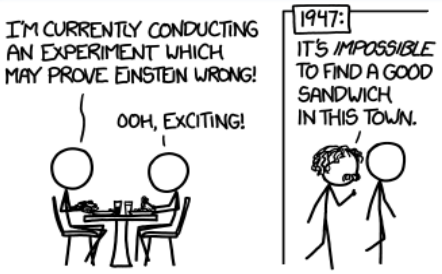
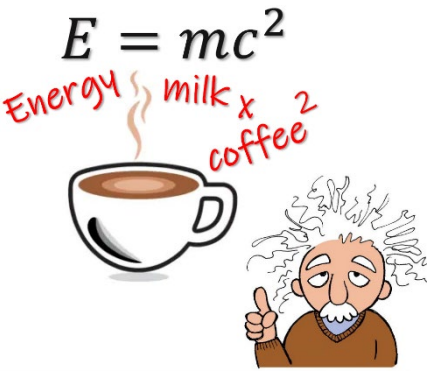


Physics @ Sunderland College

2020 - 2022

"However difficult life may seem, there is always something you can do and succeed at"

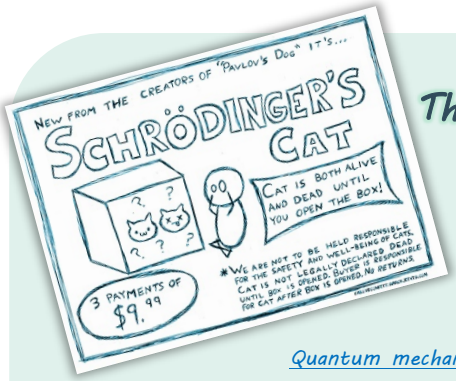
Stephen Hawking



Congratulations on choosing to study A-Level Physics with Sunderland College … we are looking forward to you joining us in September!

Choosing to study Physics is a very smart decision …

- *it's a challenging and rewarding A-Level – and it will open up a world of exciting possibilities for your education and future career!*
- *you will develop problem-solving, critical thinking, reasoning and analytical skills that are highly respected and very much in demand by employers – you will learn to think "outside of the box"*
- *it's a dynamic and continually evolving subject – new discoveries are being made all of the time – if you are curious about the world around you, Physics will help you understand it even better!*



The Schrödinger Equation

$$\hat{H}\psi = i\hbar\frac{\partial\psi}{\partial t}$$

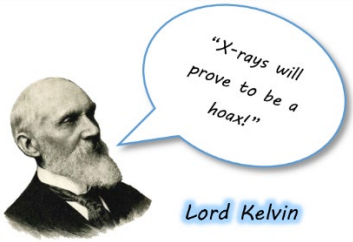
Quantum mechanics was the biggest shake up in physics since Newton formulated the foundations of classical mechanics and the Schrödinger equation, formulated by Erwin Schrödinger in 1926, is the quantum analogue of Newton's 2nd law. The equation incorporates two key concepts: the wave function (ψ) and operators (anything with a hat over it) which operate on a wave function to extract information.

Developing the skills to succeed

- ***curiosity*** *and a desire to understand*
- ***diligence*** *in completing tasks*
- ***resilience*** *when the answer doesn't come first time*
- ***independence*** *– seeking out support from text books or online – never give up*
- ***confidence*** *in numeracy and basic mathematics*
- ***accuracy*** *and* ***clarity*** *in* ***communication*** *– both written and spoken – and presentation of data*
- *ability to* ***apply new learning*** *to a different context*
- ***problem solving***

On the following pages you will find:

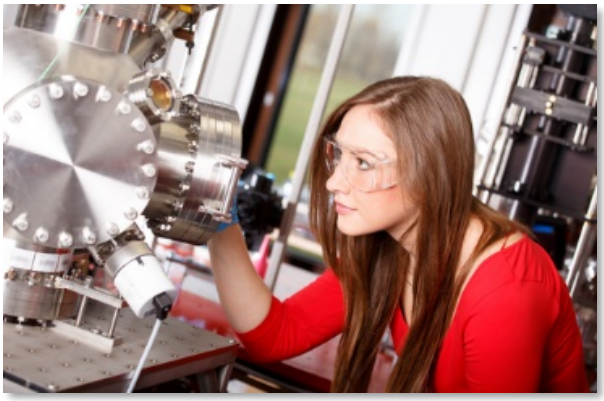
- *further details about the A-Level Physics course*
- *useful links to helpful study materials, resources and videos*
- *textbook and study equipment recommendations*
- *GCSE to A-Level transition activities – designed to give you practice in the skills that you need in studying A-Level Physics – it is highly recommended that you complete these to help prepare yourself for the course*

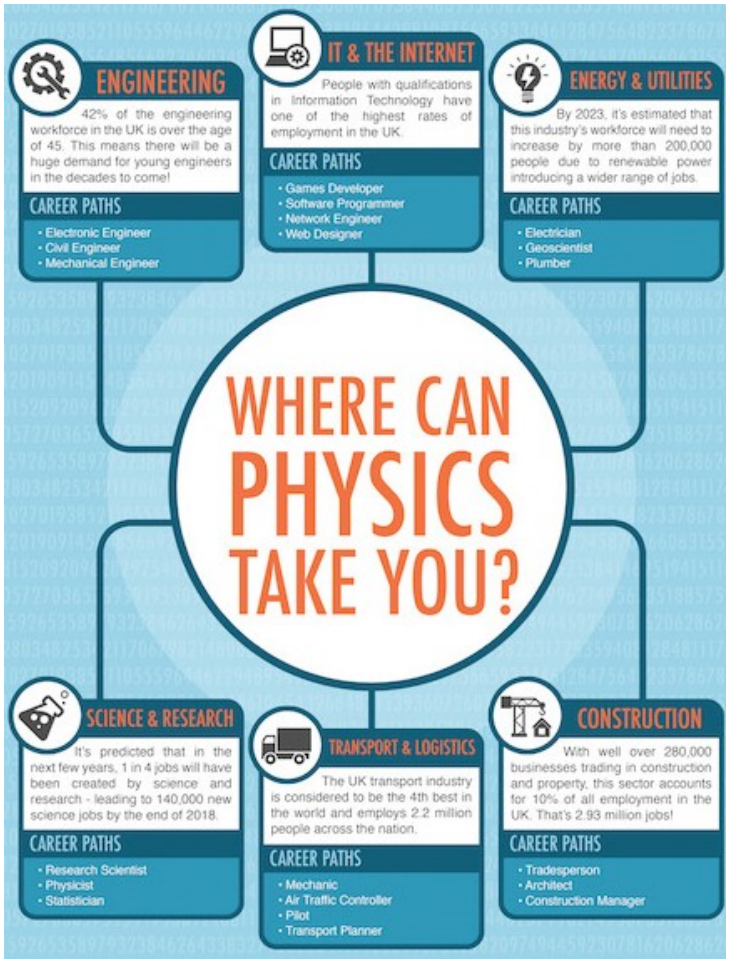


Students who complete Physics A-Level go on to study a wide range of degree courses, including:

- Physics
- Mathematics
- Engineering – mechanical, civil, etc
- Computer science
- Economics
- Business … and many others

UCAS For more information – see https://www.ucas.com

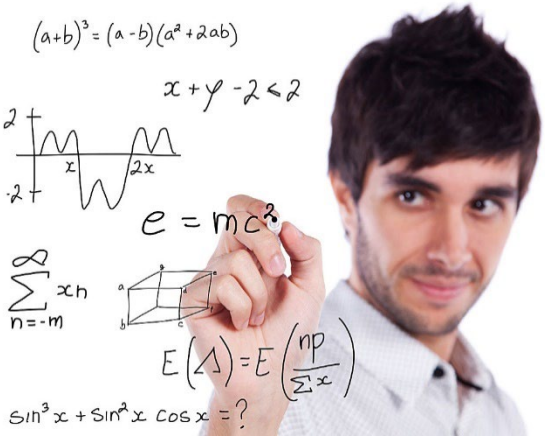


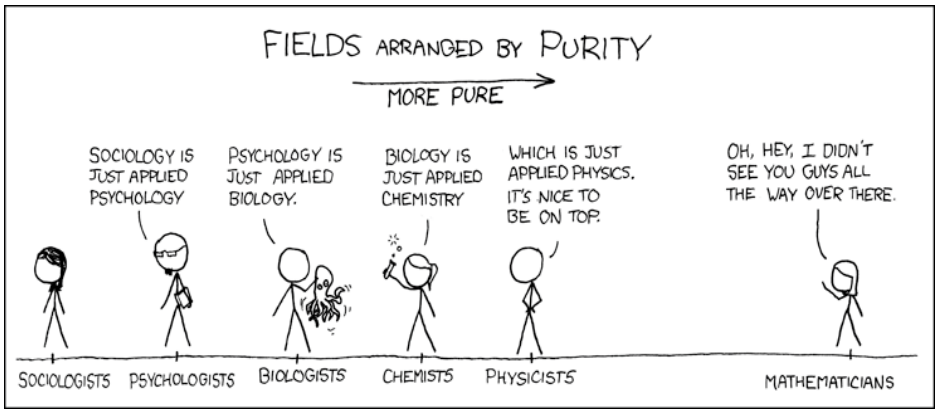


For more information – see https://www.physics.org/careers.asp?contentid=381

Studying Physics at A-Level or degree level opens up a wide range of potential career opportunities, including:

- Engineering
- Architect
- Medical or Healthcare scientist
- Theoretical or Experimental Physicist
- Lecturer or Teacher
- Research scientist
- Radiation protection practitioner
- Meteorologist
- Astrophysics
- Chemical physics
- Renewable energy sector
- Computer programmer
- … and many others



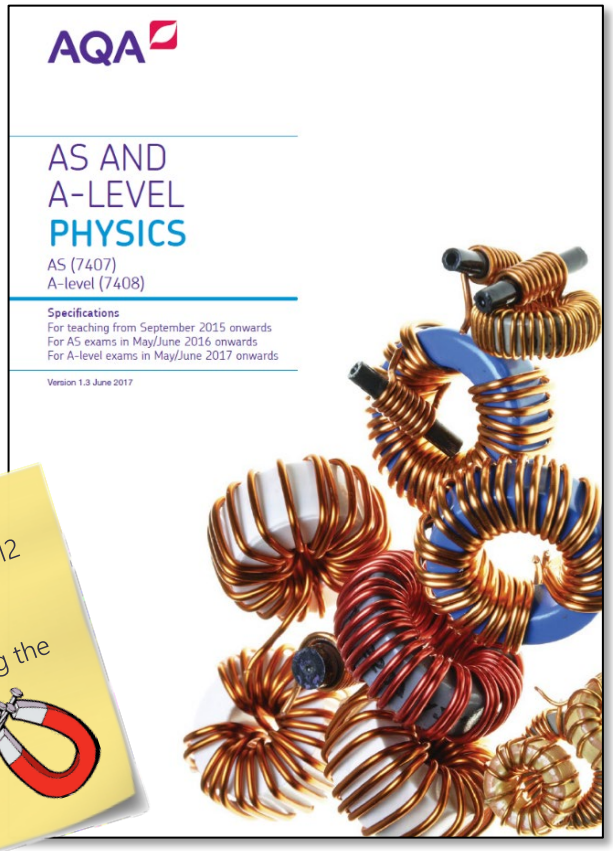


A-Level Physics at a glance

At Sunderland College we study the **AQA Linear A-Level specification (7408)**

Core content	
1	Measurements and their errors
2	Particles and radiation
3	Waves
4	Mechanics and materials
5	Electricity
6	Further mechanics and thermal physics
7	Fields
8	Nuclear physics

Option module	
9	Astrophysics



You will also complete 12 assessed practical investigations during the A-Level course

Assessments

Paper 1	Paper 2	Paper 3
What is assessed? Sections 1 – 5 and 6·1 (Periodic motion)	**What is assessed?** Sections 6·2 (Thermal Physics), 7 and 8 (also assumed knowledge from Sections 1 to 6·1)	**What is assessed?** Section A: Compulsory section – Practical skills and data analysis Section B: Option module
Assessed • written exam: 2 hours • 85 marks • 34% of A-level	**Assessed** • written exam: 2 hours • 85 marks • 34% of A-level	**Assessed** • written exam: 2 hours • 80 marks • 32% of A-level
Questions 60 marks of short and long answer questions and 25 multiple choice questions on content	**Questions** 60 marks of short and long answer questions and 25 multiple choice questions on content	**Questions** 45 marks of short and long answer questions on practical experiments and data analysis 35 marks of short and long answer questions on option module

Additional reference materials

- AQA Physics – GCSE to A-Level transition guide
  https://filestore.aqa.org.uk/resources/physics/AQA-7407-7408-TG.PDF
- AQA Physics – past exam papers and mark schemes
  https://www.aqa.org.uk/subjects/science/as-and-a-level/physics-7407-7408/assessment-resources
- Practical skills handbook – contains information and guidance on practical work
  http://filestore.aqa.org.uk/resources/physics/AQA-7407-7408-PHBK.PDF
- Mathematical skills handbook – guidance on required mathematics skills
  https://www.aqa.org.uk/resources/science/as-and-a-level/teach/maths-skills-briefings
- AQA Physics data and formulae booklet
  https://filestore.aqa.org.uk/resources/physics/AQA-7408-SDB.PDF

Greek letters are often used in science – it would be helpful to be familiar with some of them …

Uppercase	Lowercase	Name
A	α	alpha
B	β	beta
Γ	γ	gamma
Δ	δ	delta
E	ε	epsilon
Z	ζ	zeta
H	η	eta
Θ	θ	theta
I	ι	iota
K	κ	kappa
Λ	λ	lambda
M	μ	mu

Uppercase	Lowercase	Name
N	ν	nu
Ξ	ξ	ksi
O	o	omicron
Π	π	pi
P	ρ	rho
Σ	σ	sigma
T	τ	tau
Υ	υ	upsilon
Φ	ϕ	phi
X	χ	chi
Ψ	ψ	psi
Ω	ω	omega

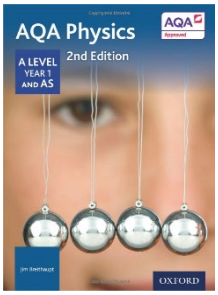
YouTube is a fantastic source for finding help with Physics!

Check out these great channels!

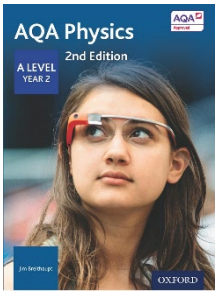
- Physics Online
- DrPhysicsA
- Science Shorts
- GorillaPhysics
- crashcourse
- minutephysics
- SnapRevise
- DrBecky

Textbooks & other resources

- we use the following AQA Physics textbooks in class …

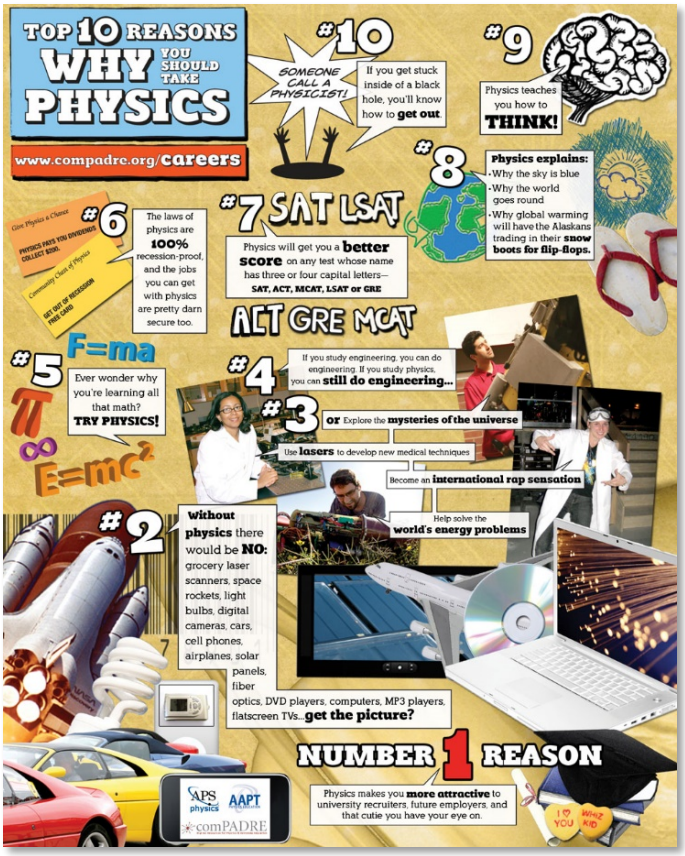


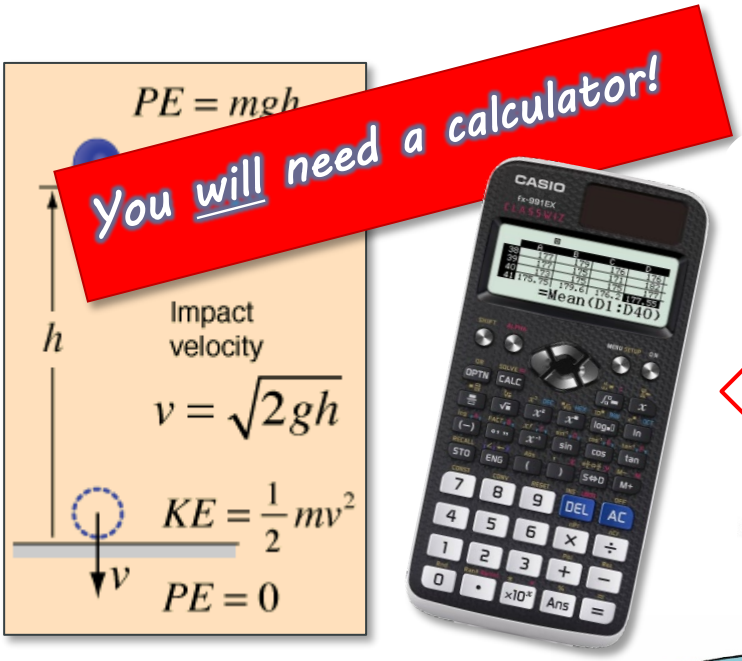
Author: Jim Breithaupt
Publisher: Oxford University Press
ISBN-13: 978-0-1983-5186-3
Price: £28·50



Author: Jim Breithaupt
Publisher: Oxford University Press
ISBN-13: 978-0-19-835772-8
Price: £28·50

Other textbooks and revision guides are available





… **this** is the best model for A-level Physics & Mathematics!

Casio FX-991EX ClassWiz

amazon Ryman £25 and other places …

BEST PRICE!

IOP Institute of Physics

sign up to Qubit – it's free!

physicsworld

Download more Marvin and Milo activities at iop.org/marvinandmilo

WORLD WIDE WEB

- AQA A Level Physics Revision Notes
- Physics and Maths Tutor
- Physics Tutor Online
- Student Room - Physics

MOOC **Massive Open Online Courses**

MOOCs are (mostly) FREE, open, online courses designed to offer a taste of higher education to learners from across the UK and the world - see if you can find something to help with Physics!

Future Learn

edX

coursera

MOOC MASSIVE OPEN ONLINE COURSES

Teaching & Learning - How will I be taught?

The A-Level Physics course is primarily laboratory based and taught using a combination of theory lecture sessions, practical experiments and other investigative activities.

You will be familiar with some of the topics through GCSE-level study but A-Level will deepen your knowledge and provide an exciting stepping stone to future study and employment as well as helping you to develop scientific understanding, logical analysis and critical thinking skills.

In addition to the course texts, we also a variety of digital platforms to deliver teaching and assessment materials.

isaac Physics

moodle

Microsoft Teams

Google Classroom

twitter @PhysicsSC

Instagram scphysics20

Preparation for A-Level Physics - transition activities

The following activities include **four** assignments set through **Isaac Physics**.

To complete these, you will need to register at **www.isaacphysics.org**

- you will need an email address - use a personal email for this (but you must change it to your College email when you start the course)
- use the code **YWLCVJ** to be assigned to the **A-Level Physics 2020-22** group and give your lecturer (Dr Stephen Bowlzer) permission to access your results and marks.

Activity	Title	
1	Definitions & Units	It is important to have the right words to describe the situations you work in. Complete this task on paper first as you will probably need to research the definitions on the Internet before you apply them to the questions online. **Isaac Physics Assignment A2**
2	Prefixes	Dealing with very large or very small numbers is what physicists are very good at. You need to get your head around these. Converting millimetres to metres or other similar changes will come naturally to you very soon. **Isaac Physics Assignments A3 and A4**
3	Means & Anomalous Results	A physicist has to be able to cope with multiple measurements. This will build on the controlled assessment work that you may have done at GCSE. *WATCH OUT!* - you are to calculate the mean (average) for all the numbers twice, once using all the results and once after removing any anomalous results.
4	Significant Figures	It is bad practice to write down every single digit that your calculator displays for an answer (e.g. 534.782303). Learning to have the confidence to include only the most significant digits is a key skill that is tested in the exams. TIP: When you multiply or divide, your answer should be given to the least s.f. (significant figures) of the numbers that you used.
5	Graphs	What makes a good graph?
6	Points plotting	Use a sharp pencil - put all the lines on the same set of axes.
7	Lines of best fit	You will have to make the call as to whether it's a line or a curve.

8	Rearranging equations	Basic mathematics skills **Isaac Physics Assignment A1**	
9	Research activities	Practise independent note taking (using the Cornell Notes technique) for three topics. Just one page on each is required.	
10	Key ideas from GCSE	Atomic Structure	Electricity
		Force & Motion	Waves
	Suggested extras	Social media · Physics websites · YouTube	

Personal Learning Checklist – transition activities

	Introductory Task	Covered	Revised	Confident
	Recall the fundamental units and their SI units			
	Recall the common prefixes for units and their value			
	Convert units between different prefixes and standard form			
	Recall the different types of error and the resolution of various instruments and scales			
	Explain the difference between			
	• precision and accuracy			
	• repeatability and reproducibility			
	Plot data accurately and draw lines of best fit			
	Re-arrange equations			
	Re-call key ideas from GCSE			
	• atomic theory			
	• forces and motion			
	• electricity			
	• waves			
Isaac Physics Assignments: Group code **YWLCVJ**				
	A1 Using and re-arranging equations			
	A2 Derived and Base SI Units			
	A3 Standard Form and prefixes			
	A4 Converting units			

Activity	Definitions and Units
1	

Define the following words:

Independent variable	Accuracy	Zero error
Dependent variable	Precision	Mean value
Control variable	Reliability	Anomalous results
Continuous variable	Calibration	Line of best fit
Discrete variable	Random error	Gradient
Categoric variable	Systematic error	y-intercept

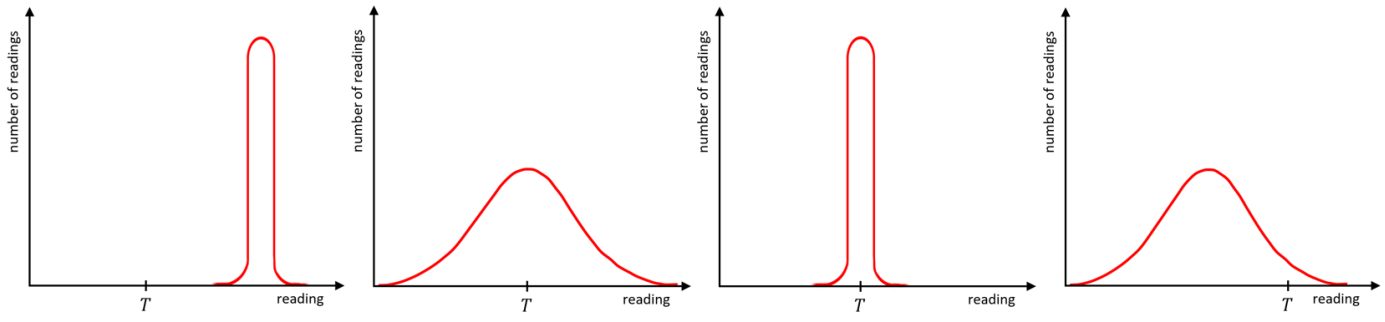
1. How do you improve the precision of a reading?
2. How do could you improve the reliability of your results?
3. If a weighing scale read 20 g when nothing was placed on it, how would you describe it?
4. If you used this to find the masses of different samples of metal what type of error would it produce?
5. How could you calculate the true value for each of the masses?
6. How do you calculate a mean value of 4 readings?
7. If all your readings are to 2 significant figures how many sig fig can your mean value be? Why?

8. Which type of variable would the following be classed as:

a)	Height in cm?	i)	Favourite chocolate bar?
b)	Gender?	j)	Current in amps?
c)	Dress size?	k)	Smelliness?
d)	Attractiveness?	l)	Age in days?
e)	Distance in m?	m)	pH?
f)	Brightness?	n)	Pressure in Pa?
g)	Volume of CO_2 produced in m^3?	o)	Loudness?
h)	Temperature in Fahrenheit?	p)	T-shirt size?

If T represents the true value, which of the graphs below represents:

A	Precise and accurate?	C	Accurate but not precise?
B	Precise but not accurate?	D	Neither accurate nor precise?



Units

1. By using internet research e.g. the *National Physics Laboratory* (NPL) produce your own notes on the base units in the SI system (there are 7 but you can ignore light intensity – candela)

2. Again, using your own research, find the derived SI units and symbols for the following quantities:

Quantity	Symbol	Unit
Velocity		
Acceleration		
Time		
Force		
Resistance		
Potential difference		
Current		
Energy		
Pressure		
Momentum		
Power		
Density		
Charge		

Now attempt the Isaac Physics Assignment A2

Activity	Prefixes
2	

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.

*After completing this sheet, attempt **Isaac Physics Assignments A3** and **A4** – or you might want to try those first.*

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

Convert the figures into the prefixes required:

s	ms	µs	ns	ps
134.6	134600 *or* 1.346×10^{5}	134 600 000 *or* 1.346×10^{8}	134 600 000 000 *or* 1.346×10^{11}	134 600 000 000 000 *or* 1.346×10^{14}
96.21				
0.773				

m	km	mm	Mm	Gm
12873	12.873	12 873 000 *or* 1.2873×10^{7}	0.012873 *or* 1.2873×10^{-2}	0.000012873 *or* 1.2873×10^{-5}
0.295				
57.23				

kg	Mg	mg	g	Gg
94.76				
0.000765				
823.46				

A	mA	µA	nA	kA
0.000000678				
3.56				
0.00092				

Activity	Means & Anomalous Results
3	

For each set of values, ***calculate the mean*** *and then calculate the mean again* ***but*** *ignoring any* ***anomalous results***

1	2	3	Mean	
4152	2996	4018	3722	4085
935.5	925.8	926.7		
16.2	19.1	17.4		
80.1316	80.1324	80.1466		
2229	2011	1610		
127.664	127.416	127.489		
55.88	11.97	37.59		
3.767	3.763	3.751		
375.5	511.5	463.4		
1048	888	1655		
0.507	0.415	0.230		
27145	25157	26017		
1450	1014	2238		
9104.32	10529.45	9160.97		

1	2	3	4	Mean	
63.10	62.97	62.53	62.99		
465.98	463.40	466.96	155.56		
3.61	7.39	3.55	3.64		
73.71	70.98	74.19	72.38		
2.058	1.566	2.078	1.787		
416	402	189	986		
700653	739762	742471	726161		
2670887	2670901	2669942	2670733		
110.4	260.1	1044.2	488.8		

1	2	3	4	5	Mean	
140	220	90	180	140		
56300	41200	58600	48300	53800		
0.186	0.341	0.276	0.216	0.314		
1.427	0.235	0.488	1.922	1.620		
34	62	46	12	39		
326.19	360.22	314.20	352.22	400.18		
1.4	5.3	2.7	3.9	2.6		

Activity	Significant Figures
4	

For each value, state how many significant figures it is given to:

Value	Sig Figs	Value	Sig Figs	Value	Sig Figs	Value	Sig Figs
2	1	1066	4	1800.45	6	0.07	1
2.0		82.42		2.483×10^4		69324.8	
2.00		750000		2.483		0.0063	
0.136		310		5906.4291		9.81×10^4	
0.34		3.10×10^2		200000		6717	
54.1		3.1×10^2		12.711		0.91	

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		
132.303	4.123	53800		
152	0.8	0.55		
0.1142	4922388	132000		

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	6.434		
91×10^2	180		
5.56	22×10^{-3}		
3.142	8.314		

Activity	Graphs
5	

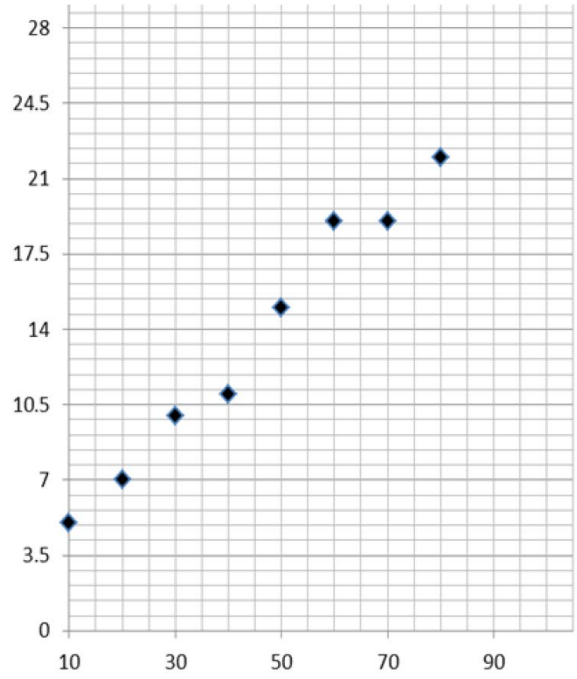
*After a practical activity, the next step is to draw a graph that will be useful to you. Drawing a graph is a skill you should be familiar with already **but** you need to be very careful and particular at A-Level.*

Before you draw your graph, you will need to identify a suitable scale, taking the following into consideration:

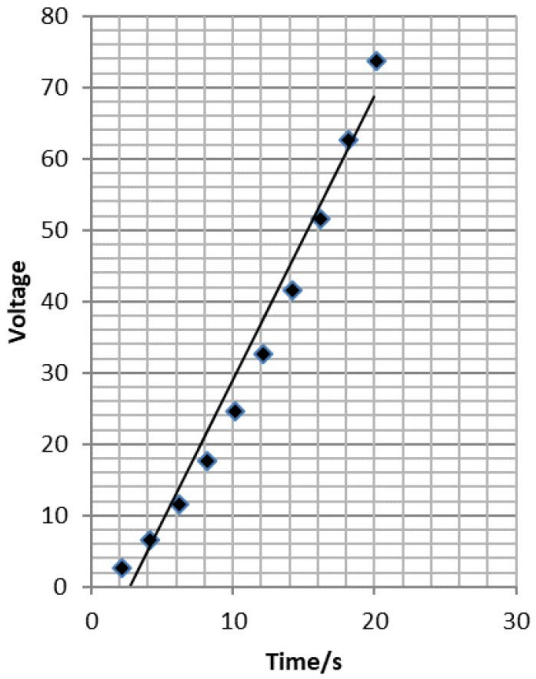
- *the maximum and minimum values of each variable*
- *whether 0.0 should be included as a data point; graphs don't always need to show the origin, a false origin can be used if your data doesn't start near zero*
- *the plots should cover at least half of the grid supplied for the graph*
- *the axes should use a sensible scale; e.g. multiples of 1, 2, 5 etc.*

Identify how the following graphs could be improved:

Graph 1



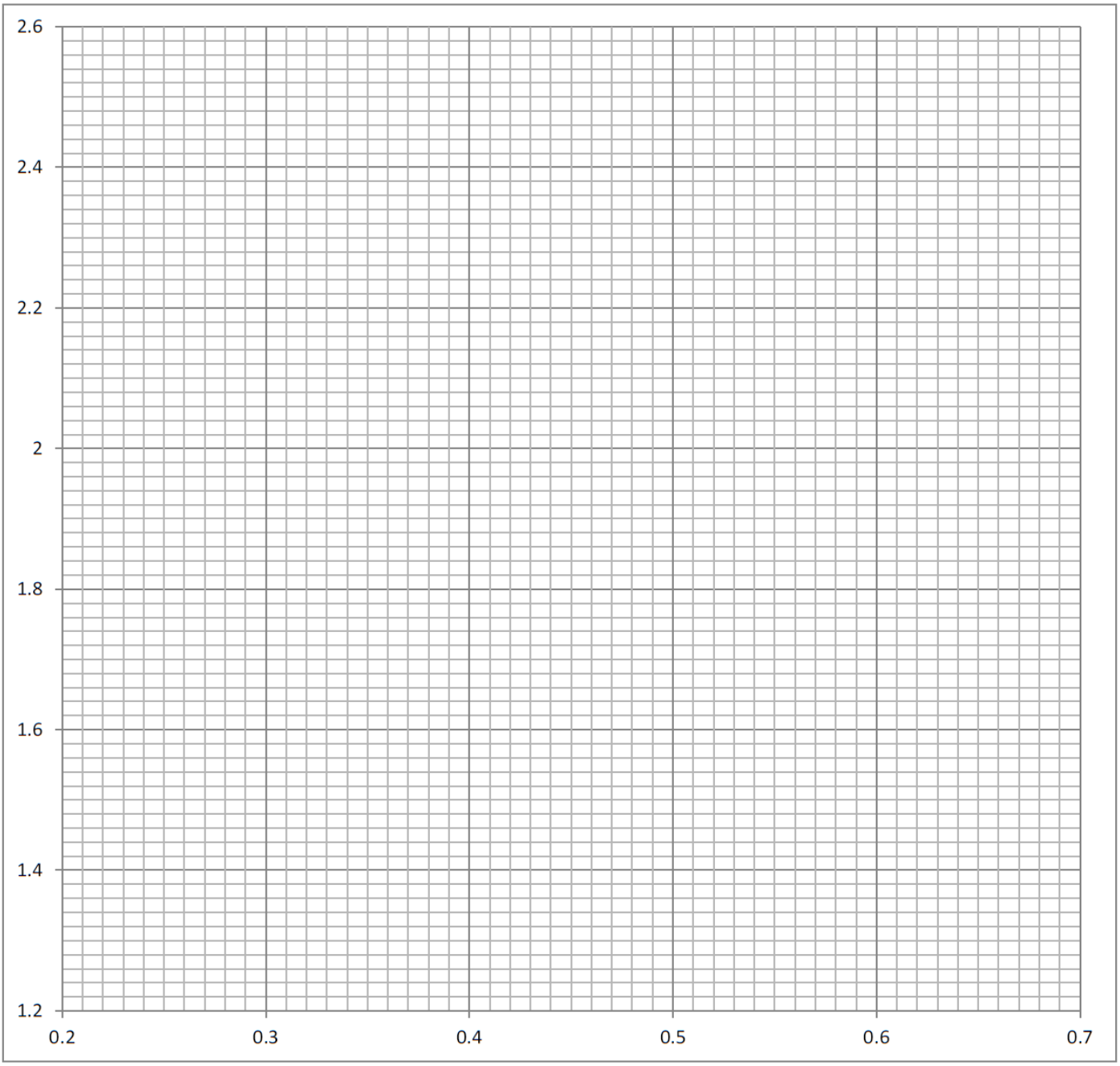
Graph 2



Activity	Plotting a graph
6	

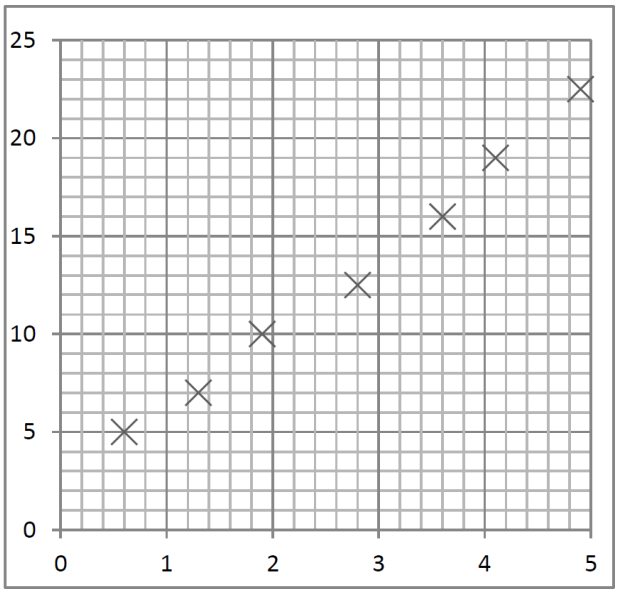
In this activity, you are going to practice plotting points on a graph. This skill carries up to 3 marks in the practical assessments.

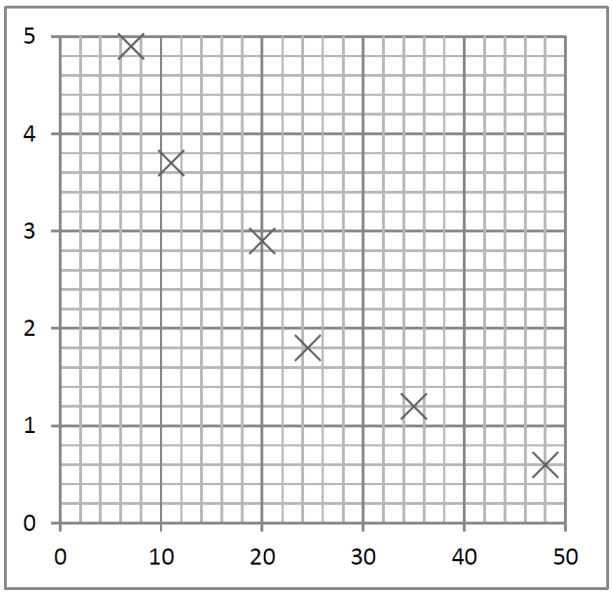
x-axis	y-axis	x-axis	y-axis	x-axis	y-axis
0.44	2.44	0.34	1.75	0.67	2.12
0.27	1.39	0.49	1.99	0.58	1.64
0.39	2.13	0.26	2.22	0.65	2.52
0.62	1.23	0.31	2.49	0.29	1.92
0.37	1.52	0.52	2.36	0.45	1.47
0.22	2.56	0.61	2.23	0.53	1.27
0.42	1.84	0.64	1.83	0.24	1.71
0.48	1.70	0.55	2.15	0.67	1.45

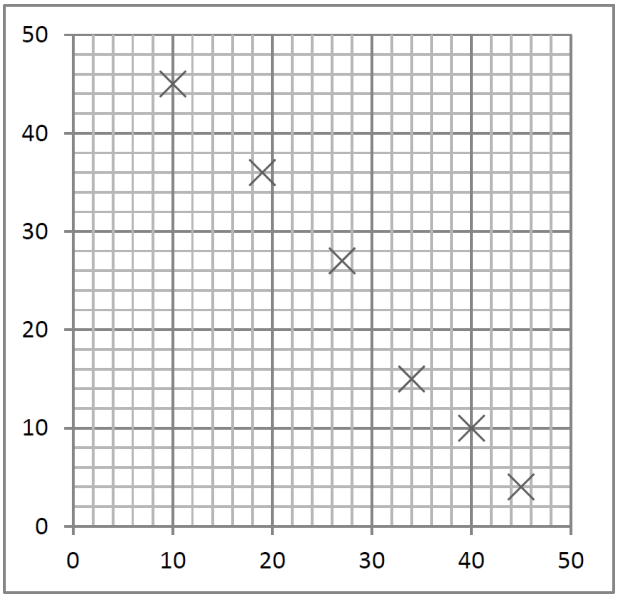


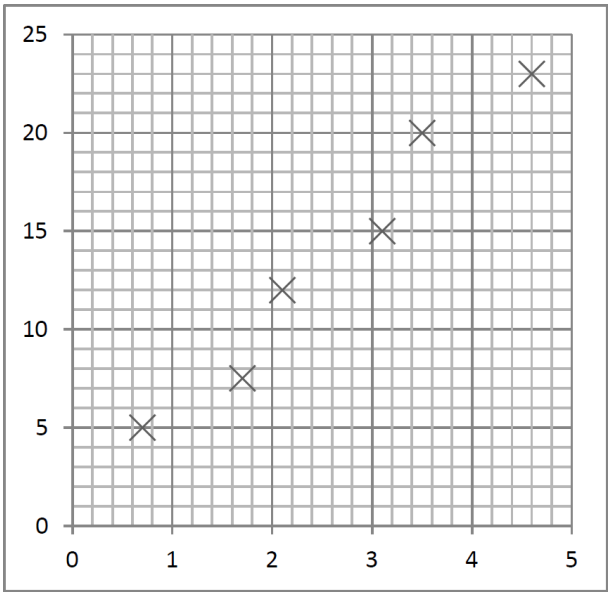
Activity	Line of best fit
7	

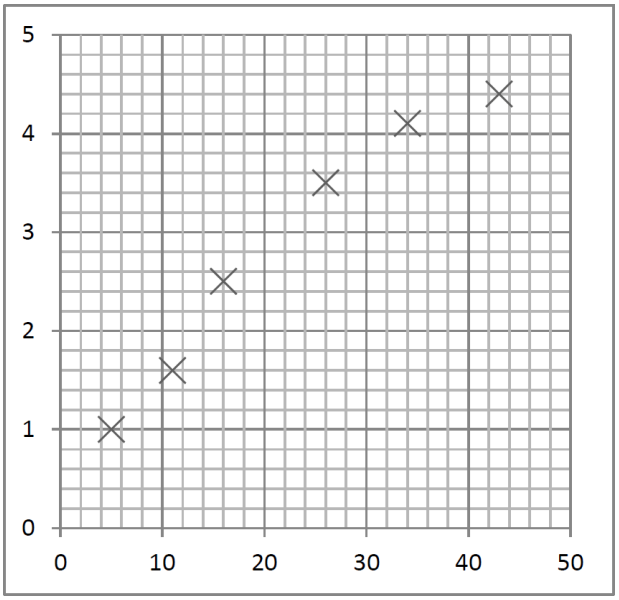
Draw a line of best fit for each of the graphs below:

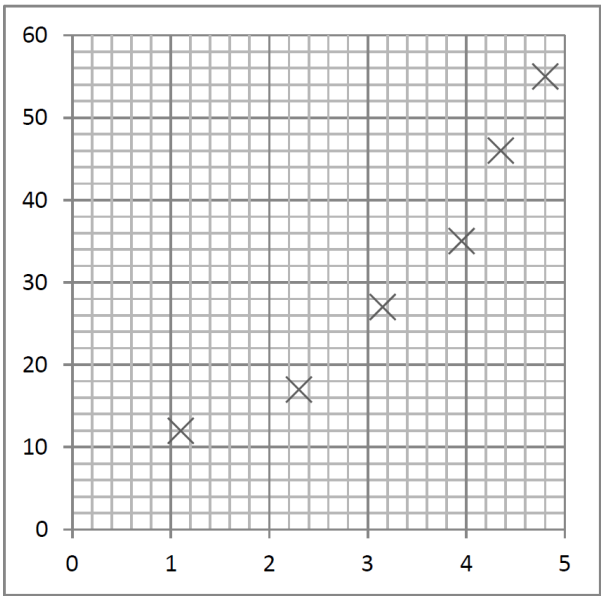












Activity	Re-arranging Equations
8	

Physics A-Level is around 40% mathematics skills and one of the most basic is rearranging equations – which you should have done at GCSE.

For example, with kinetic energy (KE) - often written as E_K at A-Level:

$$E_K = \frac{1}{2}mv^2$$

$$2E_K = mv^2$$

$$mv^2 = 2E_K$$

$$v^2 = \frac{2E_K}{m}$$

$$v = \sqrt{\frac{2E_K}{m}}$$

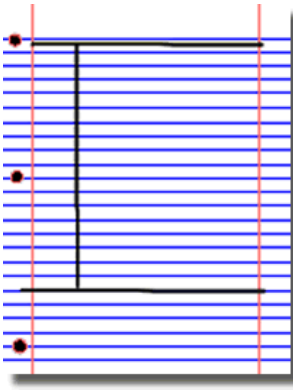
Now complete the Isaac Physics Assignment A2

Activity	Research Activities
9	

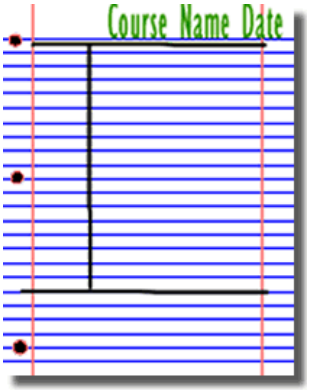
Research, reading and note-making are essential skills for A-Level Physics study.

For the following task you are going to produce 'Cornell Notes' to summarise your reading;

1. Divide your page into three sections like this



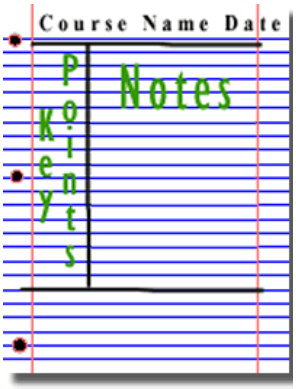
2. Write the course name, date and topic at the top of the page.



3. Use the large box to make notes.

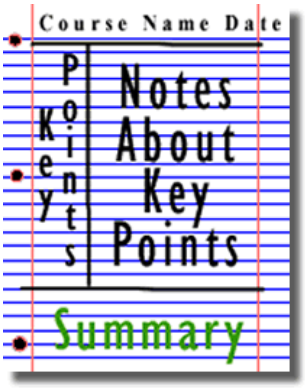
   Leave a space between separate ideas.

   Abbreviate where possible.

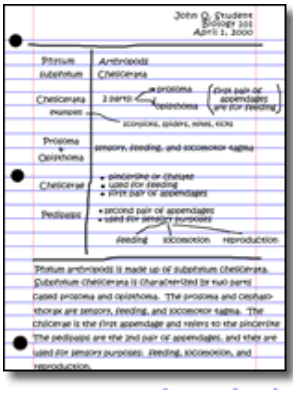


4. Review the notes as soon as possible after class

   Identify the key points and write them in the left-hand box



5. Write a summary of the main ideas in the bottom space



see http://coe.jmu.edu/learningtoolbox/cornellnotes.html

Activity	Research Activities (continued)
9	

Physics provides daily online-only news and commentary about a selection of papers from the APS journal collection.

The website is aimed at the reader who wants to keep up with highlights of physics research with explanations that don't rely on jargon and technical detail.

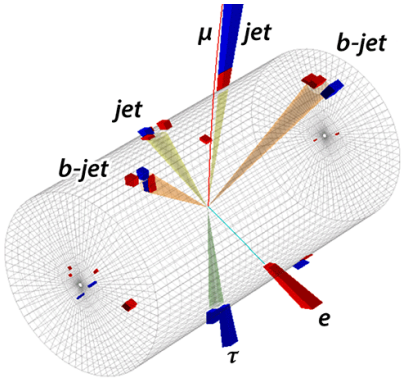
For each of the following topics, use the APS resources to produce one page of Cornell style notes.

Use the links (or scan the QR codes) to take you to the resources

Topic 1: **Sizing up the top quarks interaction with the Higgs**

Available at: https://physics.aps.org/articles/v11/56

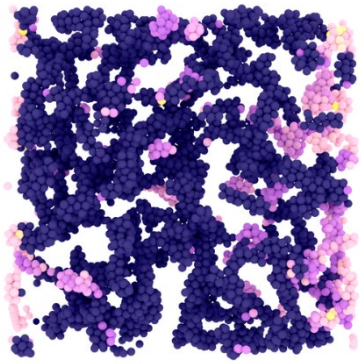
A proton collision experiment at CERN provides a new handle on the Higgs boson's interaction with the heaviest of the quarks



Topic 2: **Why soft solids get softer**

Available at: https://physics.aps.org/articles/v11/50

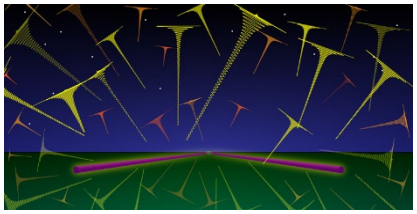
Soft materials like gels and creams exhibit fatigue resulting from the stretching of their constituent fibres, according to experiments and simulations



Topic 3: **Listening for the cosmic hum of black holes**

Available at: https://physics.aps.org/articles/v11/36

A new analysis technique would allow the gravitational wave "background" from distant black hole mergers to be detected in days instead of years



Activity	Key ideas from GCSE
10	

Atomic Structure

You will study nuclear decay in more detail at A-Level, covering the topics of radioactivity and particle physics. In order to explain what happens, you will need to have a good understanding of the model of the atom. You need to know what the atom is made up of, relative charges and masses and how sub-atomic particles are arranged.

*This video explains how the current model was discovered: **https://www.youtube.com/watch?v=wzALbzTdnc8***

***Task**: Describe the model used for the structure of an atom, including details of the individual particles that make up an atom and the relative charges and masses of these particles. You may wish to include a diagram and explain how this model was discovered by Ernest Rutherford.*

Forces and Motion

At GCSE you studied forces and motion ... and at A-Level, you will explore this topic in more detail – so it is essential that you have a good understanding of the content covered at GCSE. You will be expected to describe, explain and carry calculations concerning the motion of objects. The websites below cover Newton's laws of motion and have links to these in action.

https://www.physicsclassroom.com/Physics-Tutorial/Newton-s-Laws

https://www.thoughtco.com/introduction-to-newtons-laws-of-motion-2698881

https://www.labster.com/simulations/newtons-laws-of-motion/

***Task**: On graph paper, sketch a velocity-time graph showing the journey of a skydiver after leaving the plane to reaching the ground. Identify and mark the terminal velocity.*

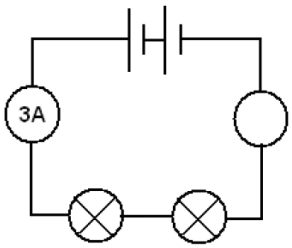
Electricity

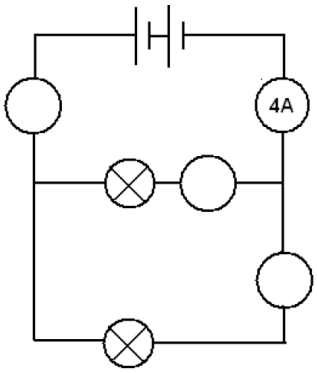
At A-Level, you will learn more about how current and voltage behave in different circuits containing different components. You should be familiar with current and voltage rules in a series and parallel circuit as well as calculating the resistance of a device.

http://www.allaboutcircuits.com/textbook/direct-current/chpt-1/electric-circuits/

http://www.physicsclassroom.com/class/circuits

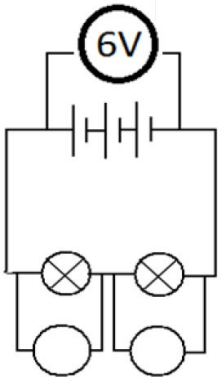
Task 1*: (a) Add the missing ammeter readings on the circuits below:*

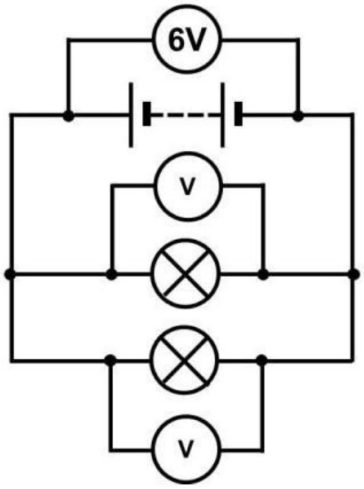




(b) Explain why the second circuit has more current flowing in it than the first:

Task 2*: Add the missing potential differences to the circuits below:*





Waves

*You have studied different types of **waves** and used the **wave equation** to calculate speed, frequency and wavelength.*

*You will also have studied **reflection** and **refraction**.*

Use the following links to review this topic:

https://www.bbc.co.uk/bitesize/guides/zgf97p3/revision/1

https://www.khanacademy.org/science/physics/mechanical-waves-and-sound/mechanical-waves/v/introduction-to-waves

***Task 1**: Draw a diagram showing the **refraction** of a wave through a rectangular glass block. Explain why the ray of light takes this path.*

***Task 2**: Describe the difference between **longitudinal** and **transverse waves** and give an example of each.*

***Task 3**: Draw a wave and label the **wavelength** and **amplitude**.*