Annotated Higher Relationships Sheet

$d = \bar{v}t$ $distance\ (m) = average\ speed\ (ms^{-1}) \times time\ (s)$
$s = \bar{v}t$ $displacement\ (m) = average\ velocity\ (ms^{-1}) \times time\ (s)$
$v = u + at$ $final\ velocity\ (ms^{-1}) = initial\ velocity\ (ms^{-1}) + acceleration\ (ms^{-2}) \times time\ (s)$
$s = ut + \frac{1}{2}at^2$ $displacement = initial\ velocity \times time + \frac{1}{2} \times acceleration\ (ms^{-2}) \times time^2\ (s^2)$
$v^2 = u^2 + 2as$ $final\ velocity^2\ (ms^{-1})^2 = initial\ velocity^2 (ms^{-1})^2 + 2 \times acceleration\ (ms^{-2}) \times dispacement\ (m)$
$s = \frac{1}{2}(v+u)t$ $displacement\ (m) = \frac{1}{2} \times (final\ velocity\ (ms^{-1}) + initial\ velocity\ (ms^{-1})) \times time\ (s)$
$F = ma$ $force\ (N) = mass\ (kg) \times acceleration\ (ms^{-2})$
$W = mg$ $weight\ (N) = mass\ (kg) \times gravitational\ field\ strength\ (N\ kg^{-1})$
$E_w = Fd$ $work\ done\ (J) = force\ (N) \times distance\ (m)$
$E_p = mgh$ $gravitational\ potential\ energy\ (J) = mass\ (kg) \times gravitational\ field\ strength\ (N\ kg^{-1}) \times vertical\ height\ (m)$
$E_k = \frac{1}{2}mv^2$ $kinetic\ energy\ (J) = \frac{1}{2} \times mass\ (kg) \times speed^2 (ms^{-1})^2$
$P = \frac{E}{t}$ $power\ (W) = \frac{energy\ (J)}{time\ (s)}$
$p = mv$ $momentum\ (kgms^{-1}) = mass(kg) \times velocity\ (ms^{-1})$
$Ft = mv - mu$ $Impulse\ (Ns) = mass\ (kg) \times final\ velocity\ (ms^{-1}) - mass\ (kg) \times initial\ velocity\ (ms^{-1})$ $Impulse\ (Ns) = change\ in\ momentum\ (kg\ ms^{-1})$
$F = G\frac{m_1 m_2}{r^2}$ $Force\ (N) = Universal\ gravitational\ Constant\ (m^3kg^{-1}s^{-2}) \frac{Mass_1(kg) \times Mass_2(kg)}{separation\ distance^2\ (m^2)}$ 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.

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

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

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

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

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

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

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 $2{\cdot}3 \times 10^{-18}\ s^{-1}$

$$W = QV$$

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

$$E = mc^2$$

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

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

$$E_k = hf - hf_o$$

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

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)

$$v = f\lambda$$

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

$$E_2 - E_1 = hf$$

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

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

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

Slit separation (m) × sin of angle from centre to the spot = m no. of 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 $$\frac{Voltage\ across\ resistor1\ (V)}{voltageacross\ resistor\ 2\ (V)} = \frac{resistance\ of\ resistor1\ (\Omega)}{resistance\ of\ resistor\ 2\ (\Omega)}$$
$$E = V + Ir$$ $$e.m.f\ (V) = terminial\ potential\ difference\ (V) + current\ (A) \times internal\ resistance\ (\Omega)$$ 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

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

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

$$Q = It$$

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

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

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

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

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

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

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

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

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

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

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

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.

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