Physics Data Booklet

Constants

Quantity	Symbol	Accepted value
Acceleration of free fall at Earth's surface	g	$9.81\ ms^{-2}$
Gravitational constant	G	$6.67 \times 10^{-11} Nm^2kg^{-2}$
Stefan Boltzmann constant	σ	$5.67 \times 10^{-8} Wm^{-2}K^{-4}$
Coulomb constant	k	$8.99 \times 10^{9} Nm^2C^{-2}$
Permittivity of free space	ε_0	$8.85 \times 10^{-12} C^2N^{-1}m^{-2}$
Speed of light in Vacuum	c	$3.0 \times 10^{8} ms^{-1}$
Planck's constant	h	$6.63 \times 10^{-34} Js$
Elementary charge	e	$1.60 \times 10^{-19} C$
Electron rest mass	m_e	$9.110 \times 10^{-31} kg = 0.000549u = 0.511 MeVc^{-2}$
Proton rest mass	m_p	$1.673 \times 10^{-27} kg = 1.007276u = 938 MeVc^{-2}$
Neutron rest mass	m_p	$1.675 \times 10^{-27} kg = 1.008665 MeVc^{-2}$
Unified atomic mass	u	$1.661 \times 10^{-27} kg = 931.5 MeVc^{-2}$
Fermi radius	R_o	$1.20 \times 10^{-15} m$
Wien Constant	b	$\lambda_{max}T = 2.9 \times 10^{-3} m\ K$

Unit Conversions

- 1 light year (ly) = 9.46×10^{15} m
- 1 parsec (pc)= 3.26 ly
- 1 astronomical unit (AU) =1.50×10^{11}m

Metric Multipliers

Prefix	Abbreviation	Value
Giga	**G**	10^9
Mega	**M**	10^6
Kilo	**k**	10^3
Mili	**m**	10^{-3}
Micro	μ	10^{-6}
Nano	**n**	10^{-9}
Pico	**p**	10^{-12}
Femto	**f**	10^{-15}

Equations – Module 1 (Reporting & Mechanics) & Module 2 (Energy & Power)

Equations	
$\frac{\Delta y}{y} = \frac{\Delta a}{a} + \frac{\Delta b}{b}$	$\frac{\Delta y}{y} = \frac{n\Delta a}{a}$
$\% \text{ discrepancy} = \frac{\text{accepted value} - \text{experimental value}}{\text{accepted value}} x\ 100\%$	$F = ma \text{ and } F = \frac{\Delta p}{\Delta t}$
$v = u + at$ $v^2 = u^2 + 2as$ $s = ut + \frac{1}{2}at^2$	$p = m\Delta v$ $I = F\Delta t$
$F = ma \text{ and } F = \frac{\Delta p}{\Delta t}$	$F_{AB} = -F_{BA}$
$W = Fs\ cos\theta$	$KE = \frac{1}{2}mv^2$
$\text{GPE} = \text{mg}\Delta h$	$P = \frac{E}{\Delta t}$
$eff = \frac{useful\ work/energy/power}{total\ work/energy/power} x100\%$	

Equations – Module 3 (Waves & Electromagnetism)

Equations	
$v = v_0 \cos(\omega t), v = v_0 \sin(\omega t)$	$x = x_0 \cos(\omega t)$ and $x = x_0 \sin(\omega t)$
$v = \pm\omega\sqrt{(x_0^2 - x^2)}$	$v = f\lambda$
$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1}$	$\theta = \frac{n\lambda}{a}$
$PD = n\lambda$ and $PD = (n + \frac{1}{2})\lambda$	$x = \frac{\lambda D}{a}$
$a = \frac{w}{N}$	$d \sin\theta = n\lambda$
$f_1 = nf_0$	Moving source: $f' = f\left(\frac{v}{v \pm u_s}\right)$ Moving observer: $f' = f\left(\frac{v \pm u_0}{v}\right)$
$I = \frac{\Delta Q}{\Delta t}$	$F = \frac{kQq}{r^2}$ $k = \frac{1}{4\pi\varepsilon_0}$
$I = nAqv$,	$V = \frac{W}{q}$
$R = \frac{V}{I}$	$R = \rho\frac{l}{A}, P = VI = I^2R = \frac{V^2}{R}$
$R_{equ} = R_1 + R_2 + \cdots, \frac{1}{R_{eqv}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$	$\varepsilon = I(R + r)$
$F = qvB \sin\theta$ $F = BIL \sin\theta$	$emf = Bvl\ (N)$
$\Phi = NBA \cos\theta$	$emf = -\frac{N\Delta\emptyset}{\Delta t}$

Equations – Module 4 (Circular Motion, Gravity & Space)

Equations	
$\omega = \frac{2\pi}{T} = 2\pi f$ $v = \omega r$	$v = \sqrt{\frac{2GM}{r}}$
$a = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$	$F = \frac{mv^2}{r} = m\omega^2 r$
$F = \frac{mv^2}{r} = m\omega^2 r$	$g = \frac{F}{m}$ $and\, g = \frac{GM}{r^2}$
$F = G\frac{Mm}{r^2}$	$\frac{T^2}{R^3} = \frac{4\pi^2}{GM}$
$PE = -\frac{GMm}{r}$	$v = \sqrt{\frac{2GM}{r}}$
$d(parsec) = \frac{1}{p(arc - sec)}$	$a = -\omega^2 x$
$L = \sigma A T^4$;	$b = \frac{L}{4\pi d^2}$
$L \propto M^{3.5}$	$v = H_0 d$
$T = \frac{1}{H_0}$	$z = \frac{\Delta\lambda}{\lambda_0} = \frac{v}{c}$
$T = \frac{1}{f}$	$\omega = \frac{2\pi}{T}$ or $\omega = 2\pi f$

Equations – Module 5 (Quantum Physics)

Equations	
$E_{upper} - E_{lower} = hf$	$E_n = -\frac{13.6}{n^2} eV$
$E = hf$ $\lambda = \frac{hc}{E}$	$A = \lambda N$
$\lambda T_{\frac{1}{2}} = ln(2)$	$A = A_0 e^{-\lambda t}$ and $N = N_0 e^{-\lambda t}$
$\Delta E = \Delta mc^2$	$R = R_0 A^{\frac{1}{3}}$
$\rho = \frac{3u}{4\pi {R_0}^3}$	$E = hf = \frac{hc}{\lambda}$
$hf = \emptyset + KE_{max}$	$\lambda = \frac{h}{p}$
$\Delta x \Delta p \geq \frac{h}{4\pi}$ $\Delta E \Delta t \geq \frac{h}{4\pi}$	