



FORMULA SHEET · CLASS 11 AND 12

Physics Formula Sheet for JEE and NEET

The formulas that carry most of the marks in JEE Main, JEE Advanced and NEET physics, grouped the way the NCERT books teach them. Print it, stick it above your desk, and test yourself on one section a day.

JEE

NEET

CBSE 12

01 Units and errors

Force – $[M L T^{-2}]$

Work, energy – $[M L^2 T^{-2}]$

Power – $[M L^2 T^{-3}]$

Pressure, stress – $[M L^{-1} T^{-2}]$

Gravitational constant G – $[M^{-1} L^3 T^{-2}]$

Planck's constant h – $[M L^2 T^{-1}]$

Error in $x = a^p b^q / c^r$ – $\Delta x/x = p(\Delta a/a) + q(\Delta b/b) + r(\Delta c/c)$

02 Kinematics

Equations of motion – $v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$

Distance in the n th second – $s_n = u + a(n - \frac{1}{2})$

Projectile – $T = 2u \sin\theta/g$, $H = u^2 \sin^2\theta/2g$, $R = u^2 \sin 2\theta/g$ (maximum at 45°)

Relative velocity – $v_{AB} = v_A - v_B$

Uniform circular motion – $a_c = v^2/r = \omega^2 r$, $v = \omega r$

03 Laws of motion and friction

Newton's second law – $F = dp/dt = ma$

Impulse – $J = F\Delta t = \Delta p$

Friction – $f_s \leq \mu_s N$, $f_k = \mu_k N$, angle of repose: $\tan\theta = \mu_s$

Banked road (no friction) – $\tan\theta = v^2/rg$

Level curve, maximum speed – $v = \sqrt{\mu rg}$

04 Work, energy and power

Work – $W = F \cdot s = Fs \cos\theta$

Kinetic energy – $K = \frac{1}{2}mv^2 = p^2/2m$

Potential energy – mgh (near Earth), $\frac{1}{2}kx^2$ (spring)

Work-energy theorem – $W_{net} = \Delta K$

Power – $P = dW/dt = F \cdot v$

Elastic collision (1D) – $v_1 = [(m_1 - m_2)u_1 + 2m_2u_2]/(m_1 + m_2)$

Coefficient of restitution – $e = (v_2 - v_1)/(u_1 - u_2)$

05 Rotational motion

Torque – $\tau = r \times F = I\alpha$

Angular momentum – $L = I\omega = r \times p$

Rotational kinetic energy – $\frac{1}{2}I\omega^2$

Parallel axis – $I = I_{cm} + Md^2$

Perpendicular axis (lamina) – $I_z = I_x + I_y$

Moments of inertia – ring MR^2 ; disc $\frac{1}{2}MR^2$; solid sphere $(2/5)MR^2$; hollow sphere $(2/3)MR^2$; rod about centre $ML^2/12$, about end $ML^2/3$

Rolling without slipping – $v = \omega R$, $K = \frac{1}{2}mv^2(1 + k^2/R^2)$

Rolling down an incline – $a = g \sin\theta/(1 + k^2/R^2)$

06 Gravitation

Newton's law – $F = Gm_1m_2/r^2$

Surface gravity – $g = GM/R^2$

At height h ($h \ll R$) – $g' \approx g(1 - 2h/R)$

At depth d – $g' = g(1 - d/R)$

Orbital speed – $v_o = \sqrt{GM/r}$

Escape speed – $v_e = \sqrt{2GM/R} = \sqrt{2gR} \approx 11.2$ km/s for Earth

Kepler's third law – $T^2 = 4\pi^2 r^3/GM$

Potential energy – $U = -GMm/r$

07 Solids and fluids

Young's modulus – $Y = (F/A)/(\Delta L/L)$

Pressure at depth – $P = P_0 + \rho gh$

Buoyant force – $F_B = \rho_{fluid} Vg$

Continuity – $A_1 v_1 = A_2 v_2$

Bernoulli – $P + \frac{1}{2} \rho v^2 + \rho gh = \text{constant}$

Stokes' law – $F = 6\pi\eta r v$

Terminal velocity – $v_t = \frac{2r^2(\rho - \sigma)g}{9\eta}$

Excess pressure – drop $2T/r$, soap bubble $4T/r$

Capillary rise – $h = \frac{2T \cos\theta}{\rho g r}$

08 Heat and thermodynamics

Thermal expansion – $\Delta L = \alpha L \Delta T$, $\beta = 2\alpha$, $\gamma = 3\alpha$

Heat – $Q = mc\Delta T$, $Q = mL$ (change of state)

First law – $\Delta U = Q - W$ (W = work done by the gas)

Isothermal work – $W = nRT \ln(V_2/V_1)$

Adiabatic – $PV^\gamma = \text{constant}$, $W = (P_1 V_1 - P_2 V_2)/(\gamma - 1)$

Specific heats – $C_p - C_v = R$, $\gamma = C_p/C_v$ (monatomic 5/3, diatomic 7/5)

Efficiency – $\eta = W/Q_1$; Carnot $\eta = 1 - T_2/T_1$

Refrigerator – $\text{COP} = T_2/(T_1 - T_2)$

Kinetic theory – $P = \frac{1}{3} \rho v_{\text{rms}}^2$, $v_{\text{rms}} = \sqrt{3RT/M}$, average KE per molecule = $(3/2)kT$

Radiation – Stefan $E = \sigma e T^4$; Wien $\lambda_m T = b \approx 2.9 \times 10^{-3} \text{ m K}$

Newton's law of cooling – $dT/dt = -k(T - T_0)$

09 Oscillations and waves

SHM – $x = A \sin(\omega t + \phi)$, $v = \omega \sqrt{A^2 - x^2}$, $a = -\omega^2 x$

Time period – spring $T = 2\pi\sqrt{m/k}$; simple pendulum $T = 2\pi\sqrt{L/g}$

Energy in SHM – $E = \frac{1}{2} k A^2$

Wave speed – $v = f\lambda$; on a string $v = \sqrt{T/\mu}$; sound in a gas $v = \sqrt{\gamma RT/M}$

Open pipe or string – $f_n = nv/2L$

Closed pipe – $f_n = (2n - 1)v/4L$ (odd harmonics only)

Beats – $f_{\text{beat}} = |f_1 - f_2|$

Doppler effect – $f' = f(v \pm v_o)/(v \mp v_s)$ (upper signs: moving towards each other)

10 Electrostatics

Coulomb's law – $F = kq_1 q_2 / r^2$, $k = 1/4\pi\epsilon_0 \approx 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$

Point charge – $E = kq/r^2$, $V = kq/r$

Dipole – axial $E = 2kp/r^3$, equatorial $E = kp/r^3$, torque $\tau = p \times E$

Gauss's law – $\Phi = q_{\text{enc}}/\epsilon_0$

Line charge – $E = \lambda/2\pi\epsilon_0 r$

Infinite sheet – $E = \sigma/2\epsilon_0$

Capacitance – $C = Q/V$; parallel plates $C = K\epsilon_0 A/d$

Energy stored – $U = \frac{1}{2} CV^2 = Q^2/2C$

Combinations – series $1/C = \sum 1/C_i$; parallel $C = \sum C_i$

11 Current electricity

Current – $I = dq/dt = nAev_d$

Ohm's law – $V = IR$, $R = \rho L/A$

Temperature – $R_T = R_0(1 + \alpha\Delta T)$

Combinations – series $R = \sum R_i$; parallel $1/R = \sum 1/R_i$

Power – $P = VI = I^2 R = V^2/R$

Cell – $V = E - Ir$; maximum power to the load when $R = r$

Kirchhoff – $\sum I = 0$ at a junction; $\sum V = 0$ round a loop

Wheatstone bridge (balanced) – $P/Q = R/S$

12 Magnetism and induction

Force on a charge – $F = q(v \times B)$; radius $r = mv/qB$; period $T = 2\pi m/qB$

Force on a wire – $F = IL \times B$

Biot-Savart – $dB = (\mu_0/4\pi) I dl \times \hat{r}/r^2$

Long straight wire – $B = \mu_0 I/2\pi r$

Centre of a loop – $B = \mu_0 I/2R$

Solenoid – $B = \mu_0 nI$

Parallel wires, force per length – $\mu_0 I_1 I_2 / 2\pi d$

Faraday's law – $\epsilon = -d\Phi/dt$; motional emf $\epsilon = Blv$

Inductance – $U = \frac{1}{2} LI^2$; solenoid $L = \mu_0 n^2 A l$

Growth in an LR circuit – $I = I_0(1 - e^{-t/\tau})$, $\tau = L/R$; RC circuit $\tau = RC$

13 Alternating current

RMS value – $V_{\text{rms}} = V_0/\sqrt{2}$

Reactance – $X_L = \omega L$, $X_C = 1/\omega C$

Impedance – $Z = \sqrt{R^2 + (X_L - X_C)^2}$

Resonance – $f_0 = 1/(2\pi\sqrt{LC})$, $Q = \omega_0 L/R$

Power – $P = V_{\text{rms}} I_{\text{rms}} \cos\phi$

Ideal transformer – $V_s/V_p = N_s/N_p = I_p/I_s$

14 Optics

Mirror – $1/v + 1/u = 1/f$, $f = R/2$, $m = -v/u$

Lens – $1/v - 1/u = 1/f$, $m = v/u$, $P = 1/f$ (dioptries, f in metres)

Lens maker's formula – $1/f = (\mu - 1)(1/R_1 - 1/R_2)$

Lenses in contact – $1/F = 1/f_1 + 1/f_2$

Snell's law – $n_1 \sin i = n_2 \sin r$; critical angle $\sin C = 1/\mu$

Prism – $\mu = \sin[(A + \delta_m)/2]/\sin(A/2)$; thin prism $\delta = (\mu - 1)A$

Young's double slit – fringe width $\beta = \lambda D/d$

Single slit, first minimum – $a \sin \theta = \lambda$

Polarisation – Malus $I = I_0 \cos^2 \theta$; Brewster $\tan i_p = \mu$

Instruments – telescope $m = f_o/f_e$; compound microscope $m \approx (L/f_o)(D/f_e)$

15 Modern physics

Photon – $E = hf = hc/\lambda$, $hc \approx 1240 \text{ eV nm}$

Photoelectric effect – $K_{\max} = hf - \phi = eV_0$

de Broglie – $\lambda = h/p = h/\sqrt{2mK}$; electron through V volts: $\lambda \approx 1.227/\sqrt{V} \text{ nm}$

Bohr model – $r_n = 0.529 n^2/Z \text{ \AA}$, $E_n = -13.6 Z^2/n^2 \text{ eV}$

Spectral lines – $1/\lambda = RZ^2(1/n_1^2 - 1/n_2^2)$, $R \approx 1.097 \times 10^7 \text{ m}^{-1}$

How to use this sheet

- 1 Cover the right-hand side of each line and say the formula out loud before you look.
- 2 Write the units next to every answer: it catches half of all slips.
- 3 Pair each formula with one solved question from your NCERT book or a previous paper.

Radioactive decay – $N = N_0 e^{-\lambda t}$, $T_{1/2} = 0.693/\lambda$, mean life $\tau = 1/\lambda$

Mass-energy – $E = mc^2$; $1 \text{ u} = 931.5 \text{ MeV}$

Nuclear radius – $R = R_0 A^{1/3}$

Diodes – a p-n junction conducts in forward bias above its barrier (about 0.7 V for silicon); a Zener diode in reverse breakdown regulates voltage

Logic and rectifiers – NAND and NOR are universal gates; full-wave output frequency = $2 \times$ input

16 Constants worth knowing

$g = 9.8 \text{ m s}^{-2}$	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
$c = 3 \times 10^8 \text{ m s}^{-1}$	$h = 6.63 \times 10^{-34} \text{ J s}$
$e = 1.6 \times 10^{-19} \text{ C}$	$m_e = 9.1 \times 10^{-31} \text{ kg}$
$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$	$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$
$k_B = 1.38 \times 10^{-23} \text{ J K}^{-1}$	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$	

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