Mr. Howard's Awesome 2-Page IB Physics Data Booklet - First Exams 2016

Motion Formulas

$\bar{v} = \frac{s}{t} = \frac{u+v}{2}$

$v = u + at$

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

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

Forces

$\Sigma F = ma$

$F_f = \mu F_N$

Work, energy, power

$W = Fs \times \cos\theta$

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

$E_p = \frac{1}{2}k\Delta x^2$

$E_p = mg\Delta h$

$power = Fv$

$efficiency = \frac{work\ out}{total\ work\ in}$

Momentum

$p = mv$

$F = \frac{\Delta p}{\Delta t}$

$E_K = \frac{p^2}{2m}$

$impulse = F\Delta t = \Delta p$

Heat and Gas

$Q = mc\Delta T$

$Q = mL$

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

$pV = nRT$

$E_K = \frac{3}{2}k_B T = \frac{3}{2}\frac{R}{N_A}T$

Oscillations and Waves

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

$c = \lambda f$

$I \propto A^2$

$I \propto x^{-2}$

$I = I_0 \cos^2\theta$

$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1}$

$s = \frac{\lambda D}{d}$

Circular Motion

$v = \omega r$

$a = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$

$F = \frac{mv^2}{r} = m\omega^2 r$

Gravitation

$F = G\frac{Mm}{r^2}$

$g = \frac{F}{m}$

$g = G\frac{M}{r^2}$

Gravitational Fields

$V_g = -\frac{GM}{r}$

$g = -\frac{\Delta V_g}{\Delta r}$

$E_p = mV_g = -\frac{GMm}{r}$

$F_G = G\frac{Mm}{r^2}$

$W = m\Delta V_g$

$v_{esc} = \sqrt{\frac{2GM}{r}}$

$v_{orbit} = \sqrt{\frac{GM}{r}}$

Electric Fields

$V_e = -\frac{kq}{r}$

$E = -\frac{\Delta V_e}{\Delta r}$

$E_p = qV_e = \frac{kQq}{r}$

$F_E = k\frac{Qr}{r^2}$

$W = q\Delta V_e$

Rigid Bodies and Rotational Dynamics

$\tau = Fr \times \sin\theta$

$I = \Sigma mr^2$

$\tau = I\alpha$

$\omega = 2\pi f$

$E_k = \frac{1}{2}I\omega^2$

$\omega_f = \omega_i + \alpha t$

$\omega_f^2 = \omega_i^2 + 2\alpha\theta$

$\theta = \omega_i t + \frac{1}{2}\alpha t^2$

$L = I\omega$

Electricity and Magnetism

$I = \frac{\Delta q}{t}$

$F = k\frac{Qq}{r^2}$

$k = \frac{1}{4\pi\epsilon_0}$

$V = \frac{W}{q}$

$E = \frac{F}{q}$

$I = nAvq$

$\Sigma V = 0 \quad (loop)$

$\Sigma I = 0 \quad (junction)$

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

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

$R_{eq} = R_1 + R_2 + \ldots$

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

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

$\varepsilon = I(R + r)$

$F = qvb \times \sin\theta$

$F = BIL \times \sin\theta$

Thermodynamics

$Q = \Delta U + W$

$U = \frac{3}{2}nRT$

$\Delta S = \frac{\Delta Q}{T}$

$pV^{5/3} = constant$

$W = p\Delta V$

$\eta = \frac{work\ done}{energy\ input}$

$\eta_{Carnot} = 1 - \frac{T_{cold}}{T_{hot}}$

Electromagnetic Induction

$\Phi = BA \times \cos\theta$

$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$

$\varepsilon = Bvl$

$\varepsilon = BvlN$

Capacitance

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

$C_{parallel} = C_1 + C_2 + \ldots$

$\frac{1}{C_{series}} = \frac{1}{C_1} + \frac{1}{C_2} + \ ..$

$C = \varepsilon\frac{A}{d}$

$E = \frac{1}{2}CV^2$

$\tau = RC$

$q = q_0 e^{-\frac{t}{\tau}}$

$I = I_0 e^{-\frac{t}{\tau}}$

$V = V_0 e^{-\frac{t}{\tau}}$

Power Generation

$I_{rms} = \frac{I_0}{\sqrt{2}}$

$V_{rms} = \frac{V_0}{\sqrt{2}}$

$R = \frac{V_0}{I_0} = \frac{V_{rms}}{I_{rms}}$

$P_{max} = I_0 V_0$

$\bar{P} = \frac{1}{2}I_0 V_0$

$\frac{\varepsilon_p}{\varepsilon_s} = \frac{N_p}{N_s} = \frac{I_s}{I_p}$

Simple Harmonic Motion

$\omega = \frac{2\pi}{T}$

$a = -\omega^2 x$

$x = x_0 \times \sin(\omega t)$

$v = v_0 \times \cos(\omega t)$

$v = \pm\omega\sqrt{(x_0^2 - x^2)}$

$E_K = \frac{1}{2}m\omega^2(x_0^2 - x^2)$

$E_T = \frac{1}{2}m\omega^2 x_0^2$

$T = 2\pi\sqrt{\frac{l}{g}}$

$T = 2\pi\sqrt{\frac{m}{k}}$

Waves

$\theta = \frac{\lambda}{b}$

$n\lambda = d \times \sin\theta$

$const:\ 2dn = (m + \frac{1}{2})\lambda$

$destr:\ 2dn = m\lambda$

$\theta = 1.22\frac{\lambda}{b}$

$R = \frac{\lambda}{\Delta\lambda} = mN$

Doppler effect

Moving source

$f' = f\left(\frac{v}{v \pm u_s}\right)$

Moving observer

$f' = f\left(\frac{v \pm u_o}{v}\right)$

$\frac{\Delta f}{f} = \frac{\Delta\lambda}{\lambda} \approx \frac{v}{c}$

Fluids

$B = \rho_f V_f g$

$P = P_0 + \rho_f g d$

$Av = constant$

$\frac{1}{2}\rho v^2 + \rho g z + P = constant$

$F_D = 6\pi\eta r v$

$R = \frac{vr\rho}{\eta}$

Nuclear Physics and Matter/Radiation Interactions

$R = R_0 A^{\frac{1}{3}}$

$N = N_0 e^{-\lambda t}$

$A = \lambda N_0 e^{-\lambda t}$

$\sin\theta \approx \frac{\lambda}{D}$

$E = hf$

$E_{max} = hf - \Phi$

$E = -\frac{13.6}{n^2}eV$

$mvr = \frac{nh}{2\pi}$

$P(r) = |\Psi|^2\Delta V$

$\Delta x\Delta p \geq \frac{h}{4\pi}$

$\Delta E\Delta t = \frac{h}{4\pi}$

Forced vibrations and resonance

$Q = 2\pi\frac{energy\ stored}{energy\ dissipated\ per\ cycle}$

$Q = 2\pi \times resonant\ frequency \times \frac{energy\ stored}{power\ loss}$

There is no crying in physics.

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Fundamental Constants

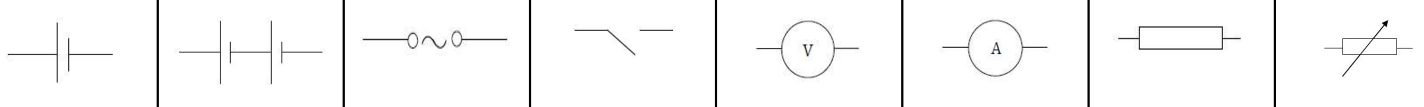
Quantity	Symbol	Value	Quantity	Symbol	Value
Acceleration of free fall	g	9.81 m s^{-2}	Speed of light	c	3.00×10^{8} m s^{-1}
Gravitational constant	G	6.67×10^{-11} N m^{2} kg^{-2}	Plank's constant	h	6.63×10^{-34} J s
Avogadro's constant	N_A	6.02×10^{23}mol^{-1}	Elementary charge	e	1.60×10^{-19} C
Gas constant	R	8.31 J K^{-1} mol^{-1}	Solar constant	S	1.36×10^{3} W m^{-2}
Boltzmann's constant	k_B	1.38×10^{-23}J K^{-1}	Fermi radius	R_0	1.20×10^{-15} m
Stefan-Boltzmann	σ	5.67×10^{-8} W m^{-2} K^{-4}	Coulomb constant	k	8.99×10^{9} N m^{2} C^{-2}
Permittivity of free space	ϵ_0	8.85×10^{-12} C^{2} N^{-1} m^{-2}	Permeability of free space	μ_0	$4\pi\times10^{-7}$ T m A^{-1}
Electron rest mass	m_e	9.110×10^{-31} kg 0.000549u 0.511 MeV c^{-2}	Proton rest mass	m_p	1.673×10^{-27} kg 1.007276u 938 MeV c^{-2}
Neutron rest mass	m_n	1.675×10^{-27} kg 1.008665 u 940 MeV c^{-2}	Unified atomic mass unit	u	1.661×10^{-27} kg 931.5 MeV c^{-2}

Metric Prefixes

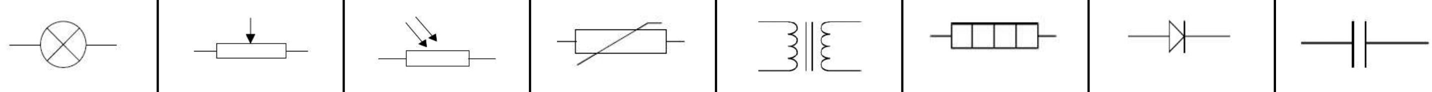
Prefix	Symbol	Exponent
Peta	P	10^{15}
Tera	T	10^{12}
Giga	G	10^{9}
Mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deca	da	10^{1}
Base	-	-
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

Electrical circuit symbols

cell	battery	AC supply	switch	voltmeter	ammeter	resistor	Variable resistor



lamp	potentiometer	Light dependent resistor LDR	thermistor	transformer	Heating element	diode	capacitor



Uncertainties and Errors

If: $y = a \pm b$

then: $\Delta y = \Delta a + \Delta b$

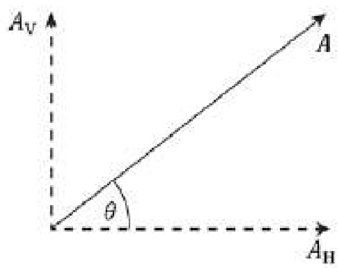
If: $y = \dfrac{ab}{c}$

then: $\dfrac{\Delta y}{y} = \dfrac{\Delta a}{a} + \dfrac{\Delta b}{b} + \dfrac{\Delta c}{c}$

If: $y = a^n$

then: $\dfrac{\Delta y}{y} = \left| n\dfrac{\Delta a}{a} \right|$

Vectors and Scalars



$A_H = A\cos\theta$

$A_V = A\sin\theta$

Unit Conversions

1 radian = 180°/π
$T_K = T_{\circ}+273$
1 light year (ly) = 9.45×10^{15} m
1 parsec (pc) = 3.26 ly
1 astronomical unit (AU) = 1.50×10^{11} m
1 Kilowatt-hour (kWh) = 3.60×10^{6} J
$hc = 1.99\times10^{-25}$ J m $= 1.24\times10^{-6}$ eV m