



Data

The value of the following constants will be provided in each examination paper.

Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$ (close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
Coulomb's law constant	$k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$
Electron charge	$e = -1.60 \times 10^{-19} \text{ C}$
Electron mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Electronvolt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$
Gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^{-2} \text{ kg}^{-2}$
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$ (close to Earth's surface)
Permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
Proton mass	$m_p = 1.67 \times 10^{-27} \text{ kg}$
Speed of light in a vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
Stefan–Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Unified atomic mass unit	$u = 1.66 \times 10^{-27} \text{ kg}$



Formulae

Unit 4

Mechanics	
Momentum	$p = mv$
Kinetic energy of a nonrelativistic particle	$E_k = p^2/2m$
Motion in a circle	$v = \omega r$ $T = 2\pi/\omega$ $F = ma = mv^2/r$ $a = v^2/r$ $a = r\omega^2$
Fields	
Coulomb's law	$F = kQ_1Q_2/r^2$ where $k = 1/4\pi\epsilon_0$
Electric field	$E = F/Q$ $E = kQ/r^2$ $E = V/d$
Capacitance	$C = Q/V$
Energy stored in capacitor	$W = \frac{1}{2} QV$
Capacitor discharge	$Q = Q_0 e^{-t/RC}$
In a magnetic field	$F = BIl \sin \theta$ $F = Bqv \sin \theta$ $r = p/BQ$
Faraday's and Lenz's laws	$\mathcal{E} = -d(N\Phi)/dt$
Particle physics	
Mass–energy	$\Delta E = c^2\Delta m$
de Broglie wavelength	$\lambda = h/p$



Formulae

Unit 5

Energy and matter	
Heating	$\Delta E = mc\Delta\theta$
Molecular kinetic theory	$\frac{1}{2}m \langle c^2 \rangle = \frac{3}{2}kT$
Ideal gas equation	$pV = NkT$
Nuclear physics	
Radioactive decay	$dN/dt = -\lambda N$ $\lambda = \ln 2/t_{1/2}$ $N = N_0 e^{-\lambda t}$
Mechanics	
Simple harmonic motion	$a = -\omega^2 x$ $a = -A\omega^2 \cos \omega t$ $v = A\omega \sin \omega t$ $x = A \cos \omega t$ $T = 1/f = 2\pi/\omega$
Gravitational force	$F = Gm_1m_2/r^2$
Observing the universe	
Radiant energy flux	$F = L/4\pi d^2$
Stefan–Boltzmann law	$L = \sigma T^4 A$ $L = 4\pi r^2 \sigma T^4$
Wien's law	$\lambda_{\max} T = 2.898 \times 10^{-3} \text{ m K}$
Redshift of electromagnetic radiation	$z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$
Cosmological expansion	$v = H_0 d$