Keeping you afloat

B.A. daVinci with Physics

https://mrsphysics.co.uk/

Name: ____________________

Class: ____________________

J A HARGREAVES

NATIONAL 5 COMPENDIUM

2023 Don't Panic!

Updated

Speed of light in materials

Material	*Speed* in $m\,s^{-1}$
Air	$3{\cdot}0 \times 10^8$
Carbon dioxide	$3{\cdot}0 \times 10^8$
Diamond	$1{\cdot}2 \times 10^8$
Glass	$2{\cdot}0 \times 10^8$
Glycerol	$2{\cdot}1 \times 10^8$
Water	$2{\cdot}3 \times 10^8$

Gravitational field strengths

	Gravitational field strength on the surface in $N\,kg^{-1}$
Earth	9·8
Jupiter	23
Mars	3·7
Mercury	3·7
Moon	1·6
Neptune	11
Saturn	9·0
Sun	270
Uranus	8·7
Venus	8·9

Specific latent heat of fusion of materials

Material	*Specific latent heat of fusion* in $J\,kg^{-1}$
Alcohol	$0{\cdot}99 \times 10^5$
Aluminium	$3{\cdot}95 \times 10^5$
Carbon dioxide	$1{\cdot}80 \times 10^5$
Copper	$2{\cdot}05 \times 10^5$
Iron	$2{\cdot}67 \times 10^5$
Lead	$0{\cdot}25 \times 10^5$
Water	$3{\cdot}34 \times 10^5$

Specific latent heat of vaporisation of materials

Material	*Specific latent heat of vaporisation* in $J\,kg^{-1}$
Alcohol	$11{\cdot}2 \times 10^5$
Carbon dioxide	$3{\cdot}77 \times 10^5$
Glycerol	$8{\cdot}30 \times 10^5$
Turpentine	$2{\cdot}90 \times 10^5$
Water	$22{\cdot}6 \times 10^5$

Speed of sound in materials

Material	*Speed* in $m\,s^{-1}$
Aluminium	5200
Air	340
Bone	4100
Carbon dioxide	270
Glycerol	1900
Muscle	1600
Steel	5200
Tissue	1500
Water	1500

Specific heat capacity of materials

Material	*Specific heat capacity* in $J\,kg^{-1}\,{}^{o}C^{-1}$
Alcohol	2350
Aluminium	902
Copper	386
Glass	500
Ice	2100
Iron	480
Lead	128
Oil	2130
Water	4180

Melting and boiling points of materials

Material	*Melting point* in °C	*Boiling point* in °C
Alcohol	−98	65
Aluminium	660	2470
Copper	1077	2567
Glycerol	18	290
Lead	328	1737
Iron	1537	2737

Radiation weighting factors

Type of radiation	*Radiation weighting factor*
alpha	20
beta	1
fast neutrons	10
gamma	1
slow neutrons	3
X-rays	1

DATA SHEET
PERIODIC TABLE

Electron Arrangements of Elements

Key

Atomic number Symbol Electron arrangement Name

Transition Elements

Group 1 (1)	Group 2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Group 3 (13)	Group 4 (14)	Group 5 (15)	Group 6 (16)	Group 7 (17)	Group 0 (18)
1 **H** 1 Hydrogen																	2 **He** 2 Helium
3 **Li** 2,1 Lithium	4 **Be** 2,2 Beryllium											5 **B** 2,3 Boron	6 **C** 2,4 Carbon	7 **N** 2,5 Nitrogen	8 **O** 2,6 Oxygen	9 **F** 2,7 Fluorine	10 **Ne** 2,8 Neon
11 **Na** 2,8,1 Sodium	12 **Mg** 2,8,2 Magnesium											13 **Al** 2,8,3 Aluminium	14 **Si** 2,8,4 Silicon	15 **P** 2,8,5 Phosphorus	16 **S** 2,8,6 Sulfur	17 **Cl** 2,8,7 Chlorine	18 **Ar** 2,8,8 Argon
19 **K** 2,8,8,1 Potassium	20 **Ca** 2,8,8,2 Calcium	21 **Sc** 2,8,9,2 Scandium	22 **Ti** 2,8,10,2 Titanium	23 **V** 2,8,11,2 Vanadium	24 **Cr** 2,8,13,1 Chromium	25 **Mn** 2,8,13,2 Manganese	26 **Fe** 2,8,14,2 Iron	27 **Co** 2,8,15,2 Cobalt	28 **Ni** 2,8,16,2 Nickel	29 **Cu** 2,8,18,1 Copper	30 **Zn** 2,8,18,2 Zinc	31 **Ga** 2,8,18,3 Gallium	32 **Ge** 2,8,18,4 Germanium	33 **As** 2,8,18,5 Arsenic	34 **Se** 2,8,18,6 Selenium	35 **Br** 2,8,18,7 Bromine	36 **Kr** 2,8,18,8 Krypton
37 **Rb** 2,8,18,8,1 Rubidium	38 **Sr** 2,8,18,8,2 Strontium	39 **Y** 2,8,18,9,2 Yttrium	40 **Zr** 2,8,18, 10,2 Zirconium	41 **Nb** 2,8,18, 12,1 Niobium	42 **Mo** 2,8,18,13, 1 Molybdenum	43 **Tc** 2,8,18,13, 2 Technetium	44 **Ru** 2,8,18,15, 1 Ruthenium	45 **Rh** 2,8,18,16, 1 Rhodium	46 **Pd** 2,8,18, 18,0 Palladium	47 **Ag** 2,8,18, 18,1 Silver	48 **Cd** 2,8,18, 18,2 Cadmium	49 **In** 2,8,18, 18,3 Indium	50 **Sn** 2,8,18, 18,4 Tin	51 **Sb** 2,8,18, 18,5 Antimony	52 **Te** 2,8,18, 18,6 Tellurium	53 **I** 2,8,18, 18,7 Iodine	54 **Xe** 2,8,18, 18,8 Xenon
55 **Cs** 2,8,18,18, 8,1 Caesium	56 **Ba** 2,8,18,18, 8,2 Barium	57 **La** 2,8,18,18, 9,2 Lanthanum	72 **Hf** 2,8,18,32, 10,2 Hafnium	73 **Ta** 2,8,18, 32,11,2 Tantalum	74 **W** 2,8,18,32, 12,2 Tungsten	75 **Re** 2,8,18,32, 13,2 Rhenium	76 **Os** 2,8,18,32, 14,2 Osmium	77 **Ir** 2,8,18,32, 15,2 Iridium	78 **Pt** 2,8,18,32, 17,1 Platinum	79 **Au** 2,8,18, 32,18,1 Gold	80 **Hg** 2,8,18, 32,18,2 Mercury	81 **Tl** 2,8,18, 32,18,3 Thallium	82 **Pb** 2,8,18, 32,18,4 Lead	83 **Bi** 2,8,18, 32,18,5 Bismuth	84 **Po** 2,8,18, 32,18,6 Polonium	85 **At** 2,8,18, 32,18,7 Astatine	86 **Rn** 2,8,18, 32,18,8 Radon
87 **Fr** 2,8,18,32, 18,8,1 Francium	88 **Ra** 2,8,18,32, 18,8,2 Radium	89 **Ac** 2,8,18,32, 18,9,2 Actinium	104 **Rf** 2,8,18,32, 32,10,2 Rutherfordium	105 **Db** 2,8,18,32, 32,11,2 Dubnium	106 **Sg** 2,8,18,32, 32,12,2 Seaborgium	107 **Bh** 2,8,18,32, 32,13,2 Bohrium	108 **Hs** 2,8,18,32, 32,14,2 Hassium	109 **Mt** 2,8,18,32, 32,15,2 Meitnerium	110 **Ds** 2,8,18,32, 32,17,1 Darmstadtium	111 **Rg** 2,8,18,32, 32,18,1 Roentgenium	112 **Cn** 2,8,18,32, 32,18,2 Copernicium						

Lanthanides	57 **La** 2,8,18, 18,9,2 Lanthanum	58 **Ce** 2,8,18, 20,8,2 Cerium	59 **Pr** 2,8,18,21, 8,2 Praseodymium	60 **Nd** 2,8,18,22, 8,2 Neodymium	61 **Pm** 2,8,18,23, 8,2 Promethium	62 **Sm** 2,8,18,24, 8,2 Samarium	63 **Eu** 2,8,18,25, 8,2 Europium	64 **Gd** 2,8,18,25, 9,2 Gadolinium	65 **Tb** 2,8,18,27, 8,2 Terbium	66 **Dy** 2,8,18,28, 8,2 Dysprosium	67 **Ho** 2,8,18,29, 8,2 Holmium	68 **Er** 2,8,18,30, 8,2 Erbium	69 **Tm** 2,8,18,31, 8,2 Thulium	70 **Yb** 2,8,18,32, 8,2 Ytterbium	71 **Lu** 2,8,18,32, 9,2 Lutetium
Actinides	89 **Ac** 2,8,18,32, 18,9,2 Actinium	90 **Th** 2,8,18,32, 18,10,2 Thorium	91 **Pa** 2,8,18,32, 20,9,2 Protactinium	92 **U** 2,8,18,32, 21,9,2 Uranium	93 **Np** 2,8,18,32, 22,9,2 Neptunium	94 **Pu** 2,8,18,32, 24,8,2 Plutonium	95 **Am** 2,8,18,32, 25,8,2 Americium	96 **Cm** 2,8,18,32, 25,9,2 Curium	97 **Bk** 2,8,18,32, 27,8,2 Berkelium	98 **Cf** 2,8,18,32, 28,8,2 Californium	99 **Es** 2,8,18,32, 29,8,2 Einsteinium	100 **Fm** 2,8,18,32, 30,8,2 Fermium	101 **Md** 2,8,18,32, 31,8,2 Mendelevium	102 **No** 2,8,18,32, 32,8,2 Nobelium	103 **Lr** 2,8,18,32, 32,9,2 Lawrencium

RELATIONSHIPS SHEET

$d = vt$

$d = \bar{v}t$

$s = vt$

$s = \bar{v}t$

$a = \frac{v-u}{t}$

$F = ma$

$W = mg$

$E_w = Fd$

$E_p = mgh$

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

$Q = It$

$V = IR$

$V_2 = \left(\frac{R_2}{R_1 + R_2}\right)V_S$

$\frac{V_1}{V_2} = \frac{R_1}{R_2}$

$R_T = R_1 + R_2 + ...$

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + ...$

$P = \frac{E}{t}$

$P = IV$

$P = I^2R$

$P = \frac{V^2}{R}$

$E_h = cm\Delta T$

$E_h = ml$

$p = \frac{F}{A}$

$p_1V_1 = p_2V_2$

$\frac{p_1}{T_1} = \frac{p_2}{T_2}$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{pV}{T} = \text{constant}$

$f = \frac{N}{t}$

$v = f\lambda$

$T = \frac{1}{f}$

$A = \frac{N}{t}$

$D = \frac{E}{m}$

$H = Dw_r$

$\dot{H} = \frac{H}{t}$

Additional Relationships

Circle

circumference $= 2\pi r$

area $= \pi r^2$

Sphere

area $= 4\pi r^2$

volume $= \frac{4}{3}\pi r^3$

Trigonometry

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\sin^2\theta + \cos^2\theta = 1$$

PREFIXES

http://www.youtube.com/watch?v=N_9IBQ3Pxz0

Prefix	Symbol	Multiple	Multiple in full
Tera	T	x10^{12}	x1 000 000 000 000
Giga	G	x10^{9}	x1 000 000 000
Mega	M	x10^{6}	x1 000 000
Kilo	k	x10^{3}	x1 000
Basic SI	**UNIT**	x10^{1}	x1
Milli	m	x10^{-3}	÷1 000
Micro	μ	x10^{-6}	÷1 000 000
Nano	n	x10^{-9}	÷1 000 000 000
Pico	p	x10^{-12}	÷1 000 000 000 000

Above is a table of prefixes, which you will commonly find in Physics.
NB THE STANDARD UNIT FOR MASS IS THE KILOGRAM. Do not try changing it to grammes!
Watch out for **ms** which is not metres per second but milli seconds

HELP WITH THE 'RELATIONSHIPS SHEET'

UNDERSTANDING QUANTITIES, SYMBOLS AND UNITS

Symbol	Quantity	Unit & Symbol	
a	acceleration	ms^{-2}	metres per second per second
A	activity	Bq	becquerels
A	area	m^2	square metres
c	specific heat capacity	J kg^{-1} °C^{-1}	joules per kilogram per degree Celsius
d	distance (or displacement)	m	metres
D	absorbed dose	Gy	grays
E	energy	J	joules
E_h	heat energy	J	joules
E_k	kinetic energy	J	joules
E_p	potential energy	J	joules
E_W	work done	J	joules
f	frequency	Hz	hertz

Symbol	Quantity	Unit & Symbol	
F	force	N	newtons
g	gravitational field strength	$N\ kg^{-1}$	newtons per kilogram
h	height	m	metres
H	equivalent dose	Sv	sieverts
$\dot{H}$	equivalent dose rate	$Sv\ s^{-1}$ etc...	(many possible units)
I	current	A	amps
l	specific latent heat	$J\ kg^{-1}$	joules per kilogram
m	mass	kg	kilograms
N	Number of radioactive nuclei decaying		(no units)
p	pressure	Pa	pascals
P	power	W	watts
Q	charge	C	coulombs
R	resistance	Ω	ohms
R_T	total resistance	Ω	ohms
s	distance (or displacement)	m	metres
t	time	s	seconds
T	period	s	seconds
T	temperature	K	kelvin
ΔT	change in temperature	° C	degrees Celsius
u	initial velocity	ms^{-1}	metres per second
v	velocity (or final velocity)	ms^{-1}	metres per second
$\bar{v}$	average velocity	ms^{-1}	metres per second
V	volume	m^3	metres cubed
V	voltage	V	volts
V_s	supply voltage	V	volts
W	weight	N	newtons
λ	wavelength	m	metres
ω_R	radiation weighting factor		(no units)

The next page takes each of the equations on the Relationships Sheet and writes them out in words. It is vital that you learn these if you are to succeed in the course.

Relationships Sheet in Words

Equation	First page Equations written in words with units
$d = vt$	$distance\ (m) = speed\ (m\ s^{-1}) \times time\ (s)$
$d = \bar{v}t$	$total\ distance\ (m) = average\ speed\ (m\ s^{-1}) \times\ time\ (s)$
$s = vt$	$displacement\ (m) = velocity\ (m\ s^{-1}) \times time\ (s)$
$s = \bar{v}t$	$total\ displacement\ (m) = average\ velocity\ (m\ s^{-1}) \times time\ (s)$
$a = \frac{v-u}{t}$	$acceleration\ (m\ s^{-2}) = \frac{final\ velocity\ (m\ s^{-1}) - initial\ velocity\ (m\ s^{-1})}{time\ (s)}$
$F = ma$	$force\ (N) = mass\ (kg) \times acceleration\ (m\ s^{-2})$
$W = mg$	$weight\ (N) = mass\ (kg) \times gravitational\ field\ strength (N\ kg^{-1})$
$E_w = Fd$	$work\ done\ (J) = force\ (N) \times distance\ (m)$
$E_p = mgh$	$gravitational\ potential\ energy\ (J) = mass\ (kg) \times gravitational\ field\ strength (N\ kg^{-1}) \times vertical\ height\ (m)$
$E_k = \frac{1}{2}mv^2$	$kinetic\ energy\ (J) = \frac{1}{2} \times mass\ (kg) \times speed^2\ \ (m\ s^{-1})^2$
$Q = It$	$charge\ (C) = current\ (A) \times\ time\ (s)$
$V = IR$	$voltage\ (V) = current\ (A) \times resistance\ (\Omega)$
$V_2 = \left(\frac{R_2}{R_1 + R_2}\right) V_s$	**For potential dividers:** $voltage\ across\ second\ series\ resistor\ (V) = \frac{resistance\ of\ R_2\ (\Omega)}{\text{total resistance}\ (\Omega)} \times voltage\ supply\ (V)$
$\frac{V_1}{V_2} = \frac{R_1}{R_2}$	$\frac{voltage\ 1\ (V)}{voltage\ 2\ (V)} = \frac{resistance\ 1\ (\Omega)}{resistance\ 2\ (\Omega)}$
$R_T = R_1 + R_2 + ..$	**For resistors in series:** $total\ resistance\ (\Omega) = resistance\ of\ R_1 (\Omega) + resistance\ of\ R_2 (\Omega) + ..$
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$	**For resistors in parallel** $\frac{1}{total\ resistance\ (\Omega)} = \frac{1}{resistance\ of\ R_1\ (\Omega)} + \frac{1}{resistance\ of\ R_2\ (\Omega)} + \cdots$
$P = \frac{E}{t}$	$power\ (W) = \frac{energy\ (J)}{time\ (s)}$
$P = IV$	$power\ (W) = current\ (A) \times voltage\ (V)$
$P = I^2R$	$power\ (W) = current\ ^2 (A)^2 \times resistance\ (\Omega)$
$P = \frac{V^2}{R}$	$power\ (W) = \frac{voltage^2\ (V)^2}{resistance\ (\Omega)}$

Equation	Second page of Equations written in words with units
$E_h = cm\Delta T$	$heat\ energy\ (J) = specific\ heat\ capacity\ (Jkg^{-1}\,°C^{-1}\ or Jkg^{-1}K^{-1}) \times mass\ (kg) \times change\ in\ temperature\ (°C)$ Find the value of *c* on the data sheet
$E_h = ml$	$heat\ energy\ (J) = mass\ (kg) \times specific\ latent\ heat\ (Jkg^{-1})$ Find the value of *l* on the data sheet NB there is no change in temperature just state
$p = \frac{F}{A}$	$pressure\ (Pa) = \frac{Force\ (N)}{Area\ (m^2)}$
$p_1V_1 = p_2V_2$	$pressure_1(Pa) \times volume_1(m^3) = Pressure_2(Pa) \times volume_2(m^3)$
$\frac{p_1}{T_1} = \frac{p_2}{T_2}$	$\frac{pressure_1(Pa)}{Temperature_1(K)} = \frac{Pressure_2(Pa)}{Temperature_2(K)}$ **Temp MUST be in Kelvin**
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$	$\frac{volume_1(m^3)}{Temperature_1(K)} = \frac{volume_2(m^3)}{Temperature_2(K)}$ **Temp MUST be in Kelvin**
$\frac{pV}{T} = constant$	$\frac{Pressure(Pa) \times volume(m^3)}{Temperature\ (K)} = constant\ value$
$f = \frac{N}{t}$	$Frequency\ (Hz) = \frac{No.of\ waves\ produced\ or\ passing\ a\ point\ (no\ units)}{time(s)}$
$v = f\lambda$	$wave\ speed\ (m\,s^{-1}) = Frequency\ (Hz) \times wavelength\ (m)$
$T = \frac{1}{f}$	$Period\ (s) = \frac{1}{Frequency(Hz)}$
$A = \frac{N}{t}$	$Activity\ (Bq) = \frac{No.of\ disintegrations\ (no\ units)}{time(s)}$
$D = \frac{E}{m}$	$Absorbed\ Dose\ (Gy) = \frac{Energy\ (J)}{mass\ (kg)}$
$H = Dw_R$	$Equivalent\ Dose\ (Sv) = Absorbed\ Dose\ (Gy) \times radiation\ weighting\ factor(no\ units)$
$\dot{H} = \frac{H}{t}$	$Equivalent\ Dose\ rate\ (Svh^{-1}\ or\ Svy^{-1}) = \frac{Equivalent\ Dose\ (Sv)}{time\ (s\ or\ h\ or\ y)}$

THE PHYSICS COURSE

THERE ARE 6 UNITS IN THE NATIONAL 5 PHYSICS COURSE

DYNAMICS	SPACE	ELECTRICITY
PROPERTIES OF MATTER	WAVES	RADIATION

THERE IS ALSO AN ASSIGNMENT WHICH MUST BE COMPLETED.

There are two parts to the exam

Component	Marks	Scaled mark	Duration & Notes
Part 1: question paper	135	100	2 hours and 30 minutes **Section 1** (objective test) has 25 marks. **Section 2** contains restricted and extended response questions and has 110 marks. This is scaled to 75 marks.
Part 2: assignment	20	25	8 hours of which a maximum of 1 hour and 30 minutes is allocated to the reporting stage The assignment has two stages: • research • report

THE ASSIGNMENT

The research stage must involve an experiment which allows you to make measurements. You must also gather data from the internet, books or journals to compare against their experimental results. You must produce a report on your research which will be sent away for marking.

The assignment is:

- an individually produced piece of work from each candidate
- started at an appropriate point in the course
- conducted under controlled conditions

MARK SCHEME FOR THE ASSIGNMENT

Section	Expected response	Max marks
Title	The report has an informative title.	1
Aim	A description of the purpose of the investigation.	1
Underlying physics relevant to the aim	A description of the physics relevant to the aim which shows understanding.	3
Data collection and handling	A brief description of the experiment	1
	Sufficient raw data from the experiment.	1
	Raw data presented in a table with headings and units.	1
	Values correctly calculated from the raw data.	1
	Data from an internet/literature source.	1
	A reference for the internet/literature source.	1
Graphical presentation	The correct type of graph used to present the experimental data.	1
	Suitable scales.	1
	Suitable labels and units on axes.	1
	All points plotted accurately, with line or curve of best fit if appropriate.	1
Analysis	Experimental data compared to data from internet/literature source.	1
Conclusion	A conclusion related to the aim and supported by data in the report.	1
Evaluation	A discussion of a factor affecting the reliability, accuracy or precision of the results.	2
Structure	A report which can be easily followed.	1
	Total	**20**

ALL UNITS

No.	CONTENT	✓×	Traffic Light		
0.1	I know the units for all of the physical quantities used in this course.		☺	😐	☹
0.2	I can use the prefixes: nano (n), micro(μ), milli (m), kilo(k), Mega(M) & Giga (G)		☺	😐	☹
0.3	I can give an appropriate number of significant figures when carrying out calculations (This means that the final answer can have no more significant figures than the value with least number of significant figures used in the calculation).		☺	😐	☹
0.4	I can use scientific notation when large and small numbers are used in calculations.		☺	😐	☹

DYNAMICS (start:_________end: _________)

No.	CONTENT	✓×	Traffic Light		
Vectors and scalars					
1.1	I can define scalar quantities and vector quantities a scalar has magnitude/size, and unit only, a vector has magnitude/size and unit + direction		☺	😐	☹
1.2	I can identify vector and scalar quantities such as: force, speed, velocity, distance, displacement, acceleration, mass, time and energy.		☺	😐	☹
1.3	I can calculate the resultant of two vector quantities in one dimension or at right angles.		☺	😐	☹
1.4	I can determine displacement and/or distance using scale diagram or calculation.		☺	😐	☹
1.5	I can determine velocity and/or speed using scale diagram or calculation.		☺	😐	☹
1.6	I can perform calculations/ solve problems involving the relationship between speed, distance and time ($d = vt$, and $d = \bar{v}t$)		☺	😐	☹
1.7	I can perform calculations/ solve problems involving the relationship between velocity, displacement and time ($s = \bar{v}t$) in one dimension		☺	😐	☹
1.8	I can determine average and instantaneous speed.		☺	😐	☹
1.9	I can describe experiments to measure average and instantaneous speed.		☺	😐	☹

No.	CONTENT	✓×	Traffic Light		
Velocity- time graphs					
2.1	I can draw velocity-time graphs for objects from recorded or experimental data.		☺	😐	☹
2.2	I can interpret velocity-time graphs to describe the motion of an object.		☺	😐	☹
2.3	I can find displacement from a velocity-time graph, where s = *area under the v-t graph*.		☺	😐	☹
Acceleration					
3.1	I can define acceleration as rate of change of velocity. Which is found from the final velocity subtract the initial velocity all divided by the time for the change.		☺	😐	☹
3.2	I can use ($a = \Delta v/t$).to solve problems on acceleration, change in speed and time.		☺	😐	☹
3.3	I can use ($a = (v - u)/t$).to solve problems involving acceleration, initial velocity (or speed) final velocity (or speed) and time of change.		☺	😐	☹
3.4	I can find the acceleration from the gradient of velocity-time graphs.		☺	😐	☹
3.5	**I can describe an experiment to measure acceleration**		☺	😐	☹
Newton's Laws					
4.1	I can give applications and use Newton's laws and balanced forces to explain constant velocity (or speed), making reference to frictional forces of this.		☺	😐	☹
4.2	I can give applications of Newton's laws and balanced forces to explain and or determine acceleration for situations where more than one force is acting, ($F=ma$)		☺	😐	☹
4.3	I can use $F=ma$ to solve problems involving unbalanced force, mass and acceleration for situations where more than one force is acting, in one dimension or at right angles.		☺	😐	☹
4.4	I can use $W=mg$ to solve problems involving weight mass and gravitational field strength, including on different planets (where g is given on page 2 of section1)		☺	😐	☹
4.5	I can use Newton's 3rd law and its application to explain motion resulting from a 'reaction' force.		☺	😐	☹
4.6	I can use Newton's laws to explain free-fall and terminal velocity.		☺	😐	☹
Energy					
5.1	I can state that energy is never created or destroyed, it is conserved.		☺	😐	☹
5.2	I can identify and explain energy conversions and transfer.		☺	😐	☹

No.	CONTENT	✓×	Traffic Light		
5.3	I can apply the principle of 'conservation of energy' to examples where energy is transferred between stores.		☺	😐	☹
5.4	I can use ***Ew=Fd*** to solve problems involving work done, unbalanced force, and distance or displacement.		☺	😐	☹
5.5	I can identify and explain 'loss' of energy where energy is transferred.		☺	😐	☹
5.6	I can define gravitational potential energy. Ep is the energy an object has because of its position above the Earth's surface and its mass		☺	😐	☹
5.7	I can use ***Ep=mgh*** to solve problems on involving gravitational potential energy, mass, gravitational field strength and height		☺	😐	☹
5.8	I can define kinetic energy as the energy an object has because of its speed.		☺	😐	☹
5.9	I can use $E_k = \frac{1}{2} mv^2$ to solve problems involving kinetic energy, mass and speed		☺	😐	☹
5.10	I can use ***Ew=Fd***, ***Ep=mgh***, $E_k = \frac{1}{2} mv^2$ to solve problems involving conservation of energy		☺	😐	☹
Projectile Motion					
6.1	I can explain that projectile motion occurs when an object has both a constant horizontal velocity and a constant vertical acceleration		☺	😐	☹
6.2	I can use appropriate relationships to solve problems involving projectile motion from a horizontal launch, including the use of motion graphs.		☺	😐	☹
6.3	I can state that the area under v_h-t graphs is equal to the horizontal range.		☺	😐	☹
6.4	I can calculate the horizontal range from the area under a v_h-t graphs		☺	😐	☹
6.5	I can state that the area under v_v-t graphs is equal to the vertical height.		☺	😐	☹
6.6	I can calculate the height, and acceleration from v_v-t graphs		☺	😐	☹
6.7	I can state and use the relationships area under a v_h-t graphs equals the horizontal range area under v_v-t graphs is equal to the vertical height. $v_h = \frac{s}{t}$ where v_h is a constant horizontal velocity $v_v = u_v + at$ where v_v is a constant vertical acceleration		☺	😐	☹
6.8	I can explain satellite orbits in terms of projectile motion, horizontal velocity and weight.		☺	😐	☹

SPACE (start:________end: ________)

No.	Content	✓×	Traffic Light		
Space Exploration					
7.1	I have a basic understanding of the Universe https://map.gsfc.nasa.gov/universe/uni_life.html		☺	😐	☹
7.2	I can use the following terms correctly and in context: planet, dwarf planet, moon, Sun, asteroid, solar system, star, exoplanet, galaxy, and universe.		☺	😐	☹
7.3	I am aware of the benefits of satellites: for example for GPS, weather forecasting, communications, scientific discovery and space exploration (for example Hubble telescope, ISS).		☺	😐	☹
7.4	I know that geostationary satellites have a period of 24 hours and orbit at an altitude of 36 000 km above the equator on the Earth's surface.		☺	😐	☹
7.5	I know that the period of a satellite in a high altitude orbit is greater than the period of a satellite in a lower altitude orbit.		☺	😐	☹
7.6	I am aware of the challenges of space travel.		☺	😐	☹
7.7	I am aware of potential space travel across large distances by the possible solution of attaining high velocity by using ion drive (producing a small unbalanced force over an extended period of time)		☺	😐	☹
7.8	I have a basic awareness that travelling large distances through space using a 'catapult' from a fast moving asteroid, moon or planet might be possible.		☺	😐	☹
7.9	I have a basic awareness of how astronauts manoeuvre a spacecraft in a zero friction environment, possibly to dock with the ISS		☺	😐	☹
7.10	I have a basic awareness of maintaining sufficient energy to operate life support systems in a spacecraft, with the possible solution of using solar cells with area that varies with distance from the Sun		☺	😐	☹
7.11	I can describe the risks associated with manned space exploration such as fuel load on take-off, potential exposure to radiation, pressure differential and re-entry through an atmosphere.		☺	😐	☹
7.12	I have knowledge of Newton's second and third laws and their application to space travel, rocket launch and landing.		☺	😐	☹
7.13	I can use **W=mg** to solve problems involving weight, mass and gravitational field strength, in different locations in the universe.		☺	😐	☹
Cosmology					
8.1	I can correctly use the term light year.		☺	😐	☹
8.2	I can convert between light years and metres.		☺	😐	☹
8.3	I can give a basic description of the Big Bang theory of the origin of the Universe.		☺	😐	☹
8.4	I know that the estimated age of the Universe is approximately 14 billion years or **13.8 billion years old.**		☺	😐	☹

No.	Content	✓×	Traffic Light		
8.5	I can describe how different parts of the electromagnetic spectrum are used to obtain information about astronomical objects.		☺	😐	☹
8.6	I can identify continuous and line spectra.		☺	😐	☹
8.7	I can use spectral data for known elements, to identify the elements present in stars.		☺	😐	☹

ELECTRICITY (start:________end: ________)

No.	CONTENT	✓×	Traffic Light		
Electrical Charge Carriers					
9.1	I can define electrical current as the electrical charge transferred per unit time.		☺	😐	☹
9.2	I can carry out calculations using ***Q=It*** where t is measured in seconds.		☺	😐	☹
9.3	I can explain the difference between A.C. and D.C.		☺	😐	☹
9.4	I can compare the traces of A.C with D.C when viewed on an oscilloscope or data logging software.		☺	😐	☹
Potential Difference (Voltage)					
10.1	I know that a charged particle experiences a force in an electric field		☺	😐	☹
10.2	I can describe the effect of electric fields on a charged particle		☺	😐	☹
10.3	I know the path a charged particle takes between two oppositely charged parallel plate		☺	😐	☹
10.4	I know the path a charged particle takes near a single point charge		☺	😐	☹
10.5	I know the path a charged particle takes between two oppositely charged points		☺	😐	☹
10.6	I know the path a charged particle takes between two like charged points		☺	😐	☹
10.7	I can define the potential difference (voltage) of the supply as a measure of the energy given to the charge carriers in a circuit.		☺	😐	☹
Ohm's Law					
11.1	I can make use of a *V-I* graph to determine resistance. (gradient of V against I graph = resistance)		☺	😐	☹
11.2	I can make use of an appropriate relationship to calculate potential difference (voltage), current and resistance ***V = IR*** $V_2 = \left(\frac{R_2}{R_1+R_2}\right)V_S$ $\frac{V_1}{V_2} = \frac{R_1}{R_2}$		☺	😐	☹

No.	CONTENT	✓×	Traffic Light		
11.3	I can describe the relationship between temperature and resistance of a conductor.		☺	😐	☹
11.4	I can describe that increasing the temperature of a conductor increases the resistance of the conductor. Increasing the temperature does not affect the resistance of a resistor.		☺	😐	☹
11.5	**I can describe an experiment to prove Ohm's Law.**		☺	😐	☹
Practical Electricity and Electronics					
12.1	I can make measurements of I, V and R using appropriate meters in simple and complex circuits.		☺	😐	☹
12.2	I can describe the symbol, function and application of standard electrical and electronic components including cell, battery, lamp, switch, resistor, variable resistor, voltmeter, ammeter, LED, motor, microphone, loudspeaker, photovoltaic cell, fuse, diode, capacitor, thermistor, LDR, relay and transistor		☺	😐	☹
12.3	I can draw and identify the symbols for an npn transistor, and an n-channel enhancement MOSFET		☺	😐	☹
12.4	I can explain the function of the transistors above as a switch in transistor switching circuits		☺	😐	☹
12.5	I can apply the current and voltage relationships in a series circuit. $I_s=I_1=I_2=\ldots$ $V_s=V_1+V_2=\ldots$		☺	😐	☹
12.6	I can apply the current and voltage relationships in a parallel circuit. $I_s=I_1+I_2=\ldots$ $V_s=V_1=V_2=\ldots$		☺	😐	☹
12.7	I can describe and explain practical applications of series and parallel circuits.		☺	😐	☹
12.8	I can use the relationship $R_s=R_1+R_2+R_3$ to solve problems involving total resistance of resistors in a series circuit		☺	😐	☹
12.9	I can perform calculations involving current and voltage relationships in a parallel circuit.		☺	😐	☹
12.10	I can use the relationship $\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$ to calculate the resistance of resistors in parallel circuits		☺	😐	☹
12.11	I can use the appropriate relationships to calculate the resistance of resistors in with circuits with combinations of resistors in series and parallel		☺	😐	☹
12.12	I know what happens in a circuit when I increase the resistance in both series and parallel circuits.		☺	😐	☹

No.	CONTENT	✓×	Traffic Light		
Electrical Power					
13.1	I can state that electrical power is a measure of the energy transferred by an appliance every second or the energy provided by a source per second.		☺	😐	☹
13.2	I can used the word dissipated as it relates to power.		☺	😐	☹
13.3	I am able to use ***E* = *Pt*** to solve calculations relating to Power, Energy and time.		☺	😐	☹
13.4	I know the effect of potential difference (voltage) and resistance on the current in and power developed across components in a circuit.		☺	😐	☹
13.5	I can use appropriate relationships to solve problems involving power, potential difference (voltage), current and resistance in electrical circuits. $P = IV$ $P = I^2R$ $P = \frac{V^2}{R}$		☺	😐	☹
13.6	I know that I would use a 3A fuse for most appliances rated up to 720W and a 13A fuse for appliances rated over 720W.		☺	😐	☹
13.7	I could select the appropriate fuse rating given the power rating of an electrical appliance		☺	😐	☹

PROPERTIES OF MATTER (start:________end: ________)

No.	CONTENT	✓×	Traffic Light		
Specific heat capacity					
14.1	I know that the same mass of different materials require different quantities of heat energy to raise their temperature by 1 degree Celsius.		☺	😐	☹
14.2	I am able to use ***Eh* = *cmΔT*** to carry out calculations involving: mass, heat energy, temperature change and specific heat capacity.		☺	😐	☹
14.3	I am able to explain that the temperature of a substance is a measure of the mean kinetic energy of its particles.		☺	😐	☹
14.4	I can use the principle of conservation of energy to determine heat transfer.		☺	😐	☹

No.	CONTENT	✓×	Traffic Light		
Specific Latent Heat					
15.1	I know that different materials require different quantities of heat to change the state of unit mass.		☺	😐	☹
15.2	I know that the same material requires different quantities of heat to change the state of unit mass from solid to liquid (fusion) and to change the state of unit mass from liquid to gas (vaporisation)		☺	😐	☹
15.3	I can use $E_h = ml$ to solve problems involving mass, heat energy and specific latent heat.		☺	😐	☹
Gas laws and the kinetic model					
16.1	I can explain that pressure is the force per unit area exerted on a surface		☺	😐	☹
16.2	I am able to use $P=F/A$ to calculate pressure, force and area		☺	😐	☹
16.3	I can describe the kinetic model of a gas.		☺	😐	☹
16.4	I can describe the kinetic model of a gas and how this accounts for pressure		☺	😐	☹
16.5	I can convert temperatures between Kelvin and degrees Celsius and understand the term absolute zero of temperature.		☺	😐	☹
16.6	I know that **0 K = -273 °C**		☺	😐	☹
16.7	I can explain the relationship between the volume, pressure and temperature of a fixed mass of gas using qualitative (info) in terms of kinetic theory.		☺	😐	☹
16.8	I can use appropriate relationships to calculate the volume, pressure and temperature of a fixed mass of gas $p_1V_1/T_1(K)= p_2V_2/T_2(K)$. $p_1V_1 = p_2V_2$ $p_1/T_1(K) = p_2/T_2(K)$ $V_1/T_1(K) = V_2/T_2(K)$ $pV/T(K)= constant$		☺	😐	☹
16.9	I can describe an experiment to verify Boyle's Law (pressure and volume)		☺	😐	☹
16.10	I can describe an experiment to verify Gay-Lussac's Law (pressure and temperature)		☺	😐	☹
16.11	I can describe an experiment to verify Charles' Law (volume and temperature)		☺	😐	☹

WAVES (start:________end: ________)

No.	CONTENT	✓✗	Traffic Light		
Wave parameters and behaviours					
17.1	I can state that energy can be transferred as waves.		☺	😐	☹
17.2	I can define transverse waves as waves where the particles of the medium vibrate at right angles to the direction of energy travels.		☺	😐	☹
17.3	I can define longitudinal waves as waves where the energy travels along in the same plane as the particles vibrate.		☺	😐	☹
17.4	I know that sound is an example of longitudinal waves and waves in the e-m spectrum are transverse waves.		☺	😐	☹
17.5	I can determine the frequency, period, wavelength, amplitude and wave speed for longitudinal and transverse waves.		☺	😐	☹
17.6	I can make use of the relationships between wave speed, frequency, wavelength, distance, number of waves and time ***($v = f\lambda$) ($d = vt$)($f=1/T$) ($f=N/t$) ($\lambda=d/N$.)***.		☺	😐	☹
17.7	I can describe diffraction and associated practical limitations.		☺	😐	☹
17.8	I can state that long wave diffract more than short-waves.		☺	😐	☹
17.9	I know that diffraction occurs when waves pass through a gap or around an object.		☺	😐	☹
17.10	I can draw diagrams using wavefronts to show diffraction when waves pass through a gap or around an object.		☺	😐	☹
Electromagnetic Spectrum					
18.1	I can state the relative frequency and wavelength bands of the electromagnetic spectrum.		☺	😐	☹
18.2	I can make reference to typical sources, detectors and applications, of the electromagnetic spectrum.		☺	😐	☹
18.3	I can state that all radiations in the electromagnetic spectrum are transverse.		☺	😐	☹
18.4	I can state that all radiations in the electromagnetic spectrum travel at the same speed of light (3×10^{8} ms^{-1} in air)		☺	😐	☹
Refraction					
19.1	I know that refraction occurs when waves pass from one medium to another.		☺	😐	☹
19.2	I can give a description of refraction in terms of change of direction (where angle of incidence is greater than 0°)for waves passing into both a more dense and a less dense medium.		☺	😐	☹

No.	CONTENT	✓×	Traffic Light		
19.3	I can describe the qualitative (info) relationship between the frequency and the energy associated with a form of radiation.		☺	😐	☹
19.4	I can identify the normal, angle of incidence and angle of refraction in ray diagrams showing refraction.		☺	😐	☹

RADIATION (start:________end: ________)

No.	CONTENT	✓×	Traffic Light		
Nuclear Radiation					
20.1	I understand the nature of alpha, beta and gamma radiation: including the relative effect of ionization, and their relative penetration.		☺	😐	☹
20.2	I can explain the term 'ionisation' as the gaining or losing of electrons from (neutral) atoms		☺	😐	☹
20.3	I can state that alpha is the most ionising nuclear radiation, and gamma the least ionising.		☺	😐	☹
20.4	I can state that alpha can travel a few cm in air and is stopped by a sheet of paper, beta can travel a few metres in air and can be stopped by a few mm of aluminium and gamma radiation can travel through air and most is stopped by several cm of lead or a few metres of concrete.		☺	😐	☹
20.5	I can state that Activity is the number of nuclear disintegrations per second.		☺	😐	☹
20.6	I can state that the activity of a source is measured in becquerels.		☺	😐	☹
20.7	I can use $A=N/t$ to solve problems involving activity, number of nuclear disintegrations and time.		☺	😐	☹
20.8	I can identify background sources of radiation, e.g. cosmic radiation from space, radioactivity from rocks (e.g. granite) and soil of the earth, radiation from buildings e.g. radon, radiation from the human body etc. artificial sources, such as medical, fallout from weapons tests or power stations and radioactive waste.		☺	😐	☹
20.9	I know of the dangers of ionising radiation to living cells and of the need to measure exposure to radiation		☺	😐	☹
20.10	I can use $H = DW_R$, $D = E / m$ to solve problems involving absorbed dose and equivalent dose energy, mass and radiation weighting factor.		☺	😐	☹
20.11	I can state that the unit for absorbed dose is the Gray (Gy), the unit for equivalent dose is the Sievert (Sv) and the radiation weighting factor has no unit		☺	😐	☹

No.	CONTENT	✓×	Traffic Light		
20.12	I can use **(H dot)** $\dot{H}$**=H/t** to solve problems involving equivalent dose and time to calculate an equivalent dose rate.		☺	😐	☹
20.13	I can state the units of H dot are Sieverts per year, Sieverts per day, Sieverts per hour etc.		☺	😐	☹
20.14	I can compare equivalent dose due to a variety of natural and artificial sources.		☺	😐	☹
20.15	I know that the average annual background radiation in the UK is **2.2 mSv**		☺	😐	☹
20.16	I know that the average annual effective dose limit for a member of the public in the UK is **1 mSv** (ie 1 mSv/y)		☺	😐	☹
20.17	I know that the average annual effective dose limit for radiation workers is **20 mSv** (ie 20 mSv/y)		☺	😐	☹
20.18	I can give some applications of nuclear radiation: for example electricity generation, cancer treatment and other industrial and medical uses. For example used in smoke detectors		☺	😐	☹
20.19	I can define half-life as the ***Time for activity to decrease by half or time taken for half of the radioactive atoms to decay***		☺	😐	☹
20.20	I can use graphical and numerical data to determine the half-life		☺	😐	☹
20.21	I can describe an experiment to determine the half-life of a radioactive material.		☺	😐	☹
20.22	I can provide a qualitative (info) description of fission chain reactions and their role in the generation of energy.		☺	😐	☹
20.23	I can provide a qualitative description of fusion, plasma containment, and their role in the generation of energy.		☺	😐	☹

NOTES

SOME MATHS (MATHS INTRODUCTION)

Do not get worried about the MATHS that we use in Physics. It can easily be learned and practised.
This is about as complicated as it gets…….
e.g. Start with the formula:

$$c = b \times a$$

So what is a? $10 = 5 \times a$

So a = 2.

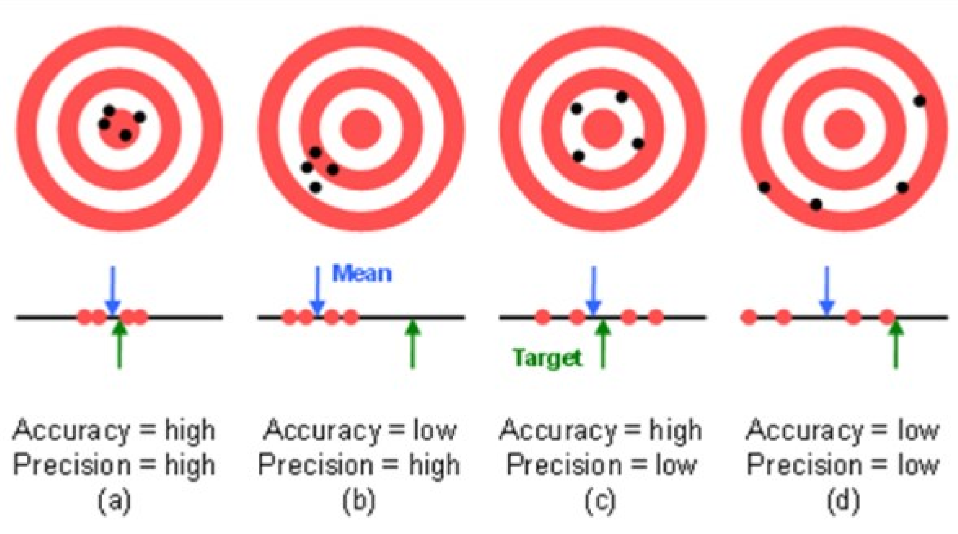
This is exactly the same as we have in Physics but instead of

$$c = b \times a$$
$$P = I \times V$$
$$10 = 5 \times V$$
$$F = m \times a$$
$$10 = 5 \times a$$
$$E = P \times t$$
$$10 = 5 \times t$$

In each e.g. the last letter always works out to be 2. We are doing the same thing each time but with different letters. This is the maths that you'll need in National 5 Physics!

ACCURACY & PRECISION

Accuracy is **how close your answer is to the true value. Precision is how repeatable a measurement is.** Use the diagram below to remind you which is which.



http://preview.tinyurl.com/lwanwoh

In Physics you will often calculate an answer to a question that has a large number of significant figures or decimal places. Because it is highly unlikely that we need to know the answer that precisely. It is important to round off any answers that you find.

How many Significant Figures?

The simple rule is this: Your answer should have no more than the number of significant figures given in the question.

If different numbers in the question are given to a different number of significant figure you should use the number of significant figures in the value given to the smallest number of significant figures.

Example

Question: A rocket motor produces 4,570N of thrust to a rocket with a mass of 7.0kg.What is the acceleration of the rocket?

The calculated answer to this question would be 652.8571429 ms^{-2} . However the least accurate value we are given in the question is the value of the mass. This is only given to two significant figures. Therefore our answer should also be to two significant figures: 650 ms^{-2} .

TACKLING MATHEMATICAL QUESTIONS

Always set out maths problems using the structure given below. It may seem to take longer but it will save time in the long run as it makes the question clearer.

USE IESSUU

http://www.youtube.com/watch?v=u7akhlAS5Ck

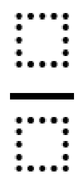
1. Information- Summarise the question by writing down what you know from the information given. Use the letter that goes with the quantity and this will help you be able to work out the correct formula
2. Equation – write down the equation as it occurs in the data sheet. Do not attempt to rearrange it before substituting.
3. Substitution – put the numbers into the equation as they appear in the formula
4. Solution – work out the answer. You are ALWAYS allowed to use a calculator
5. Units- you will need to use the correct units so will need to learn these. No or wrong units no mark for the answer
6. Underline – underline with 2 lines the answer to make your final answer clear.

In short:

1. (**I**nformation)- Summarise the question.
2. Change any units that are not standard.
3. (**E**quation) -Write out the formula.
4. (**S**ubstitution) -Put the numbers in.
5. *Use the magic triangle to rearrange the formula, only if you must!*
6. (**S**olution)- Work out the answer.
7. Write out the answer, but not to too many sig fig.
8. (**U**nits) -Add units to your answer.
9. (**U**nderline) Underline the answer

USING YOUR CALCULATORS

Remember the only friend you will have in your exam is your CALCULATOR! If you know how it works, how to turn it on! It will give you great service!

Exp / $x10^x$	This is a really important button on you calculator and one YOU MUST KNOW HOW TO USE. We can deal with numbers that are too big to copy into the calculator for example can you put in this number 147 250 000 000 000 As scientists we put it in our calculators as 1.4725 Exp / $x10^x$ 14 Be careful as people using this often get an extra 10 Eg. One of the most important numbers you will use is the speed of light which is $3x10^8$ m/s Try putting this into your calculator. It should come out at 300 000 000
Sci	Sci button displays in scientific notation form. This is ONE number before the decimal point followed by the rest of the numbers after the decimal point and then the power to convert to Eg the speed of light in air is 300 000 000 ms^{-1} 3.0 x 10^8 ms^{-1} NB This can be done during a caluclation
Eng	This puts your answer to the nearest prefix for example 500000 would become 0.5 $x10^6$, which you should know is 0.5M (how much our Head Teacher gets paid annually!)
Fix	This can limit the number of decimal places that are displayed on the calculator.
1/x or x^{-1}	Another vital button in Physics and possibly elsewhere. It is useful when you have worked out the bottom line of an equation and you want need to divide it INTO a number on the top. This button puts your number over 1 Eg 2 1/x or x^{-1} becomes ½ or one half. We will use this when working out resistance in parallel.
Fraction Button	To use this button your calculator needs to be in Maths Mode On Casio calculators find this by doing…. Shift -> mode ->1 ->1 
Powers of 10	YOU MUST LEARN THESE. Now I encourage you to replace the power of ten by its correct form. We will do lots of examples of this.
Degrees radians and gradians	For Physics, you must have your calculator in DEG, look for DRG or Deg, Rad, Grad
Degrees, minutes and seconds	You can use this to change from hours and minutes and seconds into seconds. You just need to find out how. It is really useful in questions about trains and things!
Intermediate rounding	If you must write down additional lines from 1) Equation 2) Substitution 3) Answer then round using the improper fraction button, there are less numbers to copy down incorrectly

CHANGING UNITS

Changing between cm and metres is like changing between pounds and pence as there are 100cm in a metre and 100 pence in a pound.

For example
7.8cm is like 7.8p
7.8p is £0.078
7.8cm is 0.078m

Fuel costs 1.339 pounds per litre equal to 133.p pence per litre.

What is 16cm in metres? 0.16m

FINDING THE AVERAGE

When finding the mean average you add up all the values and divide by the total number of values.

$$\text{average} = \frac{\sum x}{n}$$

Where Σ = sum of
For example
Find the average of
600, 100, 900, 450, 50
It should be 420

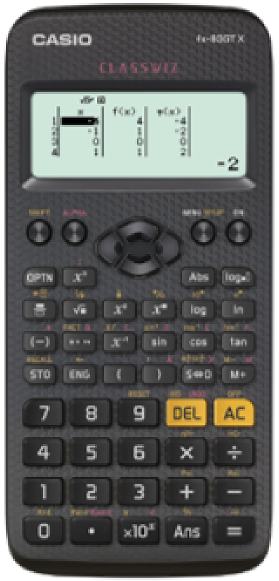
Some of you might have got 2060, which I am afraid, is the WRONG answer.

Look at what an average is it is somewhere BETWEEN the highest and lowest.

This is because you never pushed the equals button on your calculator BEFORE the divide by 5 so your sum was
600+100+900+450+ 50/5
50/5 which is 10
So your sum became
600+100+900+450+10

So EIITHER use brackets (600+100+900+450+50)/5
Or push the equals before the divide by symbol " 600+100+900+450+50=/5"
If you have the old style casio calculator the crib sheet for that is on the front page of
https://mrsphysics.co.uk/n5

CALCULATOR CRIB SHEET



Button/	How to get there	What is does
$x10^x$		Puts your answer to the power of 10, use for m, μ, k etc
ENG		Puts your answer to the power of 10 to a value that can be converted to a prefix, keep clicking the Eng to move up powers of 3 or shift Eng to move down
S↔D		Toggles between leaving your answer as a fraction or decimal
DEG		WHAT YOUR CALCULATOR MUST BE IN WHEN DOING PHYSICS USED FOR TRIG
RAD/Grad		DON'T LET YOUR CALCULATOR BE IN EITHER OF THESE
calculate		To work out a sum rather than statistics, the default setting
Input/output	Shift /set up 1	This decides if you want to use the MathIO (recommended MathI decimalO) which allows for the fraction button to be used or put in equations in a line format
Angle unit	Shift/set up 2	For checking your calculator is set to DEGREES
Number format	Shift/ set up 3	
Fix	Shift/ set up 3 /1	This fixes the number of decimal places you want to display so will round up. Use this for individual questions only
Sci	Shift/ set up 3 /2	Displays your answer in scientific notation, good when your answer requires this (lots of decimal places or a big number of sig fig etc
Norm	Shift/ set up 3 /3	Cancels the Fix and Sci but you then select the type of input you want (see above)
Norm 1~2		Selects between maths or line
Ab/c or d/c	Shift/ set up 4	Do you want vulgar fractions or full numbers and fractions
Recurring decimal	Shift / set up /down. 3	I RECOMMEND THIS BEING OFF, IT GIVES YOU THE DOT WHICH YOU MIGHT NOT NOTICE
Decimal mark	Shift/ set up / down 4	Should be set to dot, some countries use a comma instead of a dot in a number
pol	Shift +	Shift + number comma number bracket = FOR USE WITH VECTORS RIGHT ANGLED TRIANGLES, CONVERTS A VECTOR AND ANGLE TO X,Y
Rec	Shift -	**Shift – number comma number bracket = FOR USE WITH VECTORS RIGHT ANGLED TRIANGLES, Converts an X and Y to resultant and angle (but not a bearing)**
ANS		This stores the answer so you can use this for additional parts of the calculation
x^{-1}		Puts your number/answer over 1 (e.g. in Resistance in parallel)
Sin, cos, tan		Only needs for the angle in vector questions
° ′ ″		Converts between hours, mins and second
$\frac{\square}{\square}$		Fraction button RECOMMENDED to avoid problems of BODMAS

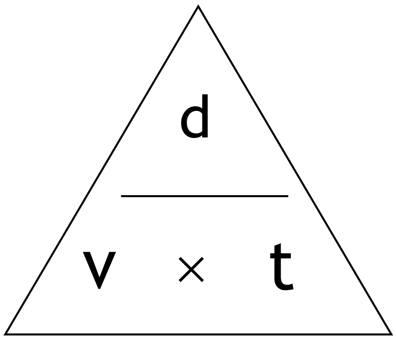
MAKING MAGIC TRIANGLES

The first thing to note is there is NO MAGIC here!
These can help rearrange your formula, **but it is much better to be able to do this without these. NEVER use these INSTEAD of FORMULA as you will not get marks!**

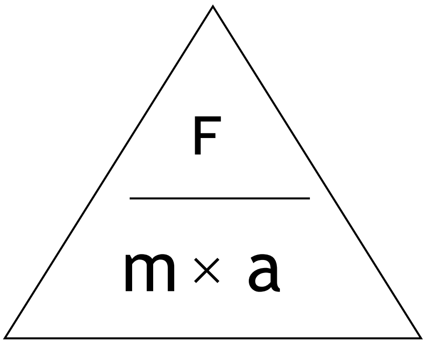
HOW DO YOU DECIDE HOW TO MAKE A MAGIC TRIANGLE?

For example

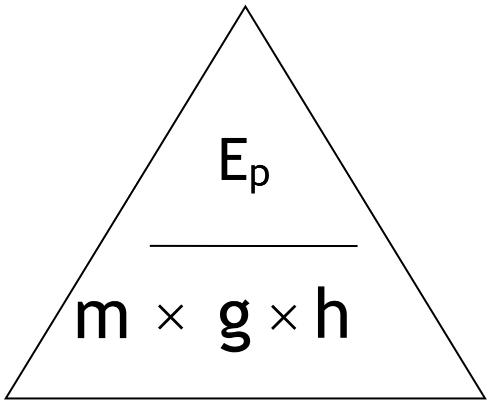
$$v = \frac{d}{t}$$



The one on the TOP of the divide goes on the TOP of the triangle
Some formula come in a line and there is no divide by in the equation for example
F=ma
If this is the case the letter ON ITS OWN on the left hand side, goes on the TOP of your triangle



What about this one?
Ep=mgh



ROUNDING OFF AND DECIMAL PLACES.

When we use a calculator we often get an answer that has more decimal places than we need. If we write them all down we will lose 33% of the marks. We must therefore round up.

Rounding off
Suppose we have the number: 5.918504
Rounding to 1 decimal place (d.p) = look at the 2nd decimal place if it is 5 or more round up, 4 or less leave as it is
Rounding to 1 decimal place (d.p) =5.9
Rounding to 2 decimal place (d.p) =5.92
Rounding to 3 decimal place (d.p) =5.919

(5 or more round up, 4 or less ignore!)

Suppose we had the number= 5.99292
Rounding to 1 decimal place (d.p) =6.0
Rounding to 2 decimal place (d.p) =5.99
Rounding to 3 decimal place (d.p) 5.993

USE THE FIX BUTTON ON YOUR CALCULATORS!

Using the exp / $x10^x$ button

The speed of light in air is 300 000 000 m/s (fast) We will use this number loads of times over the next few years. It is a big number and must be entered carefully into your calculators.
300 000 000 means 3×10^8 or $3 \times 10 \times 10 \times 10 \times 1010 \times 10 \times 10 \times 10$

THIS IS NOT THE SAME AS 3^8 WHICH EQUALS 6561

There are various ways of putting this number into your calculator.
Obviously you can do 300 000 000
you can use the x^y or y^x Here you would do 3×10 y^x 8. This should give you the correct answer.
The EASIEST WAY IS USING THE exp / ee/ $\times 10^x$ button. Here you go 3 exp8 or 3 ee8 or $3 \times 10^x 8$
PLEASE NOTE. The exp / ee/ $\times 10^x$ button means $\times 10^x$. DO NOT ADD TOO MANY 10s ON HERE!

USING SCIENTIFIC NOTATION

In Physics you will be working with very large and very small numbers.
In Astronomy you will be dealing with very large distances.
For example, the distance from Earth to the nearest star Sirius is 82 000 000 000 000 000 metres.
In atomic Physics you will be dealing with very small distances.
For example, the spacing between atoms in a solid is about 0.000 000 000 1 metres.

It is not convenient to work with numbers written out in full. For this reason, it is usual when dealing with very large or very small numbers to use *scientific notation*.

LARGE NUMBERS

5 000 000 can be written as 5×10^6.

5×10^6 - 5 multiplied by 10 six times
$5 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$

Another way of looking at this is as follows:

Firstly insert a decimal point after the first number.

5.0×10^6 - 5 0 0 0 0 0 0 . 0
the decimal point moves to the right 6 places

82 000 000 000 000 000 can be written as 8.2×10^{16}.

8.2×10^{16} - 8.2 multiplied by 10 sixteen times

$8.2 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$

Another way of looking at this is as follows:

8.2×10^{16} - 8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 . 0
the decimal point moves to the right 16 places

82 000 000 000 000 000 can also be written as 0.82×10^{17} or 82×10^{15}.

0.82×10^{17} - 0.82 multiplied by 10 seventeen times

$0.82 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$

Another way of looking at this is as follows:

0.82×10^{17} - 0 8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 . 0
the decimal point moves to the right 17 places

82×10^{15} - 82 multiplied by 10 fifteen times

82 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10

Another way of looking at this is as follows:

Firstly insert a decimal point after the first number.

82.0×10^{15} - 82 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 . 0
the decimal point moves to the right 15 places

SMALL NUMBERS

0.0000005 can be written as 5×10^{-7}.

5×10^{-7}- 5 divided by 10 seven times
5 / 10 / 10 / 10 / 10 / 10 / 10 / 10

Another way of looking at this is as follows:
Firstly insert a decimal point after the first number.

5.0×10^{-7} - 0 .0 0 0 0 0 0 5 0
the decimal point moves to the left 7 places
can be written as 1×10^{-10}.

1×10^{-10} - 1 divided by 10 ten times
1 / 10 / 10 / 10 / 10 / 10 / 10 / 10 / 10 / 10 / 10

Another way of looking at this is as follows:
Firstly insert a decimal point after the first number.

1.0×10^{-10} - 0 .0 0 0 0 0 0 0 0 0 1 0
the decimal point moves to the left 10 places
can also be written as 0.1×10^{-9}, 10×10^{-11}, etc.

0.1×10^{-9} - 0.1 divided by 10 nine times
0.1 / 10 / 10 / 10 / 10 / 10 / 10 / 10 / 10 / 10

Another way of looking at this is as follows:

0.1×10^{-9} - 0 .0 0 0 0 0 0 0 0 0 1
the decimal point moves to the left 9 places

10.0×10^{-11} - 10 divided by 10 eleven times
10 / 10 / 10 / 10 / 10 / 10 / 10 / 10 / 10 / 10 / 10 / 10

Another way of looking at this is as follows:
Firstly insert a decimal point after the first number.

10.0×10^{-11} - 0 .0 0 0 0 0 0 0 0 0 1 0 0
the decimal point moves to the left 11 places

Instead of using powers of 10, we sometimes use prefixes.

Prefixes are used to denote multiples and sub-multiples of any unit used to measure a physical quantity.

For example:

Instead of saying 1000 metres, we can say 1 kilometre.

1 kilometre can be written as:

1 km = 1000 m= 1.0×10^3 m

The 'k' before 'm' stands for kilo. The $\times 10^3$ is replaced by k.

Another example:

Instead of saying 0.001 metres, we can say 1 millimetre.

1 millimetre can be written as:

1 mm = 0.1 cm = 0.001 m = 1.0×10^{-3} m

The 'm' before 'm' stands for milli. The $\times 10^{-3}$ is replaced by m.

GRAPHS

In Physics it is often useful to use a graph to interpret and understand experimental data or a relationship between two variables. There are several types of graph we can use and they are listed below:

• Bar graphs and charts — these are (almost) never used in Physics. You can assume that if a question asks you to draw a graph the examiner is not looking for a bar graph (and you will get no marks).

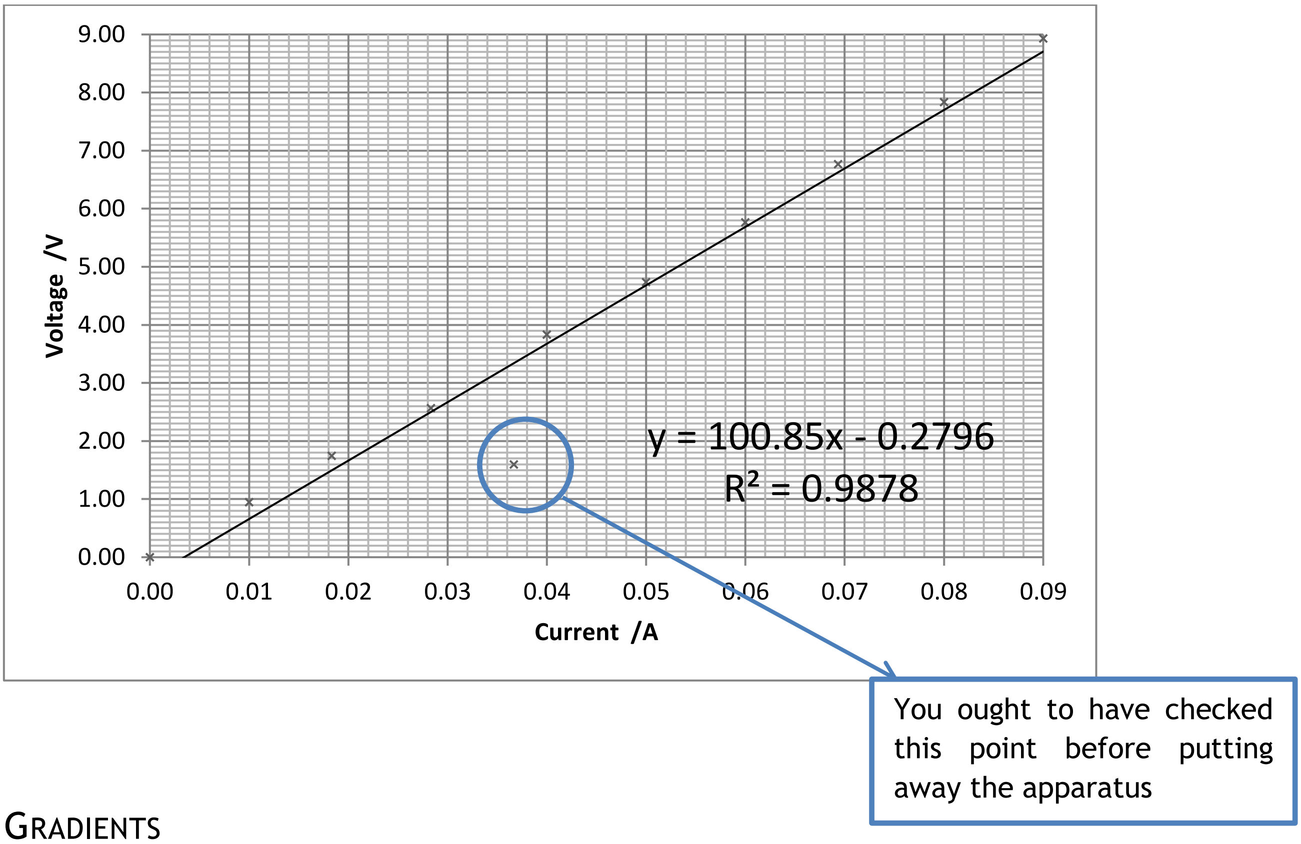
• Pie charts — these are used on occasion, typically when it is needed to represent percentages, such as showing the different energy sources used across the country.

• Line graphs — these are used sometimes in Physics, most notably in velocity/time graphs. The independent variable or time is always plotted on the x−axis. The dependant variable is always plotted on the y−axis. The points should always be plotted with an × or a +, never dots or circles. The points should be joined with straight lines. Line graphs should usually not be used for experimental data.

• Scatter graphs — the most used type of graph used in Physics. The independent variable or time is always plotted on the x−axis. The dependant variable is always plotted on the y−axis. The points should always be plotted with an × or a +, never dots or circles. If the points look like they are almost on a straight line then a line of best fit should be added.

If the points do not look straight then a free hand curve or curve of best fit should be added.

An Example of a Good Graph



Gradients

The gradient of a line is a measure of how steep the slope is. The larger the gradient the steeper the slope. For a straight line you can work out the gradient by taking any two points on the line and finding the difference in the y values and dividing by the difference in the x values. There are several ways of writing the formula for this

(gradient is represented be the letter **m**):

$$m = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

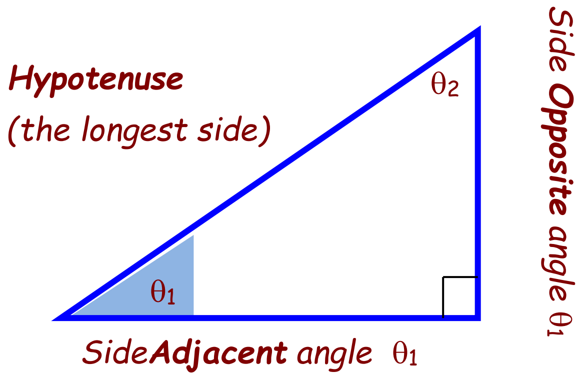
$$m = \text{change in } y \div \text{change in } x$$

TRIANGLES

DESCRIBING TRIANGLES

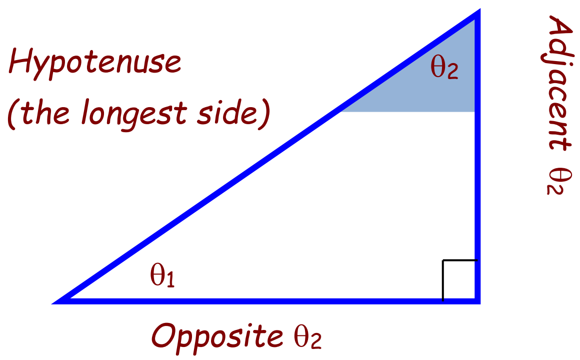
Triangles all have three sides. A special triangle you will work with is the right angled triangle. All angles in any triangle add up to **180°** In a right handed triangle as one of the sides is 90° and all angles add up to 180° then **$\theta_1+\theta_2=90°$**

To label the three sides you have to decide which of the angles you are taking as a reference point. In the top case I have used angle 1. We usually show a θ sign to show an angle. The adjacent side is the one next to the angle marked (but not the long side or hypotenuse) and the opposite is the side opposite the angle marked.



In the triangle below I have used angle 2 or θ2 as a reference, and although the hypotenuse is the same the adjacent and opposite sides are reverse.

$$\sin\theta = \frac{\text{opposite}}{hypotenuse}$$
$$\cos\theta = \frac{\text{adjacent}}{hypotenuse}$$
$$\tan\theta = \frac{\text{opposite}}{adjacent}$$

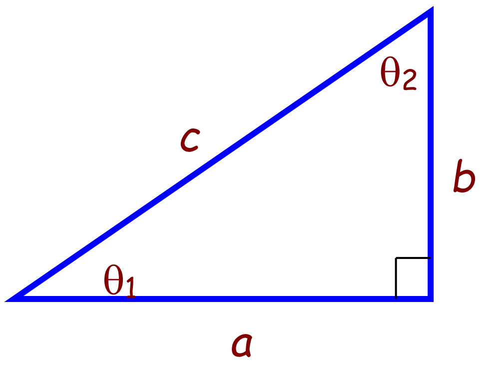


$$\sin\theta_1 = \frac{b}{c} \qquad \cos\theta_1 = \frac{a}{c}$$
$$\sin\theta_2 = \frac{a}{c} \qquad \cos\theta_2 = \frac{b}{c}$$
$$\therefore \sin\theta_1 \equiv \cos\theta_2$$
$$\tan\theta_1 = \frac{b}{a} \qquad \tan\theta_2 = \frac{a}{b}$$

PYTHAGORAS

Pythagoras discovered that the area of the two shorter sides of a right angled triangle is equal to the area of the hypotenuse. This gives us a way of calculating unknown sides of triangle

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

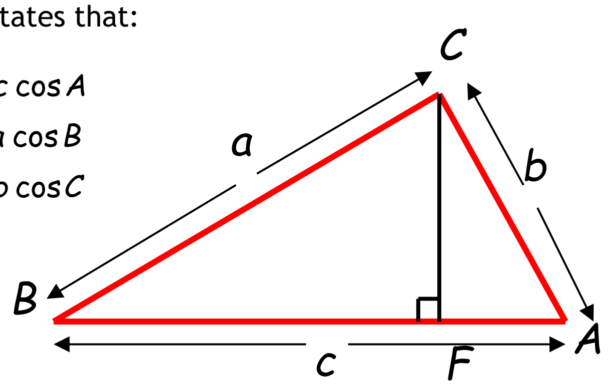


$$\theta_1 = 90 - \theta_2$$

COSINE RULE

The cosine rule for a triangle states that:

$$a^2 = b^2 + c^2 - 2bc\cos A$$
$$OR \quad b^2 = c^2 + a^2 - 2ca\cos B$$
$$OR \quad c^2 = a^2 + b^2 - 2ab\cos C$$



To prove these formula consider the following triangle, ABC:

Drop a line from C to form a perpendicular with AB at F.

$$CF = b\sin A \qquad and \qquad AF = b\cos A$$
$$so \quad BF = AB - AF = c - b\cos A$$

Using Pythagoras' theorem in the triangle BFC:

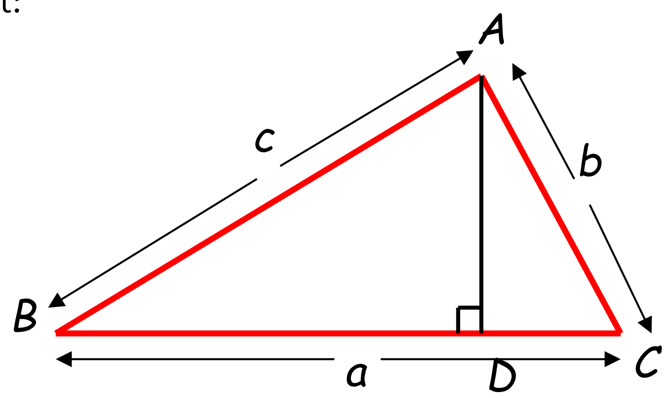
$$\begin{aligned} & BC^2 &&= BF^2 + CF^2 \\ or \quad & a^2 &&= (c - b\cos A)^2 + b^2\sin^2 A \\ & &&= c^2 - 2bc\cos A + b^2(\sin^2 A + \cos^2 A) \\ & &&= b^2 + c^2 - 2bc\cos A \end{aligned}$$

SINE RULE

The sine rule for a triangle states that:

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

To prove these formula consider the following triangle, ABC: Drop a line from C to form a perpendicular with BC at D.

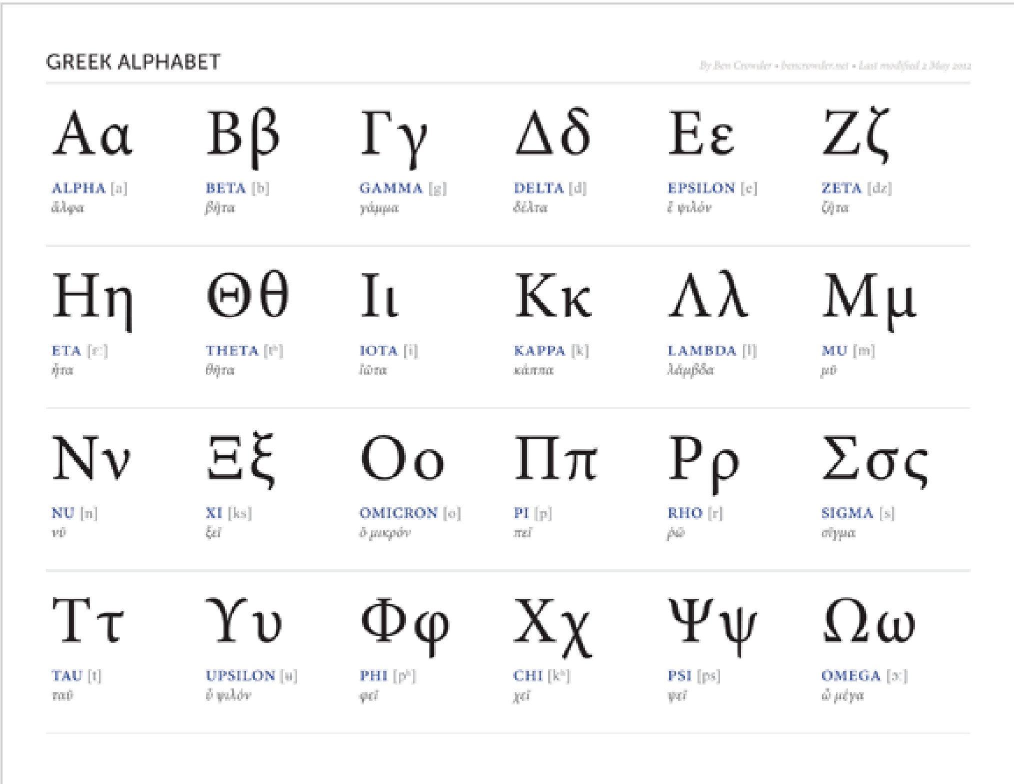


$$AD = c \sin B = b \sin C$$

$$\therefore \frac{b}{\sin B} = \frac{c}{\sin C}$$

GREEK SYMBOLS

In Physics we often use greek letters as symbols for physical quantities (such as wavelength), units (such as Ohms) and prefixes (micro). Below is a handy guide to what these letters are:



COMMAND WORDS

There are no questions on the Physics N5 paper 2- honestly! Instead there will be commands for you to complete. Here is a table showing the command words that are used in the exams. When you go through past paper questions you will see these terms being frequently used.

Word	What you are expected to do
describe	you must provide a statement or structure of characteristics and/or features;
determine or calculate	you must determine a number from given facts, figures or information; You should use numbers given in the question to work out the answer. You should always show your working, as it may be possible for the examiner to award some marks for the method even if the final answer is wrong. Always give the units as the final mark is for the answer and unit.
estimate	you must determine an approximate value for something;
explain	you must relate cause and effect and/or make relationships between things clear. Students should make something clear, or state the reasons for something happening. The answer should **not** be a simple list of reasons. This means that points in the answer must be linked coherently and logically. All of the stages/steps in an explanation must be included to gain full marks.
identify, name, give, or state	you need only name or present in brief form. Only a short answer is required, not an explanation or a description. Often it can be answered with a single word, phrase or sentence. If the question asks you to state, give, or write down one (or two etc) examples, you should write down only the specified number of answers, or you may not be given the mark for some correct examples given.
justify	you must give reasons to support their suggestions or conclusions, eg this might be by identifying an appropriate relationship and the effect of changing variables;

Word	What you are expected to do
predict	you must suggest what may happen based on available information;
show that	you must use the appropriate formula to prove something e.g. a given value – All steps, **including the stated answer and units**, must be shown;
suggest	you must apply their knowledge and understanding of physics to a new situation. A number of responses are acceptable: marks will be awarded for any suggestions that are supported by knowledge and understanding of physics.
use your knowledge of physics or aspect of physics to comment on	you must apply your skills, knowledge and understanding to respond appropriately to the problem/situation presented (for example by making a statement of principle(s) involved and/or a relationship or equation, and applying these to respond to the problem/situation). you will be rewarded for the breadth and/or depth of their conceptual understanding.
Use the information in the passage/ diagram/ graph/ table to…	The answer must be based on the information given in the question. Unless the information given in the question is used, no marks can be given.
compare	This requires you to describe the similarities and/or differences between things, not just write about one. If you are asked to 'compare *x* with *y*', you need to write down something about *x* compared to *y*, using comparative words such as 'better, 'more than', 'less than', 'quicker', 'more expensive', 'on the other hand.'

NOTES