Wath Sixth Form Subject Preparation Pack

PHYSICS

World-class learning	The highest expectations	No excuses	Growth mindset	Never give up	Everyone is valued	Integrity
World-class learning every lesson, every day	Everyone can be successful; always expect the highest standards	Create solutions not excuses; make positive thinking a habit	Believe you can improve; work hard and value feedback	Resilience is essential; be relentless in the pursuit of excellence	Diversity is celebrated; see the best in everyone	Be trustworthy and honest; deliver on promises and walk the talk

A Level Physics Transition Pack

Contents

What is Physics?

The dictionary definition of physics is "the study of matter, energy, and the interaction between them", but what that really means is that physics is about asking fundamental questions and trying to answer them by observing and experimenting.

The A Level physics course is a mixture of highly conceptual thinking and very practical applications. Students need to be able to think about abstract ideas such as fields, but be able to apply those ideas to how, for instance, electric motors work.

Practical work is key and obtaining accurate results from experiments requires practice and competence in the use of lab equipment. Calculations are an important part of A level Physics but at the same time descriptive work requires students to communicate clearly on paper.

Why should I study physics?

Physics trains your brain to think beyond boundaries, the subject combines practical skills with theoretical ideas. Analytical, mathematical and problem solving skills become highly developed through A-level physics.

Life-changing discoveries and events from the discovery of graphene to the Higgs boson at CERN have brought physics centre stage. It is widely believed that the momentum for enabling discoveries is leading us towards a new "golden age" of physics. Physics continues to underpin many advances and successes in fields as wide-ranging as healthcare and the digital economy.

Physics is fundamentally an experimental subject, A Level physics provides numerous opportunities to use practical experiences to link theory to reality, and equip students with the essential practical skills.

A Level Physics is classed as a facilitating subject, one of a small number of subjects commonly asked for in universities' entry requirements, regardless of the course being applied for – this makes it a good choice to keep your degree options open.

What careers could physics lead to?

Due to the problem solving nature of physics and it being a facilitating subject the breadth of careers available is extremely wide. Some examples of the most common areas are:

Engineering – aeronautical, space , civil, mechanical, electronic, electrical, structural, transport, nuclear

Medical physics – healthcare engineering, technology development for medical needs, diagnosis and treatment

Environmental – clean energy development, sustainability, clean transport solutions

Information technology - games development, software development

The Physics Team

Mrs Pritchard
Physics Teacher
Head of Physics & KS4, Second in Department

I love teaching physics because it clarifies how everything works and explains the mathematical beauty of the universe at scales ranging from subatomic to cosmological.
I became a teacher to support and empower students to expand their understanding of the world, to strengthen their quantative reasoning and to help develop problem solving skills that are essential across so many career areas beyond physics.

Mr Shaw
Physics Teacher

I have a real passion for physics, and I love to see that passion passed onto students. When students are focussed and engaged with the lesson I get a real sense of fulfilment. It is a pleasure to come to work to teach the next generation of physicists.

What will I study?

At Wath Academy we cover the physics syllabus which covers a breadth of knowledge split across **3** papers.

Paper 1

Measurements and their Errors

Development of understanding of fundamental (base) units of measurement. Awareness of the nature of measurement errors and of their numerical treatment. The ability to carry through reasonable estimations is developed.

Particles and Radiation

Introduces students to the fundamental properties of matter, electromagnetic radiation and quantum phenomena

Waves

GCSE wave phenomena are extended through characteristics, properties, and applications of travelling and stationary waves.

Mechanics and Materials

Vectors and their treatment, forces, projectile motion, energy and momentum are investigated. Also bulk properties and tensile strength.

Electricity

Builds on and develops electricity from GCSE. Provides opportunities for the development of practical skills at an early stage in the course and lays the groundwork for later study of the many electrical applications that are important to society

Periodic Motion

Advancement of previous study of mechanics by considering circular motion and simple harmonic motion (the harmonic oscillator).

Paper 2

Thermal Physics

Thermal properties of materials, the properties and nature of ideal gases, and the molecular kinetic theory will be studied in depth.

Fields and their Consequences

The ideas of gravitation, electrostatics and magnetic field theory are developed within the topic to emphasise this unification. Many ideas from mechanics and electricity from earlier in the course support this and are further developed. Practical applications considered include: planetary and satellite orbits, capacitance and capacitors, their charge and discharge through resistors, and electromagnetic induction.

Nuclear Physics

Builds on Particles and Radiation to link the properties of the nucleus to the production of nuclear power through the characteristics of the nucleus, the properties of unstable nuclei, and the link between energy and mass. Also covers nuclear energy production and also of the impact that it can have on society.

Paper 3

Practical skills and data analysis

Practical work is at the heart of physics, the course contains 12 required practicals which students will need to show understanding of and be able to analyse data around.

Option topic

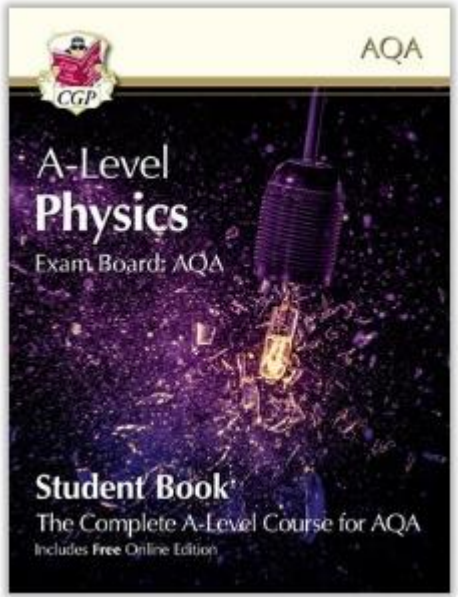
One option topic is selected from the following list for the group.

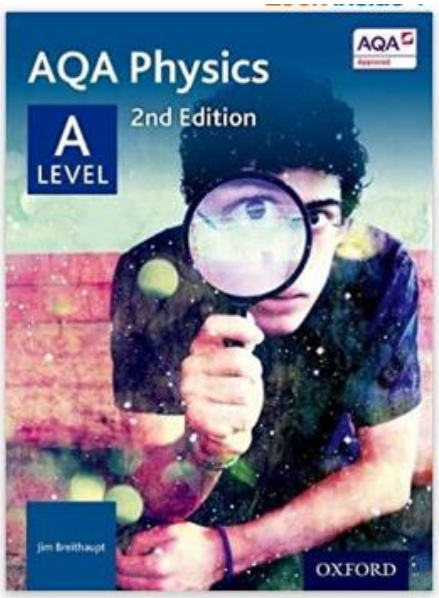
Astrophysics
Medical physics
Engineering physics
Turning points (preferred option)
Electronics

How will I be assessed?

AQA assesses all content at the end of the course meaning that you will sit 3 x 2 hour exams in the summer of Y13. As a department, we conduct ongoing assessment throughout the two years which will reflect the full spectrum of skill and question styles assessed by the exam board.

Recommended resources





These textbooks will be issued to you when you commence the course and provide excellent reference material and practice questions.

CGP Headstart to A Level (free as a kindle book)

https://www.amazon.co.uk/AQA-Physics-Level-Student-Book/dp/0198351879/ref=sr_1_2?dchild=1&keywords=oxford+a+level+physics&qid=1587380663&sr=8-2

This Head Start book from CGP is a good way to bridge the gap between GCSE and 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. There are also introductions to some of the key topics you will meet at A-Level.

PIXL Transition pack:

https://drive.google.com/open?id=1MjhEFDrnfqZxSCQALKUMStEP0CSln9Xn

Provides information on preparatory background reading and focuses on reinforcing skills and learning from GCSE, to provide a firm foundation.

Isaac Physics:

https://isaacphysics.org/alevel

Physics insight and understanding comes through doing physics, in particular solving problems. Isaac is platform for learning designed to offer support and activities in physics problem solving to students transitioning from GCSE (Y11), through to Sixth Form (Y12 & 13), to university.

Physics Transition Workbook

https://drive.google.com/open?id=1imydFOC7beMR-9cYiyDfFBowQoUHExaI

This workbook will help prepare you for A Level physic. It covers some of the basic skills that will be used throughout the course. Many of these are extended from GCSE, they may require some persistence but you will succeed if you persevere.

AQA Transition Guide

https://drive.google.com/open?id=14JweDdLpxm0yRtwTS7aIk0Dfs5bu23xD

A student support resource to help make the transition from GCSE to AS or A-level Physics.

Open University Press Science skills pack

https://fdslive.oup.com/www.oup.com/oxed/secondary/science/Science_A_Level_skills_pack.pdf?region=uk

Student support resources focussing on the maths content in A Level Physics.

Institute of Physics (IOP) Pocket Physics – A Study Aid for 16 – 18 Year Olds

http://www.iop.org/publications/iop/2019/file_72975.pdf

Brief reference guide which covers the basics of A Level Physics.

Additional resources

The following resources may or may not link directly to the specification but are useful in developing your wider understanding of key theories and concepts.

Information from Tomorrows Engineers on engineering careers available.

https://www.tomorrowsengineers.org.uk/

Website for The Institute of Physics, which aims to advance physics for the benefit of all.

http://www.iop.org/#gref

Website to assist with understanding A Level choices and explanation of facilitating subjects

https://www.thecompleteuniversityguide.co.uk/a-levels-and-highers/choosing-a-levels/which-subjects-should-i-choose

Applications of physics in the real world:

From mach-20 glider to hummingbird drone

https://www.ted.com/talks/regina_dugan_from_mach_20_glider_to_hummingbird_drone?language=en

"What would you attempt to do if you knew you could not fail?" asks Regina Dugan, then director of DARPA, the Defence Advanced Research Projects Agency. In this talk, she describes some of the extraordinary projects that her agency has created.

Is our universe the only universe?

https://www.ted.com/talks/brian_greene_is_our_universe_the_only_universe?language=en#t-736088

Brian Greene shows how the unanswered questions of physics (starting with a big one: What caused the Big Bang?) have led to the theory that our own universe is just one of many in the "multiverse."

The fascinating physics of everyday life.

https://www.ted.com/talks/helen_czerski_the_fascinating_physics_of_everyday_life?language=en

Physicist Helen Czerski presents various concepts in physics you can become familiar with using everyday things found in your kitchen.

We need nuclear power to solve climate change

https://www.ted.com/talks/joe_lassiter_we_need_nuclear_power_to_solve_climate_change?language=en

Joe Lassiter is focused on developing clean, secure and carbon-neutral supplies of reliable, low-cost energy. His analysis of the world's energy realities puts a powerful lens on the touchy issue of nuclear power.

Aim: *In physics you need to excel at manipulating data. To facilitate this students need to be able to use prefixes and unit conversions, be able to correctly utilise significant figures and to rearrange equations. The attached work builds on GCSE and aims to hone your skills in these areas.*

Prefixes and Units

In Physics we have to deal with quantities from the very large to the very small. A prefix is something that goes in front of a unit and acts as a multiplier. This sheet will give you practice at converting figures between prefixes.

Symbol	Name	What it means		How to convert	
P	peta	10^{15}	1000000000000000		↓ x1000
T	tera	10^{12}	1000000000000	↑ ÷ 1000	↓ x1000
G	giga	10^{9}	1000000000	↑ ÷ 1000	↓ x1000
M	mega	10^{6}	1000000	↑ ÷ 1000	↓ x1000
k	kilo	10^{3}	1000	↑ ÷ 1000	↓ x1000
			1	↑ ÷ 1000	↓ x1000
m	milli	10^{-3}	0.001	↑ ÷ 1000	↓ x1000
µ	micro	10^{-6}	0.000001	↑ ÷ 1000	↓ x1000
n	nano	10^{-9}	0.000000001	↑ ÷ 1000	↓ x1000
p	pico	10^{-12}	0.000000000001	↑ ÷ 1000	↓ x1000
f	femto	10^{-15}	0.000000000000001	↑ ÷ 1000	

Convert the figures into the units required.

6 km	=	6 x 10^{3}	m
54 MN	=		N
0.086 µV	=		V
753 GPa	=		Pa
23.87 mm/s	=		m/s

Convert these figures to suitable prefixed units.

640	GV	=	640 x 10^{9}	V
		=	0.5 x 10^{-6}	A
		=	93.09 x 10^{9}	m
	kN	=	32 x 10^{5}	N
	nm	=	0.024 x 10^{-7}	m

Convert the figures into the prefixes required.

s	ms	µs	ns	ps
0.00045	0.45	450	450 000 or 450 x10^{3}	450 x 10^{6}
0.000000789				
0.000 000 000 64				

mm	m	km	µm	Mm
1287360				
295				

The equation for wave speed is:

$$wave\ speed = frequency \times wavelength$$

$$(m/s) \qquad (Hz) \qquad (m)$$

Whenever this equation is used, the quantities must be in the units stated above. At GCSE we accepted m/s but at AS/A Level we use the index notation. m/s becomes m s^{-1} and m/s^2 becomes m s^{-2}.

By convention we should also leave one space between values and units. 10m should be 10 m.

We also leave a space between different units but no space between a prefix and units.

This is to remove ambiguity when reading values.

Example ms^{-1} means 1/millisecond because the ms means millisecond, 10^{-3} s

but m s^{-1} means metre per second the SI unit for speed.

or mms^{-1} could mean mm s^{-1} compared with m ms^{-1}

millimeters per second compared with meters per millisecond - quite a difference!!!

Calculate the following quantities using the above equation, giving answers in the required units.

1) Calculate the speed in m s^{-1} of a wave with a frequency of 75 THz and a wavelength 4.0 μm.

$v = f\lambda = 75 \times 10^{12} \times 4.0 \times 10^{-6} = 3.0 \times 10^{8}$ m s^{-1} (300 Mm s^{-1})

2) Calculate the speed of a wave in m s^{-1} which has a wavelength of 5.6 mm and frequency of 0.25 MHz.

3) Calculate the wavelength in metres of a wave travelling at 0.33 km s^{-1} with a frequency of 3.0 GHz.

4) Calculate the frequency in Hz of a wave travelling at 300×10^3 km s^{-1} with a wavelength of 0.050 mm.

5) Calculate the frequency in GHz of a wave travelling at 300 Mm s^{-1} that has a wavelength of 6.0 cm.

Significant Figures

1. **All non-zero numbers ARE significant.** The number 33.2 has THREE significant figures because all of the digits present are non-zero.

2. **Zeros between two non-zero digits ARE significant.** 2051 has FOUR significant figures. The zero is between 2 and 5

3. **Leading zeros are NOT significant.** They're nothing more than "place holders." The number 0.54 has only TWO significant figures. 0.0032 also has TWO significant figures. All of the zeros are leading.

4. **Trailing zeros when a decimal is shown ARE significant.** There are FOUR significant figures in 92.00 and there are FOUR significant figures in 230.0.

5. **Trailing zeros in a whole number with no decimal shown are NOT significant.** Writing just "540" indicates that the zero is NOT significant, and there are only TWO significant figures in this value.

(THIS CAN CAUSE PROBLEMS!!! WE SHOULD USE POINT 8 FOR CLARITY, BUT OFTEN DON'T - 2/3 significant figures is accepted in IAL final answers - eg 500/260 = 1.9 to 2 sf. Better $5.0 \times 10^2 / 2.6 \times 10^2 = 1.9$)

8. **For a number in scientific notation: $N \times 10^x$, all digits comprising N ARE significant by the first 5 rules; "10" and "x" are NOT significant.** 5.02×10^4 has THREE significant figures.

For each value state how many significant figures it is stated to.

Value	Sig Figs	Value	Sig Figs	Value	Sig Figs	Value	Sig Figs
2		1066		1800.45		0.070	
2.0		82.42		2.483×10^4		69324.8	
500		750000		0.0006		0.0063	
0.136		310		5906.4291		9.81×10^4	
0.0300		3.10×10^4		200000		40000.00	
54.1		3.1×10^2		12.711		0.0004×10^4	

When adding or subtracting numbers

Round the final answer to the **least precise** number of decimal places in the original values.

Eg. 0.88 + 10.2 – 5.776 (= 5.304) = **5.3** (to 1d.p. , since 10.2 only contains 1 decimal place)

(Khan Academy- Addition/ subtraction with sig fig excellent video- make sure you watch .)

Add the values below then write the answer to the appropriate number of significant figures

Value 1	Value 2	Value 3	Total Value	Total to correct sig figs
51.4	1.67	3.23		
7146	–32.54	12.8		
20.8	18.72	0.851		
1.4693	10.18	–1.062		
9.07	0.56	3.14		
739762	26017	2.058		
8.15	0.002	106		
152	0.8	0.55		

When multiplying or dividing numbers

Round the final answer to the **least** number of significant figures found in the initial values.

E.g. 4.02 x 3.1 ÷ 0.114 = (109.315…) = **110** (to 2s.f. as 3.1 only has 2 significant figures.

Multiply the values below then write the answer to the appropriate number of significant figures

Value 1	Value 2	Total Value	Total to correct sig figs
0.91	1.23		
8.764	7.63		
2.6	31.7		
937	40.01		
0.722	634.23		

Divide value 1 by value 2 then write the answer to the appropriate number of significant figures

Value 1	Value 2	Total Value	Total to correct sig figs
5.3	748		
3781	6.50		
91×10^2	180		
5.56	22×10^{-3}		
3.142	8.314		

When calculating a mean

1) Remove any **obvious** anomalies (circle these in the table)
2) Calculate the mean with the remaining values, and record this to the **least** number of decimal places in the included values

E.g. Average 8.0, 10.00 and 145.60:

1) Remove 145.60
2) The average of 8.0 and 10.00 is **9.0** (to 1 d.p.)

Calculate the mean of the values below then write the answer to the appropriate number of significant figures

Value 1	Value 2	Value 3	Mean Value	Mean to correct sig figs
1	1	2		
435	299	437		
5.00	6.0	29.50		
5.038	4.925	4.900		
720.00	728.0	725		
0.00040	0.00039	0.000380		
31	30.314	29.7		

Rearranging Equations

Rearrange each equation into the subject shown in the middle column.

Equation		Rearrange Equation
$V = IR$	R	
$I = \frac{Q}{t}$	t	
$\rho = \frac{RA}{l}$	A	
$\varepsilon = V + Ir$	r	
$s = \frac{(u+v)}{2}t$	u	

Equation		Rearrange Equation
$hf = \phi + E_K$	f	
$E_P = mgh$	g	
$E = \frac{1}{2}Fe$	F	
$v^2 = u^2 + 2as$	u	
$T = 2\pi\sqrt{\frac{m}{k}}$	m	