Physics Transition Tasks

So you are considering A level Physics?

This pack contains a programme of activities and resources to prepare you to start A level in Physics in September. It is aimed to be used after you complete your GCSE throughout the remainder of the summer term and over the summer holidays to ensure you are ready to start your course in September.

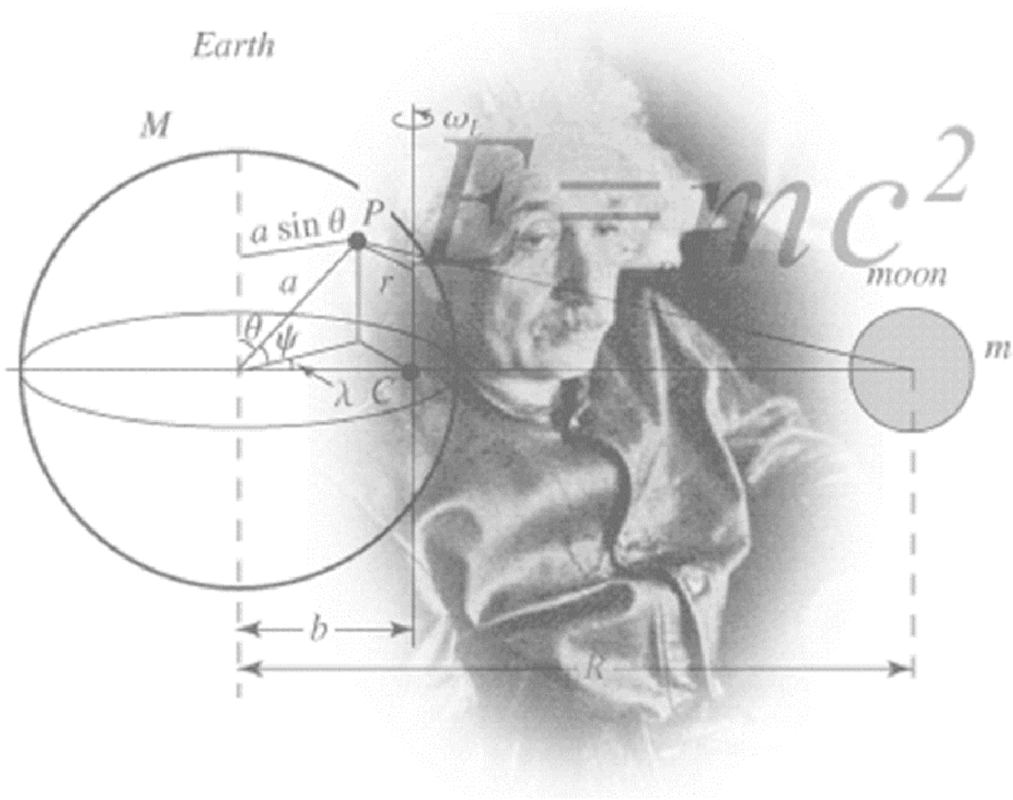


Figure 1 http://scienceworld.wolfram.com/physics/images/main-physics.gif

Section 1 – Maths

Although A Level Maths is not a requirement to study A Level Physics, it is crucial for your success in A Level Physics that you are confident with the mathematical skills and techniques in this booklet.

During your first week in Year 12 at Higham Lane Sixth Form you will be given a 'Maths for Physics' test, which will include rearranging equations, trigonometry, indices, standard form, significant figures, substituting numbers into formulae, prefixes (e.g. kilo, mega etc) and graphs. This booklet will help you prepare for the test.

Your Task

1. Read through the whole section.
2. Read through the section again, completing the exercises as you go:
3. If there are any topics you do not understand then you need to research them and then seek help if you still don't understand.
4. Revise using the booklet for the test in the first week back.
5. Be prepared to hand in the completed exercises and show your sets of notes to your Physics teacher in your first lesson.

Please work hard at mastering the techniques in this booklet, as experience has shown us that students who struggle with these concepts tend to find Physics A Level very difficult.

Using prefixes and powers of ten

Very large and very small numbers can be complicated to work with if written out in full with their SI unit. For example, measuring the width of a hair or the distance from Manchester to London in metres (the SI unit for length) would give numbers with a lot of zeros before or after the decimal point, which would be difficult to work with.

So, we use prefixes that multiply or divide the numbers by different powers of ten to give numbers that are easier to work with. You will be familiar with the prefixes milli (meaning 1/1000), centi (1/100), and kilo (1 × 1000) from millimetres, centimetres and kilometres.

There is a wide range of prefixes. Most of the quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, we would quote a distance of 33 000 m as 33 km.

Kg is the only base unit with a prefix.

The most common prefixes you will encounter are given in the table.

Prefix	Symbol	Power of 10	Multiplication factor	
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	µ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

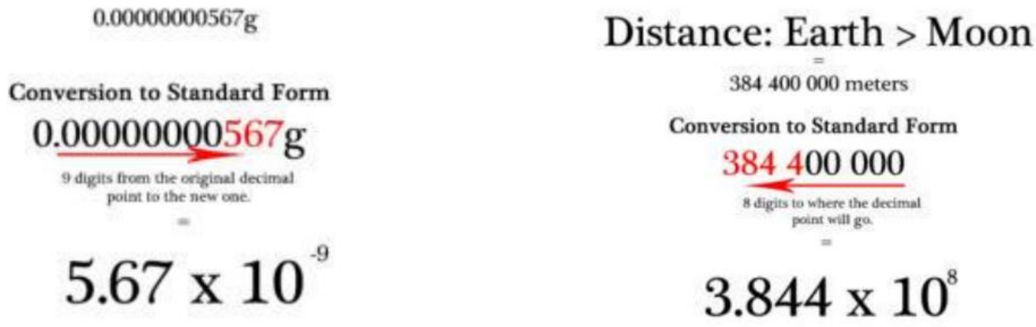
Exercise 1: Converting data

Re-write the following quantities.

1. 1.5 kilometres in metres
2. 450 milligrams in kilograms
3. 96.7 megahertz in hertz
4. 5 nanometers in metres
5. 3.9 gigawatts in watts

Standard Form

At A level, quantities will be written in standard form and it is expected that your answers will be too.



http://www.ultimatemaths.com/standard-form-conversion.htm

This means answers should be written as ….x 10^y. E.g. for an answer of 1200kg we would write 1.2 x 10^3kg.

Exercise 2: Complete the following questions:

1. Write 2530 in standard form.
2. Write 280 in standard form.
3. Write 0.77 in standard form.
4. Write 0.0091 in standard form.
5. Write 1 872 000 in standard form.
6. Write 12.2 in standard form.
7. Write 2.4 x 10^2 as a normal number.
8. Write 3.505 x 10^1 as a normal number.
9. Write 8.31 x 10^6 as a normal number.
10. Write 6.002 x 10^2 as a normal number.
11. Write 1.5 x 10^{-4} as a normal number.
12. Write 4.3 x 10^3 as a normal number.

Significant Figures

At A level you will be expected to use an appropriate number of significant figures in your answers. The number of significant figures you should use is the same as the number of significant figures in the data you are given. You can never be more precise than the data you are given so if that is given to 3 significant your answer should be too. E.g. Distance = 8.24m, time = 1.23s therefore speed = 6.75m/s

The website below summarises the rules and how to round correctly.

http://www.purplemath.com/modules/rounding2.htm

Exercise 3: Give the following to 3 significant figures:

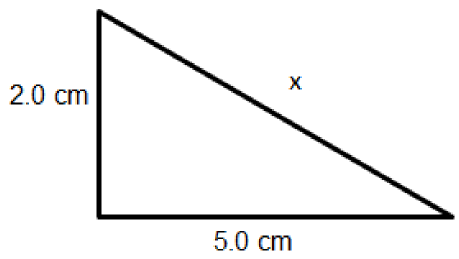
1. 3.4527
2. 40.691
3. 0.838991
4. 1.0247

Calculate the following to a suitable number of significant figures:

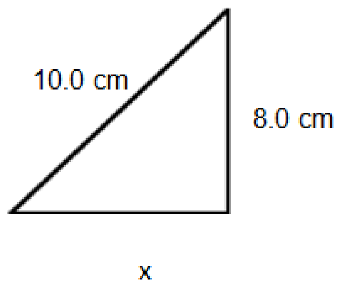
1. 63.2 ÷78.1 =
2. 39 + 78 + 120 =
3. (3.4+3.7+3.2) ÷3 =
4. 0.0256 x 0.129 =

Exercise 4: Pythagoras' theorem

1. Calculate the length of side x.

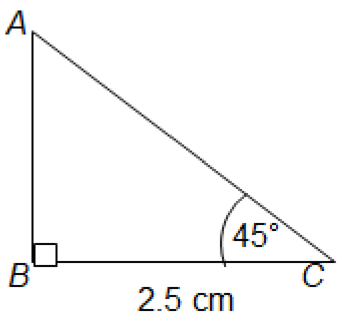


2. Calculate the length of side x.



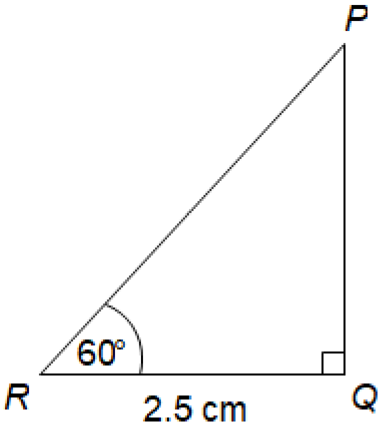
Exercise 5: Trigonometry

1. Calculate length AB



(not drawn to scale)

2. Calculate length PR



(not drawn accurately)

1.3 THE BASIC RULES OF ALGEBRA AND ARITHMETIC

In order to be able to manipulate algebraic equations as well as carrying out numerical calculations, you must know and understand the basic rules of algebra. Four useful examples are shown in Table 1.2.

Table 1.2 Simple algebraic rules

	Example
$by = y + y + \ldots$(b times)	$3y = y + y + y$
$ay + by = (a + b)y$	$2y + 3y = 5y$
$\dfrac{1}{\left(\frac{a}{y}\right)} = \dfrac{y}{a}$	$\dfrac{1}{\left(\frac{2}{y}\right)} = \dfrac{y}{2}$
$\dfrac{\left(\frac{b}{z}\right)}{\left(\frac{a}{y}\right)} = \dfrac{by}{az}$	$\dfrac{\left(\frac{3}{z}\right)}{\left(\frac{2}{y}\right)} = \dfrac{3y}{2z}$

1.4 HANDLING INDICES

y^a means y multiplied by itself a times. For example, 4^3 means $4 \times 4 \times 4 = 64$.

a is called the **index**, or the **power** to which y is raised. (We say, for example 'y to the power of a' or '4 to the power of 3'.)

Many scientific equations contain indices. The rules for manipulating indices are shown in Table 1.3.

Table 1.3 Handling indices

	Algebraic example	Numerical example
$y^{-n} = \dfrac{1}{y^n}$	$y^{-3} = \dfrac{1}{y^3}$	$4^{-3} = \dfrac{1}{4^3} = \dfrac{1}{64} = 0.0156$
$y^{\frac{1}{a}} = \sqrt[a]{y}$	$y^{\frac{1}{2}} = \sqrt{y}$	$4^{\frac{1}{2}} = \sqrt{4} = 2$
$y^a + y^b$ cannot be simplified		$4^2 + 4^3 = 16 + 64 = 80$
$y^a \times y^b = y^{a+b}$	$y^2 \times y^3 = y^5$	$4^2 \times 4^3 = 4^5 = 1024$
$\dfrac{y^a}{y^b} = y^{a-b}$	$\dfrac{y^2}{y^3} = y^{2-3} = y^{-1}$	$\dfrac{4^2}{4^3} = 4^{-1} = \dfrac{1}{4} = 0.25$
$(y^a)^b = y^{a \times b}$	$(y^2)^3 = y^6$	$(4^2)^3 = 4^6 = 4096$
$y^{\frac{b}{a}} = \sqrt[a]{y^b}$	$y^{\frac{3}{2}} = \sqrt[2]{y^3}$	$4^{\frac{3}{2}} = \sqrt[2]{4^3} = 8$
$y^0 = 1$		$4^0 = 1$

Exercise 6

a) Simplify the following:

i) $y^6 \times y^7$ ii) $y^8 \div y^5$

iii) $(y^3)^4$ iv) $3y^2 \times 4y^3$

b) Calculate the values of the following:

i) 3^4 ii) $8^{\frac{1}{3}}$ iii) 5^{-2}

iv) $9^{\frac{3}{2}}$ v) $16^{-\frac{1}{2}}$ vi) 6^0

1.5 CHANGING THE SUBJECT OF AN EQUATION

In the equation $v = u + at$, v is known as the **subject** of the equation. You can calculate a value for v if you know the values of u, a and t by substituting these values into the equation. However, you may need to calculate the value of t, for example, so you would need to make t the subject of the equation.

Changing the subject of an equation is based on the general principle:

Whatever change you make to one side of the equation, you must make the same change to the other side.

The following examples should make this clear.

i) Addition and subtraction

The equation for resistors in series is:

$$R_T = R_1 + R_2$$

To make R_1 the subject of the equation, we subtract R_2 from the right hand-side, leaving only R_1, so we also subtract R_2 from the left-hand side, giving:

$$R_T - R_2 = R_1$$

or

$$R_1 = R_T - R_2$$

Effectively, we have moved R_2 to the other side of the equation and changed its sign from positive to negative.

If something which is added to one side of an equation is moved to the other side, it changes its sign from positive to negative. Conversely, if something which is subtracted from one side of an equation is moved to the other side, it changes its sign from negative to positive.

Exercise 7

a) Make u the subject of $v = u + at$

b) Make E_k the subject of $hf = \varphi + E_k$

c) Make $\frac{1}{v}$ the subject of $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

ii) Multiplication and division

This is by far the most common kind of equation in Physics.

The equation for power in an electric circuit is:

$$P = VI$$

To make V the subject of the equation, we divide the right hand side by I, so we must also divide the left hand side by I giving:

$$\frac{P}{I} = V$$

Effectively we have moved I to the other side of the equation and changed its sign from 'multiply' to 'divide'.

If something which multiplies one side of an equation is moved to the other side, it divides that side of the equation (it moves from being a *numerator* to being a *denominator*). Conversely, if something which divides one side of an equation moves to the other side, it multiplies that side of the equation.

Exercise 8

a) Make B the subject of $F = BIl$

b) Make ρ the subject of $R = \frac{\rho l}{A}$

c) Make V the subject of $C = \frac{Q}{V}$

iii) Squares and square roots

If $x^2 = a + b$

then to find x we must find the square root of both sides, so

$$x = \sqrt{a + b}$$

If $\sqrt{y} = c + d$

then to find y we must square both sides, so

$$y = (c + d)^2$$

iv) Further examples

Example a)

The efficiency of a heat engine is given by the equation:

$$E = \frac{T_1 - T_2}{T_1}$$

Make T_2 the subject of the equation.

Since the whole of the right-hand side of the equation is divided by T_1, the first step is to take this T_1 to the left-hand side:

$$ET_1 = T_1 - T_2$$

Now $-T_2$ can be taken to the left, and ET_1 to the right:

$$T_2 = T_1 - ET_1$$

Finally, T_1 could be taken out as a common factor on the right:

$$T_2 = T_1(1 - E)$$

If we wanted to make T_1 the subject of the equation, we would have to go through the same steps, and finally take the $(1 - E)$ to the left-hand side, leaving just T_1 on the right:

$$\frac{T_2}{(1 - E)} = T_1$$

> **❋ *Pitfall 1.1***
>
> In this example, it is easy to forget that T_2 is divided by T_1, resulting in the following:
>
> $$E = \frac{T_1 - T_2}{T_1} \implies E + T_2 = \frac{T_1}{T_1} = 1$$
>
> which is clearly nonsense!

Example b)

The frequency of oscillation of a mass on a spring is given by:

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

Make k the subject of the equation.

Since m is inside the square root sign, we start by moving 2π to the left-hand side:

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \implies 2\pi f = \sqrt{\frac{k}{m}}$$

Now both sides of the equation can be squared to remove the square root:

$$2\pi f = \sqrt{\frac{k}{m}} \implies (2\pi f)^2 = \frac{k}{m}$$

Finally, m can be moved to the opposite side of the equation.

$$(2\pi f)^2 = \frac{k}{m} \implies m(2\pi f)^2 = k$$

> **❋ *Pitfall 1.2***
>
> Beware of accidentally removing a variable from within a square root. A possible mistake in the previous example is:
>
> $$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \implies mf = \frac{1}{2\pi}\sqrt{k}$$
>
> However, the following is correct, although not particularly easy to work with:
>
> $$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \implies \sqrt{m}\,f = \frac{1}{2\pi}\sqrt{k}$$
>
> However, it is possible to confuse the following:
>
> $\sqrt{m}\,f$ with $\sqrt{mf}$
>
> especially with hasty handwriting. It is much safer to write this as:
>
> $$f\sqrt{m}$$

Example c)

Make u the subject of the following equation of motion:

$$v^2 = u^2 + 2as$$

The necessary stages are:

$$v^2 = u^2 + 2as \implies u^2 = v^2 - 2as$$

$$u^2 = v^2 - 2as \implies u = \sqrt{v^2 - 2as}$$

> **❋ *Pitfall 1.3***
>
> $\sqrt{v^2 - 2as}$ does not equal $v - \sqrt{2as}$

Example d)

It is often necessary to move several variables to achieve what is required, but the principles remain the same.

The magnetic field in a long solenoid is given by:

$$B = \frac{\mu_0 NI}{l}$$

To make I the subject of the equation, we move l to the left, where it becomes part of the numerator ('from the bottom to the top of the fraction'), while $\mu_0 N$ moves to the left to become part of the denominator ('from the top to the bottom of the fraction'), giving:

$$\frac{Bl}{\mu_0 N} = I \quad \text{or} \quad I = \frac{Bl}{\mu_0 N}$$

Exercise 9

a) Make l the subject of $R = \frac{\rho l}{A}$

b) Make x the subject of $\frac{\lambda}{x} = \frac{s}{l}$

c) Make v the subject of $F = \frac{mv^2}{r}$

d) Make r the subject of $F = \frac{Gm_1m_2}{r^2}$

e) Make E the subject of $c = \sqrt{\frac{E}{\rho}}$

f) Make T the subject of $f = 2\pi\sqrt{\frac{T}{\mu}}$

g) Make L the subject of $f_r = \frac{1}{2\pi\sqrt{LC}}$

1.6 SIMULTANEOUS EQUATIONS

If you have two equations relating two different unknown quantities, these equations are known as 'simultaneous'. They have a limited use in A-level Physics.

A simple example of a pair of simultaneous equations is:

$$x + 7y = 38$$
$$x + 3y = 18$$

To solve these equations (that is, find the values of x and y), we need to eliminate one of the variables; in this case it is easiest to eliminate x by subtracting the second equation from the first:

$$\begin{array}{c} x + 7y = 38 \\ x + 3y = 18 \\ \hline (x - x) + (7y - 3y) = (38 - 18) \\ 4y = 20 \\ \therefore y = 5 \end{array}$$

This value for y can now be substituted back into the first of the pair of equations to find a value for x:

$$x + (7 \times 5) = 38$$
$$x + 35 = 38$$
$$\therefore x = 3$$

Example

Two cars are moving along a road; car 1 is moving at a steady speed of 20 m/s; car 2 is 150 m in front of car 1 and moving at a steady speed of 15 m/s.

How much time passes before car 1 catches up with car 2, and how far will it have travelled?

Let s be the displacement when they meet, measured from the starting position of the first car, v_1 and v_2 the respective speeds of the cars and t the time at which they meet.

For car 1: $s = v_1 t$ $\quad \therefore s = 20t$

For car 2: $s = v_2 t + 150$ $\quad \therefore s = 15t + 150$

Subtracting the two equations gives:

$$0 = 5t - 150$$
$$5t = 150$$
$$\therefore t = 30$$

Car 1 passes car 2 after 30 seconds.

By substituting this value into the first equation, we can see that car 1 travels

$$20 \text{ m/s} \times 30 \text{ s} = 600 \text{ m}$$

before overtaking car 2.

The **gradient** or **slope** of a graph (that is, how 'steep' the graph is,) measure the rate at which the 'y' variable is changing with respect to the 'x' variable.

The gradient is simply a change in the y value (denoted by Δy) divided by the corresponding change in the x value (denoted by Δx) as shown in Figure 4.12.

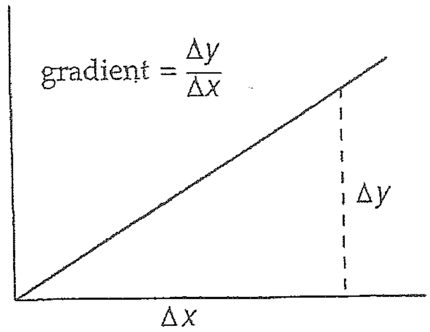


Figure 4.12

In Figure 4.13, the gradient is $6 \div 2 = 3$. Notice that in this graph the value of y is always 3 times the value of x; in other words, the equation of the line is $y = 3x$.

In general, the equation of a straight line through the origin is $y = mx$, where m is the gradient of the line. (See Section 4.1.)

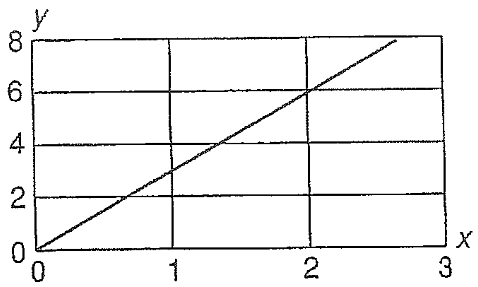


Figure 4.13

A graph such as that in Figure 4.14, which slopes in the opposite direction to that in the previous diagram, has a **negative** gradient. The gradient of this graph is -0.4

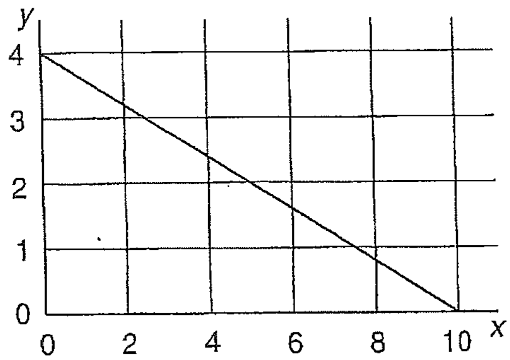


Figure 4.14

Exercise 10

What is the equation of the line shown in Figure 4.14?

(It will be of the form $y = mx + c$, since the line does not go through the origin. c is the intercept on the y-axis. See Pitfall 4.1.)

The gradient of a curved graph clearly changes - it is different at all points on the graph. In this case it is necessary to draw a tangent to the curve at the place in which you are interested, and find the gradient of that tangent, as shown in Figure 4.15.

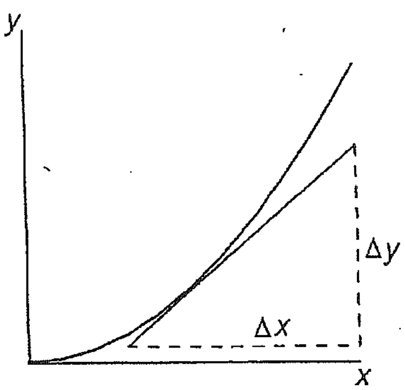


Figure 4.15

The gradient of a graph often has a physical significance and can provide useful information about a situation. For example, the gradient of a graph of velocity against time is equal to the acceleration; the gradient of a graph of electric potential against distance is equal to the electric field.

Exercise 11

a) Calculate the gradients of the graphs shown in Figures 4.15 and 4.16.

b) Estimate the gradient of the graph in Figure 4.17 at point P and at point Q.

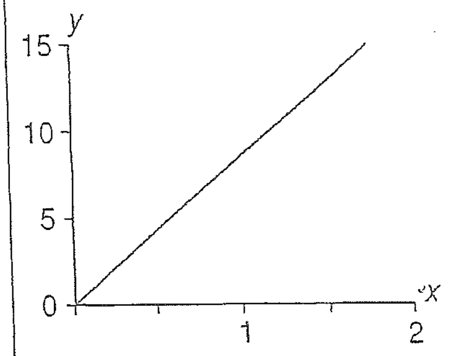


Figure 4.15

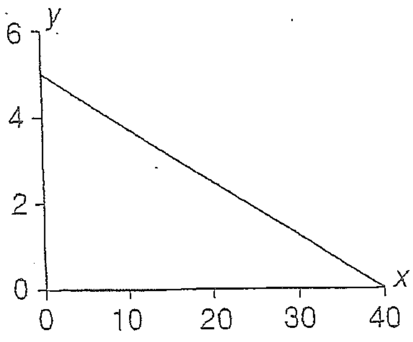


Figure 4.16

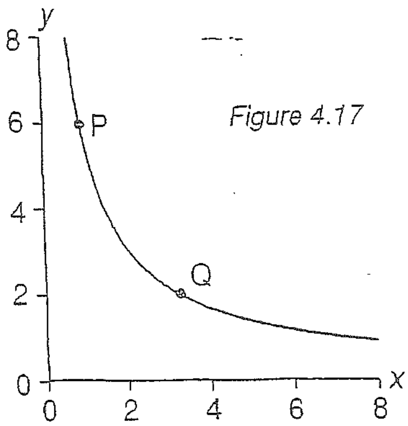


Figure 4.17

Exam board guidance on drawing graphs

Note: 'Solidus' means '/'

Labelling in table headings and on graph axes

The convention we prefer is

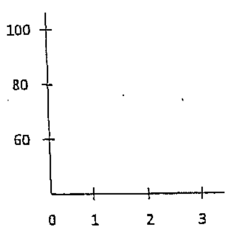
variable symbol – solidus – unit

Candidates should be discouraged from naming the variable (which in any case will be defined in the question), in full.

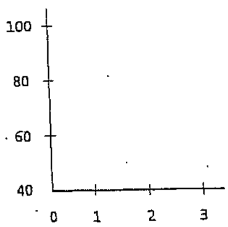
eg 'V/mV' is simple and effective, 'output pd of solar cell in millivolts' is not

The solidus indicates the division of a physical quantity by its unit, thus what follows is a pure number.

eg 'V/mV = 340' literally means 340 is the value of V divided by mV; using 'V/mV ' as a table heading is logical and correct in a way that V(mV) is not.

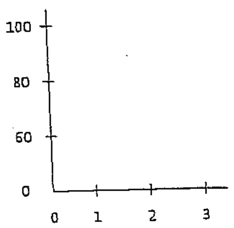


Unacceptable:
leaving an origin unmarked on either axis will not be accepted; the scale will still be treated as non-linear since the origin is now ambiguous.

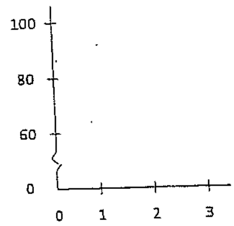


Solution:
use of a false origin is acceptable but candidates should be careful if they are then asked to calculate the gradient.

Marking the origin correctly on a graph,
eg PHAB3X Sec A Part 1 Q2(b)



Unacceptable:
the marking of the origin as above produces a non-linear scale which will always be penalised.



Solution:
use of the broken scale convention resolves the problem but watch out if a gradient calculation is then required.

Exercise 12 – More practice at rearranging equations

These are all Physics equations which you will meet over the next two years. Rearrange them for the variables listed.

1. $d \sin \theta = n\lambda$ rearrange for (a) d (b) $\sin\theta$ (c) λ

2. $V = \frac{Q}{4\pi\varepsilon_0 r}$ rearrange for (a) ε_0 (b) Q (c) r

3. $F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$ rearrange for (a) r (b) Q_1

4. $\frac{\sin \theta_1}{\sin \theta_2} = \frac{n_2}{n_1}$ rearrange for (a) $\sin\theta_1$ (b) $\sin\theta_2$ (c) n_2 (d) n_1

5. $v^2 = u^2 + 2as$ rearrange for (a) a (b) s (c) u

6. $T = \frac{1}{f}$ rearrange for f

7. $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ rearrange for (a) N_s (b) N_p (c) V_s (d) V_p

8. $F = \frac{G m_1 m_2}{r^2}$ rearrange for m_1

9. $\rho = \frac{RA}{l}$ rearrange for (a) R (b) A

10. $P = I^2 R$ rearrange for (a) I^2 (b) I (c) R

Exercise 13 – Rearranging special relativity equations

These are the most complex equations you may meet during your Physics A Level course. Have a go at completing the questions below, **but do not worry if you struggle to complete this exercise.**

1. $t = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$

   (a) Rearrange for t_0
   (b) Rearrange for v
   (c) Calculate t if $t_0 = 2.20 \times 10^{-6}$ s
   $c = 3 \times 10^8$ m/s
   $v = 2.97 \times 10^8$ m/s

2. $l = l_0\sqrt{1 - \frac{v^2}{c^2}}$

   (a) Rearrange for l_0
   (b) Rearrange for v
   (c) Calculate l if $l_0 = 60$ m
   $c = 3 \times 10^8$ m/s
   $v = 2.94 \times 10^8$ m/s

3. $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$

   (a) Rearrange for m_0
   (b) Rearrange for v
   (c) Calculate m if $m_0 = 1.67 \times 10^{-27}$ kg
   $c = 3 \times 10^8$ m/s
   $v = 2.7 \times 10^8$ m/s

Section 2 – Physics Introduction

Choose at least one of the following tasks to complete to help you prepare for some of the content you will cover in A Level Physics

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 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.

The following video explains how the current model was discovered www.youtube.com/watch?v=wzALbzTdnc

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 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 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.

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

Task: On graph paper sketch a velocity-time graph showing the journey of a skydiver after leaving the plane to reaching the ground. Mark on terminal velocity.

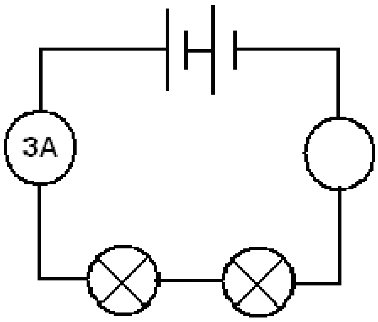
Electricity

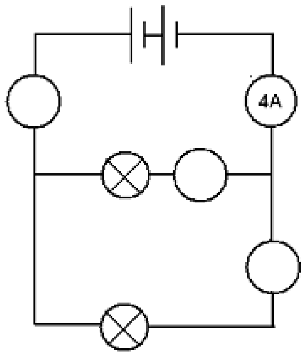
At A level you will learn more about how current and voltage behave in different circuits containing different components. You should be familiar with current and voltage rules in a series and parallel circuit as well as calculating the resistance of a device.

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

Task:

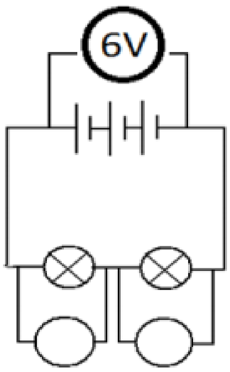
1a) Add the missing ammeter readings on the circuits below.

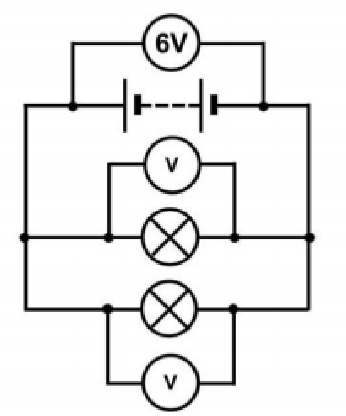




b) Explain why the second circuit has more current flowing than the first.

2) Add the missing potential differences to the following circuits





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

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

2) Describe the difference between longitudinal and transverse waves and give an example of each.

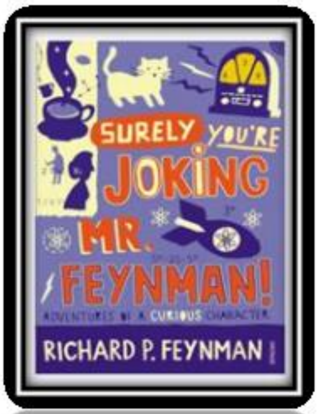
3) Draw a wave and label the wavelength and amplitude.

Section 3 – Super-curricular ideas

A very important part of A Level will be the work you do **beyond** what is taught. The next few pages will give you loads of ideas of activities etc. that you may wish to complete.

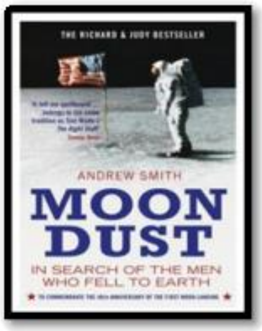
Book Recommendations

Below is a selection of books that should appeal to a physicist – someone with an enquiring mind who wants to understand the universe around us.



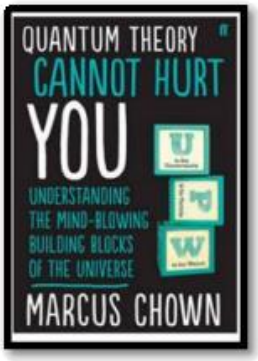
Moondust: In Search of the Men Who Fell to Earth

This book uses the personal accounts of 9 astronauts and many others involved in the space program, looking at the whole space-race era.



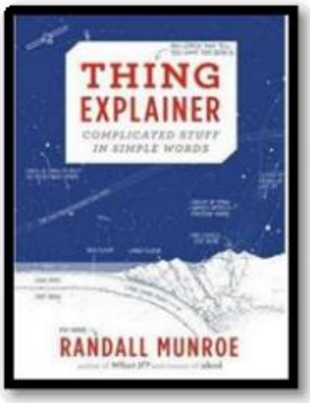
Surely You're Joking Mr Feynman: Adventures of a Curious Character

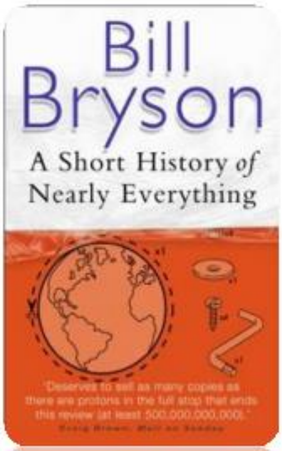
By reading this book you will get insight into his life's work including the creation of the first atomic bomb and his work in the field of particle physics.



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

Any physics book by Marcus Chown is an excellent insight into some of the more exotic areas of physics that require no prior knowledge.





A Short History of Nearly Everything

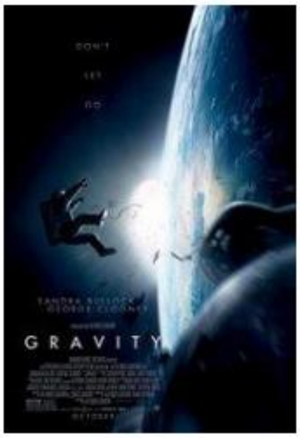
A whistle-stop tour through many aspects of history from the Big Bang to now. This is a really accessible read that will re-familiarise you with common concepts and introduce you to some of the more colourful characters from the history of science.

Thing Explainer: Complicated Stuff in Simple Words

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.

Movie Recommendations

Everyone loves a good story and everyone loves some great science. Here are some picks of the best films based on real life scientists and discoveries. You wont find Jurassic Park on this list! We've looked back over the last 30 years to give you our top 5 films you might not have seen before. Great watching for a rainy day.



Gravity (2013)

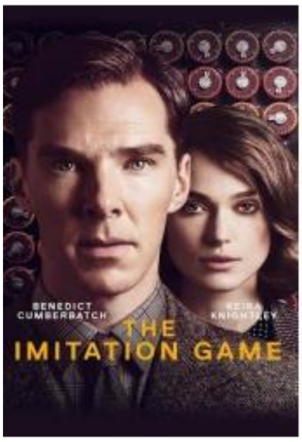
Two astronauts work together to survive after an accident which leaves them stranded in space.

Moon (2009)

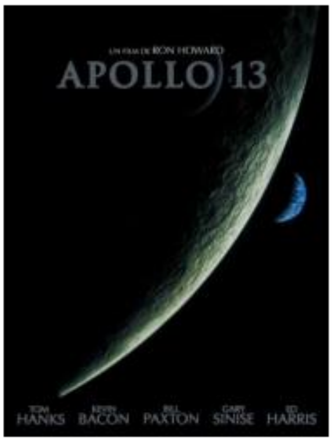
With only three weeks left in his three year contract, Sam Bell is getting anxious to finally return to Earth. He is the only occupant of a Moon-based manufacturing facility along with his computer and assistant, GERTY. When he has an accident however, he wakens to find that he is not alone.

Interstellar (2014)

A team of explorers travel through a wormhole in space in an attempt to ensure humanity's survival.



The Imitation Game (2014)
Based on a true story. During World War II, the English mathematical genius Alan Turing tries to crack the German Enigma code with help from fellow mathematicians.



Apollo 13 (1995)

Based on a true story. NASA must devise a strategy to return Apollo 13 to Earth safely after the spacecraft undergoes massive internal damage putting the lives of the three astronauts on board in jeopardy.

There are some great TV series and box sets available too! You might want to check out: Blue Planet, Planet Earth, Wonders of the Universe, Wonders of the Solar System, NASA TV and Shock & Awe – The Story of Electricity.

Movie Recommendations

If you have 30 minutes to spare, here are some great presentations (and free!) from world leading scientists and researchers on a variety of topics. They provide some interesting answers and ask some thought-provoking questions. Use the link or scan the QR code to view:

From mach-20 glider to hummingbird drone

Available at:

www.ted.com/talks/regina_dugan_from_mach_20_glider_to_humming_bird_drone/up-next?language=en

"What would you attempt to do if you knew you could not fail?" asks Regina Dugan, then director of DARPA, the Defense 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?

Available at:

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

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

Available at :

https://www.ted.com/talks/helen_czerski_fun_home_experiments_that_teach_you_physics?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

Available at :

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.

Research Activities

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.

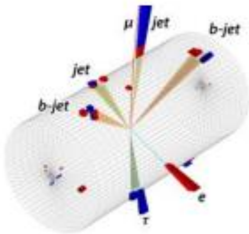
For each of the following topics, you are going to use the resources to produce one page of Cornell style notes.

Use the links or scan the QR code 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

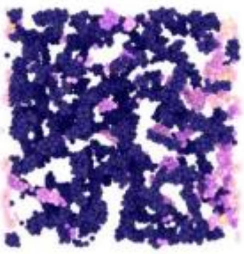
A proton collision experiment at CERN provides a new handle on the Higgs boson's interaction with the heaviest of the quarks.



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.



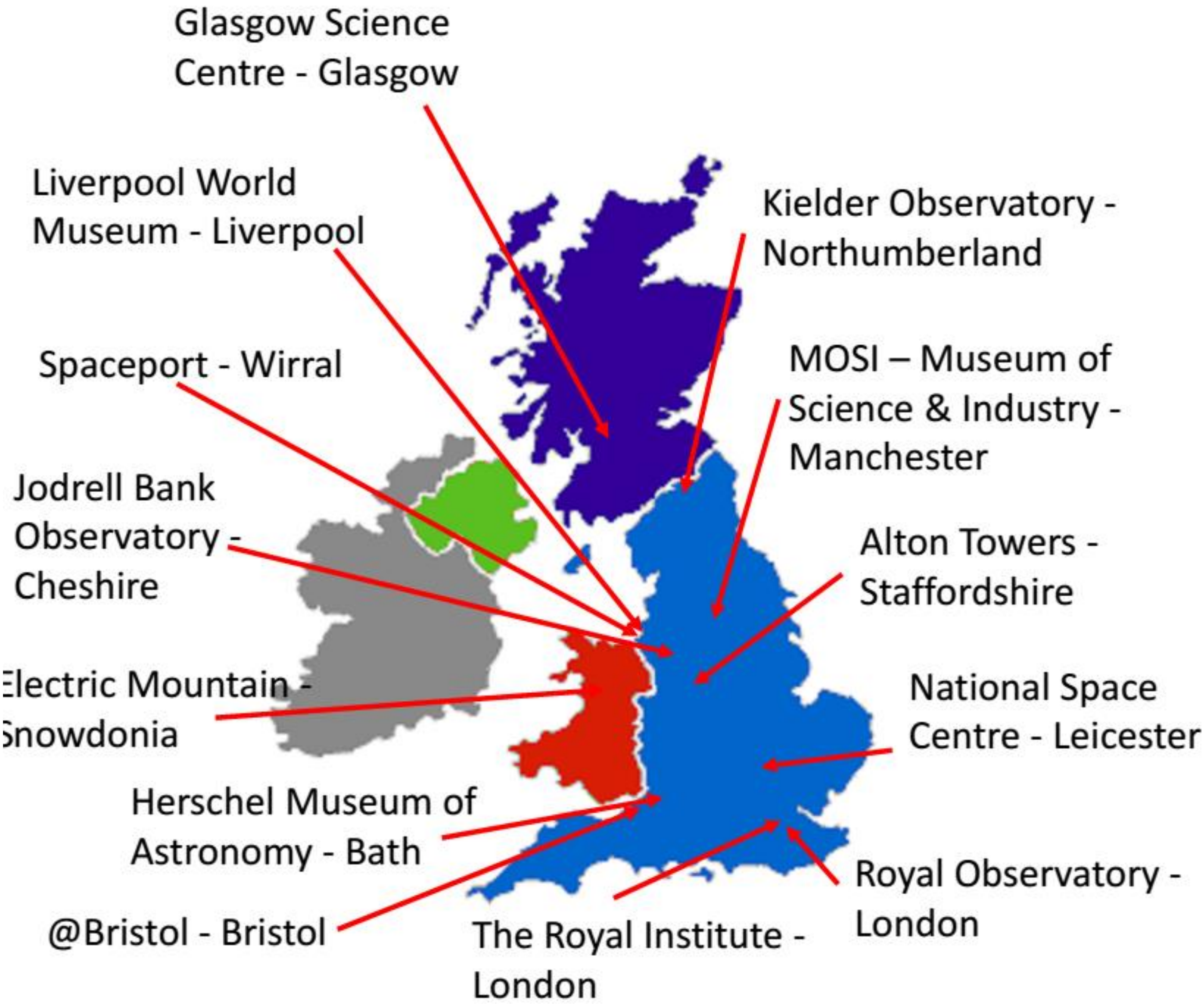
Topic 3: **Listening for the cosmic hum of black holes**

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.

Ideas for Day Trips

If you are on holiday in the UK, or on a staycation at home, why not plan a day trip to one of these :



Ideas for Day Trips

the PiXL club partners in excellence

If you are on holiday in the UK, or on a staycation at home, why not plan a day trip to one of these :

Northern England and Scotland

1. **Jodrell Bank Observatory** – Cheshire – one of the largest moveable radio telescopes in the world and the location of the filming of the BBC's Stargazing Live. The site has both indoor and outdoor activities.
2. **MOSI –** Manchester – Massive free museum showing how science helped Britain lead the way through the industrial revolution. Contains hands on exhibits and displays and often host regular travelling exhibitions.
3. **Liverpool World Museum / Spaceport –** Liverpool/Wirral – Start the day off at an excellent family science museum with a top floor dedicated to astronomy including a planetarium. Take the ferry across the Mersey to another family friendly museum dedicated to spaceflight.
4. **Kielder Observatory** – Northumberland – Book ahead at this popular observatory in the midst of the darkest night skies the UK has to offer. Regular tours and opportunities to view the stars through professional telescopes take place on a nightly basis.
5. **Glasgow Science Centre -** The Centre is home to hundreds of interactive exhibits throughout the three engaging floors.

The Midlands and Wales

1. **Electric Mountain –** Snowdonia – Set against a mountainous backdrop is a working pumped storage power station. Take a tour deep into the heart of the mountain and see the turbines spring into action to meet our ever increasing demand for electricity. Take a stroll up on of the UKs highest peaks in the afternoon.
2. **National Space Centre –** Leicester - With six interactive galleries, the UK's largest planetarium, unique 3D simulator experience, the award-winning National Space Centre in Leicester is an out of this world visitor attraction.
3. **Alton Towers –** Staffordshire – Treat yourself to a go on a few rollercoasters whilst discussing Newton's Laws. You may want to download and take these handy rollercoaster physics notes with you

   http://www.explainthatstuff.com/rollercoasters.html

Southern England

1. **Royal Observatory –** London - Visit the Royal Observatory Greenwich to stand on the historic Prime Meridian of the World, see the home of Greenwich Mean Time (GMT), and explore your place in the universe at London's only planetarium.
2. **Herschel Museum of Astronomy –** Bath – As you walk around the picturesque Roman city – take an hour or two out at the home of one of the great scientists – discoverer of Infra-red radiation and Uranus.
3. **@Bristol –** Bristol - home to the UK's only 3D Planetarium and one of the biggest science centres.
4. **The Royal Institution –** London – The birthplace of many important ideas of modern physics, including Michael Faraday's lectures on electricity. Now home to the RI Christmas lectures and many exhibits of science history.

Science on Social Media

Science communication is essential in the modern world and all the big scientific companies, researchers and institutions have their own social media accounts. Here are some of our top tips to keep up to date with developing news or interesting stories:

Follow on Twitter:

Commander Chris Hadfield – former resident aboard the International Space Station
@cmdrhadfield

NASA's Voyager 2 – a satellite launched nearly 40 years ago that is now travelling beyond our solar system
@NSFVoyager2

Neil deGrasse Tyson – Director of the Hayden Planetarium in New York
@neiltyson

The SETI Institute – The Search for Extra Terrestrial Intelligence, be the first to know what they find!
@setiinstitute

Phil Plait – tweets about astronomy and bad science
@badastronomer

Institute of Physics – The leading scientific membership society for physics
@PhysicsNews

Scientific America – Journal sharing discoveries and insights into science that develops the world
@sciam

SN Students – Science news for students
@SNStudents

Find on Facebook:

National Geographic - since 1888, National Geographic has travelled the Earth, sharing its amazing stories in pictures and words.

Science News Magazine - Science covers important and emerging research in all fields of science.

BBC Science News - The latest BBC Science and Environment News: breaking news, analysis and debate on science and nature around the world.

Institute of Physics - The Institute of Physics is a leading scientific membership society working to advance physics for the benefit of all.

Chandra X-ray Observatory - NASA's Chandra X-ray Observatory is a telescope specially designed to detect X-ray emission from very hot regions of the Universe such as exploded stars, clusters of galaxies, and matter around black holes.

Interesting Engineering - Interesting Engineering is a cutting edge, leading community designed for all lovers of engineering, technology and science.

Science websites

These websites all offer an amazing collection of resources that you should use again and again throughout your course.

At CERN, the European Organization for Nuclear Research, physicists and engineers are probing the fundamental structure of the universe. They use the world's largest and most complex scientific instruments to study the basic constituents of matter – the fundamental particles.

https://home.cern/

Isaac Physics is a fantastic resource of free online A Level Physics lessons and exercises. We will use this site throughout your A Level Physics course, and you will be provided with a book containing all of the exercises

https://isaacphysics.org/

The AQA exam board website contains a lot of useful documents, including the specification, practical handbook and past papers

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

A website written by a practicing physics and maths tutor in London. @physicsandmathstutor is an Oxford physics graduate with a PGCE from Kings College London.

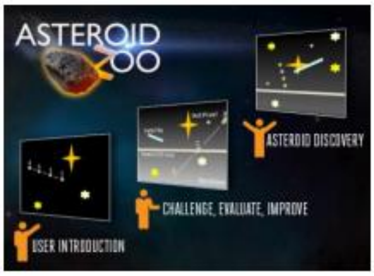
www.physicsandmathstutor.com

There are loads of fab channels on Youtube (and some not so good ones!), so make use of this free resource.

www.youtube.co.uk

Science: Things to do!

Day 4 of the holidays and boredom has set in?
There are loads of citizen science projects you can take part in either from the comfort of your bedroom, out and about, or when on holiday. Wikipedia does a comprehensive list of all the current projects taking place. Google 'citizen science project'



Want to stand above the rest when it comes to UCAS? Now is the time to act.
MOOCs are online courses run by nearly all universities. They are short FREE courses that you take part in. They are usually quite specialist, but aimed at the public, not the genius!
There are lots of websites that help you find a course, such as edX and Future learn.
You can take part in any course, but there are usually start and finish dates. They mostly involve taking part in web chats, watching videos and interactives.

Completing a MOOC will look great on your Personal statement and they are dead easy to take part in!