Keeping you afloat

B.A. daVinci with Physics

https://mrsphysics.co.uk/

2025

CfE Higher Physics Compendium

NAME: ____________________

CLASS: ____________________

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Mostly Harmles
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DATA SHEET

COMMON PHYSICAL QUANTITIES

Quantity	*Symbol*	*Value*	*Quantity*	*Symbol*	*Value*
Speed of light in vacuum	c	$3{\cdot}00 \times 10^{8}$ m s^{-1}	Planck's constant	h	$6{\cdot}63 \times 10^{-34}$ J s
Magnitude of the charge on an electron	e	$1{\cdot}60 \times 10^{-19}$ C	Mass of electron	m_e	$9{\cdot}11 \times 10^{-31}$ kg
Universal Constant of Gravitation	G	$6{\cdot}67 \times 10^{-11}$ m^3 kg^{-1} s^{-2}	Mass of neutron	m_n	$1{\cdot}675 \times 10^{-27}$ kg
Gravitational acceleration on Earth	g	$9{\cdot}8$ m s^{-2}	Mass of proton	m_p	$1{\cdot}673 \times 10^{-27}$ kg
Hubble's constant	H_0	$2{\cdot}3 \times 10^{-18}$ s^{-1}			

REFRACTIVE INDICES

The refractive indices refer to sodium light of wavelength 589 nm and to substances at a temperature of 273 K.

Substance	*Refractive index*	*Substance*	*Refractive index*
Diamond	2·42	Water	1·33
Crown glass	1·50	Air	1·00

SPECTRAL LINES

Element	*Wavelength/nm*	*Colour*	*Element*	*Wavelength/nm*	*Colour*
Hydrogen	656	Red	Cadmium	644	Red
	486	Blue-green		509	Green
	434	Blue-violet		480	Blue
	410	Violet	Lasers		
	397	Ultraviolet	*Element*	*Wavelength/nm*	*Colour*
	389	Ultraviolet	Carbon dioxide	9550 }	Infrared
Sodium	589	Yellow		10590 }	
			Helium-neon	633	Red

PROPERTIES OF SELECTED MATERIALS

Substance	*Density/kg m^{-3}*	*Melting Point/K*	*Boiling Point/K*
Aluminium	$2{\cdot}70 \times 10^{3}$	933	2623
Copper	$8{\cdot}96 \times 10^{3}$	1357	2853
Ice	$9{\cdot}20 \times 10^{2}$	273	. . . .
Sea Water	$1{\cdot}02 \times 10^{3}$	264	377
Water	$1{\cdot}00 \times 10^{3}$	273	373
Air	1·29	. . . .	. . . .
Hydrogen	$9{\cdot}0 \times 10^{-2}$	14	20

The gas densities refer to a temperature of 273 K and a pressure of $1{\cdot}01 \times 10^{5}$ Pa.

NEXT PAGE

RELATIONSHIPS REQUIRED FOR HIGHER PHYSICS

$$d = \bar{v}t$$
$$s = \bar{v}t$$
$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$
$$s = \frac{1}{2}(v + u)t$$
$$F = ma$$
$$W = mg$$
$E_w = Fd$, or $W = Fd$
$$E_p = mgh$$
$$E_k = \frac{1}{2}mv^2$$
$$P = \frac{E}{t}$$
$$p = mv$$
$$Ft = mv - mu$$
$$F = G\frac{m_1 m_2}{r^2}$$
$$t' = \frac{t}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}$$
$$l' = l\sqrt{1 - \left(\frac{v}{c}\right)^2}$$
$$f_o = f_s\left(\frac{v}{v \pm v_s}\right)$$
$$z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}}$$
$$z = \frac{v}{c}$$
$$v = H_o d$$

$$W = QV$$
$$E = mc^2$$
$$I = \frac{P}{A}$$
$$I = \frac{k}{d^2}$$
$$I_1 d_1^2 = I_2 d_2^2$$
$$E = hf$$
$$E_k = hf - hf_o$$
$$v = f\lambda$$
$$E_2 - E_1 = hf$$
$$d\sin\theta = m\lambda$$
$$n = \frac{\sin\theta_1}{\sin\theta_2}$$
$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$$
$$\sin\theta_c = \frac{1}{n}$$

$$V_{rms} = \frac{V_{peak}}{\sqrt{2}}$$
$$I_{rms} = \frac{I_{peak}}{\sqrt{2}}$$
$$T = \frac{1}{f}$$
$$V = IR$$
$$P = IV = I^2R = \frac{V^2}{R}$$
$$R_T = R_1 + R_2 + \cdots$$
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$$
$$V_1 = \left(\frac{R_1}{R_1 + R_2}\right)V_s$$
$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$
$$E = V + Ir$$
$$C = \frac{Q}{V}$$
$$Q = It$$
$$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$$

$$Path\ difference = m\lambda\ or\ \left(m + \frac{1}{2}\right)\lambda,\ where\ m = 0,1,2 \ldots$$
$$Random\ Uncertainty = \frac{max\ value - \min value}{number\ of\ values}$$
$$or\ \Delta R = \frac{R_{max} - R_{min}}{n}$$

ANNOTATED RELATIONSHIPS SHEET FOR HIGHER PHYSICS

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

$$distance\ (m) = average\ speed\ (ms^{-1}) \times time\ (s)$$

$$s = \bar{v}t$$

$$displacement\ (m) = average\ velocity\ (ms^{-1}) \times time\ (s)$$

$$v = u + at$$

$$final\ velocity\ (ms^{-1}) = initial\ velocity\ (ms^{-1}) + acceleration\ (ms^{-2}) \times time\ (s)$$

$$s = ut + \frac{1}{2}at^2$$

$$displacement = initial\ velocity\ \times time + \frac{1}{2} \times acceleration\ (ms^{-2}) \times time^2\ (s^2)$$

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

$$final\ velocity^2\ (ms^{-1})^2 = initial\ velocity^2 (ms^{-1})^2 + 2 \times acceleration\ (ms^{-2}) \times dispacement\ (m)$$

$$s = \frac{1}{2}(v + u)t$$

$$displacement\ (m) = \frac{1}{2} \times (final\ velocity\ (ms^{-1}) + initial\ velocity\ (ms^{-1})) \times time\ (s)$$

$$F = ma$$

$$force\ (N) = mass\ (kg) \times acceleration\ (ms^{-2})$$

$$W = mg$$

$$weight\ (N) = mass\ (kg) \times gravitational\ field\ strength\ (N\ kg^{-1})$$

$$E_w = Fd$$

$$work\ done\ (J) = force\ (N) \times distance\ (m)$$

$$E_p = mgh$$

$$gravitational\ potential\ energy\ (J) = mass\ (kg) \times gravitational\ field\ strength\ (N\ kg^{-1}) \times vertical\ height\ (m)$$

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

$$kinetic\ energy\ (J) = \frac{1}{2} \times mass\ (kg) \times speed^2 (ms^{-1})^2$$

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

$$power\ (W) = \frac{energy\ (J)}{time\ (s)}$$

$$p = mv$$

$$momentum\ (kgms^{-1}) = mass (kg)\ \times velocity\ (ms^{-1})$$

$$Ft = mv - mu$$

$$Impulse\ (Ns) = mass\ (kg) \times final\ velocity\ (ms^{-1}) - mass\ (kg) \times initial\ velocity\ (ms^{-1})$$

$$Impulse\ (Ns) = change\ in\ momentum\ (kg\ ms^{-1})$$

$$F = G\frac{m_1 m_2}{r^2}$$

$$Force\ (N) = Universal\ gravitational\ Constant\ (m^3kg^{-1}s^{-2})\frac{Mass_1 (kg) \times Mass_2 (kg)}{separation\ distance^2\ (m^2)}$$

NB The Universal Gravitational Constant $= 6.67 \times 10^{-11}\ m^3kg^{-1}s^{-2}$

$$t' = \frac{t}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}$$

$$relativistic\ time\ (s) = \frac{time\ (s)}{\sqrt{1 - \left(\frac{speed\ (ms^{-1})}{speed\ of\ light\ in\ vacuum\ (ms^{-1})}\right)^2}}$$

NB time can be in other units as this is a ratio, but both times must be in the same unit.

$c = 3.0 \times 10^8\ ms^{-1}$

$$l' = l\sqrt{1 - \left(\frac{v}{c}\right)^2}$$

$$relativistic\ length\ (m) = length\ (m)\ \times \sqrt{1 - \left(\frac{speed\ (ms^{-1})}{speed\ of\ light\ in\ vacuum\ (ms^{-1})}\right)^2}$$

$c = 3.0 \times 10^8\ ms^{-1}$

$$f_o = f_s\left(\frac{v}{v \pm v_s}\right)$$

$$\underset{(Hz)}{frequency\ observed} = \underset{(Hz)}{frequency\ of\ source} \times \left(\frac{speed\ of\ sound\ (ms^{-1})}{\underset{(ms^{-1})}{speed\ of\ sound} \pm \underset{(ms^{-1})}{velocity\ of\ source}}\right)$$

ADD when the object moves AWAY from the observer and

TAKE AWAY (subtract) when the object comes TOWARDS the observer

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$$z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}}$$

$$Redshift\ (no\ unit) = \frac{observed\ wavelength\ (m) - rest\ wavelength\ (m)}{rest\ wavelength\ (m)}$$

$$z = \frac{v}{c}$$

$$Redshift\ (no\ unit) = \frac{recessional\ velocity\ (ms^{-1})}{speed\ of\ light\ in\ vacuum\ (ms^{-1})}$$

$$v = H_o d$$

$$\frac{recessional\ velocity}{(ms^{-1})} = \frac{Hubble's\ Constant}{(s^{-1})} \times \frac{distance\ from\ galaxy\ to\ observer}{(m)}$$

NB for this course the Hubble Constant Ho is given as 2·3 x 10^{-18} s^{-1}

$$W = QV$$

$$Work\ done\ moving\ a\ charge\ across\ a\ p.d.\ (J) = electrical\ charge\ (C) \times voltage\ (V)$$

$$E = mc^2$$

$$Energy\ (J) = mass\ (kg) \times speed\ of\ light\ squared\ (ms^{-1})^2$$

NB the speed of light squared is equal to 9.0 $\times 10^{16}$ m^2s^{-2}

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

$$irradiance\ (Wm^{-2}) = \frac{power\ (W)}{area\ (m^2)}$$

$$I = \frac{k}{d^2}$$

$$irradiance\ (Wm^{-2}) = \frac{constant\ (W)}{distance^2 (m^2)}$$

This is more easily understood as

$$irradiance (Wm^{-2}) \times distance^2 (m^2) = constant\ value\ (W)$$

$$I_1 d_1^2 = I_2 d_2^2$$

$$irradiance_1\ (Wm^{-2}) \times initial\ distance\ ^2 (m^2) = Irradiance_2\ (Wm^{-2}) \times final\ distance\ ^2 (m^2)$$

$$E = hf$$

$$energy\ (J) = Planck's\ Constant\ (Js) \times frequency\ (Hz)$$

NB Planck's constant = 6.63 x 10^{-34} Js

$$E_k = hf - hf_o$$

$$\frac{Kinetic\ Energy}{(J)} = \left(\frac{Planck's\ Constant}{(Js)} \times \frac{incident\ frequency}{(Hz)}\right) - \left(\frac{Planck's\ Constant}{(Js)} \times \frac{threshold\ frequency}{(Hz)}\right)$$

NB Planck's constant = 6.63 x 10^{-34} Js

hf_o is also known as the work function (J), hf is the energy of the incident photon (J)

$$v = f\lambda$$

$$speed\ (ms^{-1}) = frequency\ (Hz) \times wavelength\ (m)$$

$$E_2 - E_1 = hf$$

$$most\ excited\ energy (J) - least\ excited\ energy\ (J) = Planck's\ Constant\ (Js) \times frequency\ (Hz)$$

$$d\sin\theta = m\lambda$$

$$Slit\ separation\ (m) \times sin\ of\ angle\ from\ centre\ to\ the\ spot = m\ \ a\ whole\ number\ of\ wavelengths\ (m)$$

NB This equation is for constructive interference

$$n = \frac{\sin\theta_1}{\sin\theta_2}$$

$$Refractive\ index = \frac{sine\ of\ the\ angle\ in\ vacuum/air}{sine\ of\ the\ angle\ in\ the\ material}$$

$$\frac{sin\,\theta_1}{sin\,\theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$$

$$Refractive\ index = \frac{sin\ of\ the\ angle\ in\ vacuum/air}{sin\ of\ the\ angle\ in\ the\ material} = \frac{wavelength\ (air)(m)}{wavelength\ (material)(m)} = \frac{speed\ \ (air)\ (ms^{-1})}{speed\ (material)(ms^{-1})}$$

$$refractive\ index = ratio\ of\ wavelengths\ in\ vacuum/air\ and\ material$$

$$refractive\ index = ratio\ of\ the\ speeds\ in \frac{vacuum}{air} and\ the\ material$$

This formula really applies to material 1 being a vacuum, but there is not much difference between the refractive indexes of air and a vacuum ∴ we assume for Higher they have the same value.

$$\sin\theta_c = \frac{1}{n}$$

$$Sine\ of\ the\ critical\ angle = \frac{1}{refractive\ index}$$

The critical angle is the angle in the material when the angle in air is 90°

$$V_{rms} = \frac{V_{peak}}{\sqrt{2}}$$

$$root\ mean\ square\ A.C. voltage\ (V) = \frac{peak\ voltage\ (V)}{1.414}$$

$$I_{rms} = \frac{I_{peak}}{\sqrt{2}}$$

$$root\ mean\ square\ A.C. current\ (A) = \frac{peak\ current\ (A)}{1.414}$$

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

$$Period\ (s) = \frac{1}{Frequency\ (Hz)}$$

$$V = IR$$

$$Voltage(V) = Current\ (A) \times Resistance(\Omega)$$

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

$$Power\ (W) = current\ (A) \times voltage(V) = current\ ^2(A^2) \times Resistance\ (\Omega) = \frac{Voltage^2\ (V^2)}{Resistance\ (\Omega)}$$

For resistors in series

$$R_T = R_1 + R_2 + \cdots$$

$$total\ resistance\ (\Omega) = resistance\ _1(\Omega) + resistance\ _2(\Omega) + \cdots$$

For resistors in parallel

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

$$\frac{1}{total\ resistance\ (\Omega)} = \frac{1}{resistance\ _1(\Omega)} + \frac{1}{resistance\ _2(\Omega)} + \cdots$$

$$V_1 = \left(\frac{R_1}{R_1 + R_2}\right) V_s$$

$$voltage\ across\ component\ 1\ in\ potential\ divider(V) = \left(\frac{resistance_1\ (\Omega)}{total\ resistance(\Omega)}\right) \times supply\ voltage\ (V)$$

For resistances in series (potential divider circuits)

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

Ratio of the voltages in series = ratio of the resistance in series

$$\frac{Voltage\ across\ resistor 1\ (V)}{voltageacross\ resistor\ 2\ (V)} = \frac{resistance\ of\ resistor 1\ (\Omega)}{resistance\ of\ resistor\ 2\ (\Omega)}$$

$$E = V + Ir$$

$$e.m.f\ (V) = \ terminial\ potential\ difference\ (V) + \ current\ (A) \times\ internal\ resistance\ (\Omega)$$

This can also be written as

$$E = I(R + r) \quad or \quad E = IR + Ir$$

I is the total current in the circuit, r is in series with the combined circuit resistance

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$$C = \frac{Q}{V}$$

$$Capacitance\ (F) = \frac{Charge\ (C)}{Voltage\ (V)}$$

$$Q = It$$

$$Charge\ (C) \ = \ current\ (A) \times time\ (s)$$

$$This\ is\ better\ explained\ as\ current\ is\ the\ rate\ of\ flow\ of\ charge\ \left(I = \frac{Q}{t}\right)$$

$$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$$

$$\underset{(J)}{Energy\ stored\ in\ capacitor} = \frac{1}{2} \times \underset{(C)}{charge\ stored\ in\ capacitor} \times \underset{(V)}{voltage\ across\ capacitor}$$

$$\underset{(J)}{Energy\ stored\ in\ capacitor} = \frac{1}{2} \times \underset{(F)}{capacitance} \times \underset{(V)^2}{voltage\ across\ capacitor^2}$$

$$\underset{(J)}{Energy\ stored\ in\ capacitor} = \frac{1}{2} \times \frac{(charge\ stored\ in\ capacitor)^2\ (C^2)}{voltage\ across\ capacitor (V)}$$

$$Path\ difference = m\lambda\ or\ \left(m + \frac{1}{2}\right)\lambda, where\ m = 0, 1, 2 \ldots$$

$$\underset{(m)}{Path\ difference} = \underset{(constructive\ interference)}{whole\ number\ of\ wavelengths}$$

$$\underset{(m)}{path\ difference} = \underset{(destructive\ interference)}{whole\ number\ of\ wavelengths + \frac{1}{2}\ a\ wavelength}$$

$$Random\ Uncertainty = \frac{Max\ value - \min value}{number\ of\ values}$$

$$or\ \Delta R = \frac{R_{max} - R_{min}}{n}$$

NB for the random uncertainty in a value the units of the random uncertainty are the same as for the quantity you are finding the uncertainty for.

$$Random\ Uncertainty(units\ of\ the\ quantity) = \frac{Max\ value - \min value}{number\ of\ values}$$

QUANTITY SYMBOL UNIT AND UNIT SYMBOL

Physical Quantity	Symbol	Unit	Unit Abb.
acceleration	a	metre per second per second	m s^{-2}
acceleration due to gravity	g	metre per second per second	m s^{-2}
amplitude	A	metre	m
angle	θ	degree	°
area	A	square metre	m^2
average speed	$\bar{v}$	metres per second	m s^{-1}
average velocity	$\bar{v}$	metres per second	m s^{-1}
capacitance	C	farad	F
change of speed	Δv	metre per second	m s^{-1}
change of velocity	Δv	metre per second	m s^{-1}
critical angle	θc	degree	°
current	I	ampere	A
displacement	s	metre	m
distance	D	metre, light year	m , ly
distance, depth, height	d or h	metre	m
electric charge	Q	coulomb	C
electric charge	Q or q	coulomb	C
electric current	I	ampere	A
electric field strength	E	newton per coulomb volts per metre	N C^{-1} Vm^{-1}
electromotive force (e.m.f)	E or ε	volt	V
energy	E	joule	J
energy level	E_1, E_2	joule	J
final velocity	v	metre per second	m s^{-1}
force	F	newton	N
force, tension, upthrust, thrust	F	newton	N
frequency	f	hertz	Hz
frequency of source	f_s	hertz	Hz
fringe separation	Δx	metre	m

Physical Quantity	Symbol	Unit	Unit Abb.
grating to screen distance	D	metre	m
gravitational field strength	g	newton per kilogram	N kg^{-1}
gravitational potential energy	E_p	joule	J
heat energy	E_h	joule	J
height, depth	h	metre	m
impulse	Ft	newton second kilogram metre per second	Ns kgm s^{-1}
initial speed	u	metre per second	ms^{-1}
initial velocity	u	metre per second	m s^{-1}
internal resistance	r	ohm	Ω
irradiance	I	watt per square metre	W m^{-1}
kinetic energy	Ek	joule	J
length	l	metre	m
mass	m	kilogram	kg
momentum	p	kilogram metre per second	kg m s^{-1}
number of photons per second per cross sectional area	N	-	-
observed wavelength	$\lambda_{observed}$	metre	m
peak current	I_{peak}	ampere	A
peak voltage	V_{peak}	volt	V
period	T	second	s
Planck's constant	h	joule second	Js
potential difference	V	volt	V
potential energy	E_p	joule	J
power	P	watt	W
pressure	P or p	pascal	Pa
radius	r	metre	m
Redshift	Z	-	-
refractive index	n	-	-
relativistic length	l'	metre	m
relativistic time	t'	second	s
resistance	R	ohm	Ω
rest wavelength	λ_{rest}	metre	m
root mean square current	I_{rms}	ampere	A
root mean square voltage	V_{rms}	volt	V
slit separation	d	metre	m
specific heat capacity	c	joule per kilogram per kelvin	$Jkg^{-1}K^{-1}$
specific latent heat	l	joule per kilogram	Jkg^{-1}
speed of light in a vacuum	c	metre per second	m s^{-1}
speed, final speed	v	metre per second	ms^{-1}
speed, velocity, final velocity	v	metre per second	m s^{-1}

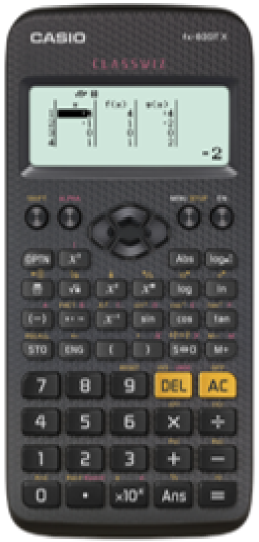
Physical Quantity	**Symbol**	**Unit**	**Unit Abb.**
supply voltage	V_s	volt	V
temperature	T	degree Celsius	°C
temperature	T	kelvin	K
threshold frequency	f_o	hertz	Hz
time	t	second	s
total resistance	R_t	ohm	Ω
velocity of observer	v_o	metre per second	m s^{-1}
velocity of source	v_s	metre per second	m s^{-1}
voltage	V	volt	V
voltage, potential difference	V	volt	V
volume	V	cubic metre	m^3
Wavelength	λ	metre	m
weight	W	newton	N

GREEK ALPHABET

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

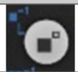
CALCULATOR CRIBSHEET

Instructions for the old style Casio are on the front page of mrsphysics in the resources table https://mrsphysics.co.uk/higher



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 Mathl 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 / down. 3	I RECOMMEND THIS BEING OFF, IT GIVES YOU THE DOT WHICH YOU MIGHT NOT NOTICE
Decimal mark	Shift 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
		Fraction button RECOMMENDED to avoid problems of BODMAS

Let's set up the calculator				
Settings button (above the blue button) 	Calculator setting click ok	Input/output	Choose MathsI/DecimalO	Choose 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 format	Choose degree	WHAT YOUR CALCULATOR MUST BE IN WHEN DOING PHYSICS USED FOR TRIG
		Number format	Choose either setting	
		Fraction results	Choose improper fraction	Do you want vulgar fractions or full numbers and fractions
		(down) Decimal mark	Choose dot	Should be set to dot, some countries use a comma instead of a dot in a number
		(down) Digit separator	Choose on	(this spreads out the number so it is easier to read).
Settings button (above the blue button)	system setting click ok	Contrast	Use the L and R arrows until the colour difference is good	
		Autopower off	10 mins except for exam then 60 mins	
		Multiline font	Normal font, unless you've really great eyesight!	
Catalog (the one with a book)Ca 	Catalogue->Numeric calc	Recurring decimal		
	Catalogue-> angle/coord/sexa_> rect to polar	Rect to Polar	Pol(adjacent,opposite)	**FOR USE WITH VECTORS RIGHT ANGLED TRIANGLES, Converts an X and Y to resultant and angle (but not a bearing) Does your trig for you. Enter Pol(ADJACENT,OPPOSITE) to get the comma press shift and then). Don't forget the) on the end** Answer gives r= hypotenuse θ = angle between adjacent and hypotenuse
	Catalogue-> angle/coord/sexa_>down arrow-> rect to polar	Polar to Rect	Rec(hypotenuese,angle)	FOR USE WITH VECTORS RIGHT ANGLED TRIANGLES, CONVERTS A VECTOR AND ANGLE TO X,Y **Enter Rec(hypotenuse,angle) to get the comma press shift and then). Don't forget the) on the end.** Answer gives adjacent (X) and then opposite (Y)

Button/	How to get there	What is does
Sin, cos, tan	First buttons above the number keys. Mark sure calculator is in degrees	Only needs for the angle in vector questions
° ′ ″		Converts between hours, mins and second.
x10ˣ		Puts your answer to the power of 10, use for m, µ, k etc and the speed of light 3  8. **With this calculator it is probably best to bracket powers of 10!**
		Fraction button RECOMMENDED to avoid problems of BODMAS and for resistance in parallel questions. BEWARE: https://www.youtube.com/watch?v=rEXWHcyMklo
Fix		This fixes the number of decimal places you want to display so will round up. Use this for individual questions only
Sci		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		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
pol	Catalogue-> angle/coord/sexa_> rect to polar	**FOR USE WITH VECTORS RIGHT ANGLED TRIANGLES, Converts an X and Y to resultant and angle (but not a bearing) Does your trig for you.** **Enter Pol(ADJACENT,OPPOSITE) to get the comma press shift and then). Don't forget the) on the end**
Rec	Catalogue-> angle/coord/sexa_>down arrow-> rect to polar	FOR USE WITH VECTORS RIGHT ANGLED TRIANGLES, CONVERTS A VECTOR AND ANGLE TO X,Y **Enter Rec(hypotenuse,angle) to get the comma press shift and then). Don't forget the) on the end**
ANS	Find it two buttons below the blue shift button	This stores the answer so you can use this for additional parts of the calculation
x⁻¹		Puts your number/answer over 1 (eg in Resistance in parallel) Nowadays it is easier to use $\frac{\square}{ANS}$
π	Shift 7 now gets you pi!	 Can also get this through the catalog funtion, but why would you? It is a terrible place to get it! Catalog->down until you reacher "other"-> right arrow-> right arrow-> ok
Power button		For you powers, beware the shift and this button has limited use, especially when using powers of 10.
root		Direct algebraic logic states that you need to use this button before putting the number in. This button is the square root, Shift and this button allows for other roots such as cube root etc.

	When you have done your calculation you can decide how you want to display the answer.	 And down arrow And down arrow	Decimal	Allows you to change your answer to a decimal
			Recurring decimal	Will give you a recurring decimal DON'T USE unless you've got really good light
			Improper fraction	Can be useful if you want to hold over a value and don't want intermediate rounding errors.
			Mixed fraction	Not recommended
			ENG Notation	GREAT! 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, or use the right and left arrows to alter between the
			Sexagesimal	

ADD SOME NOTES FOR YOUR CALCULATOR SETTINGS

PERIODIC TABLE

Electron Arrangements of Elements

Key

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

SI UNITS

There is an international standard for units called the Systeme International D'Unites, SI units for short.

These consist of seven basic units, two of which we do not use in this course (the unit of luminous intensity, the candela, and the amount of substance containing a certain number of elementary particles, the mole).

The 5 basic units we use are units of mass, length, time, temperature and current. Every other unit can be expressed using a combination of these seven basic units.

Quantity	Symbol	Units
Mass	m	kilogram, kg
Length	l	metre, m
Time	t	second, s
Temperature	T	degrees Celsius, Kelvin, K
Current	I	ampere, A

e.g. Velocity is measured in metres per second, ms^{-1}

TRIGANOMETRY

PYTHAGORAS

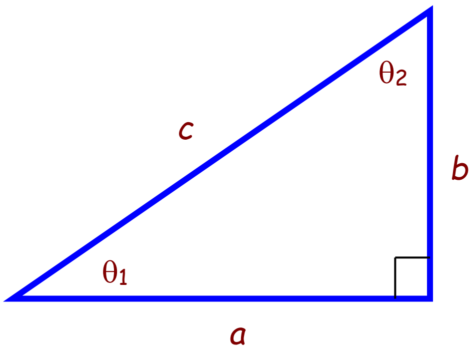
$$c^2 = a^2 + b^2$$

$$\sin\theta_1 = \frac{b}{c} \qquad \cos\theta_1 = \frac{a}{c}$$

$$\sin\theta_2 = \frac{a}{c} \qquad \cos\theta_2 = \frac{b}{c}$$

$$\therefore \sin\theta_1 \equiv \cos\theta_2$$

$$\tan\theta_1 = \frac{b}{a} \qquad \tan\theta_2 = \frac{a}{b}$$



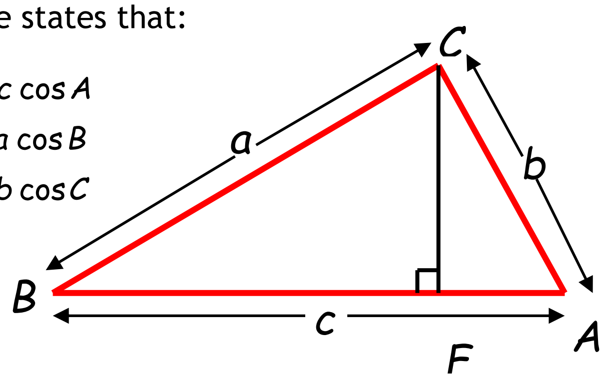
COSINE RULE

The cosine rule for a triangle states that:

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

OR $$b^2 = c^2 + a^2 - 2ca\cos B$$

OR $$c^2 = a^2 + b^2 - 2ab\cos C$$



To prove these formula consider the following triangle, ABC:

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

$$CF = b \sin A \text{ and } AF = b \cos A$$
$$\text{so } BF = AB - AF = c - b \cos A$$

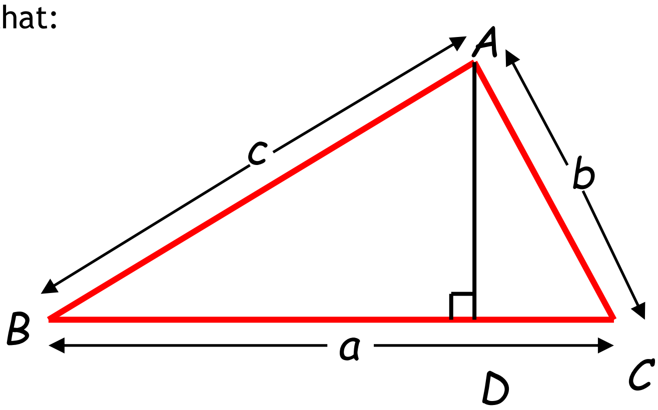
Using Pythagoras' theorem in the triangle BFC:

$$BC^2 = BF^2 + CF^2$$
$$\text{or } a^2 = (c - b \cos A)^2 + b^2 \sin^2 A$$
$$= c^2 - 2bc \cos A + b^2(\sin^2 A + \cos^2 A)$$
$$= b^2 + c^2 - 2bc \cos A$$

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.

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

PREFIXES

Prefix	Symbol	Multiple	Multiple in full
Tera	T	$\times 10^{12}$	x1 000 000 000 000
Giga	G	$\times 10^{9}$	x1 000 000 000
Mega	M	$\times 10^{6}$	x1 000 000
Kilo	k	$\times 10^{3}$	x1 000
		x1	1
Milli	m	$\times 10^{-3}$	÷1 000
Micro	µ	$\times 10^{-6}$	÷1 000 000
Nano	n	$\times 10^{-9}$	÷1 000 000 000
Pico	p	$\times 10^{-12}$	÷1 000 000 000 000

Above is a table of prefixes, which you will commonly find in Higher Physics.

NB THE STANDARD UNIT FOR MASS IS THE KILOGRAM. Do not try changing it to grams!

Watch out for ms which is milli seconds not metres per second!

THE PHYSICS COURSE

The following material is taken from the Higher Course Specifications version 1.0 April 2018 produced by the SQA. https://www.sqa.org.uk/sqa/47916.html

There are three units to this course and an Assignment

OUR DYNAMIC UNIVERSE

The topics covered are:

- motion – equations and graphs
- forces, energy and power
- collisions, explosions, and impulse
- gravitation
- special relativity
- the expanding Universe

PARTICLES AND WAVES

The topics covered are:

- forces on charged particles
- the Standard Model
- nuclear reactions
- inverse square law
- wave-particle duality
- interference
- spectra
- refraction of light

ELECTRICITY

The topics covered are:

- monitoring and measuring AC
- current, potential difference, power, and resistance
- electrical sources and internal resistance
- capacitors
- semiconductors and p-n junctions

There is also an assignment which must be completed.

The length of time for students to complete the course is 160 hours.
There are three parts to the exam.

Component	Marks	Scaled mark	Duration & Notes
Question paper 1: multiple choice	25	25	45 minutes
Question paper 2	130	95	2 hours and 15 minutes
Assignment	20	30	8 hours including a max of 2 hours for the writing stage

COURSE ASSESSMENT STRUCTURE: QUESTION PAPERS

QUESTION PAPER 1: MULTIPLE CHOICE 25 MARKS

QUESTION PAPER 2: 130 MARKS

The question papers total 155 marks, and makes up 80% of the overall marks

Question paper 1 contains multiple-choice questions and has 25 marks. This is not scaled.

Question paper 2 contains restricted-response and extended-response questions and has 130 marks. This is scaled to 95 marks.

A data sheet and a relationships sheet are provided. The majority of the marks are awarded for applying knowledge and understanding. The other marks are awarded for applying scientific inquiry, scientific analytical thinking and problemsolving skills.

COURSE ASSESSMENT STRUCTURE: ASSIGNMENT

ASSIGNMENT 20 MARKS

The assignment has a total mark allocation of 20 marks. This is scaled to 30 marks by SQA. This contributes 20% to the overall marks for the course assessment.

The assignment assesses the application of skills of scientific inquiry and related physics knowledge and understanding.

It allows assessment of skills that cannot be assessed through the question paper, for example the handling and processing of data gathered from experimental work by the candidate.

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 TO THE ASSIGNMENT

Section	Expected response	Marks
Aim.	An aim that describes clearly the purpose of the investigation	1
Underlying physics	An account of the physics relevant to the aim of the investigation.	3
Data collection and handling	A brief summary of an approach used to collect experimental data.	1
	Sufficient raw data from the candidate's experiment.	1
	Data, including any mean and/or derived values, presented in correctly produced table.	1
	Data relevant to the experiment obtained from an internet/literature source or data relevant to the aim of the investigation obtained from a second experiment.	1
	A citation and reference for a source of internet/literature data or information.	1
Graphical presentation	Axes of the graph have suitable scales.	1
	Axes of the graph have suitable labels and units.	1
	Accurately plotted data points and, where appropriate, a line of best fit.	1
Uncertainties	Scale reading uncertainties and random uncertainties.	2
Analysis	Analysis of experimental data.	1
Conclusion	A valid conclusion that relates to the aim and is supported by all the data in the report.	1
Evaluation	Evaluation of the investigation.	3
Structure	A clear and concise report with an informative title.	1
TOTAL		**20**

COURSE OUTCOMES / SUCCESS CRITERIA

NB Bold comments are straight learn statements and can be copied to make flashcards. Red typeface indicates the core experiments.

UNCERTAINTIES

No	CONTENT	✓ ✗	Traffic Light		
1.	**Uncertainties**				
eq	$\text{random uncertainty} = \frac{\text{max. value - min. value}}{\text{number of values}}$ or $\Delta R = \frac{R_{max} - R_{min}}{n}$		☺	😐	☹
1.1	I can identify that **all measurements of physical quantities are liable to uncertainty** which I can express in absolute or percentage form.		☺	😐	☹
1.2	I can quantify and recognise scale reading, random and systematic uncertainties in a measured quantity.		☺	😐	☹
1.3	I can express uncertainties in absolute or percentage form		☺	😐	☹
1.4	I know that **random uncertainties arise when an experiment is repeated and slight variations occur.**		☺	😐	☹
1.5	I can explain that **scale reading uncertainty is a measure of how well an instrument scale can be read.**		☺	😐	☹
1.6	I know that **scale reading uncertainty is an indication of how precisely a scale can be read.**		☺	😐	☹
1.7	I can state that **random uncertainties can be reduced by taking repeated measurements.**		☺	😐	☹
1.8	I can explain that **systematic uncertainties occur when readings taken are either all too small or all too large.**		☺	😐	☹
1.9	I can recognise that **systematic uncertainties can arise due to measurement techniques or experimental design.**		☺	😐	☹
1.10	I know **the mean of a set of repeated measurements is the best estimate of the 'true' value of the quantity being measured.**		☺	😐	☹
1.11	I know that **when systematic uncertainties are present, they offset the mean value**		☺	😐	☹
1.12	I know **when mean values are used, the approximate random uncertainty should be calculated.**		☺	😐	☹
1.13	I can correctly calculate, use and identify uncertainties during data analysis.		☺	😐	☹
1.14	I know that **when an experiment is being undertaken and more than one physical quantity is measured, the quantity with the largest percentage uncertainty should be identified and this may often be used as a good estimate of the percentage uncertainty in the final numerical result of an experiment.**		☺	😐	☹
1.15	I can express the numerical result of an experiment in the form final value ±uncertainty.		☺	😐	☹

UNITS PREFIXES AND SCIENTIFIC NOTATION

No	CONTENT	✓ ✗	Traffic Light		
2.	**Units, prefixes and scientific notation**				
2.1	I know the units for all of the physical quantities used in this unit.		☺	😐	☹
2.2	I can use the prefixes: pico (p), nano (n), micro (μ), milli (m), kilo (k), mega (M), giga (G) and tera (T).		☺	😐	☹
2.3	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).		☺	😐	☹
2.4	I can use scientific notation when large and small numbers are used in calculations.		☺	😐	☹

OUR DYNAMIC UNIVERSE (START:________END: ________)

No	CONTENT	✓ ✗	Traffic Light		
3.	**Equations of Motion**				
Eq	$d = \bar{v}t$, $s = \bar{v}t$; $s = \frac{1}{2}(u+v)t$; $v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$		☺	😐	☹
3.1	I can use the equations of motion to find distance, displacement, speed, velocity, and acceleration for objects with constant acceleration in a straight line.		☺	😐	☹
3.2	I can interpret and draw motion-time graphs for motion with constant acceleration in a straight line, including graphs for bouncing objects and objects thrown vertically upwards.		☺	😐	☹
3.3	I know the interrelationship of displacement-time, velocity-time and acceleration- time graphs.		☺	😐	☹
3.4	I can calculate distance, displacement, speed, velocity, and acceleration from appropriate graphs (graphs restricted to constant acceleration in one dimension, inclusive of change of direction).		☺	😐	☹
3.5	***I can give a description of an experiment to measure the acceleration of an object down a slope***		☺	😐	☹

4.	**Forces, energy and power**				
Eq	$W = mg$ $F = ma$ Ew or $W = Fd$ $Ep = mgh$ $Ek = ½ mv^2$ $E = Pt$		☺	😐	☹
4.1	I can use vector addition and appropriate relationships to solve problems involving balanced and unbalanced forces, mass, acceleration and gravitational field strength.		☺	😐	☹
4.2	I know the effects of friction on a moving object (static and dynamic friction are not required)		☺	😐	☹
4.3	I can identify and explain the effects of friction on moving objects. I do not need to use reference to static and dynamic friction.		☺	😐	☹

No	CONTENT	✓ ✗	Traffic Light		
4.4	I can identify and explain, in terms of forces an object moving with terminal velocity		☺	😐	☹
4.5	I can interpret and produce velocity-time graphs for a falling object when air resistance is taken into account.		☺	😐	☹
4.6	I can analyse motion using Newton's first and second laws.		☺	😐	☹
4.7	I can use free body diagrams and appropriate relationships to solve problems involving friction and tension.		☺	😐	☹
4.8	I can resolve a vector into two perpendicular components.		☺	😐	☹
4.9	I can resolve the weight of an object on a slope into a component acting parallel (down the slope) and a component acting normal to the slope.		☺	😐	☹
4.10	I can use the principle of conservation of energy and appropriate relationships to solve problems involving work done, potential energy, kinetic energy and power.		☺	😐	☹

5.	**Collisions and explosions**				
eq	$p = mv$ $Ft = mv - mu$ $E_k = \frac{1}{2}mv^2$		☺	😐	☹
5.1	I can use the principle of conservation of momentum and an appropriate relationship to solve problems involving the momentum, mass and velocity of objects interacting in one dimension.		☺	😐	☹
5.2	I can explain the role in kinetic energy in determining whether a collision is described as elastic and inelastic collisions or in explosions.		☺	😐	☹
5.3	I can use appropriate relationships to solve problems involving the total kinetic energy of systems of interacting objects.		☺	😐	☹
5.4	I can use Newton's third law to explain the motion of objects involved in interactions.		☺	😐	☹
5.5	I can draw and interpret force-time graphs involving interacting objects.		☺	😐	☹
5.6	I know that **the impulse of a force is equal to the area under a force-time graph and is equal to the change in momentum of an object involved in the interaction.**		☺	😐	☹
5.7	I can use data from a force-time graph to solve problems involving the impulse of a force, the average force and its duration.		☺	😐	☹
5.8	I can use appropriate relationships to solve problems involving mass, change in velocity, average force and duration of the force for an object involved in an interaction.		☺	😐	☹

6.	**Gravitation**				
Eq	$d = \bar{v}t,\ s = \bar{v}t;\ s = \frac{1}{2}(u+v)t;$ $v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ $F = \frac{Gm_1m_2}{r^2}$		☺	😐	☹
6.1	I can use the equation $F = \frac{Gm_1m_2}{r^2}$		☺	😐	☹
6.2	***I can give a description of an experiment* to measure the acceleration of a falling object.**		☺	😐	☹
6.3	I know that **the horizontal motion and the vertical motion of a projectile are independent of each other.**		☺	😐	☹
6.4	I know that **satellites are in free fall around a planet/star.**		☺	😐	☹
6.5	I can resolve the initial velocity of a projectile into horizontal and		☺	😐	☹

No	CONTENT	✓ ✗	Traffic Light		
	vertical components and their use in calculations.				
6.6	I can use resolution of vectors, vector addition, and appropriate relationships to solve problems involving projectiles.		☺	😐	☹
6.7	I can use Newton's Law of Universal Gravitation to solve problems involving force, masses and their separation.		☺	😐	☹

7.	**Special relativity**				
Eq	$t' = \frac{t}{\sqrt{1-\frac{v^2}{c^2}}}$ $l' = l\sqrt{1-\frac{v^2}{c^2}}$		☺	😐	☹
7.1	I know that **the speed of light in a vacuum is the same for all observers.**		☺	😐	☹
7.2	I know that **measurements of space, time and distance for a moving observer are changed relative to those for a stationary observer, giving rise to time dilation and length contraction**.		☺	😐	☹
7.3	I can use appropriate relationships to solve problems involving time dilation, length contraction and speed.		☺	😐	☹

8.	**The expanding Universe**				
Eq	$f_o = f_s\left(\frac{v}{v \pm v_s}\right)$ $f_{\text{observed}} = f_{source}\frac{v}{[v+v_{source}]}$ $v = H_0 d$ $z = \frac{v}{c}$ $z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}}$		☺	😐	☹
8.1	I know that **the Doppler effect causes shifts in wavelengths of sound and light.**		☺	😐	☹
8.2	I can use appropriate relationship to solve problems involving the observed frequency, source frequency, source speed and wave speed.		☺	😐	☹
8.3	I know that **the light from objects moving away from us is shifted to longer wavelengths (redshift**).		☺	😐	☹
8.4	I know that **the redshift of a galaxy is the change in wavelength divided by the emitted wavelength. For slowly moving galaxies, redshift is the ratio of the recessional velocity of the galaxy to the velocity of light**.		☺	😐	☹
8.5	I can use appropriate relationships to solve problems involving redshift, observed wavelength, emitted wavelength, and recessional velocity		☺	😐	☹
8.6	I can use appropriate relationship to solve problems involving the Hubble constant, the recessional velocity of a galaxy and its distance from us.		☺	😐	☹
8.7	I know that **Hubble's law allows us to estimate the age of the Universe.**		☺	😐	☹
8.8	I know that **measurements of the velocities of galaxies and their distance from us lead to the theory of the expanding Universe**.		☺	😐	☹
8.9	I know that **the mass of a galaxy can be estimated by the orbital speed of stars within it.**		☺	😐	☹
8.10	I know that **evidence supporting the existence of dark matter comes from estimations of the mass of galaxies.**		☺	😐	☹
8.11	I know that **evidence supporting the existence of dark energy comes from the accelerating rate of expansion of the Universe**.		☺	😐	☹

No	CONTENT	✓ ×	Traffic Light		
8.12	I know that **the temperature of stellar objects is related to the distribution of emitted radiation over a wide range of wavelengths.**		☺	😐	☹
8.13	I know that **the peak wavelength of this distribution is shorter for hotter objects than for cooler objects.**		☺	😐	☹
8.14	I know that **hotter objects emit more radiation per unit surface area per unit time than cooler objects.**		☺	😐	☹
8.15	I know of **evidence supporting the big bang theory and subsequent expansion of the Universe: cosmic microwave background radiation, the abundance of the elements hydrogen and helium, the darkness of the sky (Olbers' paradox) and the large number of galaxies showing redshift rather than blueshift.**		☺	😐	☹

PARTICLES AND WAVES (START:________END: ________)

No	CONTENT	✓×	Traffic Light		
9.	**Forces on charged particles**				
Eq	$W = QV$ $\quad E_k = \frac{1}{2}mv^2$		☺	😐	☹
9.1	I know that **charged particles experience a force in an electric field.**		☺	😐	☹
9.2	I know that **electric fields exist around charged particles and between charged parallel plates.**		☺	😐	☹
9.3	I can sketch electric field patterns for single-point charges, systems of two-point charges and between two charged parallel plates (ignore end effects).		☺	😐	☹
9.4	I can determine the direction of movement of charged particles in an electric field.		☺	😐	☹
9.5	I can define **voltage (potential difference) as the work done moving unit charge between two points**		☺	😐	☹
9.6	I can solve problems involving the charge, mass, speed, and energy of a charged particle in an electric field and the potential difference through which it moves.		☺	😐	☹
9.7	I know that **a moving charge produces a magnetic field.**		☺	😐	☹
9.8	I can determine the direction of the force on a charged particle moving in a magnetic field for negative and positive charges using the slap rule or other method.		☺	😐	☹
9.9	I know the basic operation of particle accelerators in terms of acceleration by electric fields, deflection by magnetic fields and high-energy collisions of charged particles to produce other particles.		☺	😐	☹

10.	**Standard Model**				
10.1	I know that **the Standard Model is a model of fundamental particles and interactions.**		☺	😐	☹

No	CONTENT	✓✗	Traffic Light		
10.2	I can describe the Standard Model in terms of types of particles and groups		☺	😐	☹
10.3	I can use orders of magnitude and am aware of the range of orders of magnitude of length from the very small (sub-nuclear) to the very large (distance to furthest known celestial objects).		☺	😐	☹
10.4	I know that **evidence for the existence of quarks comes from high-energy collisions between electrons and nucleons, carried out in particle accelerators.**		☺	😐	☹
10.5	I know that **in the Standard Model, every particle has an antiparticle.**		☺	😐	☹
10.6	I know that **the production of energy in the annihilation of particles is evidence for the existence of antimatter**		☺	😐	☹
10.7	I know that **beta decay was the first evidence for the neutrino.**		☺	😐	☹
10.8	I know the equation for β- decay above (β+ decay not required) ${}^{1}_{0}n \rightarrow {}^{1}_{1}p + {}^{0}_{-1}e + \overline{\nu_e}$		☺	😐	☹
10.9	I know that **fermions, the matter particles, consist of quarks (six types: up, down, strange, charm, top, bottom) and leptons (electron, muon and tau, together with their neutrinos).**		☺	😐	☹
10.10	I know that **hadrons are composite particles made of quarks.**		☺	😐	☹
10.11	I know that **baryons are made of three quarks.**		☺	😐	☹
10.12	I know that **mesons are made of quark-antiquark pairs.**		☺	😐	☹
10.13	I know that **the force-mediating particles are bosons: photons (electromagnetic force), W- and Z-bosons (weak force), and gluons (strong force).**		☺	😐	☹

11.	**Nuclear reactions**				
eq	$E = mc^2$		☺	😐	☹
a)	I can use nuclear equations to describe radioactive decay, fission (spontaneous and induced), with reference to mass and energy equivalence.		☺	😐	☹
b)	I can use nuclear equations to describe fusion reactions, with reference to mass and energy equivalence.		☺	😐	☹
c)	Use of an appropriate relationship to solve problems involving the mass loss and the energy released by a nuclear reaction. $E = mc^2$		☺	😐	☹
d)	I know that **nuclear fusion reactors require charged particles at a very high temperature (plasma) which have to be contained by magnetic fields.**		☺	😐	☹

12.	**Inverse square law**				
eq	$I = \frac{P}{A}$ $I = \frac{k}{d^2}$ $I_1 d_1^2 = I_2 d_2^2$		☺	😐	☹

No	CONTENT	✓×	Traffic Light		
a)	I know that **irradiance is the power per unit area incident on a surface.**		☺	😐	☹
b)	I can use the equation $I = \frac{P}{A}$ to solve problems involving irradiance, the power of radiation incident on a surface and the area of the surface.		☺	😐	☹
c)	I know that **irradiance is inversely proportional to the square of the distance from a point source.**		☺	😐	☹
d)	***I can describe an experiment to verify the inverse square law for a point source of light***		☺	😐	☹
e)	I can use $I = \frac{k}{d^2}$ and $I_1 d_1^2 = I_2 d_2^2$ to solve problems involving irradiance and distance from a point source of light.		☺	😐	☹

13.	Wave Particle Duality				
eq	$E = hf \quad E = \frac{hc}{\lambda} \qquad E_k = hf - hf_0 \qquad E_k = \frac{1}{2}mv^2 \quad and\ v = f\lambda$		☺	😐	☹
a)	I know that **the photoelectric effect is evidence for the particle model of light.**		☺	😐	☹
b)	I know that **photons of sufficient energy can eject electrons from the surface of materials (photoemission).**		☺	😐	☹
c)	I can use $E = hf$ and $E = \frac{hc}{\lambda}$ to solve problems involving the frequency and energy of a photon.		☺	😐	☹
d)	I know that **the threshold frequency, *f_0* is the minimum frequency of a photon required for photoemission.**		☺	😐	☹
e)	I know that **the work function, *W* or *hf_0* of a material is the minimum energy of a photon required to cause photoemission.**		☺	😐	☹
f)	I can use $E_k = hf - hf_0 \quad E_k = \frac{1}{2}mv^2\ and\ v = f\lambda$ to solve problems involving the mass, maximum kinetic energy and speed of photoelectrons, the threshold frequency of the material, and the frequency and wavelength of the photons.		☺	😐	☹

14.	Interference				
Eq	$path\ difference = m\lambda\ or\ \left(m + \frac{1}{2}\right)\lambda$ where *m* =0,1,2. $d\ sin\theta = m\lambda$		☺	😐	☹
a)	I know that **interference is evidence for the wave model of light.**		☺	😐	☹
b)	I know that **coherent waves have a constant phase relationship.**		☺	😐	☹
c)	I can describe of the conditions for constructive and destructive interference in terms of the phase difference between two waves.		☺	😐	☹
d)	I know that **maxima are produced when the path difference between waves is a whole number of wavelengths**		☺	😐	☹
e)	I know that **minima are produced when the path difference between waves is an odd number of half-wavelengths respectively.**		☺	😐	☹

No	CONTENT	✓×	Traffic Light		
f)	I can use $path\ difference = m\lambda\ or\ (m+\frac{1}{2})\lambda$ where *m* =0,1,2... to solve problems involving the path difference between waves, wavelength and order number.		☺	😐	☹
g)	I can use $d\ sin\theta = m\lambda$ to solve problems involving grating spacing, wavelength, order number and angle to the maximum.		☺	😐	☹

15.	**Spectra**				
Eq	$E_2 - E_1 = hf$ and $E = hf$		☺	😐	☹
a)	I have knowledge of the Bohr model of the atom.		☺	😐	☹
b)	I can explain the Bohr model of the atom using the terms *ground state, energy levels, ionisation and zero potential energy*.		☺	😐	☹
c)	I know the mechanism of production of line emission spectra, continuous emission spectra and absorption spectra in terms of electron energy level transitions.		☺	😐	☹
d)	I can use $E_2 - E_1 = hf$ and $E = hf$ to solve problems involving energy levels and the frequency of the radiation emitted/absorbed.		☺	😐	☹
e)	I know that **the absorption lines (Fraunhofer lines) in the spectrum of sunlight provide evidence for the composition of the Sun's outer atmosphere.**		☺	😐	☹

16.	**Refraction**				
Eq	$n = \frac{\sin\theta_1}{\sin\theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$ and $v = f\lambda$ and $\sin\theta_c = \frac{1}{n}$		☺	😐	☹
a)	I can define **absolute refractive index of a medium as the ratio of the speed of light in a vacuum to the speed of light in the medium.**		☺	😐	☹
b)	I can use $n = \frac{\sin\theta_1}{\sin\theta_2}$ to solve problems involving absolute refractive index, the angle of incidence and the angle of refraction.		☺	😐	☹
c)	***I can describe an experiment to determine the refractive index of a medium.***		☺	😐	☹
d)	I can use $\frac{\sin\theta_1}{\sin\theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$ and $v = f\lambda$ to solve problems involving the angles of incidence and refraction, the wavelength of light in each medium, the speed of light in each medium, and the frequency, including situations where light is travelling from a more dense to a less dense medium.		☺	😐	☹
e)	I know that the refractive index of a medium increases as the frequency of incident radiation increases.		☺	😐	☹

No	CONTENT	✓ ×	Traffic Light		
f)	I can define critical angle as the angle of incidence which produces an angle of refraction of 90°.		☺	😐	☹
g)	I know that total internal reflection occurs when the angle of incidence is greater than the critical angle.		☺	😐	☹
h)	I can use $\sin\theta_c = \frac{1}{n}$ to solve problems involving critical angle and absolute refractive index.		☺	😐	☹

ELECTRICITY (START:_________END: _________

No	CONTENT	✓ ×	Traffic Light		
17.	**Monitoring and Measuring A.C.**				
eq	$T = \frac{1}{f}$ $V_{rms} = \frac{V_{peak}}{\sqrt{2}}$ $I_{rms} = \frac{I_{peak}}{\sqrt{2}}$		☺	😐	☹
a)	I know that **an A.C. is a current which changes direction and instantaneous value with time.**		☺	😐	☹
b)	I can use $V_{rms} = \frac{V_{peak}}{\sqrt{2}}$ $I_{rms} = \frac{I_{peak}}{\sqrt{2}}$ to solve problems involving peak and r.m.s. values.		☺	😐	☹
c)	I can determine the frequency, peak voltage and r.m.s. values from graphical data.		☺	😐	☹
d)	I can use $T = \frac{1}{f}$ to determine the frequency.		☺	😐	☹

18.	**Current, potential difference, power and resistance**				
eq	$V = IR$ $P = IV = I^2R = \frac{V^2}{R}$ $R_T = R_1 + R_2 + \ ...$		☺	😐	☹
Eq	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + ...$ $V_2 = \left(\frac{R_2}{R_1 + R_2}\right)V_S$ $\frac{V_1}{V_2} = \frac{R_1}{R_2}$		☺	😐	☹
a)	I can use relationships involving potential difference, current, resistance and power to analyse circuits even those that may involve several steps in the calculations.		☺	😐	☹
b)	I can correctly use calculations involving potential dividers circuits.		☺	😐	☹

19.	**Electrical sources and internal resistance**				
eq	$E = V + Ir$ $V = IR$		☺	😐	☹
a)	I can correctly use and explain the terms electromotive force (E.M.F), internal resistance, lost volts, terminal potential difference (t.p.d) ideal supplies, short circuits and open circuits.		☺	😐	☹

No	CONTENT	✓ ✗	Traffic Light		
b)	I can use $E = V + Ir$ and $V = IR$ to solve problems involving EMF, lost volts, t.p.d., current, external resistance, and internal resistance.		☺	😐	☹
c)	*I can describe of an experiment to measure the EMF and internal resistance of a cell.*		☺	😐	☹
d)	I can determine electromotive force, internal resistance and short circuit current using graphical analysis.		☺	😐	☹

20.	**Capacitors**				
eq	$C = \frac{Q}{V}$ $Q = It$ $E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$		☺	😐	☹
a)	I know that **a capacitor of 1 farad will store 1 coulomb of charge when the potential difference across it is 1 volt**.		☺	😐	☹
b)	I can use the equation C=Q/V to solve problems involving capacitance, charge and potential difference.		☺	😐	☹
c)	I can use the equation $Q = It$ to determine the charge stored on a capacitor for a constant charging current.		☺	😐	☹
d)	I know **the total energy stored in a charged capacitor is equal to the area under a charge-potential difference graph**.		☺	😐	☹
e)	I can use $E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$ to solve problems involving energy, charge, capacitance, and potential difference.		☺	😐	☹
f)	I know the variation of **current** with time for both charging and discharging cycles of a capacitor in an RC circuit (charging and discharging curves).		☺	😐	☹
g)	I know the variation of **potential difference** with time for both charging and discharging cycles of a capacitor in an RC circuit (charging and discharging curves).		☺	😐	☹
h)	I know the effect of resistance and capacitance on charging and discharging curves in an RC circuit.		☺	😐	☹
i)	*I can describe experiments to investigate the variation of current in a capacitor and voltage across a capacitor with time, for the charging and discharging of capacitors*		☺	😐	☹

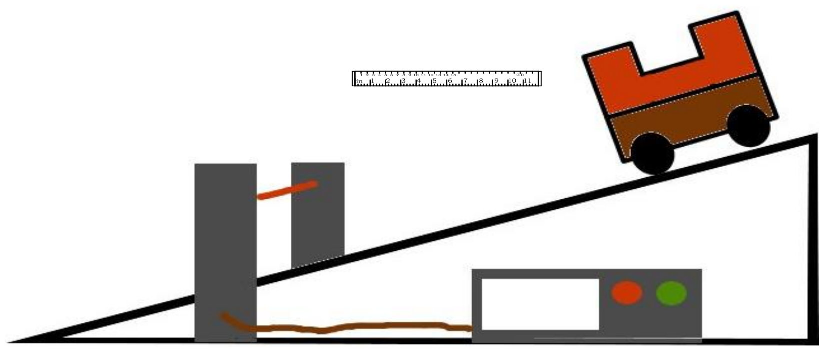
21.	**Semiconductors and p-n junctions**				
a)	I know and can explain the terms conduction band and valence band.		☺	😐	☹
b)	I know that **solids can be categorised into conductors, semiconductors or insulators by their band structure and their ability to conduct electricity. Every solid has its own characteristic energy band structure. For a solid to be conductive, both free electrons and accessible empty states must be available.**		☺	😐	☹
c)	I can explain qualitatively the electrical properties of conductors, insulators and semiconductors using the electron population of the conduction and valence bands and the energy difference between the conduction and valence bands. (Reference to Fermi levels is not required.)		☺	😐	☹
d)	I know that **the electrons in atoms are contained in energy levels. When the atoms come together to form solids, the**		☺	😐	☹

No	CONTENT	✓ ✗	Traffic Light		
	electrons then become contained in energy bands separated by gaps.				
e)	I know that **for metals we have the situation where one or more bands are partially filled.**		☺	😐	☹
f)	I know that **some metals have free electrons and partially filled valence bands, therefore they are highly conductive.**		☺	😐	☹
g)	I know that **some metals have overlapping valence and conduction bands. Each band is partially filled and therefore they are conductive.**		☺	😐	☹
h)	I know that **in an insulator, the highest occupied band (called the valence band) is full. The first unfilled band above the valence band is the conduction band. For an insulator, the gap between the valence band and the conduction band is large and at room temperature there is not enough energy available to move electrons from the valence band into the conduction band where they would be able to contribute to conduction. There is no electrical conduction in an insulator.**		☺	😐	☹
i)	I know that **in a semiconductor, the gap between the valence band and conduction band is smaller and at room temperature there is sufficient energy available to move some electrons from the valence band into the conduction band allowing some conduction to take place. An increase in temperature increases the conductivity of a semiconductor.**		☺	😐	☹
j)	I know that**, during manufacture, semiconductors may be doped with specific impurities to increase their conductivity, resulting in two types of semiconductor: p-type and n-type.**		☺	😐	☹
k)	I know that**, when a semiconductor contains the two types of doping (p-type and n- type) in adjacent layers, a p-n junction is formed. There is an electric field in the p-n junction. The electrical properties of this p-n junction are used in a number of devices.**		☺	😐	☹
l)	I know and can explain the terms forward bias and reverse bias. **Forward bias reduces the electric field; reverse bias increases the electric field in the p-n junction.**		☺	😐	☹
m)	I know that **LEDs are forward biased p-n junction diodes that emit photons. The forward bias potential difference across the junction causes electrons to move from the conduction band of the n-type semiconductor towards the conduction band of the p-type semiconductor. Photons are emitted when electrons 'fall' from the conduction band into the valence band either side of the junction**		☺	😐	☹
n)	I know that solar cells are p-n junctions designed so that a potential difference is produced when photons are absorbed. (This is known as the photovoltaic effect.) The absorption of photons provides energy to 'raise' electrons from the valence band of the semiconductor to the conduction band. The p-n junction causes the electrons in the conduction band to move towards the n-type semiconductor and a potential difference is produced across the solar cell.		☺	😐	☹

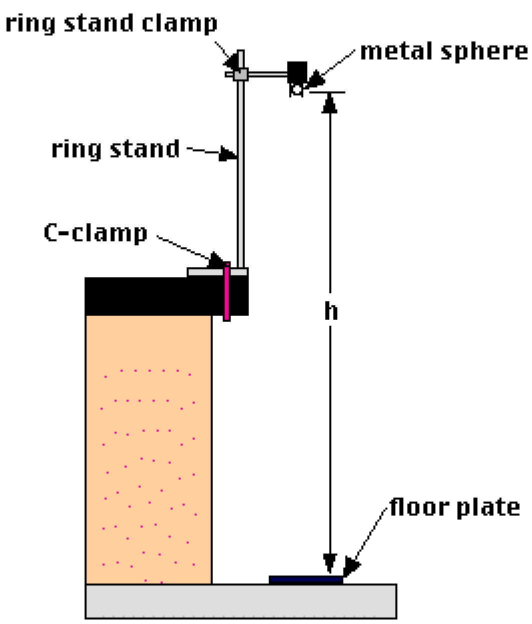
PRESCRIBED PRACTICAL EXPERIMENTS

One example of a method has been exemplified for each practical. Many more alternatives are available and just as good.

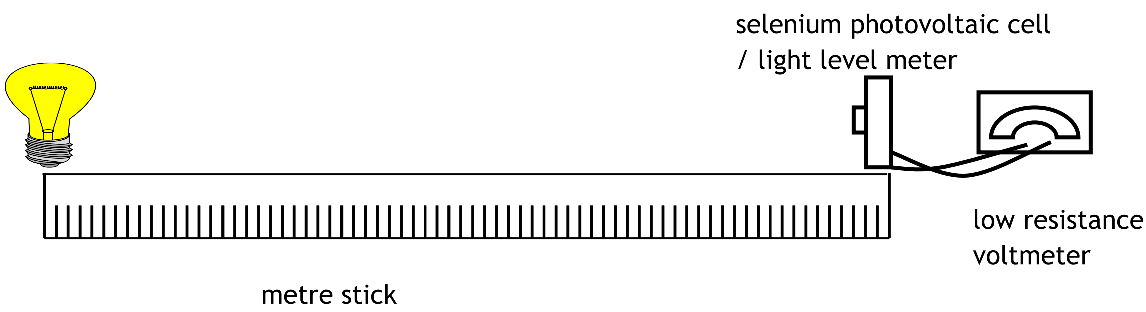
1e	An experiment to measure the acceleration of an object down a slope



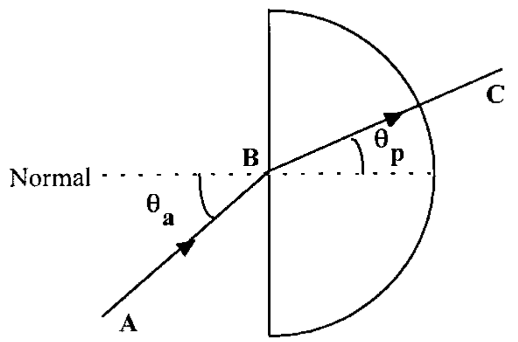
4b	An experiment to measure the acceleration of a falling object.



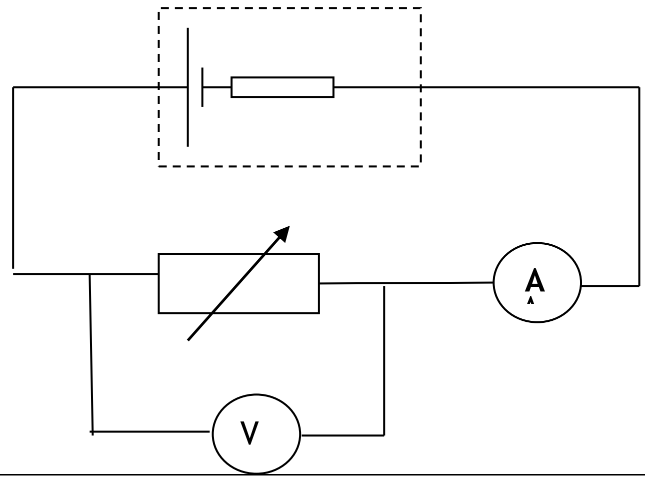
11e	*I can describe an experiment to verify the inverse square law for a point source of light*



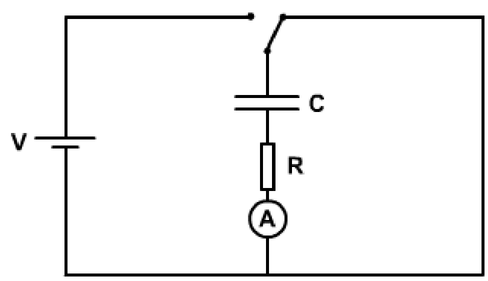
15c	***I can describe an experiment to determine the refractive index of a medium.***



19c	***I can describe of an experiment to measure the EMF and internal resistance of a cell.***



20i	***I can describe experiments to investigate the variation of current in a capacitor and voltage across a capacitor with time, for the charging and discharging of capacitors***



QUANTIFYING UNCERTAINTIES

1. **Find the mean**

$$\text{mean value} = \frac{\Sigma\text{results}}{\text{no. of observation}}$$

This is the best estimate of the "true" value but not necessary the "true" value

2. **Find the approximate random uncertainty in the mean (absolute uncertainty)**

$$\text{random uncertainty} = \frac{\text{max. value} - \text{min. value}}{\text{number of values}}$$

This can be written as $= \dfrac{\text{range}}{\text{no. of observation}}$ and it is sometimes referred to as *average deviation or absolute uncertainty*.

stop here and quote the result with an approx. random uncertainty

MEAN ± approx. random uncertainty (UNITS)

3. **Find the percentage uncertainty.**

$$\text{percentage uncertainty} = \frac{\textit{approximately randon uncertainty}}{\textit{mean value}} \times 100\% =$$

$$\text{percentage uncertainty} = \frac{\frac{range}{n}}{mean\ value} \times 100\%$$

stop here and quote the result with a percentage uncertainty

MEAN (UNITS)± percentage uncertainty (%)

Or (uncertainty in reading/reading)× 100%

SCALE READING UNCERTAINTY

Analogue device = ±½ scale division

Digital device = ±1 in the last digit

OVERALL UNCERTAINTY IN AN EXPERIMENT

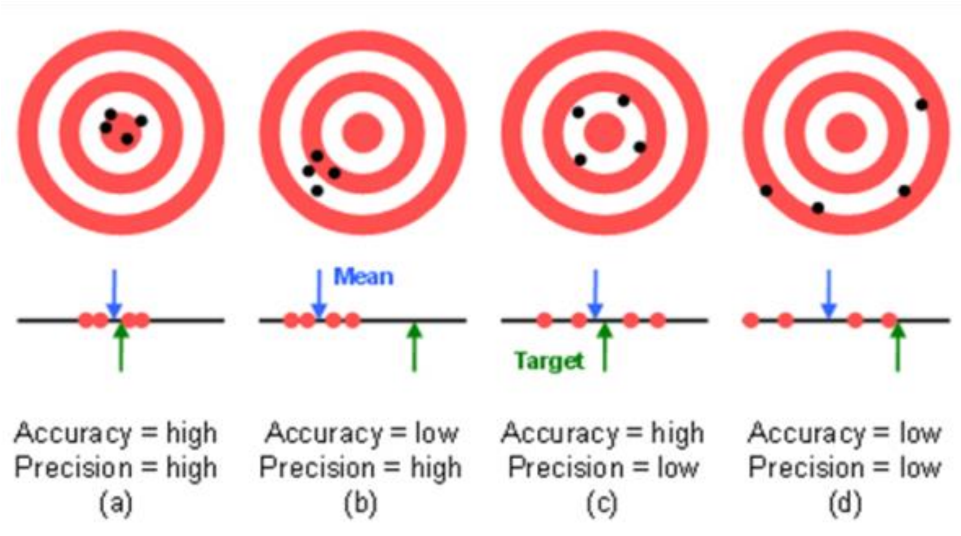
In an experiment, where more than one physical quantity has been measured, spot the quantity with the largest percentage uncertainty. This percentage uncertainty is often a good estimate of the percentage uncertainty in the final numerical result of the experiment.

eg if one measurement has an uncertainty of 3% and another has an uncertainty of 5%, then the overall percentage uncertainty in this experiment should be taken as 5%

When completing an experimental EVALUATION, always refer to the magnitude of the uncertainty to give an indication of how reliable your results are.

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} .

FROM THE GENERAL MARKING PRINCIPLES

Question: Calculate the kinetic energy of a 0·950 kg ball travelling at 2·35 m s^{-1}.

Response

$$E_k = \frac{1}{2}mv^2$$
$$E_k = 0.5 \times 0.950 \times 2.35^2$$
$$E_k = 2.6231875$$
$$E_k = 2.62\,J$$

Award 3 marks

In rounding to an expected number of significant figures, the mark can be awarded for answers which have **up to two figures more** or **one figure less** than the number in the data with the fewest significant figures.
1 mark for selected relationship.
1 mark for correct substitution.
1 mark for the correct final answer, including unit.

(2·6 J, 2·623 J and 2·6232 J are also acceptable)

If the final answer in the Response is
3 J, 2·62319 J, 2·623188 J or 2·6231875 J

Mark for final answer is not awarded.

Award a maximum of 2 marks

Question

An unbalanced force of 4·0 N is applied to a 6·0 kg mass. Calculate the cceleration of the mass.

Response

$$F = ma$$
$$4.0 = 6.0 \times a$$
$$a = 0.6\dot{6}ms^{-2}$$

Award 2 marks

1 mark for selected relationship.

1 mark for correct substitution.

Mark for final answer is not awarded.

(Use of the recurrence dot implies an infinite number of significant figures.)

Question
In a ripple tank, a wave generator produces 9 waves in 27 seconds. The wavelength of the waves is 4·5 cm. Determine the speed of the waves.

Response

$f = \frac{N}{t}$ $f = \frac{9}{27}$ $f = 0 \cdot 3$	In numerical calculations involving intermediate stages, candidates should not round intermediate values. If intermediate rounding leads to a final answer which is incorrect then treat as an arithmetic error. 1 mark for selected relationship. 1 mark for correct substitution.
$v = f\lambda$ $v = 0 \cdot 3 \times 4 \cdot 5$ $v = 1 \text{ cm s}^{-1}$	1 mark for selected relationship. 1 mark for correct substitution. Mark for final answer not awarded (rounding of f at an intermediate stage has resulted in an incorrect final answer). (Final answer should be 2 cm s^{-1} rounded from 1·5 cm s^{-1}.)

Award 4 marks

MARKING PRINCIPLES

You need to refer to the document General Marking Principles for guidance on how questions are marked.

http://www.sqa.org.uk/files_ccc/Physicsgeneralmarkingprinciples.pdf

Before you get in to the Higher Physics Course make sure you've looked over this material (there are laminated sheets in the Physics Dept).

PERSONAL NOTES

EXAM DATE: 15th May 2025