



“If you want to find the secrets of the universe, think in terms of energy, frequency and vibration.”

-Nikola Tesla

Aspire
not to
have more
but to be
more...

GCSE to A Level Physics Transition Booklet

Name _____

May the
M x A
be with
you

2 Specification at a glance

These qualifications are linear. Linear means that students will sit all the AS exams at the end of their AS course and all the A-level exams at the end of their A-level course.

2.1 Subject content

Core content

- 1 [Measurements and their errors](#) (page 10)
- 2 [Particles and radiation](#) (page 12)
- 3 [Waves](#) (page 17)
- 4 [Mechanics and materials](#) (page 21)
- 5 [Electricity](#) (page 27)
- 6 [Further mechanics and thermal physics \(A-level only\)](#) (page 30)
- 7 [Fields and their consequences \(A-level only\)](#) (page 34)
- 8 [Nuclear physics \(A-level only\)](#) (page 41)

Options

- 9 [Astrophysics \(A-level only\)](#) (page 45)
- 10 [Medical physics \(A-level only\)](#) (page 49)
- 11 [Engineering physics \(A-level only\)](#) (page 54)
- 12 [Turning points in physics \(A-level only\)](#) (page 58)
- 13 [Electronics \(A-level only\)](#) (page 62)

2.2 AS

Assessments

Paper 1	+	Paper 2
What's assessed Sections 1–5		What's assessed Sections 1–5
Assessed <ul style="list-style-type: none">written exam: 1 hour 30 minutes70 marks50% of AS		Assessed <ul style="list-style-type: none">written exam: 1 hour 30 minutes70 marks50% of AS
Questions 70 marks of short and long answer questions split by topic.		Questions Section A: 20 marks of short and long answer questions on practical skills and data analysis Section B: 20 marks of short and long answer questions from across all areas of AS content Section C: 30 multiple choice questions

2.3 A-level

Assessments

Paper 1	+	Paper 2	+	Paper 3
What's assessed Sections 1–5 and 6.1 (Periodic motion)		What's assessed Sections 6.2 (Thermal Physics), 7 and 8 Assumed knowledge from sections 1 to 6.1		What's assessed Section A: Compulsory section: Practical skills and data analysis Section B: Students enter for one of sections 9, 10, 11, 12 or 13
Assessed <ul style="list-style-type: none">written exam: 2 hours85 marks34% of A-level		Assessed <ul style="list-style-type: none">written exam: 2 hours85 marks34% of A-level		Assessed <ul style="list-style-type: none">written exam: 2 hours80 marks32% 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 optional topic.

For use in exams from the June 2016 Series onwards

DATA - FUNDAMENTAL CONSTANTS AND VALUES

Quantity	Symbol	Value	Units
speed of light in vacuo	c	3.00×10^8	m s^{-1}
permeability of free space	μ_0	$4\pi \times 10^{-7}$	H m^{-1}
permittivity of free space	ϵ_0	8.85×10^{-12}	F m^{-1}
magnitude of the charge of electron	e	1.60×10^{-19}	C
the Planck constant	h	6.63×10^{-34}	J s
gravitational constant	G	6.67×10^{-11}	$\text{N m}^2 \text{ kg}^{-2}$
the Avogadro constant	N_A	6.02×10^{23}	mol^{-1}
molar gas constant	R	8.31	$\text{J K}^{-1} \text{ mol}^{-1}$
the Boltzmann constant	k	1.38×10^{-23}	J K^{-1}
the Stefan constant	σ	5.67×10^{-8}	$\text{W m}^{-2} \text{ K}^{-4}$
the Wien constant	α	2.90×10^{-3}	m K
electron rest mass (equivalent to 5.5×10^{-4} u)	m_e	9.11×10^{-31}	kg
electron charge/mass ratio	$\frac{e}{m_e}$	1.76×10^{11}	C kg^{-1}
proton rest mass (equivalent to 1.00728 u)	m_p	$1.67(3) \times 10^{-27}$	kg
proton charge/mass ratio	$\frac{e}{m_p}$	9.58×10^7	C kg^{-1}
neutron rest mass (equivalent to 1.00867 u)	m_n	$1.67(5) \times 10^{-27}$	kg
gravitational field strength	g	9.81	N kg^{-1}
acceleration due to gravity	g	9.81	m s^{-2}
atomic mass unit (1u is equivalent to 931.5 MeV)	u	1.661×10^{-27}	kg

ALGEBRAIC EQUATION

quadratic equation $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

ASTRONOMICAL DATA

Body	Mass/kg	Mean radius/m
Sun	1.99×10^{30}	6.96×10^8
Earth	5.97×10^{24}	6.37×10^6

GEOMETRICAL EQUATIONS

arc length	$= r\theta$
circumference of circle	$= 2\pi r$
area of circle	$= \pi r^2$
curved surface area of cylinder	$= 2\pi rh$
area of sphere	$= 4\pi r^2$
volume of sphere	$= \frac{4}{3} \pi r^3$

Particle Physics

Class	Name	Symbol	Rest energy/MeV
photon	photon	γ	0
lepton	neutrino	ν_e	0
		ν_μ	0
	electron	e^\pm	0.510999
	muon	μ^\pm	105.659
mesons	π meson	π^\pm	139.576
		π^0	134.972
	K meson	K^\pm	493.821
		K^0	497.762
baryons	proton	p	938.257
	neutron	n	939.551

Properties of quarks

antiquarks have opposite signs

Type	Charge	Baryon number	Strangeness
u	$+\frac{2}{3}e$	$+\frac{1}{3}$	0
d	$-\frac{1}{3}e$	$+\frac{1}{3}$	0
s	$-\frac{1}{3}e$	$+\frac{1}{3}$	-1

Properties of Leptons

	Lepton number
Particles: $e^-, \nu_e; \mu^-, \nu_\mu$	+1
Antiparticles: $e^+, \bar{\nu}_e, \mu^+, \bar{\nu}_\mu$	-1

Photons and energy levels

photon energy	$E = hf = hc/\lambda$
photoelectricity	$hf = \phi + E_{k(\max)}$
energy levels	$hf = E_1 - E_2$
de Broglie wavelength	$\lambda = \frac{h}{p} = \frac{h}{mv}$

Waves

wave speed	$c = f\lambda$	period	$f = \frac{1}{T}$
first harmonic	$f = \frac{1}{2l} \sqrt{\frac{T}{\mu}}$		
fringe spacing	$w = \frac{\lambda D}{s}$	diffraction grating	$d \sin \theta = n\lambda$
refractive index of a substance s,	$n = \frac{c}{c_s}$		
for two different substances of refractive indices n_1 and n_2 ,			
law of refraction	$n_1 \sin \theta_1 = n_2 \sin \theta_2$		
critical angle	$\sin \theta_c = \frac{n_2}{n_1}$ for $n_1 > n_2$		

Mechanics

moments	moment = Fd
velocity and acceleration	$v = \frac{\Delta s}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$
equations of motion	$v = u + at$ $s = \left(\frac{u+v}{2}\right)t$
	$v^2 = u^2 + 2as$ $s = ut + \frac{at^2}{2}$
force	$F = ma$
force	$F = \frac{\Delta(mv)}{\Delta t}$
impulse	$F \Delta t = \Delta(mv)$
work, energy and power	$W = F s \cos \theta$
	$E_k = \frac{1}{2} m v^2$ $\Delta E_p = mg\Delta h$
	$P = \frac{\Delta W}{\Delta t}, P = Fv$
	efficiency = $\frac{\text{useful output power}}{\text{input power}}$

Materials

density	$\rho = \frac{m}{V}$	Hooke's law	$F = k \Delta L$
Young modulus	$= \frac{\text{tensile stress}}{\text{tensile strain}}$	tensile stress	$= \frac{F}{A}$
		tensile strain	$= \frac{\Delta L}{L}$
energy stored	$E = \frac{1}{2} F \Delta L$		

Electricity

current and pd $I = \frac{\Delta Q}{\Delta t}$ $V = \frac{W}{Q}$ $R = \frac{V}{I}$

resistivity $\rho = \frac{RA}{L}$

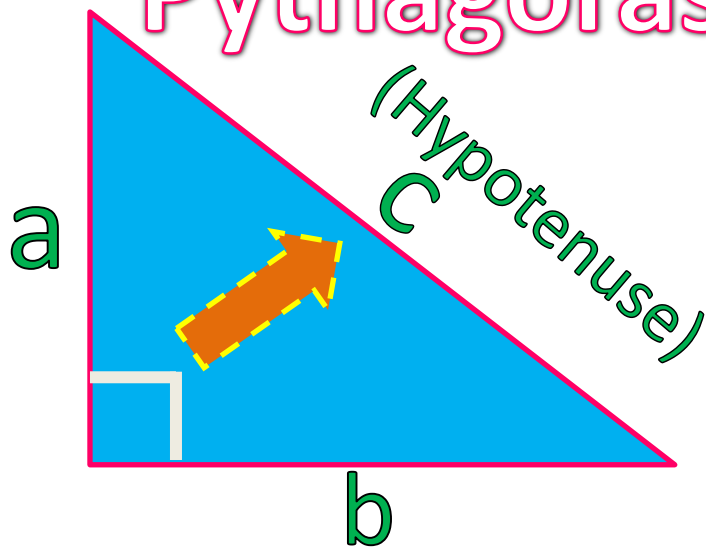
resistors in series $R_T = R_1 + R_2 + R_3 + \dots$

resistors in parallel $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$

power $P = VI = I^2R = \frac{V^2}{R}$

emf $\varepsilon = \frac{E}{Q}$ $\varepsilon = I(R + r)$

Pythagoras



Pythagoras' theorem states:

$$a^2 + b^2 = c^2$$

Rearranging gives:

$$b^2 = c^2 - a^2$$

$$\& a^2 = c^2 - b^2$$

Pythagoras' theorem, in words:

In **right angle triangles**, the **square** of the Hypotenuse is **equal to** the sum of the squares of the other two sides.

Trigonometry

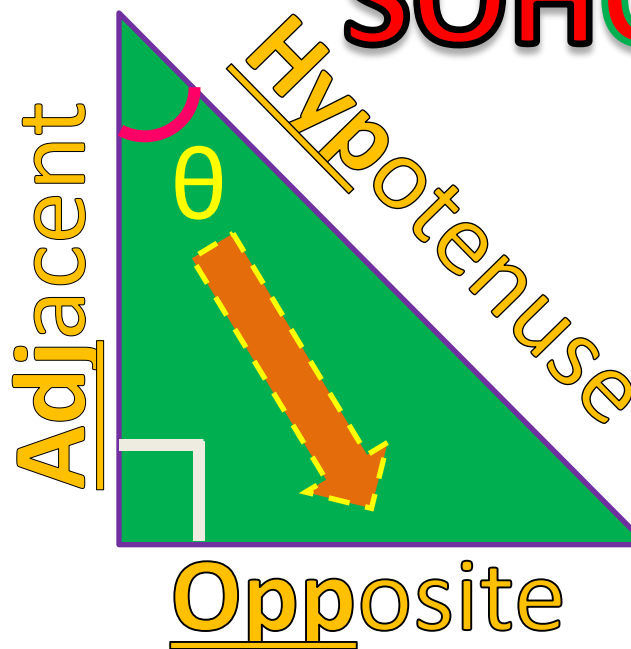


$$\sin \theta = \frac{\text{Opp}}{\text{Hyp}}$$

$$\cos \theta = \frac{\text{Adj}}{\text{Hyp}}$$

$$\tan \theta = \frac{\text{Opp}}{\text{Adj}}$$

SOHCAHTOA

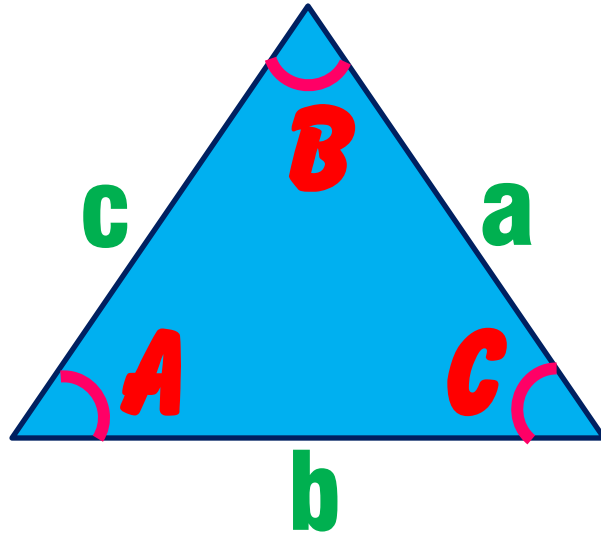


$$\sin \theta = \frac{\text{Opp}}{\text{Hyp}}$$

$$\cos \theta = \frac{\text{Adj}}{\text{Hyp}}$$

$$\tan \theta = \frac{\text{Opp}}{\text{Adj}}$$

Sine rule



Note when using Sine formulae:

Requires 2 sides and 1 angle to find an angle

OR

Requires 2 angles and 1 side to find a side

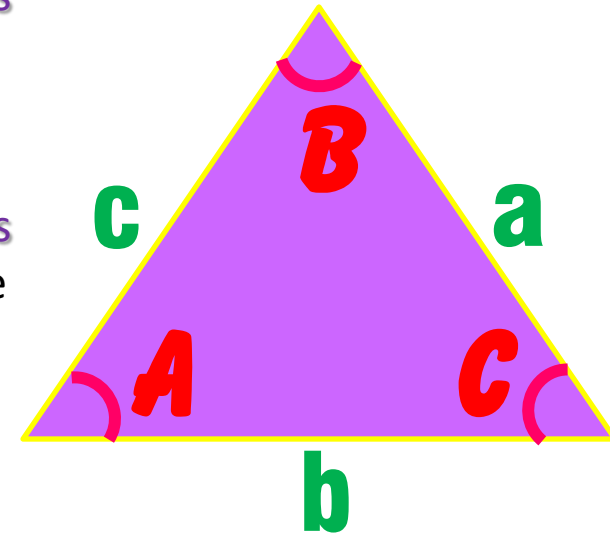
Note when using Cosine formulae:

Requires 2 sides and 1 angle to find a side

OR

Requires 3 sides to find an angle

Cosine rule



Version 1:

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Version 2:

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

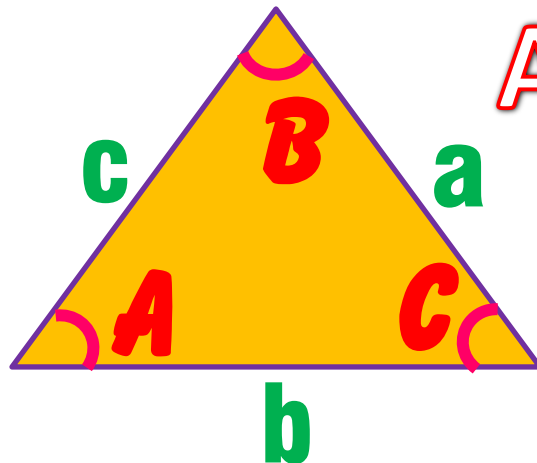
Version 1:

$$a^2 = b^2 + c^2 - 2bc \cos A$$

Version 2:

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}$$

Area of a triangle



Version 1: $A = \frac{1}{2}ab \sin C$

Version 2: $A = \frac{1}{2}ac \sin B$

Version 3: $A = \frac{1}{2}bc \sin A$

Note when using this formulae:

Requires an angle in between two sides (SAS)

Graph Skills

Lines of best fit

A line of best fit in its simplest form is a straight or curved trendline drawn through, or close to, as many of the plotted points as possible, maintaining an equal number of points on each side of the line. Do not force a line should the data not suggest a trend, and never force the line through the origin, as the point (0,0) only matters if it itself is a measured and plotted point.

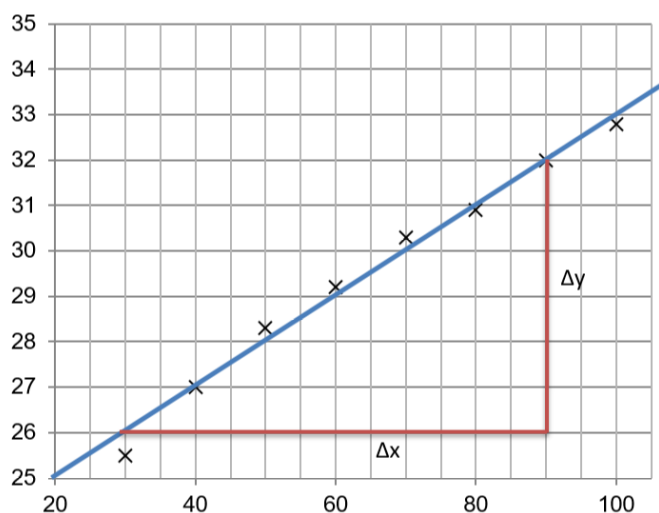
Make sure to take into consideration anomalies and error bars when relevant, and be aware of any potential links to relevant equations or physical laws (e.g. a straight line expected for Hooke's law).

Anomalies

At A-level it is expected that on the vast majority of occasions that anomalous readings arise that you will identify it during the measurements stage of the investigation, long before graphing begins. As such it is expected that anomalous results that arise are ignored when determining average readings, or better still are repeated when possible. Anomalies should always be clearly identified at any stage that they are spotted.

Equation for a straight line

During your practical work you will often be expected to determine the gradient of a best fit line through the graphical method of drawing a triangle to determine its hypotenuse. The larger the triangle the greater the better your gradient measurement will be, and aim to draw from the line rather than points plotted. You may also need to draw a tangent when the line is a curve.



The line of best fit here has an equal number of points on both sides. It is not too wide so points can be seen under it. The gradient triangle has been drawn so the hypotenuse includes more than half of the line. In addition, it starts and ends on points where the line of best fit crosses grid lines so the points can be read easily (this is not always possible).

$$\text{gradient} = \frac{\Delta y}{\Delta x}$$

tion:

$$y = mx + c$$

Where y is the dependent variable, m is the gradient, x is the independent variable and c is the y -intercept. Compare the labels on the axes to determine what quantities in equations from your data sheet might be represented by the gradient and y intercept. E.g. when plotting threshold frequency, the equation $E_k = hf - \phi$ allows us to determine the work function from the y -intercept.

Objectives:

- To give you the skills needed for the successful study of Physics at A level.
- To help you to identify areas in which you might need help.

There are several areas in which students struggle at A level:

- Use of symbols;
- Use of SI units;
- Use of a calculator;
- Use of formulae.

These notes and activities are to help you to become confident with these basic skills, which will help the start of your Physics studies to be more productive and enjoyable.

Using Symbols

An **equation** is a mathematical model that sums up how a system behaves. For example, we know that, if we have a current flowing through a wire and double the voltage, the current will double as well. We know that the quantities of current and voltage are related by the simple rule: $V = IR$

In physics problems we are given certain quantities and use them to find an unknown quantity with an equation.

Symbols

At GCSE you were often given equations in words: *Distance = speed × time*

At A level you will be provided with a data sheet in your examinations. The data sheet will provide you with equations that are given in **symbols**. The symbols all mean something; they are abbreviations. The symbols used in exams and most textbooks are those agreed by the Association of Science Education.

Some symbols are easy; V stands for voltage. Some are not so easy. I for current comes from the French *intensité du courant*, since it was a French physicist who first worked on it. In print you will always find these symbols written in *italics*.

1. What are the meanings for these symbols?
a
v
F
t
Q

You will come across symbols written in Greek letters. The normal (Latin) alphabet has 26 characters. No symbols, with accents are used such as ä (a – umlaut) or ê (e – circumflex). The Greek alphabet adds another 24.

The Greek Alphabet is this:

<i>Greek</i>	<i>Name</i>	<i>Greek</i>	<i>Name</i>
α	alpha	ν	nu
β	beta	π	pi
γ	gamma	ρ	rho
δ (Δ)	delta	σ (Σ)	sigma
ε	epsilon	τ	tau
η	eta	ϕ (Φ)	phi
θ	theta	χ	chi
λ (Λ)	lambda	ψ (Ψ)	psi
μ	mu	ω (Ω)	omega

The ones in grey are the ones you won't generally come across in A-level. You will come across the others in the context of:

- Particles – many particles are given Greek letters, e.g. π meson.
- Physics equations, e.g. $c = f\lambda$

2. The wave equation is $c = f\lambda$. What do the symbols refer to?
c
f
λ

The most common uses of Greek letters are:

- α – as in alpha particle;
- β – as in beta particle;
- γ – as in gamma ray;
- Δ – change in (Δt is time interval);
- θ – angle;
- π – 3.1415...;
- Σ – sum of.

When you use an equation, you will need to know exactly what each term means. But don't worry; the terms will be explained when the formula is introduced to you.

Units

Physics formulae use **SI** (Système International) **units** based on seven **base units** (**Read your Measurement and their Errors notes**)

Many physics formulae will give you the right answer **ONLY** if you put the quantities in SI units. This means that you have to convert. You will often find units that are prefixed, for example kilometre. The table below shows you the commonest prefixes and what they mean:

<i>Prefix</i>	<i>Symbol</i>	<i>Meaning</i>	<i>Example</i>
pico	p	$\times 10^{-12}$	1 pF
nano	n	$\times 10^{-9}$	1 nF
micro	μ	$\times 10^{-6}$	1 μ g
milli	m	$\times 10^{-3}$	1 mm
centi	c	$\times 10^{-2}$	1 cm
kilo	k	$\times 10^3$	1 km
Mega	M	$\times 10^6$	1 M Ω
Giga	G	$\times 10^9$	1 GWh

When converting, it is perfectly acceptable to write the number and the conversion factor. For example:

$$250 \text{ nm} = 250 \times 10^{-9} \text{ m} = 2.5 \times 10^{-7} \text{ m}$$

3. Convert the following quantities to SI units:	
15 cm	
3 km	
35 mV	
220 nF	

When you write out your answer, you must **always** put the correct **unit** at the end. The number 2500 on its own is meaningless; 2500 J gives it a meaning.

Failure to put units in loses 1 mark in the exam, which is 2 %. Repeated across a paper, it can mean the difference of two grades.

Converting areas and volumes causes a lot of problems.

Area:

$$1\text{m}^2 \neq 100\text{cm}^2$$

$$1\text{m}^2 = 100\text{cm} \times 100\text{cm} = 10,000\text{cm}^2 = 10^4\text{cm}^2$$

Volume:

$$1\text{m}^3 = 100\text{cm} \times 100\text{cm} \times 100\text{cm} = 1,000,000\text{cm}^3 = 10^6\text{cm}^3$$

4. Convert the following:	
1 m ² =	mm ²

45 000 mm ² =	m ²
6 000 000 cm ³ =	m ³

Standard Form

Standard form consists of a number between 1 and 10 multiplied by a **power** of 10. For big numbers and very small numbers standard form is very useful.

You should have found that very small numbers entered into a calculator are read as 0, unless they are entered as standard form. The following number is shown in standard form:

$$3.28 \times 10^5$$

$$= 3.28 \times 100\,000 = 328\,000$$

Look at this number:

4 505 000 000 000 000 000



Start counting from here to get the power of 10.

We find that there are 18 digits after the first digit, so we can write the number in standard form as:

$$4.505 \times 10^{18}$$

For fractions we count how far back the first digit is from the decimal point:

0.00000342

In this case it is six places from the decimal point, so it is:

$$3.42 \times 10^{-6}$$

A negative power of ten (negative index) means that the number is a fraction, i.e. between 0 and 1.

5. Convert these numbers to standard form:
86

381
45300
1 500 000 000
0.03
0.00045
0.0000000782

There is no hard and fast rule as to when to use standard form in an answer. Basically if your calculator presents an answer in standard form, then use it. Generally use standard form for:

- numbers greater than 100 000
- numbers less than 0.001

When doing a **conversion** from one unit to another, for example from millimetres to metres, consider it perfectly acceptable to write:

$$15 \text{ mm} = 15 \times 10^{-3} \text{ m}$$

Using a Calculator

A **scientific calculator** is an essential tool in Physics, just like a chisel is to a cabinet-maker. All physics exams assume you have a calculator, and you should always bring a calculator to every lesson. They are not expensive, so there is no excuse for not having one.

The calculator should be able to handle:

- **standard form**;
- **trigonometrical** functions;
- **angles in degrees and radians**;
- **natural logarithms** and **logarithms to the base 10**.

Most scientific calculators have this and much more.

There are no hard and fast rules as to what calculator you should buy:

- Get one that you are happy with.
- Make sure it is accurate; we have known some calculators to get an answer plain wrong!
- Avoid machines that need a hefty instruction manual.
- For the exam, there are certain types of calculator that are NOT allowed, for example those with QWERTY keypads. Make sure that your calculator is an allowable type.

We are assuming that you know the basic functions of your calculator, but we need to draw your attention to a couple of points on the next page.

Misuse of the EXP key:

Suppose we have a number like 2.31×10^7 . You key it in like this:

2 . 3 1 EXP 7

Do **NOT** key it in like this:

2 . 3 1 × 1 0 EXP 7

This will give you 2.31×10^8 . Misuse of the calculator will always cost marks.

Too Many Significant Figures

Consider this calculation: $V_{rms} = \frac{13.6}{\sqrt{2}}$

Your calculator will give the answer as $V_{rms} = 9.6166526 \text{ V}$

There is no reason at all in A-level Physics to write any answer to any more than 4 significant figures. Four significant figures is claiming accuracy to about one part in 10000. Blindly writing your calculator answer is claiming that you can be accurate to one part in 100 million, which is absurd.

The **examination mark schemes** give answers that are either 2, 3 or 4 significant figures. So our answer above could be written as:

$$V_{rms} = 9.617 \text{ V (4 s.f.)}$$

$$V_{rms} = 9.62 \text{ V (3 s.f.)}$$

$$V_{rms} = 9.6 \text{ V (2 s.f.)}$$

Do any **rounding** up or down at the end of a calculation. If you do any rounding up or down in the middle, you could end up with rounding errors.

6. Use your calculator to do the following calculations. Write your answers to three significant figures.	
	ANSWER
(a) $\frac{3.4 \times 10^{-3} \times 6.0 \times 10^{23}}{235}$	
(b) $\frac{27.3^2 - 24.8^2}{\sqrt{38}}$	
(c) 1.4509^3	
(d) $\sin 56.4^\circ$	
(e) Reciprocal of 2.34×10^5	
(f) $45 \sin 10^\circ$	

Some other tips on use of calculators:

- On most calculators the number is keyed in before the function (sin, cos, log)
- Take one step at a time and write intermediate results.

- It is easy to make a mistake such as pressing the \times key rather than the \div key. It is a good idea to do the calculation again as a check.
- As you get more experienced, you will get a feel for what is a reasonable answer. 1000 N is a reasonable force that a car would use to accelerate; 2×10^{-10} N is most certainly not.

Transposition of Formulae

The **transposition** (or **rearrangement**) of formulae is a skill that is essential for successful study of Physics. A wrong transposition of a formula will lead to a **physics error** in the exam and you will lose all the marks available in that part of the question. (However, if you use your incorrect answer correctly in subsequent parts, your error will be carried forward and you will gain the credit.)

Some students find rearrangement very difficult and it hampers their progress and enjoyment of the subject. They try to get round it by learning all the variants of a formula, which is a waste of brain power.

It is far better to get into the habit of rearranging formulae from the start. The best thing to do is to practise.

Key Points:

- What you do on one side you have to do on the other side. It applies whether you are working with numbers, symbols, or both.
- Don't try to do too many stages at once.

Transposing Simple Formulae

Simple formulae are those that consist of three quantities, taking the form $A = BC$. A typical example is $V = IR$

Suppose we are using the equation $V = IR$ and wanted to know I .

We want to get rid of the R on the RHS so that I is left on its own. So we divide both sides by R which gives us:

$$\frac{V}{R} = \frac{IR}{R}$$

The R s on the RHS cancel out because $R/R = 1$. So we are left with:

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

It does not matter which way the equation ends up, as long as it is rearranged properly.

7. Rearrange these equations:		
<i>Equation</i>	<i>Subject</i>	<i>Answer</i>
$V = IR$	R	
$p = mv$	v	
$\rho = \frac{m}{V}$	m	
$Q = CV$	C	

Formulae with Four Terms

8. Rearrange these equations:		
Equation	Subject	Answer
$pV = nRT$	V	
$E_p = mg\Delta h$	Δh (Δh is a single term)	
$V = \frac{-Gm}{r}$	G	
$\lambda = \frac{ws}{D}$	D	

Equations with + or -

If there are terms which are added or subtracted, we need to progress like this:

$$Ek = hf - \Phi$$

We want to find h .

To get rid of the Φ term we need to add it to both sides of the equation:

$$\begin{aligned} Ek + \Phi &= hf - \Phi + \Phi \\ Ek + \Phi &= hf \end{aligned}$$

Now we can get rid of the f on the RHS by dividing the whole equation by f :

$$\frac{(Ek + \Phi)}{f} = \frac{hf}{f}$$

Which gives us our final result of:

$$h = \frac{(Ek + \Phi)}{f}$$

9. Rearrange these equations:		
Equation	Subject	Answer
$v = u + at$	t	
$E = V + Ir$	r	

Now Mark your work. Ensure that it is ticked and that you have written up your corrections.

Reflection on your Holiday Homework and the AS Physics course you are about to undertake.

Which exercises I found the easiest and why?

Which exercises I found the hardest and why?

Concerns I have about the AS Physics course in Year 12:

ANSWERS

1. What are the meanings for these symbols?
a <i>acceleration</i>
v <i>velocity</i>
F <i>force</i>
t <i>time</i>
Q <i>amount of charge</i>

2. The wave equation is $= f\lambda$. What do the symbols refer to?
c <i>speed</i>
f <i>frequency</i>
λ <i>wavelength</i>

3. Convert the following quantities to SI units:	
15 cm	0.015 m
3 km	3000 m
35 mV	0.035 V
220 nF	$2.2 \times 10^{-7}F$

4. Convert the following:
$1\text{ m}^2 = 1000\ 000\text{ mm}^2$
$45\ 000\text{ mm}^2 = 0.045\text{ m}^2$
$6\ 000\ 000\text{ cm}^3 = 0.06\text{ m}^3$

5. Convert these numbers to standard form:
$86 = 8.6 \times 10^1$
$381 = 3.81 \times 10^2$
$45300 = 4.53 \times 10^4$
$1\ 500\ 000\ 000 = 1.5 \times 10^9$
$0.03 = 3.0 \times 10^{-2}$
$0.00045 = 4.5 \times 10^{-4}$
$0.0000000782 = 7.82 \times 10^{-8}$

6. Use your calculator to do the following calculations. Write your answers to no more than three significant figures.	
(a) $\frac{3.4 \times 10^{-3} \times 6.0 \times 10^{23}}{235}$	8.68×10^{18}
(b) $\frac{27.3^2 - 24.8^2}{\sqrt{38}}$	7.44×10^4
(c) 1.4509^3	3.05
(d) $\sin 56.4^\circ$	0.833

(e) Reciprocal of 2.34×10^5	4.27×10^{-6}
(f) $45 \sin 10^\circ$	7.81

7. Rearrange these equations:		
$V = IR$	R	$R = \frac{V}{I}$
$p = mv$	v	$v = \frac{p}{m}$
$\rho = \frac{m}{V}$	m	$m = \rho V$
$Q = CV$	C	$C = \frac{Q}{V}$

8. Rearrange these equations:		
$pV = nRT$	V	$V = \frac{nRT}{p}$
$E_p = mg\Delta h$	Δh (Δh is a single term)	$\Delta h = \frac{E_p}{mg}$
$V = \frac{-Gm}{r}$	G	$G = -\frac{Vr}{m}$
$\lambda = \frac{ws}{D}$	D	$D = \frac{ws}{\lambda}$

9. Rearrange these equations:		
$v = u + at$	t	$t = \frac{v - u}{a}$
$E = V + Ir$	r	$r = \frac{E - V}{I}$

Additional research, if you have time:

Spend some time looking at the **minutephysics** videos on youtube:

<https://www.youtube.com/user/minutephysics>

You could also look at: **CERN: The Standard Model of Particle Physics**

<https://www.youtube.com/watch?v=V0KjXsGRvoA>