

JEE Main Physics: Mechanics Formula Book

Advanced notes · Kinematics to Fluids · with solved PYQ-style questions · JEE Main · Physics

1. Kinematics

- Equations of motion (constant a): $v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$.
- Distance in the n th second: $s_n = u + (a/2)(2n - 1)$.
- Projectile (from ground): $T = 2u \sin\theta / g$, $H = u^2 \sin^2\theta / 2g$, $R = u^2 \sin 2\theta / g$.
- Maximum range at $\theta = 45^\circ$: $R_{\text{max}} = u^2/g$. Complementary angles (θ and $90^\circ - \theta$) give the same range.
- Trajectory: $y = x \tan\theta - g x^2 / (2u^2 \cos^2\theta)$ — a parabola.
- River crossing in minimum time: head straight across, $t = d / v_{\text{boat}}$. Zero drift: head upstream at $\sin\theta = v_{\text{river}} / v_{\text{boat}}$.

2. Laws of motion and friction

- $F = dp/dt$; for constant mass $F = ma$. Impulse $J = F\Delta t = \Delta p$.
- Static friction: $f \leq \mu_s N$. Kinetic friction: $f = \mu_k N$. Angle of repose: $\tan\theta = \mu_s$.
- Banking without friction: $\tan\theta = v^2 / (rg)$. With friction: $v_{\text{max}} = \sqrt{[rg (\mu + \tan\theta) / (1 - \mu \tan\theta)]}$.
- Atwood machine: $a = (m_1 - m_2)g / (m_1 + m_2)$, $T = 2m_1 m_2 g / (m_1 + m_2)$.
- Block on a smooth incline: $a = g \sin\theta$. With friction (sliding down): $a = g(\sin\theta - \mu \cos\theta)$.

3. Work, energy and power

- $W = F \cdot s = Fs \cos\theta$. Variable force: $W = \int F dx$.
- $KE = \frac{1}{2}mv^2 = p^2/2m$. Work-energy theorem: $W_{\text{net}} = \Delta KE$.
- Spring: $F = -kx$, $U = \frac{1}{2}kx^2$. Power: $P = dW/dt = F \cdot v$.
- Vertical circle (string): minimum speed at top $= \sqrt{gr}$; at bottom $= \sqrt{5gr}$; $T_{\text{bottom}} - T_{\text{top}} = 6mg$.

4. Collisions and centre of mass

- Momentum is conserved in all collisions (no external force). KE is conserved only in elastic collisions.
- 1D elastic: $v_1 = [(m_1 - m_2)u_1 + 2m_2 u_2] / (m_1 + m_2)$, $v_2 = [(m_2 - m_1)u_2 + 2m_1 u_1] / (m_1 + m_2)$.
- Equal masses in a 1D elastic collision exchange velocities.
- Coefficient of restitution: $e = (\text{velocity of separation}) / (\text{velocity of approach})$; $e = 1$ elastic, $e = 0$ perfectly inelastic.
- Centre of mass: $x_{\text{cm}} = \Sigma m_i x_i / \Sigma m_i$.

That was a preview.

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PREVIEW