EngineeringRise

Relative motion

Formulas and units, JEE Main. Status: Reviewed on 2026-11-20.

Result	Formula	Units or note
Relative velocity	v_AB = v_A - v_B; v_BA = -v_AB Valid when: speeds far below light speed; both velocities measured in the same frame	m/s
Magnitude of relative velocity	|v_AB| = sqrt(vA^2 + vB^2 - 2 vA vB cos(theta)) Valid when: theta is the angle between the two velocities drawn from a common point	m/s
River: minimum time	t = d/v at heading perpendicular to the bank; drift = u t Valid when: uniform current parallel to banks; v is boat speed in still water	s (m)
River: zero drift	sin(theta) = u/v (v > u); t = d/sqrt(v^2 - u^2) Valid when: boat faster than current (v > u); theta from the perpendicular, upstream	dimensionless, s
River: least drift (v < u)	sin(theta) = v/u; drift = d sqrt(u^2 - v^2)/v Valid when: boat slower than current (v < u); theta from the perpendicular, upstream	dimensionless, m
Rain and umbrella	tan(angle from vertical) = v_man/v_rain Valid when: rain steady, man walking on level ground; angle measured from the vertical	dimensionless
Aircraft and wind	ground = air + wind; ground speed = sqrt(v_air^2 - w^2) when heading cancels cross wind Valid when: steady wind; wind perpendicular to the intended ground track	m/s
Collision condition	v_AB points along r_B - r_A (from A towards B): (v_AB)_x/(v_AB)_y = (r_B - r_A)_x/(r_B - r_A)_y with the same sign; t = |r_AB|/|v_AB| Valid when: constant velocities, point-like bodies; A and B reach the same point together	m/s (s)

Full lesson with worked examples: https://www.engineeringrise.in/learn/learn/jee-main/physics/kinematics/relative-motion

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