefix to a unit we must have to do the opposite – we **divide**. Let's convert 5000 grams to kilograms as an example:

$$5000 \text{ g} = \frac{5000}{10^3} \text{ kg} = 5 \text{ kg}$$

5. Convert the following into the specified units:

i) 120 g to kg

ii) 10 m to cm

iii) 0.001 A to mA

iv) 0.0005 s to µs

v) 19850 J to MJ

f) 190 000 000 W to GW

Using Prefixes in Equations

All equations in Physics, and many equations in other sciences use SI units. Unless otherwise specified, numbers with SI units go in and numbers with SI units come out, this means that you need to convert to SI **before** using an equation, not afterwards!

Example

The world record for the longest ever sky dive is held by computer-scientist Alan Eustace. Alan jumped from a height of 41.42 **km** above the Earth's surface (nearly in space!).

Calculate Alan's gravitational potential energy before he jumped if his mass was 85 **kg**.

Gravitational Potential Energy, GPE = m x g x h

= 85 x 9.81 x (41.42 x 10^3)

Kilograms are the **only** SI unit with a built-in prefix so this is fine as it. is

All Physics constants are already in SI – no conversion needed.

Kilometres are not SI and need to be converted to **metres** – to do this we put in the 'kilo' prefix of x 10^3 after the value.

= 34538067

= 35000000 J (2 s.f.)

Our final answer is a bit on the large side so we can either write it in standard form or use a prefix.

= 3.5 x 10^7 J (standard form)

= 35 x 10^6 J

= 35 MJ

Quick Calculator Tips

• Use the 

button on your calculator (this might be labelled **EXP** or **EE** on some calculators) to enter powers of ten, **not** the the ***x***[-1] button!

• Press 

repeatedly to convert an answer into a 'prefix-able' power e.g. x 10^9, x 10^6, x 10^3 and so on. Press **SHIFT** **ENG** to go back the other way.

Convert to SI units <u>before</u> calculating

(and then add prefixes to your final answer if appropriate)

6. An x-ray beam has a wavelength, λ, of 5 nm (nanometres) and a frequency, f, of 60,000 THz (terahertz).

Calculate the velocity, c, of the wave using the equation:

$c = f\lambda$

c = _____ ms^{-1}

7. The tog rating for a duvet is calculated using the following equation:

$$\text{Tog Rating} = \frac{tA\Delta T}{E}$$

t is time (in s)

A is area (in m^2)

ΔT is temperature difference (in degree ^oC)

E is energy transferred (in J)

On a bleak mid-winter's night, the temperature indoors is 12°.

During an 8-hour sleep under a cosy 2.70 m^2 duvet you will transfer about 0.15 **MJ** of heat energy to your surroundings.

If body temperature is 37°C, calculate the tog rating for the duvet.

8. Which of the following quantities are **not** SI units?

metre, gram, newton, mile, tonne, kilogram, joule, watt, inch

9. The volume of a sphere is given by the equation $\frac{4}{3}\pi r^3$, where *r* is the radius.

The radius of a Malteser is 7.0 mm, calculate its volume in m^3 (hint: you **must** convert to SI units first)

Task 3) Research Task

Produce a PowerPoint presentation to outline an area of Physics that you find interesting. It can be something you learnt about at GCSE or from a documentary you have watched or a topic you have read about.

Your PowerPoint should include:

- Information about your chosen topics including pictures and diagrams
- What you find interesting about the topic
- What you would like to learn more about the topic

3. Getting ready for September

- Before September you need to have completed the three tasks in this booklet and have your PowerPoint presentation ready to submit to your teacher.

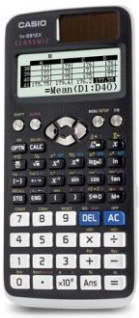
- You will be provided with class workbooks for each Physics unit you study, however **you will also need a folder** to keep yourself organised.

  Many students choose to use ring binders, however alternatively you may find a foolscape or document wallet is useful for keeping worksheets safe.

- You **do not** need to purchase a text book – we will provide you with bespoke workbooks that we write ourselves and have been rated as 'excellent' by Ofsted and our students.

  There certainly isn't any harm in having another source of information and Eduqas do indeed publish their own textbook. Unfortunately we cannot recommend this particular resource, however the Eduqas **revision guide** we feel is much better written (ISBN 1908682728). Again, this book is not a course requirement.

- You will need a scientific calculator. For Physics we recommend Casio calculators, the Casio Classwiz range is the most up to date, however the older models work great too for Physics (and in some cases better!)



  If you are also studying Engineering the Casio Classwiz range has certain statistical functions that are very useful.

  If you are also studying A-level Mathematics **don't rush to make a purchase** – they will advise you on the most appropriate models for their course (and in previous years have been able to offer discount on the most expensive graphical models)

4. Interesting things to keep you busy!

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.

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/

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/

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/abou tus.asp

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.

Ok, so not a website, but a YouTube channel you definitely want to watch. Year 1 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/ALevelPh