A Level Physics Transition Guide

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

Welcome to A-level Physics. This pack contains a programme of activities and resources to prepare you to start an A-level in Physics in September. It is aimed to be used over the Summer Holidays to ensure you are ready to start your course in September.

The transition from GCSEs to A-levels is challenging, and we as teachers expect mature and organised students, but most of all we want you to be passionate about our subject.

Physics is about understanding the Universe around us, so have a go, and remember even some of the greatest Physicists got it wrong!

"X-rays will prove to be a hoax!"

Lord Kelvin

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.

5 Reasons why being a physicist is cool!

Physicists explore the fundamental nature of almost everything we know of. They study everything from the fundamental particles that build matter, to the galaxies that make up the universe itself. We live in a world deep beneath the surface of normal human experience.

Even if you don't decide to work in physics, studying it still develops useful and transferable skills for other careers. You'll develop research, problem solving and analytical skills, alongside teamwork and communication. Universities and business regard all of these very highly.

1. You Can Get Out of a Black Hole

This is actually a joke; there is no way to get out of a black hole (that's why they're black!) But the APS outreach website PhysicsCentral has an article about this fascinating subject.

- PhysicsCentral: Black Holes (http://www.physicscentral.com/explore/action/blackholes.cfm)

2. Physics Teaches You to Think

Many people who have studied physics report it helps them develop critical thinking and problem-solving skills.

- American Institute of Physics: Skills Physics Bachelor's Use (https://www.aip.org/statistics/data-graphics/knowledge-and-skills-regularly-used-physics-bachelor's-employed-private-0)

3. Physics Explains

Learn why the sky is blue

- HyperPhysics: Blue Sky (http://hyperphysics.phy-astr.gsu.edu/hbase/atmos/blusky.html)

Why the world goes round (you might have heard it was love, but Newton knew the real answer)
▸ HyperPhysics: Angular Momentum (http://hyperphysics.phy-astr.gsu.edu/hbase/amom.html#am)

Why global warming will have the Alaskans trading in their snow boots for flip-flops
▸ HyperPhysics: Greenhouse Effect (http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/grnhse.html)

4. Physics is Versatile
Physicists explore the near and far mysteries of the universe:

Keivan Stassun explores the mysteries of the universe.
▸ Profile of Keivan Stassun (https://www.aps.org/careers/physicists/profiles/stassun.cfm)

Marta Dark-McNeese uses lasers to develop new medical techniques.
▸Profile of M. McNeese (//www.aps.org/careers/physicists/profiles/mcneese.cfm)

5. Physics Makes Things Possible
Without physics there would be no:

- Grocery laser scanners
- Space rockets
- Light bulbs
- Digital cameras
- Cars
- Cell phones
- Airplanes
- Solar panels
- Fiber optics
- DVD players
- Computers
- MP3 players
- Flatscreen TVs
-

Getting the picture? To learn more about the physics behind these technologies, search for them at Discovery Communications' online resource, *HowStuffWorks*.
▸ HowStuffWorks Website

Not to mention physics Will Help You Get into College, Get a Job, and Find Love……..!
Physics makes you more attractive to university recruiters, future employers, and that cutie you have your eye on. (You'll just have to trust us on that last one).

Follow the above links and begin to explore the wider world of physics

Course information:

- We will be following the AQA A-level Physics syllabus
- You will complete a baseline test in September to check your understanding of topics
- You will sit two exams at the end of Year 12, these help set UCAS grades. These exams do NOT contribute to your final A-level qualification.
- You will sit three exams at the end of Year 13, each contributing ≈33% towards your A-level qualification

Physics lesson information and expectations:

- You will attend 5 x 60 minute lessons each week
- Lessons and assessments will consist of both practical skill and theory content
- You must complete at least 12 assessed practical investigations over the course of the A-level course
- Homework must be completed and handed in on time
- Tests will take place at the end of each topic and each unit

Independent study will be completed each week

Specification at a glance

AS and A-level
1 Measurements and their errors
2 Particles and radiation
3 Waves
4 Mechanics and materials
5 Electricity

A-level only
6 Further mechanics and thermal physics
7 Fields and their consequences
8 Nuclear physics
9 Optional topics. You will study one of these: Astrophysics, Medical physics, Engineering physics, Turning points in physics or Electronics

Book Recommendations

Below is a selection of books that should appeal to a physicist – someone with an enquiring mind who wants to understand the universe around us. None of the selections are textbooks full of equation work (there will be plenty of time for that!) instead each provides insight to either an application of physics or a new area of study that you will be meeting at A-level for the first time.

1. **Surely You're Joking Mr Feynman: Adventures of a Curious Character**

   ISBN - 009917331X - Richard Feynman was a Nobel Prize winning Physicist. In my opinion he epitomises what a Physicist is. By reading this books you will get insight into his life's work including the creation of the first atomic bomb and his bongo playing adventures and his work in the field of particle physics.

2. Moondust: In Search of the Men Who Fell to Earth

ISBN – 1408802384 - One of the greatest scientific achievements of all time was putting mankind on the surface of the moon. Only 12 men made the trip to the surface, at the time of writing the book only 9 are still with us. The book does an excellent job of using the personal accounts of the 9 remaining astronauts and many others involved in the space program at looking at the whole space-race era, with hopefully a new era of space flight about to begin as we push on to put mankind on Mars in the next couple of decades.

https://www.waterstones.com/books/search/term/moondust++in+search+of+the+men+who+fell+to+earth

3. Quantum Theory Cannot Hurt You: Understanding the Mind-Blowing Building Blocks of the Universe

ISBN - 057131502X - Any Physics book by Marcus Chown is an excellent insight into some of the more exotic areas of Physics that require no prior knowledge. In your first year of A-Level study you will meet the quantum

world for the first time. This book will fill you with interesting facts and handy analogies to whip out to impress your peers!

https://www.waterstones.com/book/quantum-theory-cannot-hurt-you/marcus-chown/9780571315024

4. A Short History of Nearly Everything

ISBN – 0552997048 - A modern classic. Popular science writing at its best. A Short History of Nearly Everything Bill Bryson's quest to find out everything that has happened from the Big Bang to the rise of civilization - how we got from there, being nothing at all, to here, being us.

https://www.waterstones.com/books/search/term/a+short+history+of+nearly+everything

5. Thing Explainer: Complicated Stuff in Simple Words

ISBN – 1408802384 - This final recommendation is a bit of a wild-card – a book of illustrated cartoon diagrams that should appeal to the scientific side of everyone.

https://www.waterstones.com/book/thing-explainer/randall-munroe/9781473620919

Movie / Video Clip Recommendations

Hopefully you'll get the opportunity to soak up some of the Sun's rays over the summer – synthesising some important Vitamin-D – but if you do get a few rainy days where you're stuck indoors here are some ideas for films to watch or clips to find online.

Science Fictions Films

1. **Moon (2009)**
2. **Gravity (2013)**
3. **Interstellar (2014)**
4. **The Imitation Game (2015)**
5. **The Prestige (2006)**

Online Clips / Series

1. Minute Physics – Variety of Physics questions explained simply (in felt tip) in a couple of minutes. Addictive viewing that will have you watching clip after clip – a particular favourite of mine is "Why is the Sky Dark at Night?"

https://www.youtube.com/user/minutephysics

2. Wonders of the Universe / Wonders of the Solar System – Both available of Netflix as of 17/4/16 – Brian Cox explains the Cosmos using some excellent analogies and wonderful imagery.

3. Shock and Awe, The Story of Electricity – A 3 part BBC documentary that is essential viewing if you want to see how our lives have been transformed by the ideas of a few great scientists a little over 100 years ago. The link below takes you to a stream of all three parts joined together but it is best watched in hourly instalments. Don't forget to boo when you see Edison. (alternatively watch any Horizon documentary – loads of choice on Netflix and the I-Player)

https://www.youtube.com/watch?v=Gtp51eZkwoI

4. NASA TV – Online coverage of launches, missions, testing and the ISS. Plenty of clips and links to explore to find out more about applications of Physics in Space technology.

http://www.nasa.gov/multimedia/nasatv/

5. The Fantastic Mr. Feynman – I recommended the book earlier, I also cannot recommend this 1 hour documentary highly enough. See the life's work of the "great explainer", a fantastic mind that created mischief in all areas of modern Physics.

https://www.youtube.com/watch?v=LyqleIxXTpw

You are not expected to watch / read all recommendations but if you could pick a selection that particularly appeals.

Transition from GCSE to A Level

Moving from GCSE Science to A Level can be a daunting leap. You'll be expected to remember a lot more facts, equations, and definitions, and you will need to learn new maths skills and develop confidence in applying what you already know to unfamiliar situations.

This worksheet aims to give you a head start by helping you:

- to pre-learn some useful knowledge from the first chapters of your A Level course
- understand and practice of some of the maths skills you'll need.

Compulsory Task for non-Triple Science Candidates

You need to purchase and complete the 'Head Start to AS Physics' book

- Publisher: Coordination Group Publications Ltd (CGP) (2nd Mar. 2015)
- ISBN-10: 1782942815
- ISBN-13: 978-1782942818.

Having only studied the content for 2 GCSEs there are already gaps compared to those who have 3 science GCSEs. Completing this book will help to fill those gaps.

All of the questions should be fully answered with clear and structured workings on paper with content titles. *This is to be brought to your first Physics lesson*.

Retrieval questions

You need to be confident about the definitions of terms that describe measurements and results in A Level Physics.

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

Practical science key terms

When is a measurement valid?	when it measures what it is supposed to be measuring
When is a result accurate?	when it is close to the true value
What are precise results?	when repeat measurements are consistent/agree closely with each other
What is repeatability?	how precise repeated measurements are when they are taken by the *same* person, using the *same* equipment, under the *same* conditions
What is reproducibility?	how precise repeated measurements are when they are taken by *different* people, using *different* equipment
What is the uncertainty of a measurement?	the interval within which the true value is expected to lie
Define measurement error	the difference between a measured value and the true value

What type of error is caused by results varying around the true value in an unpredictable way?	random error
What is a systematic error?	a consistent difference between the measured values and true values
What does zero error mean?	a measuring instrument gives a false reading when the true value should be zero
Which variable is changed or selected by the investigator?	independent variable
What is a dependent variable?	a variable that is measured every time the independent variable is changed
Define a fair test	a test in which only the independent variable is allowed to affect the dependent variable
What are control variables?	variables that should be kept constant to avoid them affecting the dependent variable

Matter and radiation

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

What is an atom made up of?	a positively charged nucleus containing protons and neutrons, surrounded by electrons
Define a *nucleon*	a proton or a neutron in the nucleus
What are the absolute charges of protons, neutrons, and electrons?	$+1.60\times10^{-19}$, 0, and -1.60×10^{-19} coulombs (C) respectively
What are the relative charges of protons, neutrons, and electrons?	1, 0, and – 1 respectively (charge relative to proton)
What is the mass, in kilograms, of a proton, a neutron, and an electron?	1.67×10^{-27}, 1.67×10^{-27}, and 9.11×10^{-31} kg respectively
What are the relative masses of protons, neutrons, and electrons?	1, 1, and 0.0005 respectively (mass relative to proton)
What is the atomic number of an element?	the number of protons
Define an isotope	isotopes are atoms with the same number of protons and different numbers of neutrons
Write what *A*, *Z* and X stand for in isotope notation ($^{A}_{Z}X$)?	*A*: the number of nucleons (protons + neutrons) *Z*: the number of protons X: the chemical symbol
Which term is used for each type of nucleus?	nuclide
How do you calculate specific charge?	charge divided by mass (for a charged particle)
What is the specific charge of a proton and an electron?	9.58×10^{7} and 1.76×10^{11} C kg^{-1} respectively
Name the force that holds nuclei together	strong nuclear force
What is the range of the strong nuclear force?	from 0.5 to 3–4 femtometres (fm)
Name the three kinds of radiation	alpha, beta, and gamma
What particle is released in alpha radiation?	an alpha particle, which comprises two protons and two neutrons
Write the symbol of an alpha particle	$^{4}_{2}\alpha$

What particle is released in beta radiation?	a fast-moving electron (a beta particle)
Write the symbol for a beta particle	${}^{0}_{-1}\beta$
Define *gamma radiation*	electromagnetic radiation emitted by an unstable nucleus
What particles make up everything in the universe?	matter and antimatter
Name the antimatter particles for electrons, protons, neutrons, and neutrinos	positron, antiproton, antineutron, and antineutrino respectively
What happens when corresponding matter and antimatter particles meet?	they annihilate (destroy each other)
List the seven main parts of the electromagnetic spectrum from longest wavelength to shortest	radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays
Write the equation for calculating the wavelength of electromagnetic radiation	$\text{wavelength } (\lambda) = \frac{\text{speed of light } (c)}{\text{frequency } (f)}$
Define a *photon*	a packet of electromagnetic waves
What is the speed of light?	3.00×10^8 m s^{-1}
Write the equation for calculating photon energy	photon energy (E) = Planck constant (h) × frequency (f)
Name the four fundamental interactions	gravity, electromagnetic, weak nuclear, strong nuclear

Maths skills

1 Measurements

1.1 Base and derived SI units

Units are defined so that, for example, every scientist who measures a mass in kilograms uses the same size for the kilogram and gets the same value for the mass. Scientific measurement depends on standard units – most are *Système International* (SI) units. Every measurement must give the unit to have any meaning. You should know the correct unit for physical quantities.

Base units

Physical quantity	Unit	Symbol
length	metre	m
mass	kilogram	kg
time	second	s

Physical quantity	Unit	Symbol
electric current	ampere	A
temperature difference	Kelvin	K
amount of substance	mole	mol

Derived units

Example:

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

If a car travels 2 metres in 2 seconds:

$$\text{speed} = \frac{2\text{ metres}}{2\text{ seconds}} = 1\frac{\text{m}}{\text{s}} = 1\text{m/s}$$

This defines the SI unit of speed to be 1 metre per second (m/s), or 1 m s^{-1} ($s^{-1} = \frac{1}{s}$).

Practice questions

1 Complete this table by filling in the missing units and symbols.

Physical quantity	Equation used to derive unit	Unit	Symbol and name (if there is one)
frequency	period^{-1}	s^{-1}	Hz, hertz
volume	length^{3}		–
density	mass ÷ volume		–
acceleration	velocity ÷ time		–
force	mass × acceleration		
work and energy	force × distance		

1.2 Significant figures

When you use a calculator to work out a numerical answer, you know that this often results in a large number of decimal places and, in most cases, the final few digits are 'not significant'. It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, too few and you are not showing the precision and care required in scientific analysis.

Numbers to 3 significant figures (3 s.f.):

3.62   25.4   271   0.0147   0.245   39 400

(notice that the zeros before the figures and after the figures are *not* significant – they just show you how large the number is by the position of the decimal point).

Numbers to 3 significant figures where the zeros *are* significant:

207   4050   1.01 (any zeros between the other significant figures *are* significant).

Standard form numbers with 3 significant figures:

9.42×10^{-5} 1.56×10^{8}

If the value you wanted to write to 3.s.f. was 590, then to show the zero was significant you would have to write:

590 (to 3.s.f.) or 5.90×10^{2}

Practice questions

2 Give these measurements to 2 significant figures:

a 19.47 m   **b** 21.0 s   **c** 1.673×10^{-27} kg   **d** 5 s

3 Use the equation:

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

to calculate the resistance of a circuit when the potential difference is 12 V and the current is 1.8 mA. Write your answer in kΩ to 3 s.f.

1.3 Uncertainties

When a physical quantity is measured there will always be a small difference between the measured value and the true value. How important the difference is depends on the size of the measurement and the size of the uncertainty, so it is important to know this information when using data.

There are several possible reasons for uncertainty in measurements, including the difficulty of taking the measurement and the resolution of the measuring instrument (i.e. the size of the scale divisions).

For example, a length of 6.5 m measured with great care using a 10 m tape measure marked in mm would have an uncertainty of 2 mm and would be recorded as 6.500 ± 0.002 m.

It is useful to quote these uncertainties as percentages.

For the above length, for example,

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{measurement}} \times 100$$

$$\text{percentage uncertainty} = \frac{0.002}{6.500} \times 100\% = 0.03\%.$$ The measurement is 6.500 m ± 0.03%.

Values may also be quoted with absolute error rather than percentage uncertainty, for example, if the 6.5 m length is measured with a 5% error,

the absolute error = 5/100 × 6.5 m = ±0.325 m.

Practice questions

4 Give these measurements with the uncertainty shown as a percentage (to 1 significant figure):

a 5.7 ± 0.1 cm **b** 450 ± 2 kg **c** 10.60 ± 0.05 s **d** 366 000 ± 1000 J

5 Give these measurements with the error shown as an absolute value:

a 1200 W ± 10% **b** 330 000 Ω ± 0.5%

6 Identify the measurement with the smallest percentage error. Show your working.

A 9 ± 5 mm **B** 26 ± 5 mm **C** 516 ± 5 mm **D** 1400 ± 5 mm

2 Standard form and prefixes

When describing the structure of the Universe you have to use very large numbers. There are billions of galaxies and their average separation is about a million light years (ly). The Big Bang theory says that the Universe began expanding about 14 billion years ago. The Sun formed about 5 billion years ago. These numbers and larger numbers can be expressed in standard form and by using prefixes.

2.1 Standard form for large numbers

In standard form, the number is written with one digit in front of the decimal point and multiplied by the appropriate power of 10. For example:

- The diameter of the Earth, for example, is 13 000 km.
  13 000 km = 1.3 × 10 000 km = 1.3×10^4 km.
- The distance to the Andromeda galaxy is 2 200 000 light years = 2.2 × 1 000 000 ly = 2.2×10^6 ly.

2.2 Prefixes for large numbers

Prefixes are used with SI units (see Topic 1.1) when the value is very large or very small. They can be used instead of writing the number in standard form. For example:

- A kilowatt (1 kW) is a thousand watts, that is 1000 W or 10^3 W.
- A megawatt (1 MW) is a million watts, that is 1 000 000 W or 10^6 W.
- A gigawatt (1 GW) is a billion watts, that is 1 000 000 000 W or 10^9 W.

Prefix	Symbol	Value
kilo	k	10^3
mega	M	10^6

Prefix	Symbol	Value
giga	G	10^9
tera	T	10^{12}

For example, Gansu Wind Farm in China has an output of 6.8×10^9 W. This can be written as 6800 MW or 6.8 GW.

Practice questions

1 Give these measurements in standard form:

a 1350 W **b** 130 000 Pa **c** 696×10^6 s **d** 0.176×10^{12} C kg^{-1}

2 The latent heat of vaporisation of water is 2 260 000 J/kg. Write this in:

a J/g **b** kJ/kg **c** MJ/kg

2.3 Standard form and prefixes for small numbers

At the other end of the scale, the diameter of an atom is about a tenth of a billionth of a metre. The particles that make up an atomic nucleus are much smaller. These measurements are represented using negative powers of ten and more prefixes. For example:

- The charge on an electron = 1.6×10^{-19} C.
- The mass of a neutron = $0.016\,75 \times 10^{-25}$ kg = 1.675×10^{-27} kg (the decimal point has moved 2 places to the right).
- There are a billion nanometres in a metre, that is 1 000 000 000 nm = 1 m.
- There are a million micrometres in a metre, that is 1 000 000 μm = 1 m.

Prefix	Symbol	Value
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}

Prefix	Symbol	Value
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

Practice questions

3 Give these measurements in standard form:

a 0.0025 m **b** 160×10^{-17} m **c** 0.01×10^{-6} J **d** 0.005×10^6 m **e** 0.00062×10^3 N

4 Write the measurements for question 3a, c, and d above using suitable prefixes.

5 Write the following measurements using suitable prefixes.

a a microwave wavelength = 0.009 m

b a wavelength of infrared = 1×10^{-5} m

c a wavelength of blue light = 4.7×10^{-7} m

2.4 Powers of ten

When multiplying powers of ten, you must *add* the indices.

So 100 × 1000 = 100 000 is the same as $10^2 \times 10^3 = 10^{2+3} = 10^5$

When dividing powers of ten, you must *subtract* the indices.

So $\frac{100}{1000} = \frac{1}{10} = 10^{-1}$ is the same as $\frac{10^2}{10^3} = 10^{2-3} = 10^{-1}$

But you can only do this when the numbers with the indices are the same.

So $10^2 \times 2^3 = 100 \times 8 = 800$

And you can't do this when adding or subtracting.

$10^2 + 10^3 = 100 + 1000 = 1100$

$10^2 - 10^3 = 100 - 1000 = -900$

Remember: You can only add and subtract the indices when you are multiplying or dividing the numbers, not adding or subtracting them.

Practice questions

6 Calculate the following values – read the questions very carefully!

a $20^6 + 10^{-3}$

b $10^2 - 10^{-2}$

c $2^3 \times 10^2$

d $10^5 \div 10^2$

7 The speed of light is 3.0×10^8 m s^{-1}. Use the equation $v = f\lambda$ (where λ is wavelength) to calculate the frequency of:

a ultraviolet, wavelength 3.0×10^{-7} m

b radio waves, wavelength 1000 m

c X-rays, wavelength 1.0×10^{-10} m.

Answers given Below

Making the Jump to AS / A level

Please complete the AQA specific transition document 'lesson activity: GCSE to A level progression' - which can be found on our HGSS website under transition documents and on the AQA website (see link below). Mark schemes are provided.

https://www.aqa.org.uk/subjects/science/as-and-a-level/physics-7407-7408/teaching-resources

ANSWERS

1 Measurements

Practice questions

1

Physical quantity	Equation used to derive unit	Unit	Symbol and name (if there is one)
frequency	period^{-1}	s^{-1}	Hz, hertz
volume	length^3	m^3	–
density	mass ÷ volume	kg m^{-3}	–
acceleration	velocity ÷ time	m s^{-2}	–
force	mass × acceleration	kg m s^{-2}	N newton
work and energy	force × distance	N m (or kg m^2 s^{-2})	J joule

2 **a** 19 m **b** 21 s
c 1.7×10^{-27} kg **d** 5.0 s

3 Resistance $= \frac{12\text{ V}}{1.8\text{ mA}} = \frac{12\text{ V}}{0.0018\text{ A}} = 6666.666...\Omega = 6.66666...\text{k}\Omega = 6.67\Omega$

4 **a** 5.7 cm ± 2% **b** 450 kg ± 0.4%
c 10.6 s ± 0.5% **d** 366 000 J ± 0.3%

5 **a** 1200 ± 120 W **b** 330 000 ± 1650 Ω

6 **D** 1400 ± 5 mm (Did you calculate them all? The same absolute error means the percentage error will be smallest in the largest measurement, so no need to calculate.)

2 Standard form and prefixes

Practice questions

1 **a** 1.35×10^3 W (or 1.350×10^3 W to 4 s.f.) **b** 1.3×10^5 Pa
c 6.96×10^8 s **d** 1.76×10^{11} C kg^{-1}

2 **a** 2 260 000 J in 1 kg, so there will be 1000 times fewer J in 1 g: $\frac{2\,260\,000}{1000} = 2260$ J/g

b 1 kJ = 1000 J, $2\,260\,000\text{ J/kg} = \frac{2\,260\,000}{1000}\text{kJ/kg} = 2260\text{ kJ/kg}$

c 1 MJ = 1000 kJ, so $2260\text{ kJ/kg} = \frac{2260}{1000}\text{MJ/kg} = 2.26\text{ MJ/kg}$

3 **a** 2.5×10^{-3} m **b** 1.60×10^{-15} m
c 1×10^{-8} J **d** 5×10^3 m
e 6.2×10^{-1} N

4 **a** 2.5 μm **b** 1.60 f m
c 10 nJ **or** 0.01 μJ **d** 5 km
e 0.62 N **or** 62 cN

5 **a** 0.009 m = 9×10^{-3} m = 9 mm
b 1×10^{-5} m = $1 \times 10 \times 10^{-6}$ m = 10×10^{-6} m = 10 μm
c 4.7×10^{-7} m = $4.7 \times 100 \times 10^{-9}$ m = 470×10^{-9} m = 470 nm

6 **a** 64000000 **or** 6.4×10^7 **b** 99.99
c 800 **d** 10^3

7 **a** 3.0×10^8 m s^{-1} ÷ 3.03×10^{-7} m = 1.0×10^{15} Hz
b 3.0×10^8 m s^{-1} ÷ 1000 m = 3.0×10^5 Hz
c 3.0×10^8 m s^{-1} ÷ 1.0×10^{-10} m = 3.0×10^{18} Hz

Pupil Background Information

Name	
GCSE results	
Why you chose to study Physics at A-level?	
What are you most looking forward to about studying A-level Physics?	
What are you most apprehensive about studying A-level Physics?	
What areas physics of interest you the most?	

Please bring the completed background info sheet to your first lesson