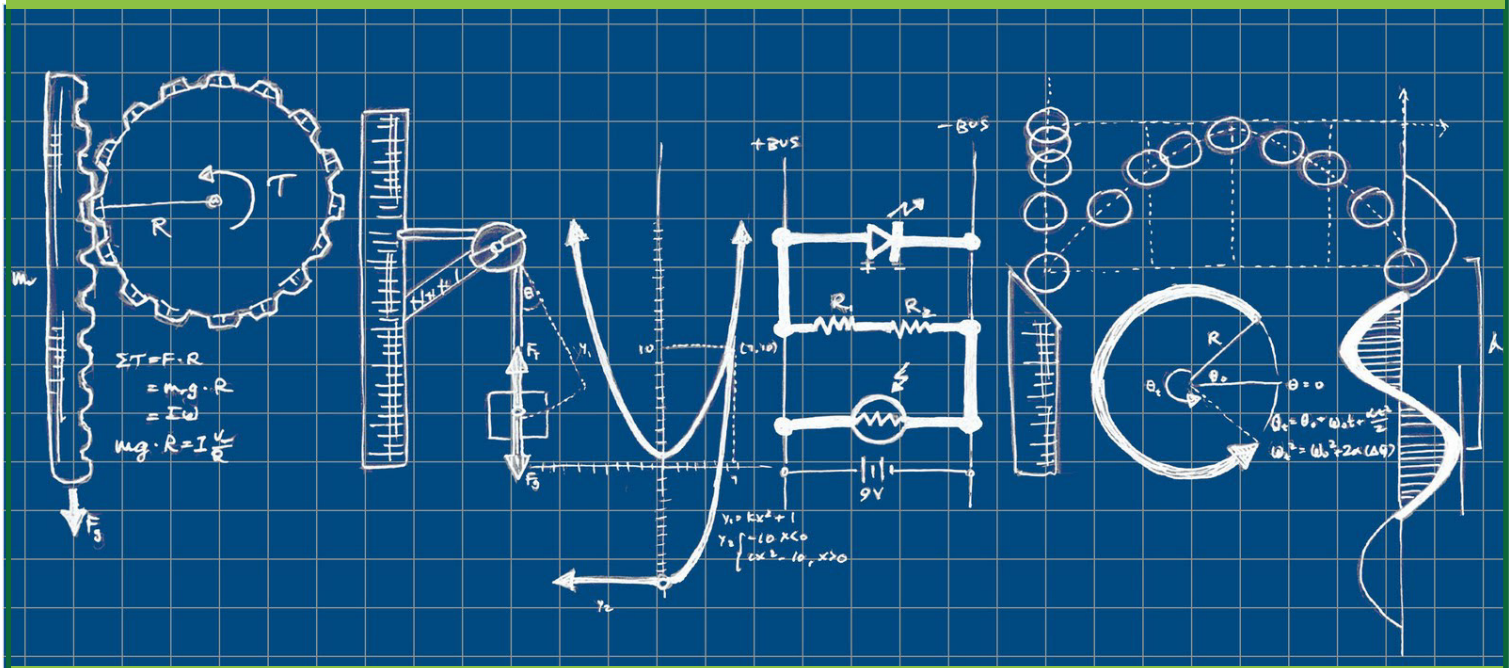
Bentley Wood

High School for Girls

Physics
GCSE to A level

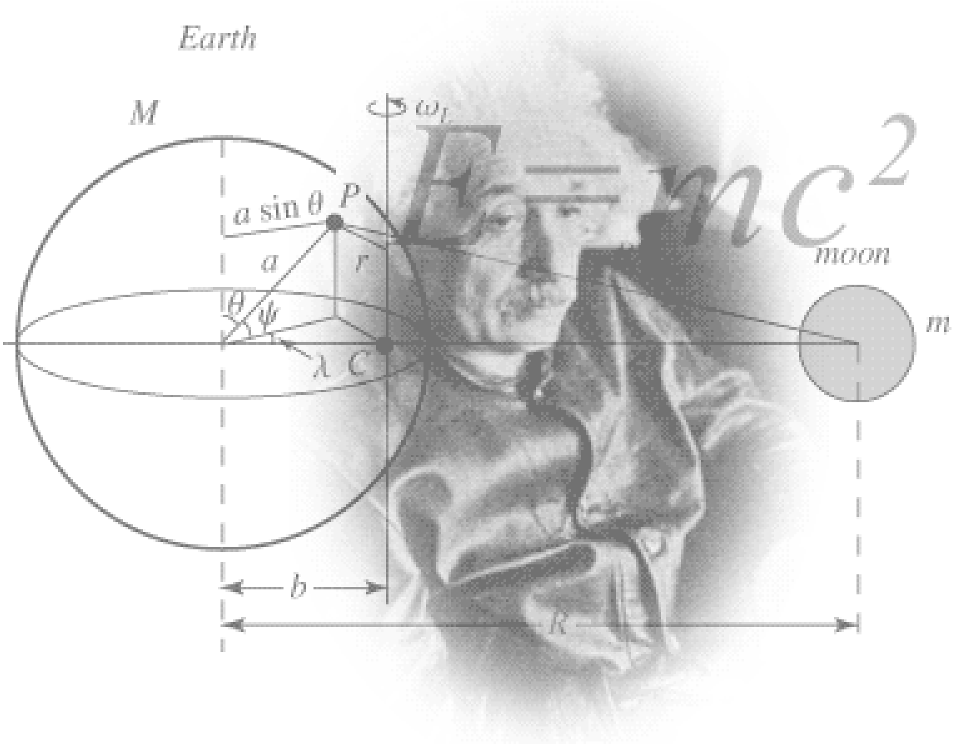
Bridging Work
Year 11 into 12 for 2022/23

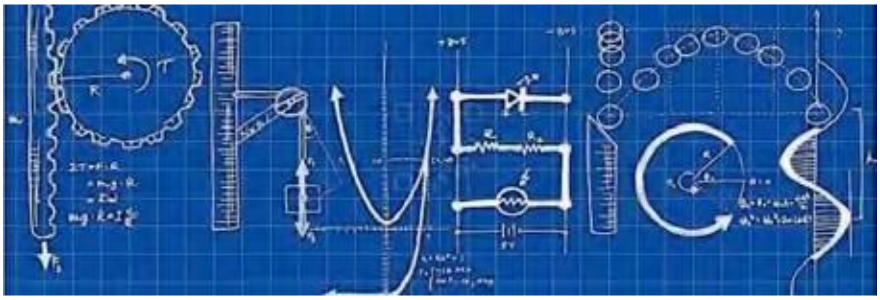


Name: ____________________

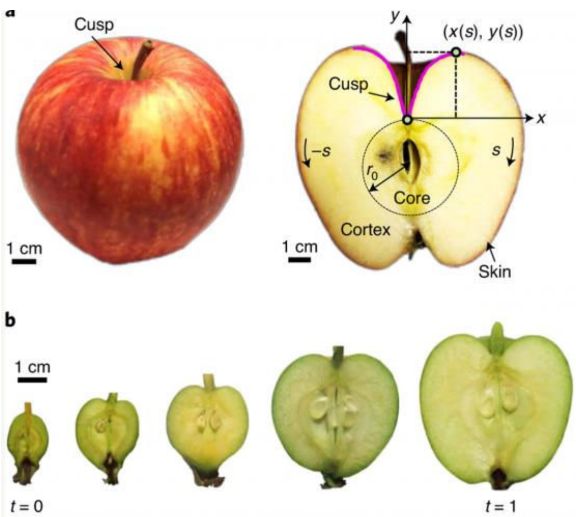
Tutor Group: ______________

Teacher: _________________________





BRIDGING WORK 11 to 12



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WELCOME TO AS PHYSICS

The purpose of this booklet is to give you essential information and resources for the AS Physics course. This booklet will also help you to understand and develop the skills you will need.

Please remember the following items for **EVERY** lesson – **ESSENTIAL**:

- Pens (highlighters are useful too) and paper
- A file with your (well organised) notes in
- Calculator, ruler and pencils

We hope you enjoy learning Physics BUT sometimes even the best of students can have problems:

- **Problems with work**
- **Problems understanding concepts**
- **Problems getting your head round all the theories in physics**
- **Problems with completing homework**
- **Problems in their personal lives**

If any of this applies to you, don't feel there's nowhere to turn – **THERE IS!**

ALL the staff in the Physics Department will be happy to talk through your concerns or can advise you – so don't panic or think about giving up, **HELP IS AT HAND**.

Come and find us, or e-mail – no problem is ever so big that we can't help, honest!

I Lambert	ilambert@bentleywood.harrow.sch.uk
A Binnion	Abinnion@bentleywood.harrow.sch.uk

Expectations

As a part of its quality approach to teaching, the Physics Department follows a common policy on the setting and marking of work. This code of practice is followed by both staff and students and is aimed to help you achieve success in Physics.

What we expect of YOU

- It is expected that your attendance will be 100% - if you are absent you MUST inform your tutor (beforehand if possible). If you do miss a lesson for medical or academic reasons it is YOUR responsibility to catch up on the work that you have missed.
- You are expected to spend **FIVE** hours a week per subject on personal study. This time may be directed by homework set by the tutor; otherwise you will be expected to use this time to read around your subject, supplement your notes and ensure that your notes are well organised and complete.
- You will be set an assessment every WEEK. If you have been unable to complete the work, you will be expected to inform your tutor prior to the lesson that the work is due in and/or find a time to catch-up.
- You are expected to manage and organise your work effectively, and to be responsible for keeping your notes, files and assessment pack up to date.
- You are expected to listen respectfully to your peers in discussions and group work

What you can expect of US

- Assessed work will be marked and handed back within TWO weeks of the handing in date.
- We will always be willing to discuss your progress and support your learning.

Useful websites

The following Internet resources are useful and will help with your AS Physics course:

Exam board website:

- https://qualifications.pearson.com/en/qualifications/edexcel-a-levels/physics-2015.html: contains past papers, exam dates and most importantly EXAMINERS' REPORTS which will tell you where students commonly go wrong/suggest how to improve.
- https://www.pearsonactivelearn.com/app/Home Once you have a login you can practice questions

Revision and consolidation of knowledge:

- https://getrevising.co.uk/resources/level/a_ib/subjects/physics
- https://senecalearning.com/en-GB/
- https://www.savemyexams.co.uk/a-level-physics-aqa/revision-notes/
- https://studywise.co.uk/a-level-revision/physics/
- https://digestiblenotes.com/physics/circles/circular_measure.php
- https://www.revisely.co.uk/alevel/physics/aqa/

Leaning towards questioning

- https://snaprevise.co.uk/
- https://www.physicsandmathstutor.com/
- https://www.alevelphysicsonline.com/
- https://mathsmadeeasy.co.uk/a-level-physics-revision/

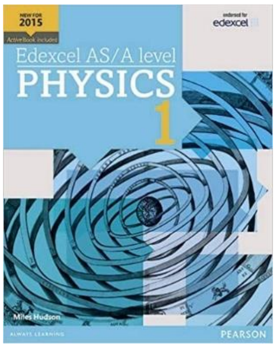
You are encouraged to keep an eye on the news as many reports and articles will be relevant to the materials you are studying in class.

Textbooks

You will need to invest in the below text book (although the more Physics books you have the better your grade will be). A good website to use is https://www.wob.com/en-gb which tends to be cheaper than amazon. Ebay is also a good place to look. If you need financial help purchasing books please see your teacher or head of department.

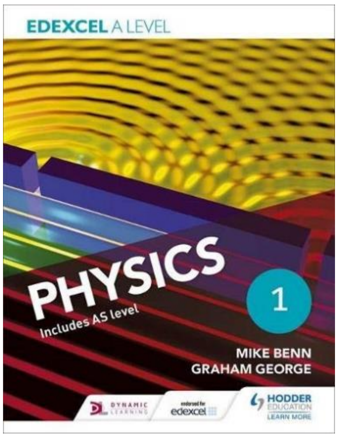
Required text book

Edexcel AS/A level Physics Student Book 1 + ActiveBook (Edexcel GCE Science 2015)

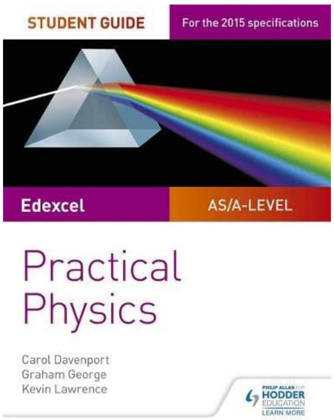


Highly recommended text books

Edexcel A Level Physics Student Book 1 by Mike Benn

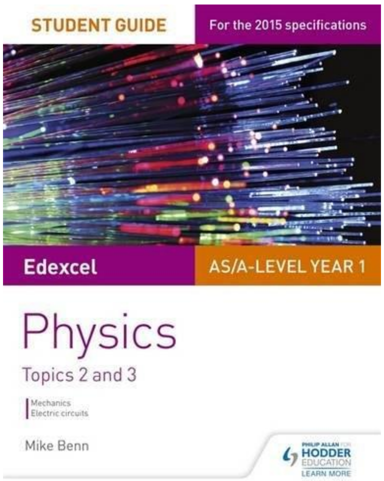


Edexcel A-level Physics Student Guide: Practical Physics by Carol Davenport

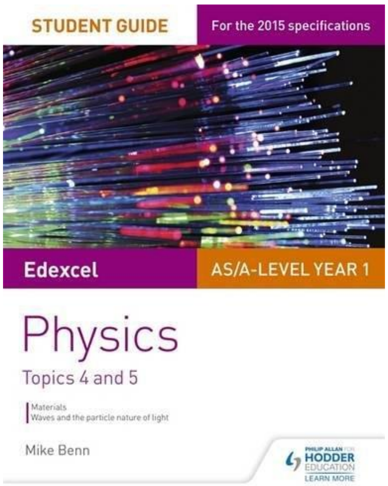


Recommended text book

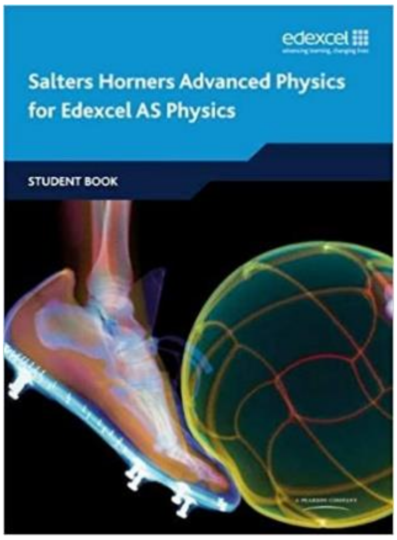
Edexcel AS/A Level Physics Student Guide: Topics 2 and 3by Mike Benn



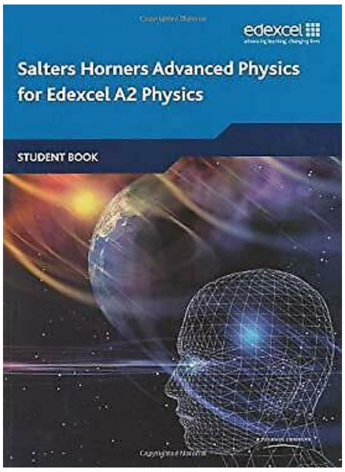
Edexcel AS/A Level Physics Student Guide: Topics 4 and 5 by Mike Benn



Salters Horners Advanced Physics AS Student Book (Salters Horners Advanced Physics 08)

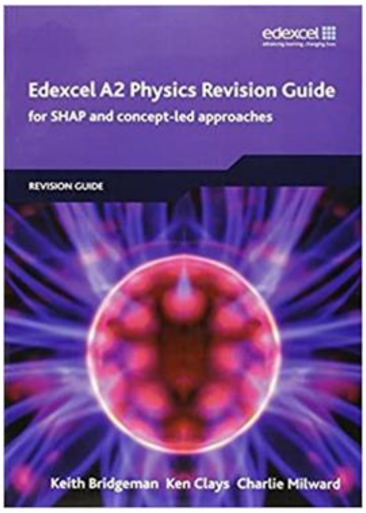


Salters Horners Advanced Physics for Edexcel A2 Physics Paperback

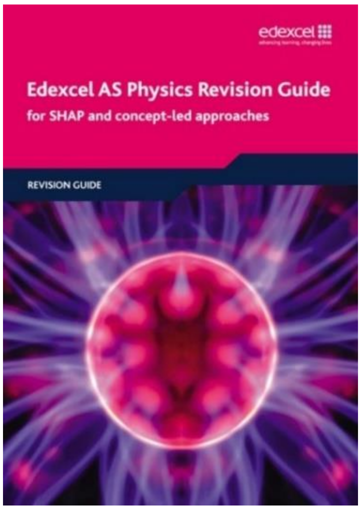


Recommended revision guides

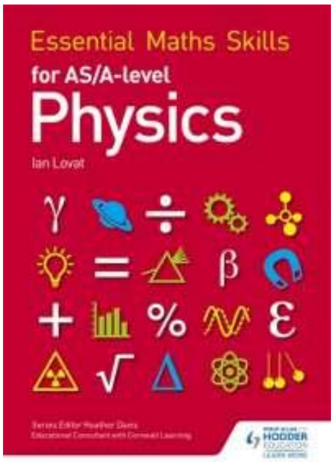
Edexcel A2 Physics Revision Guide 2008: For SHAP and Concept-Led Approaches (Edexcel GCE Physics 2008) by Mr Ken Clays (2009-08-26)



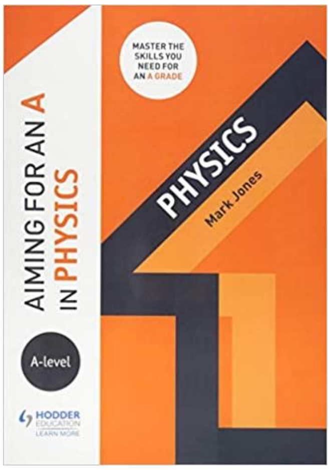
EDEXCEL AS PHYSICS REVISION GUIDE Author(s): Bridgeman, Keith



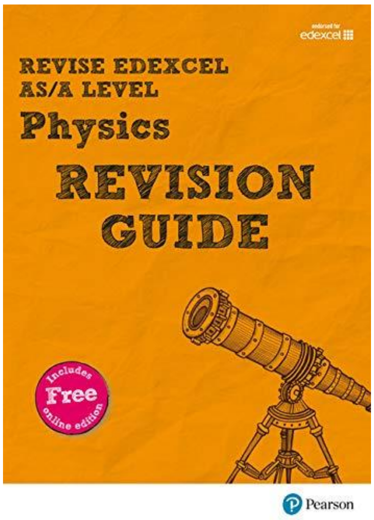
Essential math skills for Alevel physics



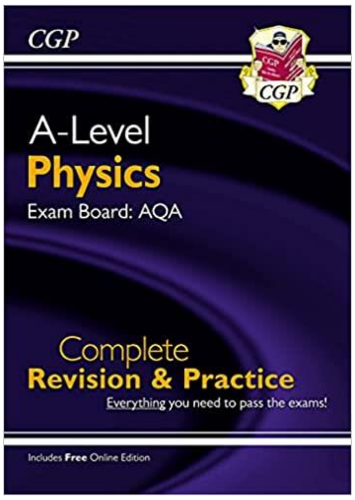
Aiming for an A in A-level Physics Paperback – 31 Aug. 2018



Revise Edexcel AS/A Level Physics Revision Guide by Steve Adams



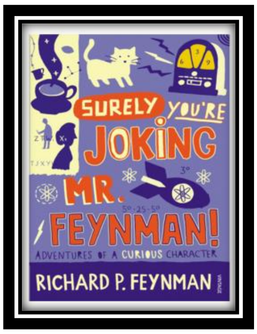
A-Level Physics: AQA Year 1 & 2 Complete Revision & Practice with Online Edition: perfect for catch-up and the 2022 and 2023 exams (CGP A-Level Physics)



Reading Recommendations

Kick back this summer with a good read. The books below are all popular science books and great for extending your understanding of Physics

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

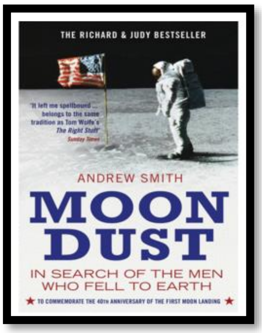


ISBN - 009917331X - Richard Feynman was a Nobel Prize winning Physicist. In my opinion he epitomises what a Physicist is. By reading this books you will get insight into his life's work including the creation of the first atomic bomb and his bongo playing adventures and his work in the field of particle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

(Also available on Audio book).

https://www.waterstones.com/books/search/term/surely+youre+joking+mr+feynman++adventures+of+a+curious+character

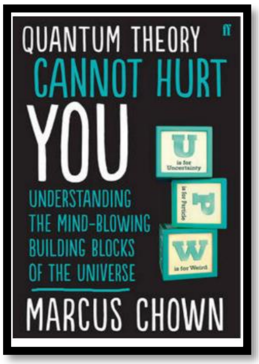
2. Moondust: In Search of the Men Who Fell to Earth



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

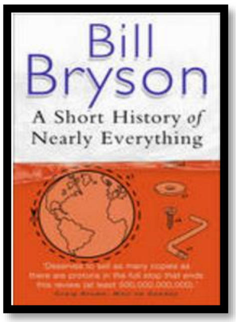
3. **Quantum Theory Cannot Hurt You: Understanding the Mind-Blowing Building Blocks of the Universe**



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

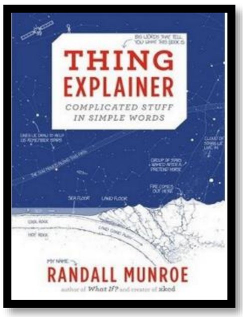
4. **A Short History of Nearly Everything**



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. Hopefully by reading it you will gain an awe-inspiring feeling of how everything in the universe is connected by some fundamental laws.

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. Written by the creator of online comic XTCD (a great source of science humour) is a book of blueprints from everyday objects such as a biro to the Saturn V rocket and an atom bomb, each one meticulously explained BUT only with the most common 1000 words in the English Language. This would be an excellent coffee table book in the home of every scientist.

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

Summer tasks

1. **Read** the specification from the Edexcel Pearson website:
https://qualifications.pearson.com/content/dam/pdf/A%20Level/Physics/2015/Specification%20and%20sample%20assessments/PearsonEdexcel-AS-Physics-Spec.pdf

Print off the specification teaching points (pages 21-24) and put in the front of your folder

This is how it should look:

Topic 2: Mechanics

In order to develop their practical skills, students should be encouraged to carry out a range of practical experiments related to this topic. Possible experiments include strobe photography or the use of a video camera to analyse projectile motion, determine the centre of gravity of an irregular rod, investigate the conservation of momentum using light gates and air track.

Mathematical skills that could be developed in this topic include plotting two variables from experimental data, calculating rate of change from a graph showing a linear relationship, drawing and using the slope of a tangent to a curve as a measure of rate of change, distinguishing between instantaneous rate of change and average rate of change and identifying uncertainties in measurements, using simple techniques to determine uncertainty when data are combined, using angles in regular 2D and 3D structures with force diagrams and using sin, cos and tan in physical problems.

This topic may be studied using applications that relate to mechanics, for example, sports.

Students should:	
9.	be able to use the equations for uniformly accelerated motion in one dimension: $s = \frac{(u+v)t}{2}$ $v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
10.	be able to draw and interpret displacement-time, velocity-time and acceleration-time graphs
11.	know the physical quantities derived from the slopes and areas of displacement-time, velocity-time and acceleration-time graphs, including cases of non-uniform acceleration and understand how to use the quantities
12.	understand scalar and vector quantities and know examples of each type of quantity and recognise vector notation
13.	be able to resolve a vector into two components at right angles to each other by drawing and by calculation
14.	be able to find the resultant of two coplanar vectors at any angle to each other by drawing, and at right angles to each other by calculation
15.	understand how to make use of the independence of vertical and horizontal motion of a projectile moving freely under gravity
16.	be able to draw and interpret free-body force diagrams to represent forces on a particle or on an extended but rigid body

Students should:	
17.	be able to use the equation $\sum F = ma$, and understand how to use this equation in situations where m is constant (Newton's second law of motion), including Newton's first law of motion where $a = 0$, objects at rest or travelling at constant velocity *Use of the term terminal velocity is expected*
18.	be able to use the equations for gravitational field strength $g = \frac{F}{m}$ and weight $W = mg$
19.	**CORE PRACTICAL 1: Determine the acceleration of a freely-falling object.**
20.	know and understand Newton's third law of motion and know the properties of pairs of forces in an interaction between two bodies
21.	understand that momentum is defined as $p = mv$
22.	know the principle of conservation of linear momentum, understand how to relate this to Newton's laws of motion and understand how to apply this to problems in one dimension
23.	be able to use the equation for the moment of a force, moment of force = Fx where x is the perpendicular distance between the line of action of the force and the axis of rotation
24.	be able to use the concept of centre of gravity of an extended body and apply the principle of moments to an extended body in equilibrium
25.	be able to use the equation for work $\Delta W = F\Delta s$, including calculations when the force is not along the line of motion
26.	be able to use the equation $E_k = \frac{1}{2}mv^2$ for the kinetic energy of a body
27.	be able to use the equation $\Delta E_{grav} = mg\Delta h$ for the difference in gravitational potential energy near the Earth's surface
28.	know, and understand how to apply, the principle of conservation of energy including use of work done, gravitational potential energy and kinetic energy
29.	be able to use the equations relating power, time and energy transferred or work done $P = \frac{E}{t}$ and $P = \frac{W}{t}$
30.	be able to use the equations $\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$ and $\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$

Topic 3: Electric Circuits

In order to develop their practical skills, students should be encouraged to carry out a range of practical experiments related to this topic. Possible experiments include estimating power output of an electric motor, using a digital voltmeter to investigate the output of a potential divider and investigating current/voltage graphs for a filament bulb, thermistor and diode.

Mathematical skills that could be developed in this topic include substituting numerical values into algebraic equations using appropriate units for physical quantities and applying the equation $y = mx + c$ to experimental data.

This topic may be studied using applications that relate to electricity, for example, space technology.

Students should:	
31.	understand that electric current is the rate of flow of charged particles and be able to use the equation $I = \frac{\Delta Q}{\Delta t}$
32.	understand how to use the equation $V = \frac{W}{Q}$
33.	understand that resistance is defined by $R = \frac{V}{I}$ and that Ohm's law is a special case when $I \propto V$ for constant temperature
34.	understand how the distribution of current in a circuit is a consequence of charge conservation
35.	understand how the distribution of potential differences in a circuit is a consequence of energy conservation
36.	be able to derive the equations for combining resistances in series and parallel using the principles of charge and energy conservation, and be able to use these equations
37.	be able to use the equations $P = VI$, $W = VIt$ and be able to derive and use related equations, e.g. $P = I^2R$ and $P = \frac{V^2}{R}$
38.	understand how to sketch, recognise and interpret current-potential difference graphs for components, including ohmic conductors, filament bulbs, thermistors and diodes
39.	be able to use the equation $R = \frac{\rho l}{A}$

Students should:	
40.	**CORE PRACTICAL 2: Determine the electrical resistivity of a material.**
41.	be able to use $I = nqvA$ to explain the large range of resistivities of different materials
42.	understand how the potential along a uniform current-carrying wire varies with the distance along it
43.	understand the principles of a potential divider circuit and understand how to calculate potential differences and resistances in such a circuit
44.	be able to analyse potential divider circuits where one resistance is variable including thermistors and light dependent resistors (LDRs)
45.	know the definition of *electromotive force (e.m.f.)* and understand what is meant by *internal resistance* and know how to distinguish between e.m.f. and *terminal potential difference*
46.	**CORE PRACTICAL 3: Determine the e.m.f. and internal resistance of an electrical cell.**
47.	understand how changes of resistance with temperature may be modelled in terms of lattice vibrations and number of conduction electrons and understand how to apply this model to metallic conductors and negative temperature coefficient thermistors
48.	understand how changes of resistance with illumination may be modelled in terms of the number of conduction electrons and understand how to apply this model to LDRs.

2. Get ahead by looking and seeing what the GCSE links are and make some summary GCSE notes. Use the specification mapping to help you.

3. You will be **retested** on the GCSE to A-level links (topics will include all topics from GCSE including triple topics) make sure you are prepared for this test.

4. Complete the below

.

1. 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	=	6×10^{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	=	$640 \times 10_{9}$	V
		=	$0.5 \times 10_{-6}$	A
		=	93.09×10^{9}	m
	kN	=	$32 \times 10_{5}$	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 $\times 10^3$	450 $\times 10^6$
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 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 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.

2. 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 x 10^2 / 2.6 x 10^2 = 1.9)

8. **For a number in scientific notation: N x 10^x, all digits comprising N ARE significant by the first 5 rules; "10" and "x" are NOT significant.** 5.02 x 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	

<u>When adding or subtracting numbers</u>

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) = <u>5.3</u> (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		

<u>When multiplying or dividing numbers</u>

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…) = <u>110</u> (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		

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		

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 <u>9.0</u> (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		

3. Converting length, area and volume

Whenever substituting quantities into an equation, you must always do this in SI units – such as time in seconds, mass in kilograms, distance in metres…

If the question doesn't give you the quantity in the correct units, you should always convert the units **first**, rather than at the end. Sometimes the question may give you an area in mm^2 or a volume in cm^3, and you will need to convert these into m^2 and m^3 respectively before using an equation.

To do this, you first need to know your length conversions:

1m = 100 cm = 1000 mm (1 cm = 10 mm)

m to cm	x 100	cm to m	÷ 100
m to mm	x 1000	M to mm	÷ 1000

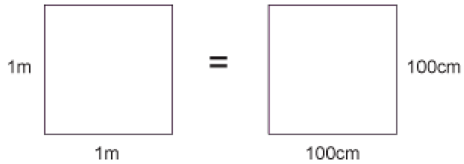
Always think –

"Should my number be getting larger or smaller?" This will make it easier to decide whether to multiply or divide.

Converting Areas

A 1m x 1m square is equivalent to a 100 cm x 100 cm square.

Therefore, $1\ m^2 = 10\ 000\ cm^2$



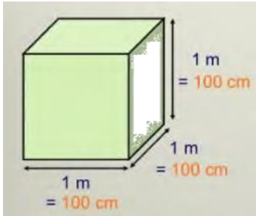
Similarly, this is equivalent to a 1000 mm x 1000 mm square;

So, $1\ m^2 = 1\ 000\ 000\ mm^2$

m^2 to cm^2	x 10 000	cm^2 to m^2	÷ 10 000
m^2 to mm^2	x 1 000 000	m^2 to mm^2	÷ 1 000 000

Converting Volumes

A 1m x 1m x 1m cube is equivalent to a 100 cm x 100 cm x 100 cm cube.



Therefore, $1\ m^3 = 1\ 000\ 000\ cm^3$

Similarly, this is equivalent to a 1000 mm x 1000 mm x 1000 mm cube;
So, $1\ m^3 = 10^9\ mm^3$

6 m_2	=	cm^2
0.002 m^2	=	mm^2
24 000 cm^2	=	m^2
46 000 000 mm^3	=	m^3
0.56 m^3	=	cm^3

750 mm^2	=	m^2
$5 \times 10^{-4}\ cm^3$	=	m^3
$8.3 \times 10^{-6}\ m^3$	=	mm^3
$3.5 \times 10^2\ m^2$	=	cm^2
152000 mm^2	=	m^2

m^3 to m^3	x 1 000 000	cm^3 to m^3	÷ 1 000 000
m^3 to mm^3	x 10^9	m^3 to mm^3	÷ 10^9

Now use the technique shown on the previous page to work out the following conversions:

$31 \times 10^8\ m^2$	=	km_2
59 cm^2	=	mm_2
24 dm^3	=	cm_3
4 500 mm^2	=	cm_2
$5 \times 10^{-4}\ km^3$	=	m_3

(*Hint: There are 10 cm in 1 dm)*

A 2.0 m long solid copper cylinder has a cross-sectional area of 3.0×10^2 mm^2. What is its volume in cm^3?

Volume = _____ cm^3

For the following, think about whether you should be writing a smaller or a larger number down to help decide whether you multiply or divide.

Eg. To convert 5 m ms^{-1} into m s^{-1} – you will travel more metres in 1 second than in 1 millisecond, therefore you should multiply by 1000 to get 5000 m s^{-1}.

5 N cm^{-2}	=	N m^{-2}
1150 kg m^{-3}	=	g cm^{-3}
3.0 m s^{-1}	=	km h^{-1}
65 kN cm^{-2}	=	N mm^{-2}
7.86 g cm^{-3}	=	kg m^{-3}

4. 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	

5. Variables

A variable is a quantity that takes place in an experiment. There are three types of variables:

Independent variable – *this is the quantity that you* ***change***

Dependent variable – *this is the quantity that you* ***measure***

Control variable – *this is a quantity that you* ***keep the same*** *so that it does not affect the results*

You can only have one independent variable and one dependent variable, but the more control variables you have the more accurate your results will be.

Further to these, you can also split the independent variable category – this can be continuous or discrete.

A continuous variable can take *any* numerical value, including decimals. You will construct line graphs for continuous variables.

A discrete variable can only take *specific* values or labels (eg. integers or categories). You will construct bar charts for discrete variables.

For each case study below, state the independent variable, dependent variable, and any control variables described. ***Add further control variables****, and state what type the independent variable is and what type of graph you will present the results with (if required).*

Case study 1 – *Measuring the effect of gravity*

The aim of this experiment is to find out how fast objects of different masses take to fall from height. To conduct this experiment we used a number of spheres of the same diameter, which had different masses. Each sphere had its mass measured on electronic scales, before being dropped from a marker exactly 2.000 m from the floor. The time the sphere took to drop was timed on a stopwatch, and repeated 3 times for each sphere to gain an average time.

Independent variable: ____ Dependent variable: ____

Control variables: ____

____

Type of independent variable: ____

Graph: ____

Case study 2 – *The number of children involved in different after school activities.*

The aim of this study is to discover which activities are most popular so the correct resources can be supplied to the correct member of staff. On a certain day after school the number of children were recorded for the different activities they took.

Independent variable: ____

Dependent variable: ____

Control variables: ____

Type of independent variable: ____

Graph: ____

Case study 3 – *How far does the spring stretch?*

The aim of this experiment is to find how far different masses stretch a spring. A spring was hung from a clamp stand, and its length end to end measured. A 10g mass was then added and the length of the spring measured and recorded. This was repeated adding 10g between 0g and 100g.

Independent variable: ____

Dependent variable: ____

Control variables: ____

Type of independent variable: ____

Graph: ____

6. Constructing tables

The **left hand column** is for your **independent variable**.

The **right hand column** is for your **dependent variable**. You may split this up into further columns if repeats are carried out, and make sure you include an average column. Each sub column must come under the main heading (including the average column).

Place results in the table in order of independent variable, usually starting with the smallest value first.

Ensure each column contains a heading with units in brackets. No units should be placed in the table.

All measured values in one column should be to the same decimal place – don't forget to add zeros if necessary!

Any averages should be given to the same number of decimal places as the measured values. Remember to remove any anomalies by circling the results and do not include them in calculating your average.

Any calculated values should be given to a suitable number of significant figures/ precision.

At AS/A Level we don’t use brackets to separate the quantity heading from the units but use a / .

Example: **mass (kg)** should be written as **mass / kg.**

speed of car (m/s) should be written as **speed of car / m s^{-1}**

Independent Variable Heading /unit	Dependent Variable Heading /unit			
	1	2	3	Average

A student forgot his exercise book when doing a practical on electrical resistance for a resistor. Below are his readings in the practical. He measured the current in the circuit three times for five different voltages. He has made many errors.

V : 0.11A, 0.1A, 0.12A
2.0V : 0.21A, 0.18A, 0.24

5V : 0.5, 5.1, 0.48   4.0V : 0.35A, 0.40A, 0.45

3.0V: 0.33A, 0.6
0.30

Construct a suitable table for his results.

7. Accuracy, Precision, Resolution

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.

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

Stop watch 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 °C. One thermometer gives a reading of 22 °C *and another gives a reading of* 23.4 °*C* . Which is most accurate and estimate its uncertainty?

23.4 °*C* has the best resolution but is not close to the correct value.
22°C has less resolution but is more accurate as it is closer to the correct result.

The uncertainty in this reading is 22 +/− 1°C

Example

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.

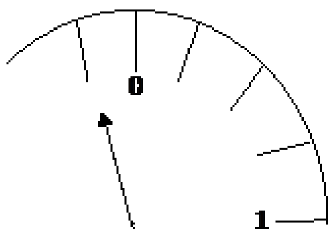
8. Identifying Errors

There are two main types of error in Science:

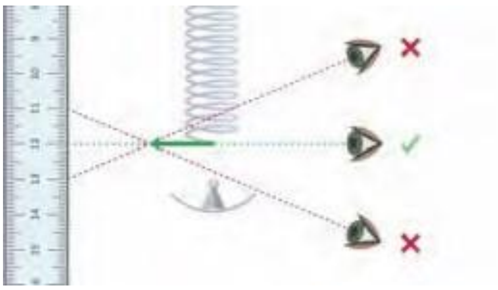
1) Random error
2) Systematic error

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		

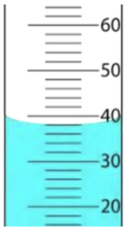
9. Improving Experiments – Accuracy, Resolution and Reliability

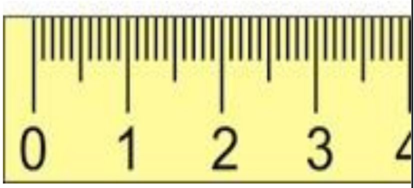
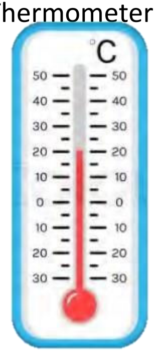
When improving **accuracy**, you must describe how to make sure your *method* obtains the best results possible. You should also try to *use as* <u>*large quantities*</u> *as possible as this reduces the percentage error in your results*. Also make your <u>range as large as possible</u>, with <u>small intervals</u> between each reading.

Resolution refers to the smallest scale division provided by your measuring instrument, or what is the smallest nonzero 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 		

10. Describing Experiments

Variables *– Which variables will you keep the same and which will you change?*
Instruments *– What measuring instruments will you use and how will you take the measurements?*
Range *– Give specific values for the range and intervals you will use. Make sure your range is large with small intervals.*
Analyse *– State any equations you will use and what graph you will plot including the axes.*
Accuracy *– State ways you are being accurate with your measuring instruments.*
Reliability *– State "Repeat and average" to improve reliability*

Using the steps above, describe how to carry out the following experiments below:

e.g.
Water is placed in a plastic tray, one end it raised, dropped and the speed of the water wave is measured. A student suggests that the speed of the wave depends on the height of the water in the tray. How could you prove this?

Change the depth of water by filling the tray to different heights. The height of the water will be measured by placing a ruler into the tray. Depths from 1.0 to 5.0 cm, at 1.0 cm intervals should be used.
The tray should be lifted to the same height each time and dropped without pushing it down. The height the tray is lifted to should also be measured with a ruler that is vertical using a set square.

When the tray hits the table, the time should be measured for the wave to pass end to end 4 times, then divided by 4 to make the reading more accurate to reduce reaction time. The time should be measured using a stopwatch.
The length of the tray should be measured using a ruler, overhead and measured at eye level for accuracy.
The equation speed = distance / time should be used to calculate the speed of the wave.
Repeat each height and average to improve reliability.

Plot a graph of speed (y axis) vs depth of water (x axis) to see if there is a relationship between the two variables.

Question. A student suggests that if an egg was dropped from different heights the area of splatter would increase as the height increases but only until a certain point. How could you investigate this?

Appendix - It's all Greek

You are expected to know most of these letters.

The letters we will not use at A level are zeta, chi, psi, iota, kappa, xi, omicron.

Greek alphabet list

Upper Case Letter	Lower Case Letter	Greek Letter Name	Upper Case Letter	Lower Case Letter	Greek Letter Name	Upper Case Letter	Lower Case Letter	Greek Letter Name
Α	α	Alpha	Ρ	ρ	Rho	Ι	ι	Iota
Β	β	Beta	Σ	σ,ς *	Sigma	Κ	κ	Kappa
Γ	γ	Gamma	Τ	τ	Tau	Λ	λ	Lambda
Δ	δ	Delta	Υ	υ	Upsilon	Μ	μ	Mu
Ε	ε	Epsilon	Φ	φ	Phi	Ν	ν	Nu
Ζ	ζ	Zeta	Χ	χ	Chi	Ξ	ξ	Xi
Η	η	Eta	Ψ	ψ	Psi	Ο	ο	Omicron
Θ	θ	Theta	Ω	ω	Omega	Π	π	Pi
						Ρ	ρ	Rho

<u>Note.</u>

The second lower case symbol for sigma is used at the end of Greek words and not in our equations.

<u>TASK.</u> Write out the Greek letters that you have used in physics and mathematics.

Can you find other letter you have not used yet? If so write them out.

We often use the upper and lower case letters so learn both.