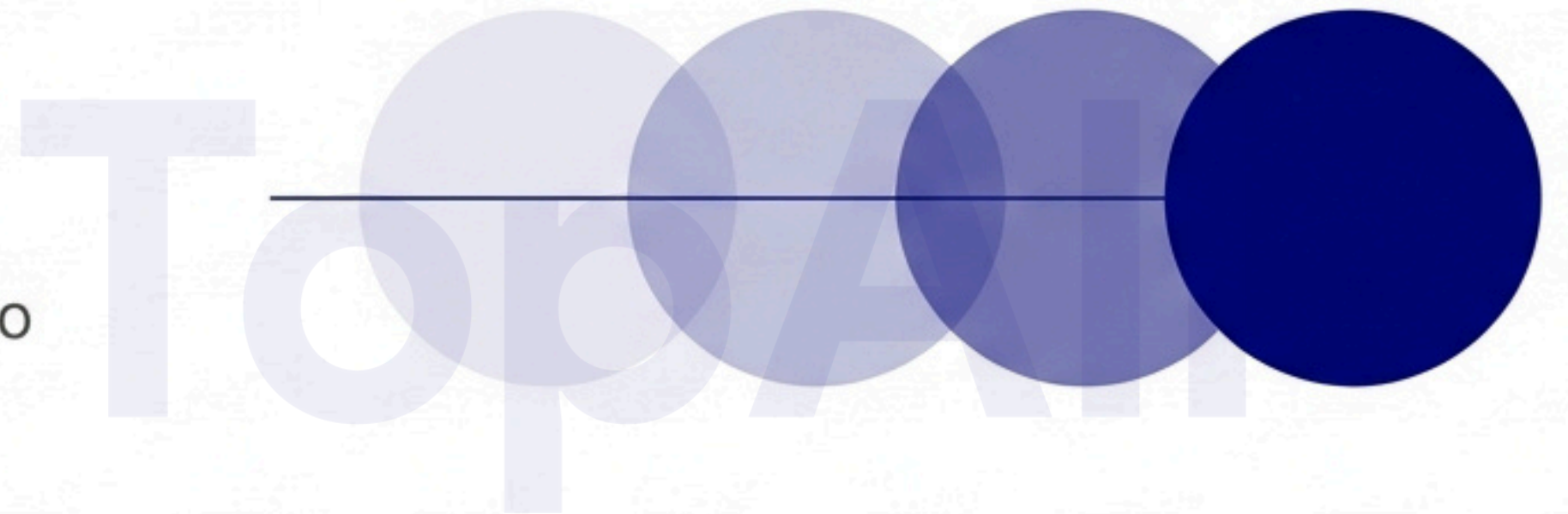


CHAPTER 5 • WORK, ENERGY AND POWER

Kinetic Energy

The energy of motion. How mass and velocity translate into the capacity to do work.

NEET/JEE Essential Concept



What Kinetic Energy Means

The Definition: Kinetic energy (K) is the energy an object possesses strictly by virtue of its motion.

Capacity for Work: It is a direct measure of the work an object can do because it is moving. Intuitively, a faster or heavier object can cause more change when it hits something.

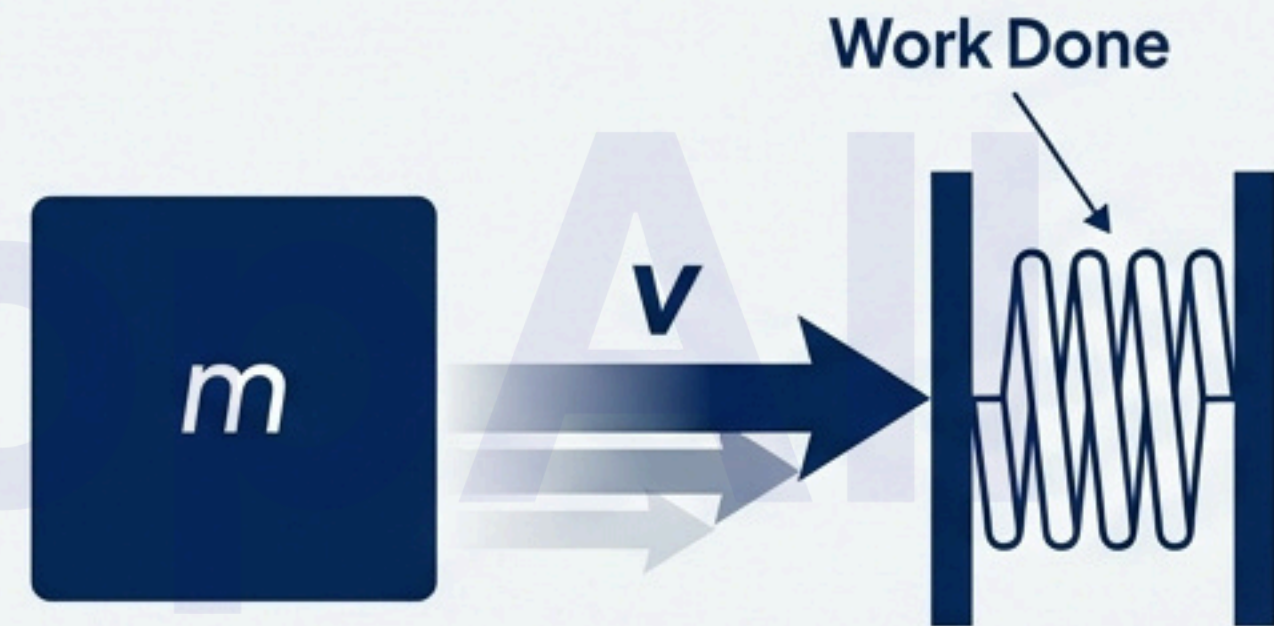
Core Properties:

SCALAR

It has magnitude but no direction

ALWAYS POSITIVE

An object's kinetic energy can never be negative



The Kinetic Energy Formula

K (Kinetic Energy): Measured in Joules (J). Dimensional formula is $[ML^2T^{-2}]$.

m (Mass): Measured in kg.
K is directly proportional to mass.

$$K = \frac{1}{2}mv^2$$

v^2 (Velocity Squared):
Measured in $(m/s)^2$.

Highlight Box

Doubling the speed quadruples the kinetic energy! (Frequent Exam Trap).

Vector Context: $\mathbf{v}^2$ is the dot product of the velocity vector with itself ($\mathbf{v} \cdot \mathbf{v}$).
Since $\mathbf{v} \cdot \mathbf{v} = |\mathbf{v}|^2$, Kinetic Energy has no direction.



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Examples of Motion With Energy



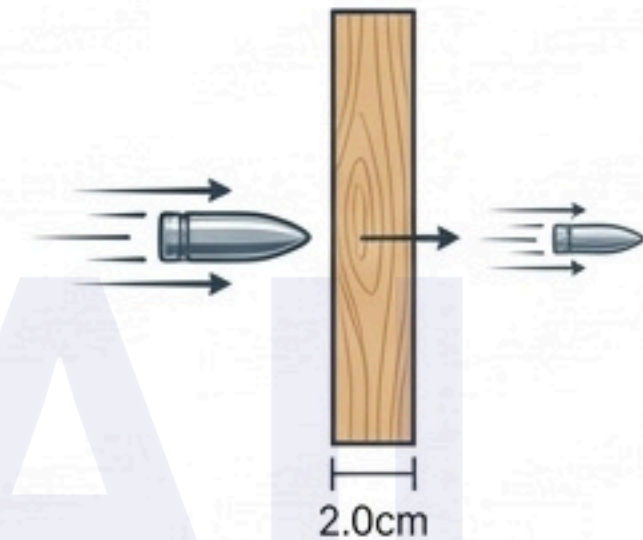
Flowing Water

The kinetic energy of a fast-flowing stream is transferred to a water wheel, doing the mechanical work of grinding corn.



Wind Energy

The moving mass of air (wind) possesses massive kinetic energy, caught by sails to push heavily loaded ships across oceans.



Ballistics (Example 5.4)

Initial: 50g bullet at 200 m/s $\rightarrow K_i = 1000 \text{ J}$

Final: Emerges with 10% energy
 $\rightarrow K_f = 100 \text{ J}$. Speed drops to 63.2 m/s.

INSIGHT: 90% loss in Energy $\neq$ 90% loss in Speed! (Speed only dropped by 68%)

Chapter Mastery

Key Takeaways: Kinetic Energy

[Definition]

Energy possessed by a body strictly by virtue of its motion.

[Formula]

$K = \frac{1}{2} m v^2$. It is mathematically equivalent to the work a moving object can do before coming to rest.

[Properties]

It is a SCALAR quantity. It is ALWAYS POSITIVE (or zero if at rest), regardless of the direction of motion.

[Dimensions]

Measured in Joules (J). The dimensional formula is $[ML^2T^{-2}]$.

[Proportionality]

Highly sensitive to speed. Because of the v^2 term, a small increase in velocity results in a massive squared increase in kinetic energy.



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