St Benedict's
Sixth Form

PHYSICS
A Level
Transition Pack

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Planning on studying A level Physics next year?

Physics is a great subject to help you build a wide range of skills, including improving your skills in Maths, problem solving and to critically analyse the world around you to draw conclusions based upon fact.

Even though you haven't been able to finish your Year 11 course this year, you can still practice and develop Physics skills at home. You can read, watch thought provoking works that make you think about the concepts expressed as well as practicing some basic skills that you learnt at GCSE.

Reading As you read around the GCSE and A Level subject matter you will gain a deeper understanding of the concepts involved in A Level physics as well as learning how to think using key vocabulary. When you are answering questions in physics the vocabulary that you use must be very specific to the subject otherwise it can cause misunderstandings. By reading around the subject you become fluent in this vocabulary.

Thinking skills can be developed if you try to take a questioning attitude to the things you watch, hear, and read. Do you agree with what is said? If you watch a film where people have different attitudes towards something, which do you agree with most, or least, and why, based on the evidence that you have? You also need to think critically to work through problems and logically sequence what the next steps would be.

Here are some different activities and exercises for you try if you're learning from home. In Religious Studies, some of the topics can be quite sensitive, so if the activity involves an issue that might make you upset, choose a different one. These times are already difficult enough; nobody wants you to be upset when there's no teacher there to talk you through your feelings.

Reading Activities

Here are some books and some online resources you could try, if you can get hold of them. *Don't worry if they're not available or you can't get on the computer for very long – you won't be at a disadvantage.*

Reading *anything* of good quality, even if it's a novel or a book about an entirely different topic, is always helpful for improving your skills, because you are practising your comprehension skills as well as practising understanding different ways in which writers express their ideas. Your own writing will improve, the more you read.

These are just *some* ideas – you don't have to choose any of these if you'd rather read something else, and there are so many good books in the world that this list could go on forever but it's a start. The books aren't directly related to the course, they are fictional books with a philosophical or ethical theme running throughout them. What is important here is that you are developing your ability to read text – these books are classics and reading some of them will help you develop key skills around the use of language, critical thinking and the ability to explore challenging themes.

Suggested Reading

- Why don't penguins' feet freeze? – NewScientist
- The Grand Design – Stephen Hawking and Leonard Mlodinow
- Newton – Peter Ackroyd
- The Quantum Universe: Everything that can happen does happen – Brian Cox and Jeff Forshaw
- The elegant universe – Brian Greene
- Cosmos – Carl Sagan
- The world according to physics – Jim Al Khalili

Skills and Knowledge Development

Here are a couple of activities to try, to start you off, and then a selection of other directions you might like to take:

Activity 1:

Watch the three episodes of Brian Cox – In Search of Giants. This series explains the history of the discovery of the atom and particle physics.

https://www.youtube.com/watch?v=-FWxd78sOZ8
https://www.youtube.com/watch?v=nNNwypIykcw
https://www.youtube.com/watch?v=DpkpNIu6tHI

Questions to think about and/or write about – try to support your answers with reasoning:

1. What is the history of the atom and how is this different to the history you had at GCSE?

2. What is the standard model of particle physics?

3. What do you think the point is of conducting research to develop knowledge like in the videos?

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Activity 2: Basic Maths skills.

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}	0.0000000000000 01	↑ ÷ 1000	

Convert the figures into the units required.

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

Convert the figures into the prefixes required.

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

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mm	m	km	µm	Mm
1287360				
295				

The equation for wave speed is:

$$\underset{(m/s)}{wave\ speed} = \underset{(Hz)}{frequency} \times \underset{(m)}{wavelength}$$

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}.

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 x 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.

Activity 3: Equations.

Rearrange each equation into the subject shown in the middle column. The first set are equations you used at GCSE. The second are ones that you will use at A Level.

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	

Activity 4: Practical Skills.

An ***accurate*** result is one that is judged to be close to the true value. It is influenced by random and systematic errors.

The true value is the value that would be obtained in an ideal measurement.

A ***precise*** measurement is described when the values 'cluster' close together. We describe measurements as precise when repeated values are close together (consistent). It is influenced by random effects.

Resolution is the smallest change in the quantity being measured that causes a perceptible change in the output of the measuring device. This is usually the smallest measuring interval. It does not mean a value is accurate.

Uncertainty is variation in measured data and is due to random and systematic effects. We usually assume the uncertainty is the same as the resolution of the measuring instrument.
example ruler, resolution +/- 1 mm so uncertainty is also +/- 1 mm
Stopwatch used by a pupil, resolution +/- 0.01 s but uncertainty estimated as +/- 0.2 s due to human reaction time.
For our exam we estimate uncertainty and as long as you have a sensible justification your answer will be ok.

Eg. The true temperature of the room is 22.4 ºC. One thermometer gives a reading of 22 □C and another gives a reading of 23.4 *ºC* . Which is most accurate and estimate its uncertainty?

23.4 *ºC* has the best resolution but is not close to the correct value.
22℃ has less resolution but is more accurate as it is closer to the correct result.
The uncertainty in this reading is +/- 1 ºC

Question

Isabelle is finding the mass of an insect, but the insect moves while on the electronic balance.

She records a set of readings as 5.00 mg , 5.01 mg, 4.98 mg, 5.02 mg.
The true value of the insect's mass is 4.5 mg.
Calculate an average value with estimated uncertainty for her results and compare this value with the true value using the terms above.

Identifying errors

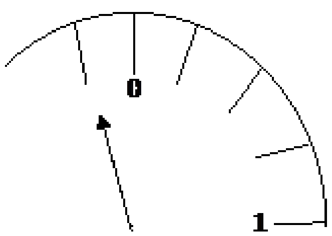
There are two main types of error in Science:

1) Random error
2) Systematic error

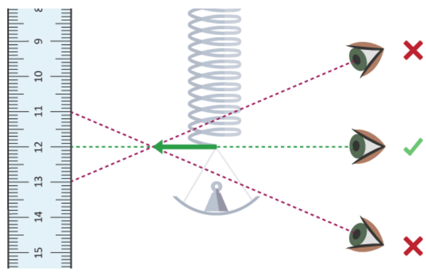
Random errors can be caused by changes in the environment that causes readings to alter slightly, measurements to be in between divisions on a scale or observations being perceived differently by other observers. These errors can vary in size and can give readings both smaller and larger than the true value.
The best way to reduce random error is to use as large values as possible (eg. Large distances) and repeat and average readings, as well as taking precaution when carrying out the experiment.

Systematic errors have occurred when all readings are shifted by the same amount away from the true value.
The two main types of systematic error are:

i) *Zero error* – this is where the instrument does not read zero initially and therefore will always produce a shifted result (eg. A mass balance that reads 0.01g before an object is placed on it). Always check instruments are zeroed before using.
ii) *Parallax error* – this is where a measurement is not observed from eye level so the measurement is always read at an angle producing an incorrect reading. Always read from eye level to avoid parallax.



Zero Error



Parallax Error

Repeat and averaging experiments will not reduce systematic errors as correct experimental procedure is not being followed.

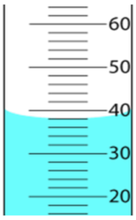
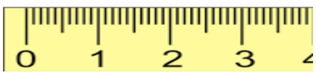
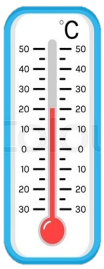
There are occasions where readings are just measured incorrectly, or an odd result is far away from other readings – these results are called **anomalies**. Anomalies should be removed and repeated before used in any averaging.

For each of the measurements listed below identify the most likely source of error what type of error this is and one method of reducing it.

Measurement	Source of error	Type of error
A range of values are obtained for the length of a copper wire		
The reading for the current through a wire is 0.74 A higher for one group in the class		
A range of values are obtained for the rebound height of a ball dropped from the same start point onto the same surface.		
A few groups obtain different graphs of resistance vs light intensity for an LDR. A light bulb placed at different distances from the LDR was used to vary the light intensity.		
The time period (time of one oscillation) of a pendulum showing a range of values		

Improving Experiments – Accuracy, Resolutions and Reliability

When improving **accuracy**, you must describe how to make sure your *method* obtains the best results possible. You should also try to *use as <u>large quantities</u> as possible as this reduces the percentage error in your results*. Also make your <u>range as large as possible</u>, with <u>small intervals</u> between each reading.
Resolution refers to the smallest scale division provided by your measuring instrument, or what is the smallest non-zero reading you can obtain from that instrument.
Reliability refers to how 'trustworthy' your results are. You can improve reliability by repeating and averaging your experiment, as well as removing anomalies.
Complete the table below to state how to use the measuring instruments as accurately as possible, as well as stating the precision (smallest scale division) of each instrument.

Measuring Instrument	Accuracy What procedures should you use to ensure you gain accurate results?	Resolution State the resolution of the instruments shown in the diagram.
Measuring Cylinder 		
Top Pan Electronic (Mass) Balance 		
Measuring Instrument	**Accuracy** What procedures should you use to ensure you gain accurate results?	**Precision** State the precision of the instruments shown in the diagram.
Ruler 		
Thermometer 		

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Research and describe a method to determine the thickness of one sheet of A4 paper accurately. You may only use a mm ruler. You should also refer to the precision and reliability of your result.

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And some online resources:

www.iop.org

YouTube Channel – A Level Physics
- Brightstorm (hard)
- Minute Physics

www.physbot.co.uk
www.cyberphysics.co.uk

Submission of work.

Please complete the transition booklet and submit for marking in September.