FREE RESOURCE · ECAT / MDCAT PHYSICS

Physics Formula Sheet

Key formulas from the HSSC (FSc) Physics course, grouped by topic. Symbols follow the usual textbook meaning; check each formula's conditions in your textbook before you use it.

Motion in a straight line

$v = u + at$	final velocity
$s = ut + \frac{1}{2}at^2$	displacement
$v^2 = u^2 + 2as$	
$s = \frac{1}{2}(u + v)t$	

Work, energy and power

$W = Fd\cos\theta$	work
$K.E. = \frac{1}{2}mv^2$	
$P.E. = mgh$	
$P = W / t = Fv$	power

Projectile motion

$T = 2u\sin\theta / g$	time of flight
$H = u^2\sin^2\theta / 2g$	max height
$R = u^2\sin2\theta / g$	range
R is maximum at $\theta = 45°$	

Circular motion

$v = r\omega$	
$a = v^2 / r = r\omega^2$	centripetal acceleration
$F = mv^2 / r$	centripetal force
$T = 2\pi r / v$, $f = 1 / T$	

Force and momentum

$F = ma$	Newton's 2nd law
$p = mv$	momentum
$F = \Delta p / \Delta t$	
$J = F\Delta t = \Delta p$	impulse
$f = \mu N$	friction

Gravitation

$F = Gm_1m_2 / r^2$	
$g = GM / R^2$	at surface
$v_o = \sqrt{(GM / r)}$	orbital speed
$v_e = \sqrt{(2GM / R)}$	escape speed

Rotational motion

$\tau = rF\sin\theta$	torque
$\tau = I\alpha$	
$L = I\omega$	angular momentum
$K.E._{rot} = \frac{1}{2}I\omega^2$	

Fluids

$P = F / A$	
$P = \rho gh$	pressure at depth
$A_1v_1 = A_2v_2$	continuity
$P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$	Bernoulli
$F = 6\pi\eta rv$	Stokes' law

Oscillations (SHM)

$a = -\omega^2 x$	
$\omega = 2\pi f$	
$T = 2\pi\sqrt{(m / k)}$	mass–spring
$T = 2\pi\sqrt{(l / g)}$	simple pendulum

Waves and sound

$v = f\lambda$	
$v = \sqrt{(T / \mu)}$	wave on a string
$f_n = nv / 2L$	open pipe, n = 1, 2, 3…
$f_n = nv / 4L$	closed pipe, n = 1, 3, 5…
$f_{beat} = \lvert f_1 - f_2 \rvert$	beats

Light

$n = c / v$	refractive index
$n_1\sin\theta_1 = n_2\sin\theta_2$	Snell's law
$\sin C = 1 / n$	critical angle
$\Delta y = \lambda L / d$	fringe spacing
$d\sin\theta = m\lambda$	diffraction grating
$1/f = 1/p + 1/q$	thin lens
$M = q / p$	magnification

Heat and thermodynamics

$PV = nRT$	ideal gas
$Q = mc\Delta T$	heat
$Q = \Delta U + W$	first law (W by gas)
$\eta = 1 - T_2 / T_1$	Carnot efficiency
$\langle K.E.\rangle = (3/2)kT$	per molecule

Constants

$g = 9.8\ m\ s^{-2}$	$G = 6.67 \times 10^{-11}\ N\ m^2\ kg^{-2}$	$c = 3.0 \times 10^8\ m\ s^{-1}$
$h = 6.63 \times 10^{-34}\ J\ s$	$e = 1.6 \times 10^{-19}\ C$	$m_e = 9.11 \times 10^{-31}\ kg$
$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2\ N^{-1}\ m^{-2}$	$\mu_0 = 4\pi \times 10^{-7}\ T\ m\ A^{-1}$	$N_A = 6.02 \times 10^{23}\ mol^{-1}$
$R = 8.314\ J\ mol^{-1}\ K^{-1}$	$k_B = 1.38 \times 10^{-23}\ J\ K^{-1}$	

Electrostatics

$F = kq_1q_2 / r^2$	$k = 9 \times 10^9\ N\ m^2\ C^{-2}$
$E = F / q_0 = kq / r^2$	
$V = kq / r$	
$C = Q / V$	
$C = \varepsilon_0 A / d$	parallel plates ($\times\ \varepsilon_r$)
$U = \frac{1}{2}CV^2$	stored energy
Series: $1/C = 1/C_1 + 1/C_2$	Parallel: $C = C_1 + C_2$
$\tau = RC$	time constant

Current electricity

$I = Q / t$	
$V = IR$	Ohm's law
$R = \rho L / A$	resistance
$P = VI = I^2R = V^2 / R$	power
$\varepsilon = V + Ir$	emf, internal resistance
Series: $R = R_1 + R_2$	Parallel: $1/R = 1/R_1 + 1/R_2$

Magnetism and induction

$F = qvB \sin\theta$	on a charge
$F = BIL \sin\theta$	on a wire
$r = mv / qB$	radius in field
$B = \mu_0 I / 2\pi r$	long straight wire
$B = \mu_0 nI$	solenoid
$\Phi = BA \cos\theta$	flux
$\varepsilon = -N\,\Delta\Phi / \Delta t$	Faraday's law
$\varepsilon = BLv$	motional emf
$V_s / V_p = N_s / N_p$	transformer
$U = \frac{1}{2}LI^2$	energy in inductor

Alternating current

$V_{rms} = V_0 / \sqrt{2}$	
$X_L = 2\pi fL$	
$X_C = 1 / 2\pi fC$	
$f_0 = 1 / 2\pi\sqrt{(LC)}$	resonance

Modern physics

$E = hf = hc / \lambda$	photon
$hf = \varphi + K.E._{max}$	photoelectric
$K.E._{max} = eV_0$	stopping potential
$\lambda = h / mv$	de Broglie
$E = mc^2$	
$t = t_0 / \sqrt{(1 - v^2/c^2)}$	time dilation
$r_n = n^2 r_1,\ r_1 = 0.053\ nm$	Bohr radius
$E_n = -13.6 / n^2\ eV$	hydrogen levels
$N = N_0 e^{-\lambda t}$	decay
$T_{½} = 0.693 / \lambda$	half-life