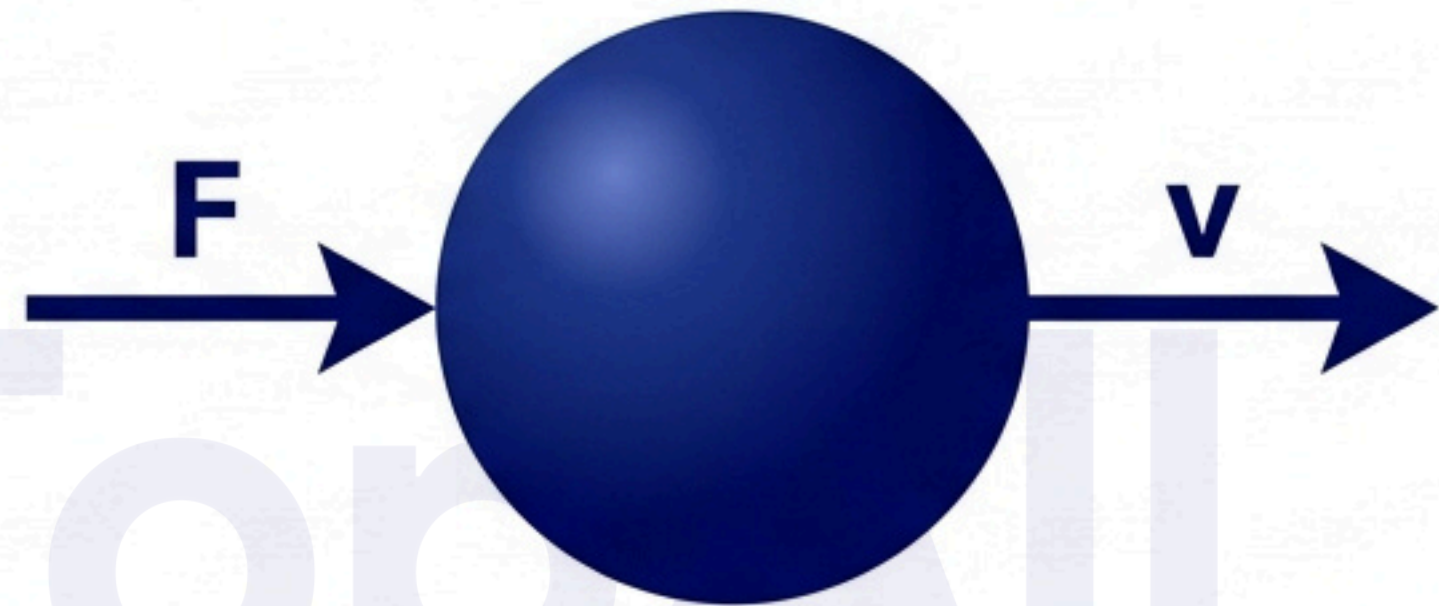


The Work-Energy Theorem

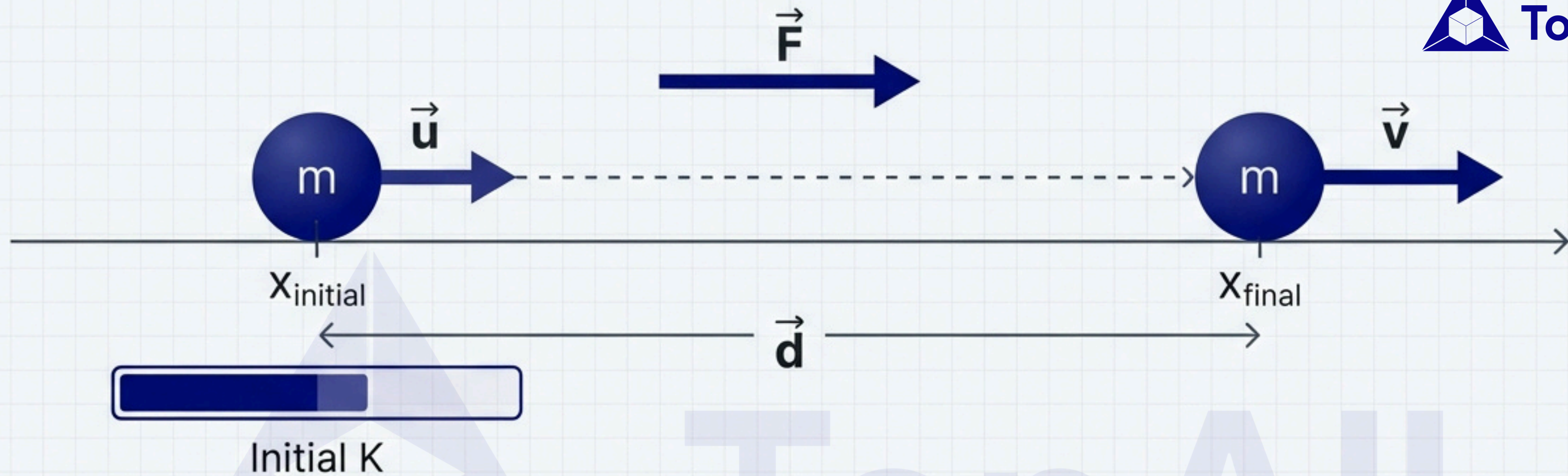
Bridging the gap between force, motion, and kinetic energy.

[NEET / JEE Focus]

[Section 5.2]



Kinetic Energy (K)



We already know from Chapter 3 kinematics...

Consider rectilinear motion under constant acceleration a .

$$v^2 - u^2 = 2as$$

Start with vectors

$$v^2 - u^2 = 2a \cdot d$$

Multiply by $m/2$

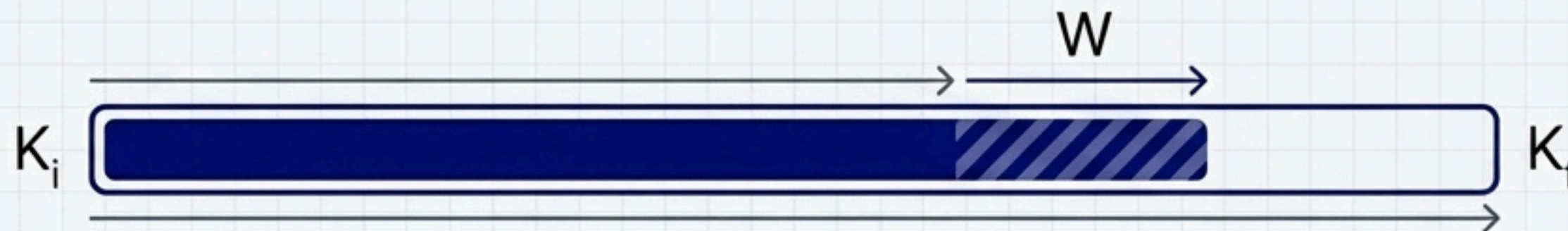
$$\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = ma \cdot d$$

Apply Newton's 2nd Law ($ma = F$)

$$\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = F \cdot d$$

Change in
Kinetic Energy
($K_f - K_i$)

Work
(W)



Energy Bar Tracker



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$$E=mc^2$$



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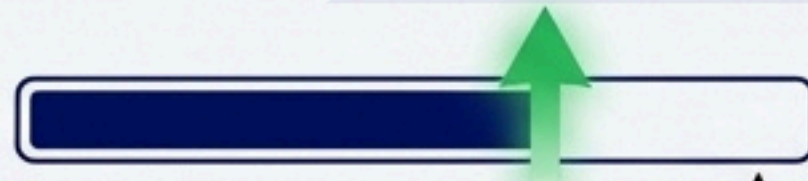
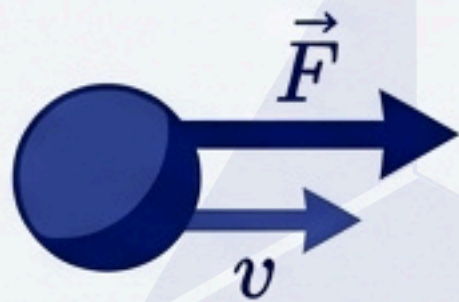
Work-Energy Theorem: Conceptual Application

$$K_f - K_i = W_{\text{net}}$$

The change in kinetic energy of a particle is equal to the work done on it by the net force.

Positive Work ($W > 0$)

Force is in the direction of motion ($\theta < 90^\circ$).



Increasing Kinetic Energy

Kinetic energy increases.
Particle speeds up.

Negative Work ($W < 0$)

Force opposes motion ($\theta > 90^\circ$, e.g., friction).

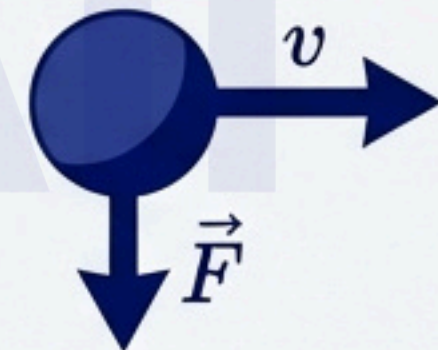


Decreasing Kinetic Energy

Kinetic energy decreases.
Particle slows down.

Zero Work ($W = 0$)

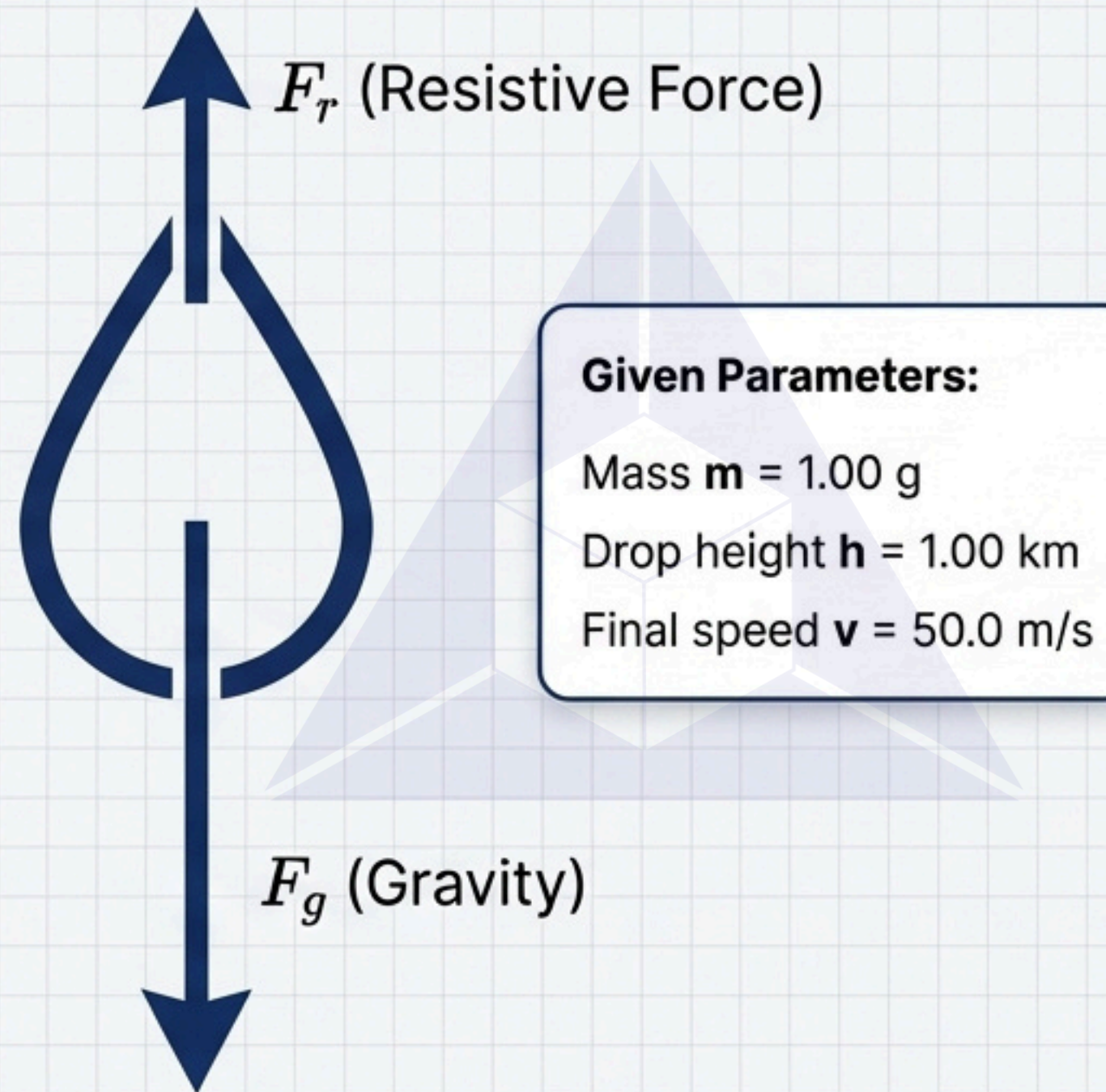
Force is perpendicular to motion ($\theta = 90^\circ$).



Unchanged Kinetic Energy

Kinetic energy is unchanged.
Constant speed.

The Physical System



Diagnostic Table



Find ΔK :

$$\Delta K = \frac{1}{2}mv^2 - 0 = \frac{1}{2}(10^{-3} \text{ kg})(50.0 \text{ m/s})^2 = 1.25 \text{ J}$$

Find Gravity's Work:

$$W_g = mgh = (10^{-3} \text{ kg})(10 \text{ m/s}^2)(10^3 \text{ m}) = 10.0 \text{ J}$$

Apply Theorem:

$$\Delta K = W_g + W_r \Rightarrow W_r = \Delta K - W_g$$

Result: Resistive Work

$$W_r = 1.25 \text{ J} - 10.0 \text{ J} = -8.75 \text{ J}$$



Notice: The negative result proves the resistive force removed kinetic energy from the system.

Key Takeaways



The Work-Energy Theorem integrates Newton's Second Law over a spatial displacement, transforming kinematics into energy mechanics.



$K = \frac{1}{2}mv^2$ represents the energy of motion (a scalar quantity).



$W = F \cdot d$ represents energy transferred by a force over a displacement.



Net Work dictates speed: Positive work speeds an object up, negative work slows it down, and zero net work maintains constant speed.



You've Learned the Theory.

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