Work, Energy & Power — Complete Formula Card

- The work–energy theorem is the shortcut: compare before/after states, skip the path
- Three energy stores in JEE problems: height (mgh), springs (½kx²), motion (½mv²)
- Friction is a leak, not a store — it converts mechanical energy to heat, F·d at a time

What	Formula	Remember
Work	**W = Fd·cosθ**	perpendicular = zero; against motion = negative
Kinetic energy	**½mv²**	square! double speed ×4
Work–energy theorem	**W_total = ΔKE**	before/after only — path-free
Height PE	**mgh**	choose one zero level
Spring PE	**½kx²**	stretch squared; metres!
Energy conservation	**KE + PE = constant (gravity/springs)**	friction leak = F·d → heat
Drop speed	**v = √(2gh)**	no mass anywhere
Loop minimums	**v_top = √(gR); v_bottom = √(5gR); h = 2.5R**	gravity helps at the top
Power	**P = W/t = Fv**	watts; 1 hp = 746 W
Efficiency	**useful ÷ input**	always < 100%
Collisions	**momentum always survives**	sticking = max KE loss; equal-mass elastic = swap
Variable force	**work = area under F–d graph**	½kx² is the triangle
PE curves	**valley = stable, hill = unstable**	slope = force

Mistakes to avoid

- Never assume constant force when told it varies — use area under the F–d graph
- Valley = stable, hill = unstable — draw the ball, feel the answer
- Efficiency direction: input = useful ÷ efficiency (bigger); output = input × efficiency (smaller)
- Human power is overestimated: we sustain ~100–150 W — light bulbs, not engines