CUBE NOTES

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Kinetic Energy and Work Done

Kinetic Energy

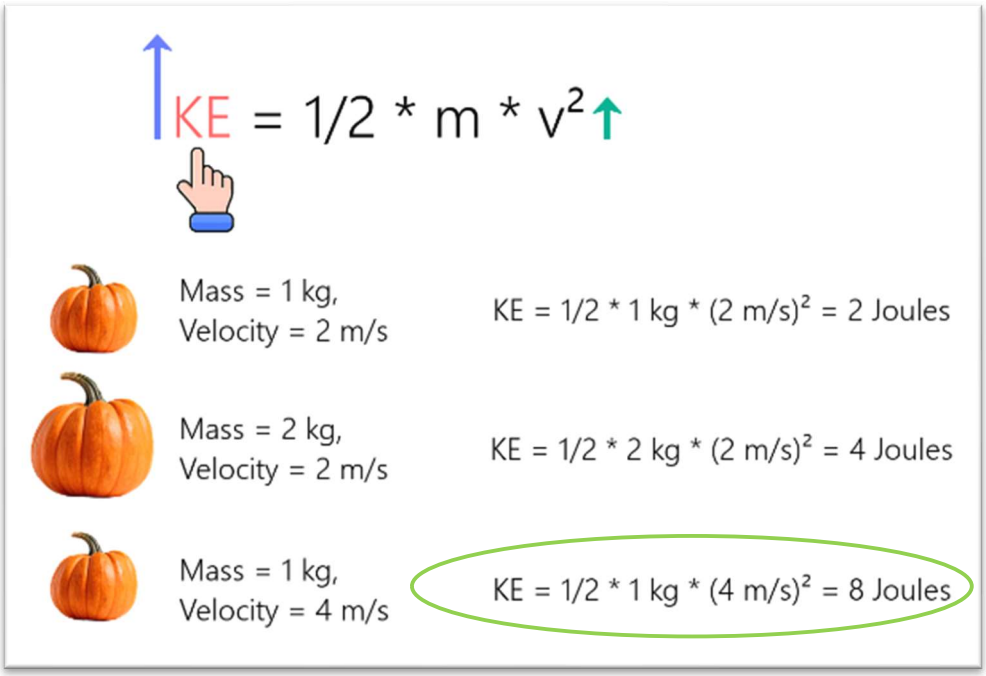
Kinetic Energy (KE) is the energy possessed by an object *due to its motion*.

Key Insight: Velocity impacts KE more than mass due to the square relationship.

$KE = 1/2 * m * v^2$

KE = Kinetic Energy
m = mass
v = velocity

Example Calculation:



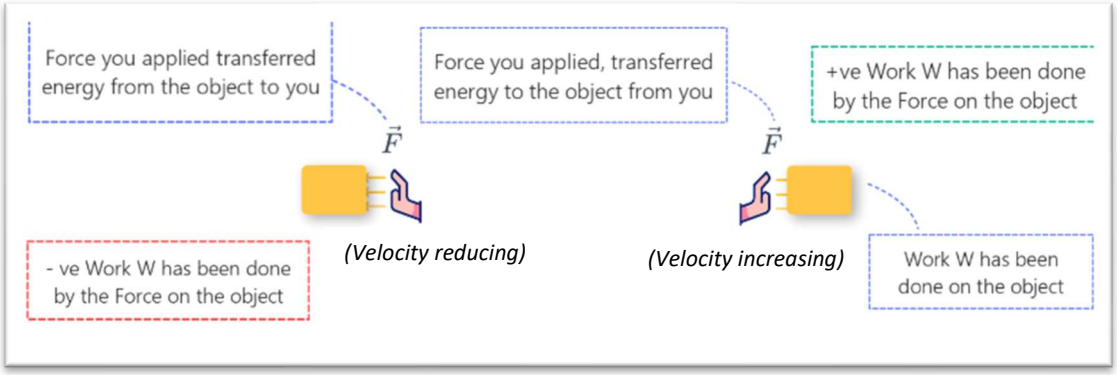
Bullet vs. Boulder: A Kinetic Energy Comparison

From the above example, you can say that a bullet, despite its small mass, can have higher KE than a larger, slower boulder *due to its high velocity*

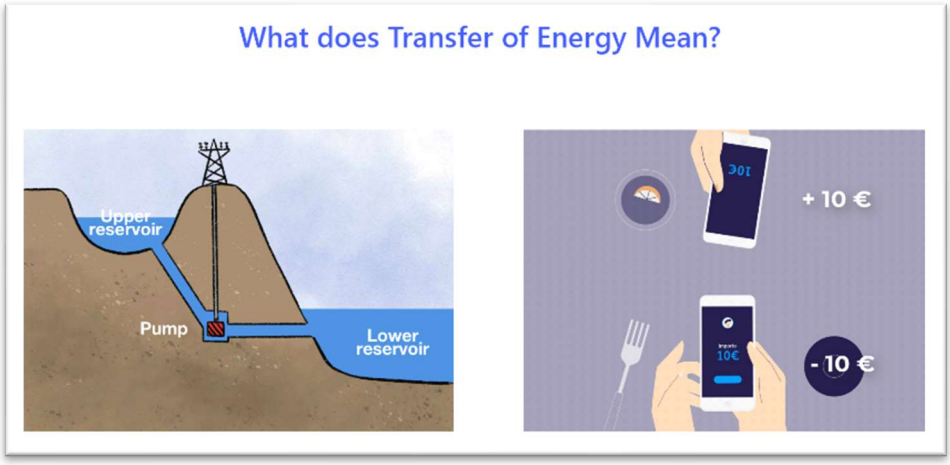
Force and Kinetic Energy

- If the applied force increases velocity and hence KE - *positive work is done*
- If the applied force decreases velocity and hence KE - *negative work is done*

  We say, the Force is transferring energy into the object (+ve work) or out of the object (-ve work)



- **Energy Transfer**: Analogous to electronic money transfer, not physical.



Deriving Work Done by a Force

Newton's Second Law: $F = ma$ (Eq. 1)

Displacement and Velocity Change:

Initial velocity = v_0, Final velocity = v, Displacement = d

$$v^2 = v_0^2 + 2ad \quad \text{(Eq. 2)}$$

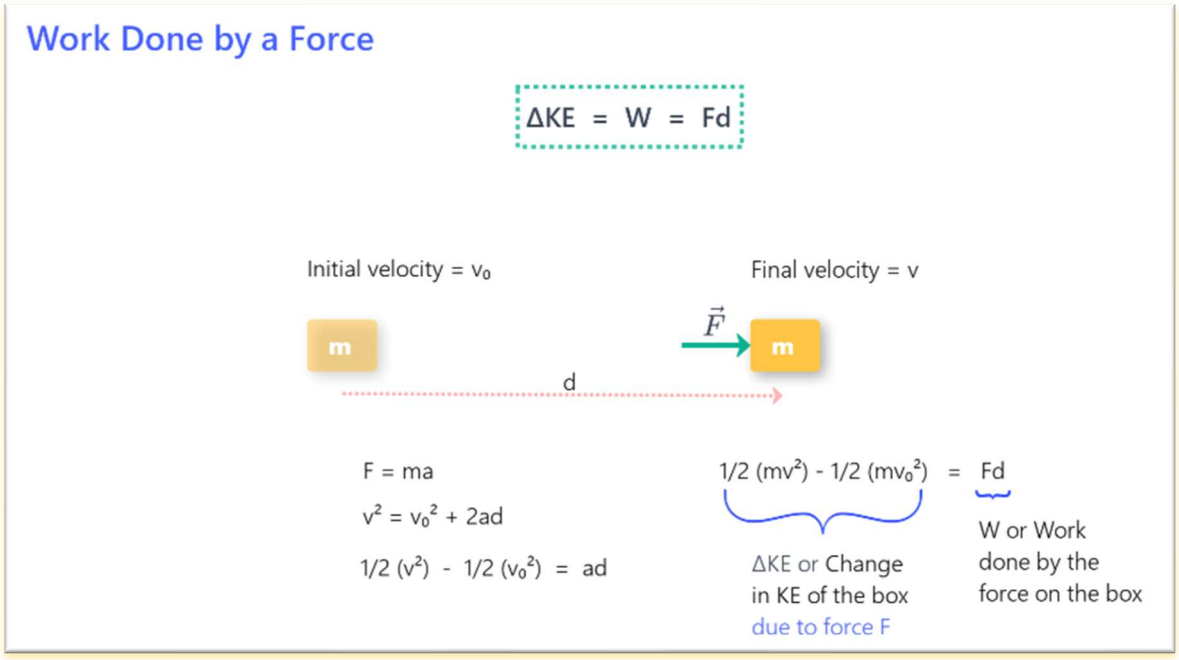
Rearranging (2) and Substituting $a = F/m$ in (1)

$$\underbrace{\tfrac{1}{2}(mv^2) - \tfrac{1}{2}(mv_0^2)}_{\text{Change in KE}} = \underbrace{Fd}_{\text{Work done}}$$

$$\Delta KE = W = Fd$$

Key Points to Remember

1. **Work is Scalar**: Independent of direction of force.
2. **Constant Force**: Formula applies only for constant force (both, magnitude and direction)
3. **Multiple Forces**: Work done can be calculated individually for each force and summed, or by using the resultant force and multiplying it with displacement



Common Misconceptions

S.N	Misconception	Reality
1	Work is only done when the force and motion are in the same direction.	Work is done whenever there is a component of force in the direction of displacement, even if the force itself is not perfectly aligned with displacement
2	Applying a force always increases an object's kinetic energy.	The kinetic energy can decrease if the force acts opposite to the direction of motion, leading to negative work.
3	The formula ΔKE = W implies that kinetic energy and work are the same thing.	This formula represents a change in kinetic energy as a result of work done; they are related but distinct concepts.
4	The faster an object moves, the more work must have been done on it.	Work depends on force and displacement, not just the final speed. An object can achieve high speeds with relatively small force over a long distance.
5	Negative work implies that energy is lost or destroyed.	Energy is conserved; negative work means energy is transferred away from the object, not lost.
6	Work is always a transfer of energy.	Work results in energy transfer, but not all energy transfers are work (e.g., heat transfer).