Progression - Physics

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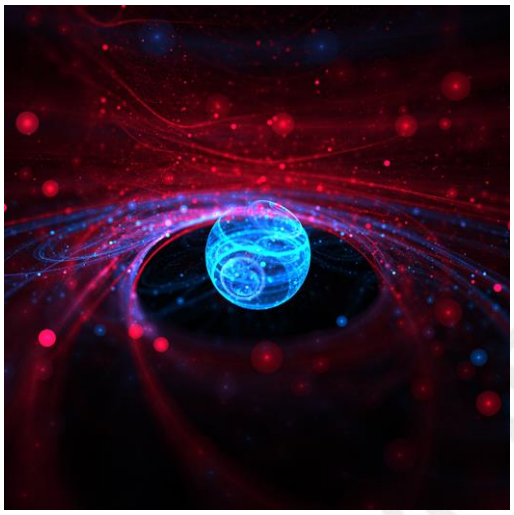
1. Why is Physics amazing?! What will you study? How do we support you at Worcester Sixth Form College?

What is Physics? Physics is a little different to other subjects in that it's mostly concerned with the question of "how?" rather than "what?".

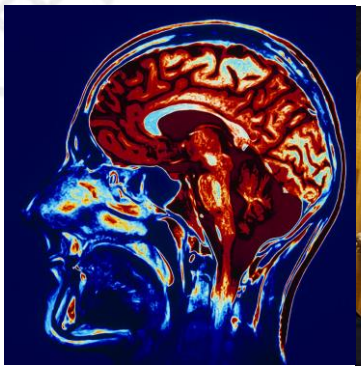
Rather than memorising lots and lots of facts, figures and processes, Physics is all about figuring out problems and finding out ***how*** things work.



What will we study? Our sister sciences, Biology and Chemistry focus on specific areas of science, namely biological processes/living things, and how atoms/molecules interact with one another. Physics deals with quite literally ***everything*** else:

At the smallest end of the scale we look *inside* atoms at tiny subatomic particles and the weird exotic matter you can create using them (including antimatter!). At the other end of the spectrum we can use the same toolkit and thinking processes to study distant stars, galaxies and the orbits of celestial objects millions of light-years away.

Even a simple Physics topic such as waves has applications ranging from musical instruments to MRI scanners, resonance in buildings and how our eyes work. If you're interested in becoming an Engineer then our material physics, electronics and mechanics topics will prepare you well for a career path in Engineering.



How do we support you? Here at Worcester Sixth Form College all of our Physics teachers are subject specialists with degrees in Physics, and we love what we do! You'll be taught from the basics so that you can understand everything properly and ultimately have everything you need become a succesful Physics student. With access to experienced teachers, excellent resources and dedicated Physics workshops, every year our Physics students achieve results that exceed the nationwide average.

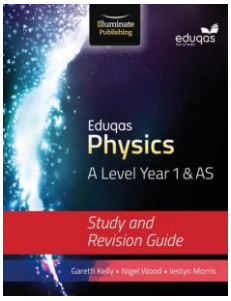
At Worcester Sixth Form College we teach the **Eduqas A-level Physics** specification.

Here is a brief summary of the topics we cover over the first year of the two-year course:

- 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!

If you want to find out more about each of these topics, you can find the full specification on the Eduqas website. Eduqas offer a revision guide which some students find useful, however, **you do not need to purchase a text book** – we will provide you with bespoke textbooks and workbooks that we publish ourselves and have been rated as 'excellent' by both Ofsted and our students.



Introduction to

Stars

A-level Physics Bridging Task #1

Wien's Law: $T = \frac{W}{\lambda}$

$W = 2.90 \times 10^{-3}$

T = temperature in Kelvin, K

λ = wavelength in metres, m

Before you have a bash at these questions, make sure you've watched this accompanying video tutorial: https://youtu.be/08j7hkIojzs

Q1 **(a)** Vega is a bright blue star, with a peak wavelength of 3.02×10^{-7} m. Use Wien's Law to calculate the surface temperature of the star.

Temperature of Vega = _____ K

(b) Antares is a red supergiant star. Its name – which is Greek for "rival to Mars" – refers to its reddish appearance in the night sky.

Antares has a peak wavelength of 792 nm (nano = $\times 10^{-9}$). Use this information to calculate the surface temperature of the star.

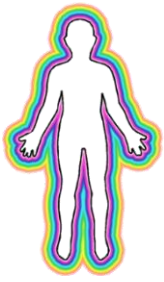
Temperature of Antares = _____ K

(c) Our Sun is classified as a **yellow** dwarf star. Without doing any calculations, how do you think its temperature will compare to the stars Vega and Antares?

Q2 **(a)** Your body has a temperature of approximately 310 Kelvin (37°C). Use Wien's Law to calculate the peak wavelength of the radiation your body emits.

Wavelength of your body = _____ m

(b) What region of the electromagnetic spectrum does your body emit in?

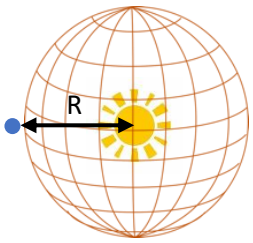


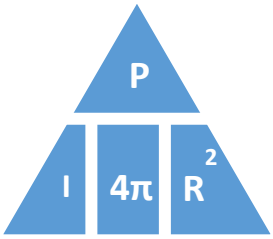
$$I = \frac{P}{4\pi R^2}$$

I = light intensity at Earth's surface in W/m^2

P = star's luminosity (power) in watts, W

R = distance from star to Earth in metres, m





Q3 The star Sirius B (also known as the dog star*) is one of Earth's nearest neighbours at 8.1 x 10^{16} m away. Sirius B also has a high luminosity (power output) of 9.72 x 10^{27} W making it the brightest star in the night sky.

(a) Work out the intensity, I, of the light from Sirius when it arrives at Earth's surface.

Intensity of light from Sirius _____ W/m^2

(b) Sirius is gradually moving closer to our solar system. Explain how this will affect the intensity of the light arriving at Earth's surface.

Q4 Proxima B is an alien world that orbits the star Proxima Centauri in the Alpha Centauri system. The planet's distance from Promixa Centauri means that it is likely to possess liquid water, and so is the closest Earth-like planet to our own home.

Proxima Centauri has a luminosity (power output) of 6.5 x 10^{23} W, and the light intensity measured at Earth's surface is 3.23 x 10^{-11} W/m^2

(a) How far away is Promixa Centauri from Earth?

Distance from Earth to Proxima Centauri _____ m

(b) If we wanted to send a message to the planet Proxima B to try to communicate with alien life, how long after sending the message would we have to wait for a reply? (speed of light = 3.00 x 10^8 m/s)

* hence Sirius Black's patronus animal in Harry Potter!

Solutions

Q1 (a) $T = \frac{W}{\lambda} = \frac{2.90\times10^{-3}}{3.02\times10^{-7}} = 9603\text{K}$ (if you didn't get this correct make sure you've laid out the equation properly on your calculator using the fraction button)

(b) $T = \frac{W}{\lambda} = \frac{2.90\times10^{-3}}{792\times10^{-9}} = 3662\text{K}$

(c) Hotter than Anteres but cooler than Vega

Q2 (a) $\lambda = \frac{W}{T} = \frac{2.90\times10^{-3}}{310} = 9.35\times10^{-6}m$

(b) Infrared

Q3 (a) $I = \frac{P}{4\pi R^2} = \frac{9.72\times10^{27}}{4\pi\times(8.1\times10^{16})^2} = 1.18\times10^{-7}W/m^2$

(b) As the distance R decreases, intensity, I, will increase.

Q4 (a) $R^2 = \frac{P}{I\times4\pi} = \frac{6.5\times10^{23}}{3.23\times10^{11}\times4\pi} = 1.60\times10^{33} \rightarrow R = \sqrt{1.60\times10^{33}} = 4\times10^{16}\ m$

(b) $\text{speed} = \frac{\text{distance}}{\text{time}} \rightarrow \text{time} = \frac{\text{distance}}{\text{speed}} = \frac{4\times10^{16}}{3\times10^{8}} = 1.3\times10^{8}\ \text{seconds} = 4.23\ \text{years}$

<u>But</u> 4.23 years is the time taken to get a signal to Proxima B, a reply would take the same amount of time to get back so we'd have to wait 2 x 4.23 years = 8.46 years or approximately 8½ years for a reply!

Bonus Research Task: In the video tutorial we talked about the discovery of other Earth-like planets. Planets are *very* tiny and dim compared to the stars that they orbit and so are impossible to see directly, even with our most powerful telescopes. Do some research to find out how astrophysicists and astronomers are able to discover planets, what properties are necessary for life and how we're able to find out about these. Make a mini PowerPoint presentation on your findings, include images and diagrams where possible.

A-level Physics Bridging Task #2

In September one of our first topics will be waves. To begin with some of this will be familiar from GCSE. 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.

Term	Definition	Diagram
Amplitude		
Wavelength		
Peak and trough		
Frequency		

Longitudinal wave		
Transverse wave		
Polarised wave		
Progressive wave		
Standing wave **(also known as a stationary wave)**		

A-level Physics Bridging Task #3

Physics deals with the Universe and **everything** it contains - this means we have to deal with very big numbers as well as very small ones! Prefixes are an easy way to express numbers of different sizes without loads and loads of zeros!

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!

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:

Prefix	Meaning	Memorisation tactic (the stranger the better!)
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}**	

3. Getting ready for September

- Before September you need to have completed the three tasks in this booklet.

- 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