

# Physics Equations Cheatsheet

Y12

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## 1 Mechanics and Materials

Kinematic equations of motion	
Motion	$s = \frac{(u+v) \cdot t}{2}$ $v = u + a \cdot t$ $s = u \cdot t + \frac{1}{2}a \cdot t^2$ $v^2 = u^2 + 2as$
Forces	$\sum F = m \cdot a$ $g = \frac{F}{m}$ $W = m \cdot g$
Momentum	$p = m \cdot v$
Moment of force	$= F \cdot x$

Materials	
Density	$\rho = \frac{m}{V}$
Stoke's law	$F = 6\pi \cdot \eta \cdot r \cdot v$
Hooke's law	$\Delta F = k \cdot \Delta x$
Young modulus	stress $\sigma = \frac{F}{A}$
	Strain $\epsilon = \frac{\Delta x}{x}$

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## Materials

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Elastic Strain Energy	$E = \frac{\sigma}{\epsilon}$ $\Delta E_d = \frac{1}{2} F \cdot \Delta x$
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## 2 Waves and Electricity

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### Waves and particle nature of light

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Wave speed	$v = f \cdot \lambda$
Speed of a transverse wave on a string	$v = \sqrt{\frac{T}{\mu}}$
Intensity of radiation	$I = \frac{P}{A}$
Refractive index	$n_1 \cdot \sin\theta_1 = n_1 \cdot \sin\theta_2$ $n = \frac{c}{v}$
Critical angle	$\sin C = \frac{1}{n}$
Difracction grating	$n \cdot \lambda = d \cdot \sin\theta$
De Broglie wavelenght	$\lambda = \frac{h}{p}$
Photon model	$E = h \cdot f$
Einstein's photoelectric equation	$hf = \phi + \frac{1}{2} m \cdot v_{max}^2$

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### Electricity

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Current	$I = \frac{\Delta Q}{\Delta t}$
Potential difference	$V = \frac{W}{Q}$
Resistance	$R = \frac{V}{I}$
Electrical power, energy and efficiency	$P = V \cdot I$ $P = I^2 R$ $P = \frac{V^2}{R}$ $W = VIt$
Resistivity	$R = \frac{\rho l}{A}$ $I = nq\nu A$

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## 3 Further Mechanics, Fields and Particles

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**Further mechanics**

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Impulse	$F\Delta t = \Delta p$
Kinetic energy of a non-relativistic particle	$E_k = \frac{p^2}{2m}$
Motion in a circle	$v = \omega r$ $T = \frac{2\pi}{\omega}$ $a = \frac{v^2}{r}$ $a = r\omega^2$

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**Electric and magnetic fields**

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Electric field	$E = \frac{F}{Q}$
Coulomb's law	$F = \frac{Q_1 Q_2}{4\pi\epsilon_0 r^2}$ $E = \frac{Q}{4\pi\epsilon_0 r^2}$ $E = \frac{V}{d}$
Electric potential	$V = \frac{Q}{4\pi\epsilon_0 r}$
Capacitance	$C = \frac{Q}{V}$
Energy stored in a capacitor	$W = \frac{1}{2} QV$ $W = \frac{1}{2} CV^2$ $W = \frac{1}{2} \frac{Q^2}{C}$
Capacitor discharge	$Q = Q_0 e^{-\frac{t}{RC}}$
Resistor-Capacitor discharge	$I = I_0 e^{-\frac{t}{RC}}$ $V = V_0 e^{-\frac{t}{RC}}$ $\ln Q = \ln Q_0 - \frac{t}{RC}$ $\ln I = \ln I_0 - \frac{t}{RC}$ $\ln V = \ln V_0 - \frac{t}{RC}$
In a magnetic field	$F = Bqv \sin\theta$ $F = BIl \sin\theta$
Faraday and Lenz's law	$\mathcal{E} = \frac{-d(N\phi)}{dt}$

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**Nuclear and Particle Physics**

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In a magnetic field	$r = \frac{p}{BQ}$
Mass energy	$\Delta E = \Delta m \cdot c^2$

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## 4 Thermodynamics, Radiation, Oscillations and Cosmology

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**Thermodynamics**

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Heating	$\Delta E = mc\Delta\theta$ $\Delta E = L\Delta m$
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### Thermodynamics

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Ideal gas equation	$pV = NkT$
Molecular kinetic theory	$\frac{1}{2}m \langle c^2 \rangle = \frac{3}{2}kT$

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### Nuclear decay

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Mass-energy	$\Delta E = \Delta m \cdot c^2$
Radioactive decay	$A = \lambda N$ $\frac{dN}{dt} = -\lambda N$ $\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$ $N = N_0 e^{-\lambda t}$ $A = A_0 e^{-\lambda t}$

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### Oscillations

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Simple harmonic motion	$F = -kx$ $a = -\omega^2 x$ $x = A \cdot \cos(\omega t)$ $v = -A\omega \cdot \sin(\omega t)$ $a = -A\omega^2 \cdot \cos(\omega t)$ $T = \frac{1}{f} = \frac{2\pi}{\omega}$ $\omega = 2\pi f$
Simple harmonic oscillator	$T = 2\pi \sqrt{\frac{m}{k}}$ $T = 2\pi \sqrt{\frac{l}{g}}$

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### Astrophysics and cosmology

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Gravitational field strength	$g = \frac{F}{m}$
Gravitational force	$F = \frac{Gm_1m_2}{r^2}$
Gravitational field	$g = \frac{Gm}{r^2}$
Gravitational potential	$V_{grav} = \frac{-Gm}{r}$
Stefan-Boltzmann law	$L = \sigma T^4 A$
Wien's law	$\lambda_{max} T = 2.898 \cdot 10^{-3} m \cdot K$
Intensity of radiation	$I = \frac{L}{4\pi d^2}$
Redshift of electromagnetic radiation	$z = \frac{\Delta \lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$
Cosmological expansion	$v = H_0 d$

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## 5 Data Sheet

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**Data sheet**

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Acceleration of the free fall	$g = 9.81 \frac{m}{s^2}$
Boltzmann constant	$k = 1.38 \cdot 10^{-23} \frac{J}{K}$
Coulomb's law constant	$k = \frac{1}{4\pi\epsilon_0} = 8.99 \cdot 10^9 \frac{Nm^2}{C^2}$
Electron charge	$e = -1.60 \cdot 10^{-19} C$
Electron mass	$m_e = 9.11 \cdot 10^{-31} kg$
Electronvolt	$1eV = 1.60 \cdot 10^{-19} J$
Gravitational constant	$G = 6.67 \cdot 10^{-11} \frac{Nm^2}{kg^2}$
Gravitational field strength	$g = 9.81 \frac{N}{kg}$
Planck constant	$h = 6.63 \cdot 10^{-34} Js$
Permittivity of free space	$\epsilon_0 = 8.85 \cdot 10^{-12} \frac{F}{m}$
Proton mass	$m_p = 1.67 \cdot 10^{-27} kg$
Speed of light in vacuum	$c = 3.00 \cdot 10^8 \frac{m}{s}$

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