PHYSICS FOR
PHYSICS TEACHER 1

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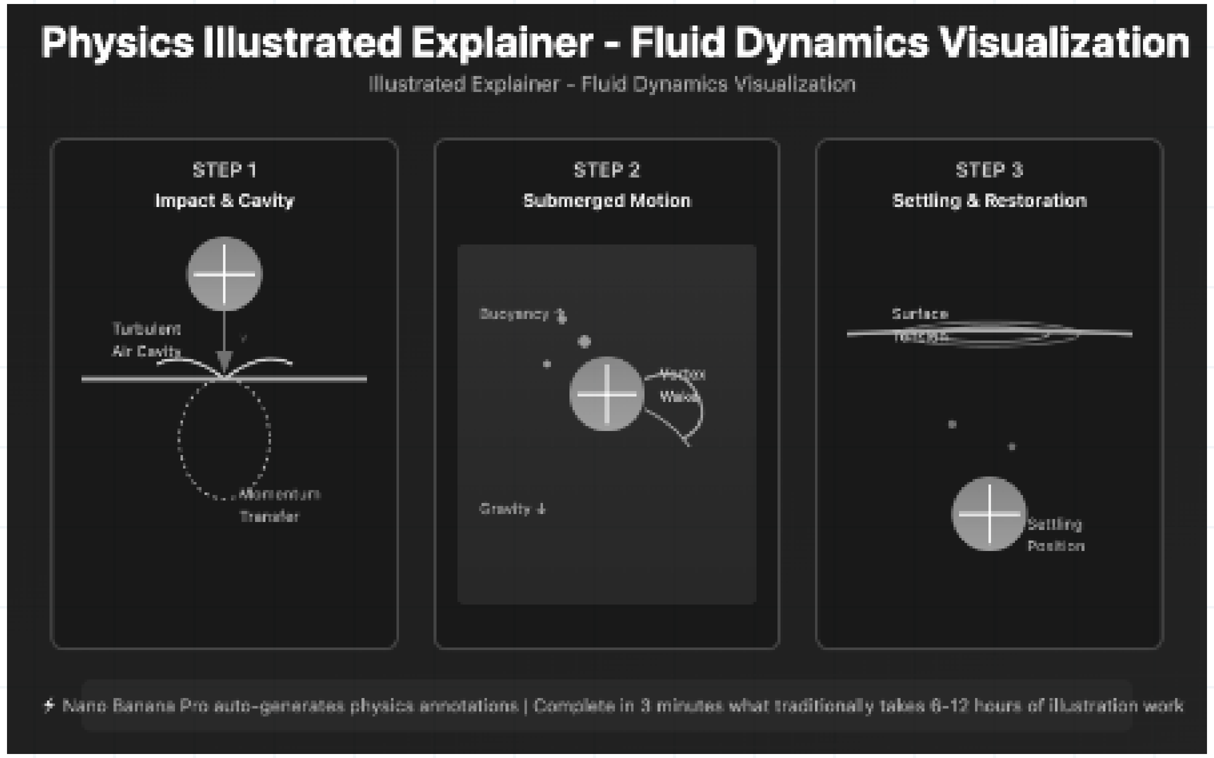

TECHNICAL SPEC: PHYS_CURRICULUM_V1.0

WORK AND ENERGY

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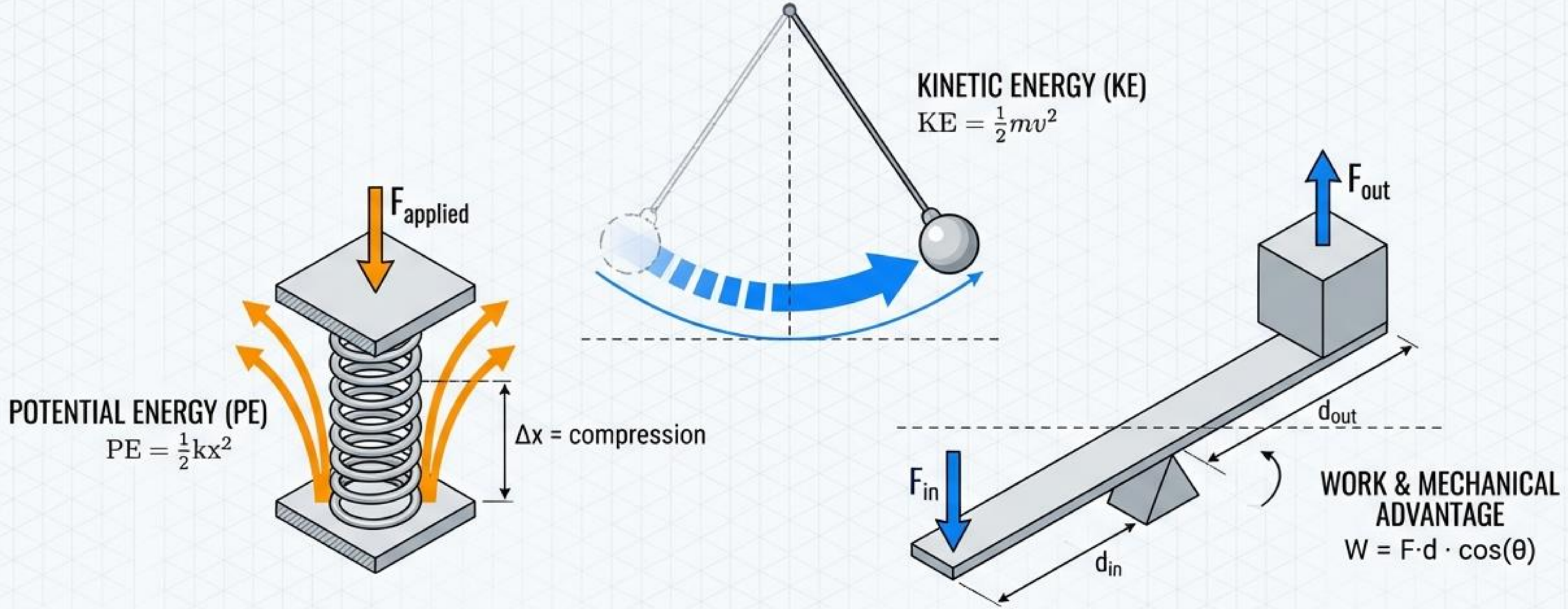
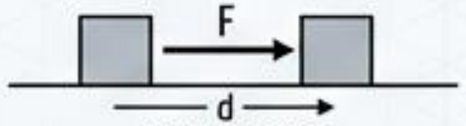
WORK & ENERGY

A Visual Synthesis of Physics Vol 2, Chapter 5



1. ACTION

Work is the transfer of energy by a force acting through a distance. $W = F \times d$.



WORK DONE

2. CURRENCY

Energy is the capacity to do work. Measured in Joules (J). It exists in various forms.

ENERGY UNITS

3. LAW

Conservation of Energy: Energy cannot be created or destroyed, only transformed or transferred.

$\boxed{E_{initial} = E_{final}}$ → KE → Heat
→ PE → Dissipation

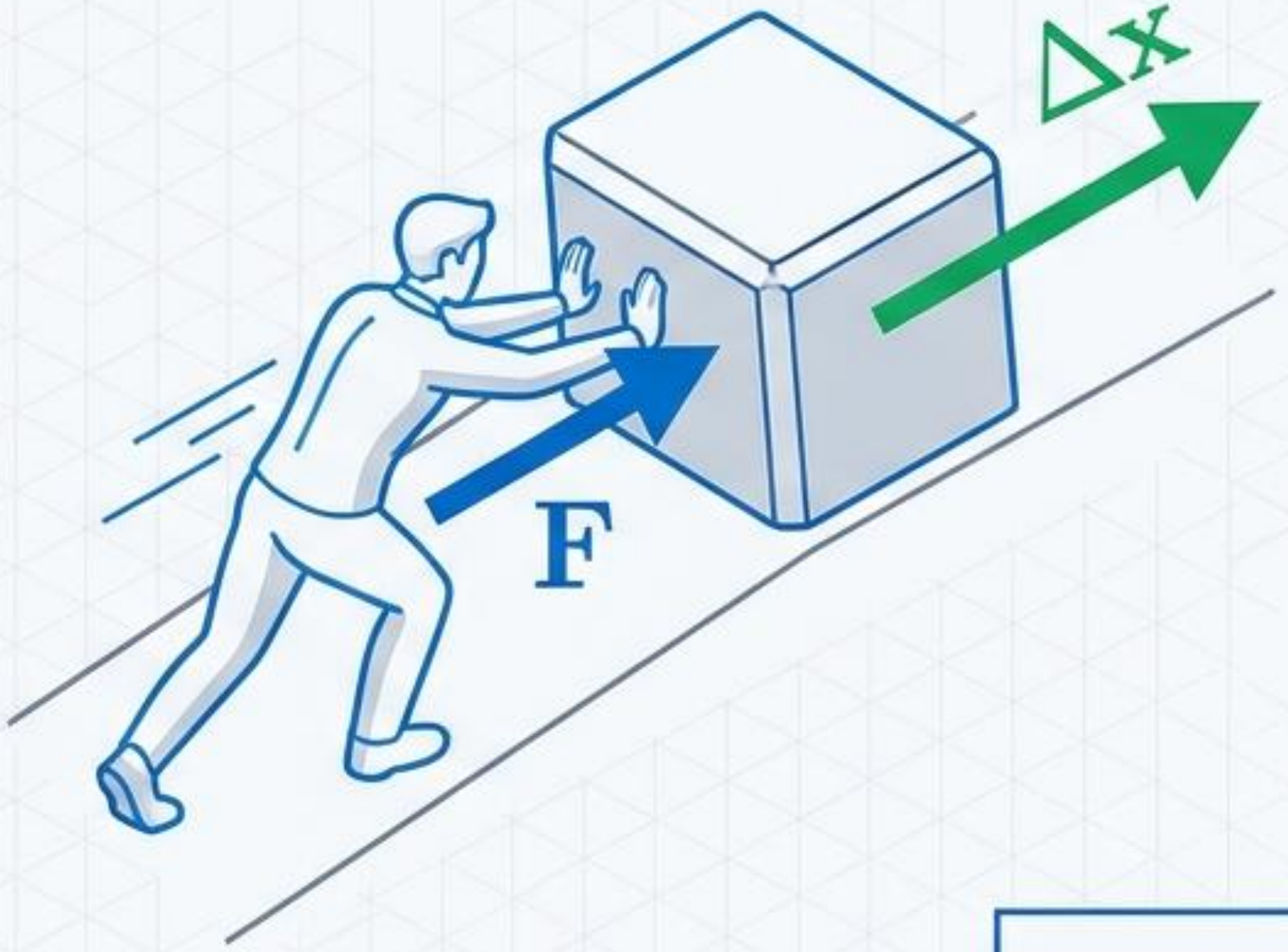
DISSIPATION RED

4. APPLICATION

Principles of work and energy are fundamental to designing machines, structures, and understanding physical systems.

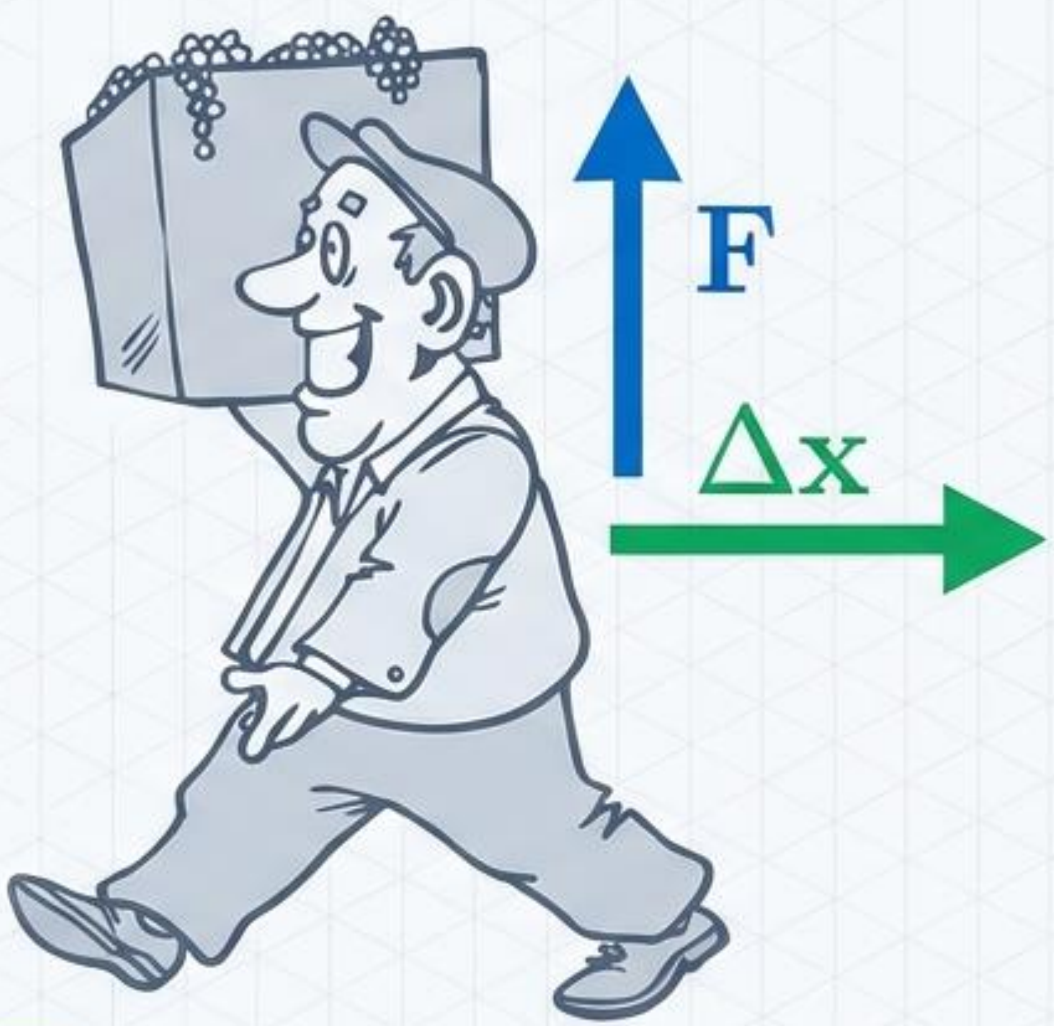
ENGINEERING SYSTEMS

PHYSICS WORK



Force & Motion are aligned.

ZERO WORK

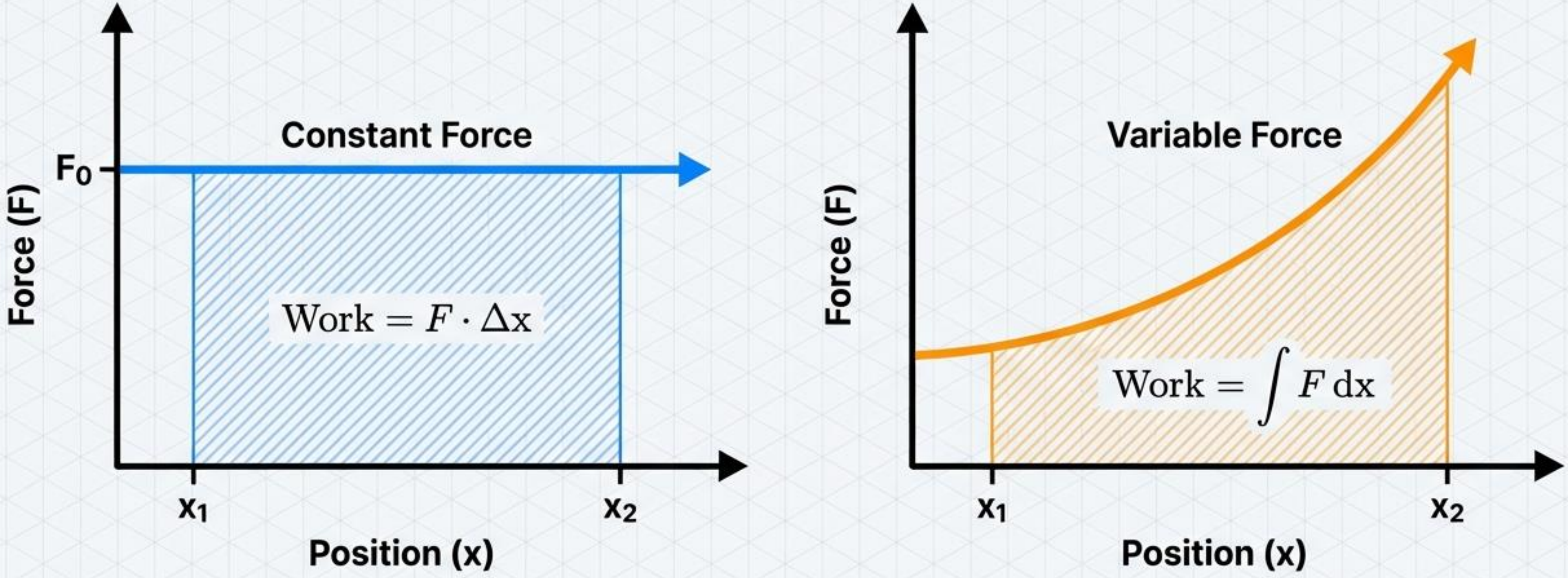


Force ⊥ Displacement (90°).

$$W = F\Delta x \cos(\theta)$$

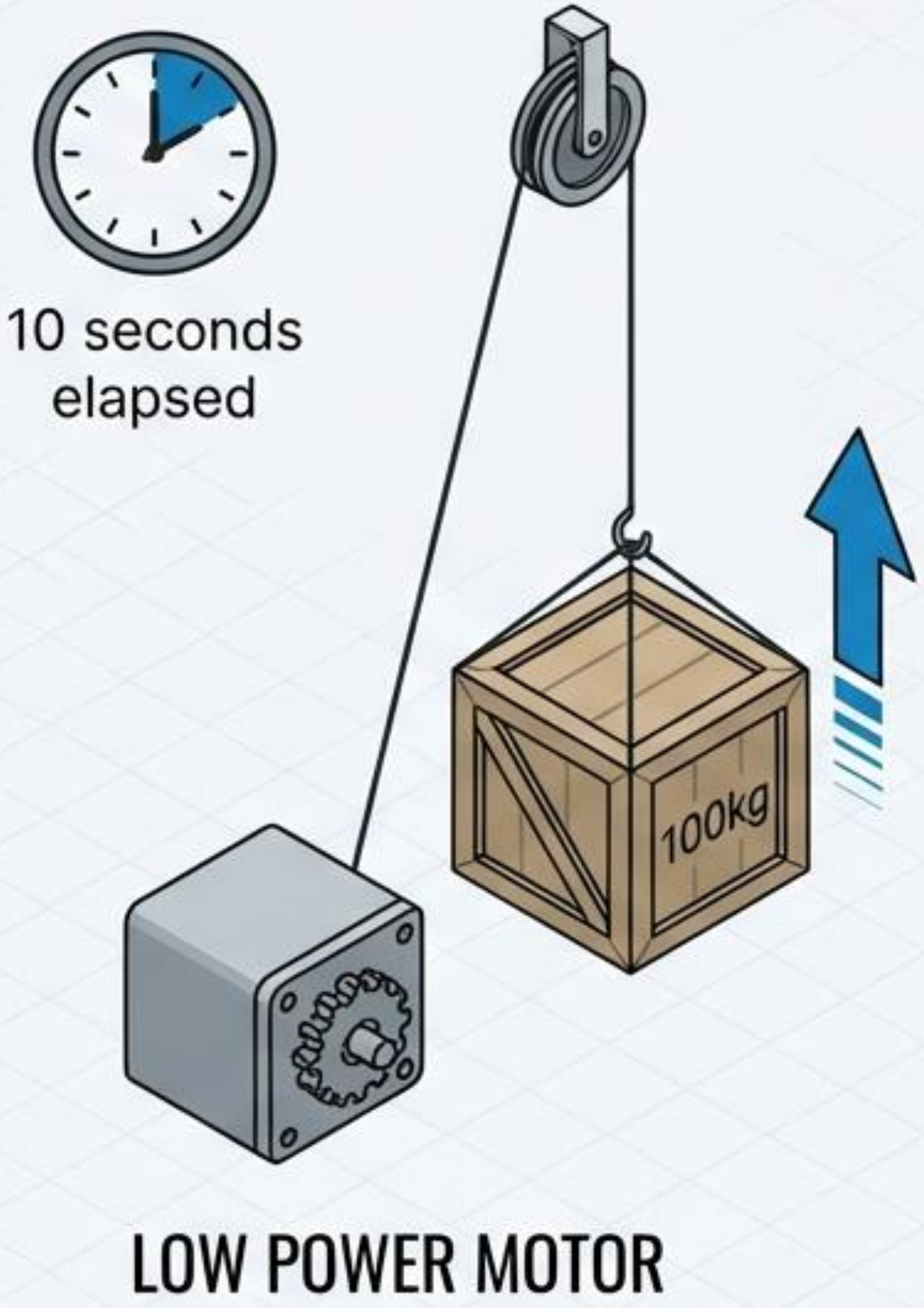
If $\theta = 90°$, Work = 0

VISUALIZING WORK: AREA UNDER THE CURVE



When force changes (like stretching a spring), Work is the total area underneath the graph.

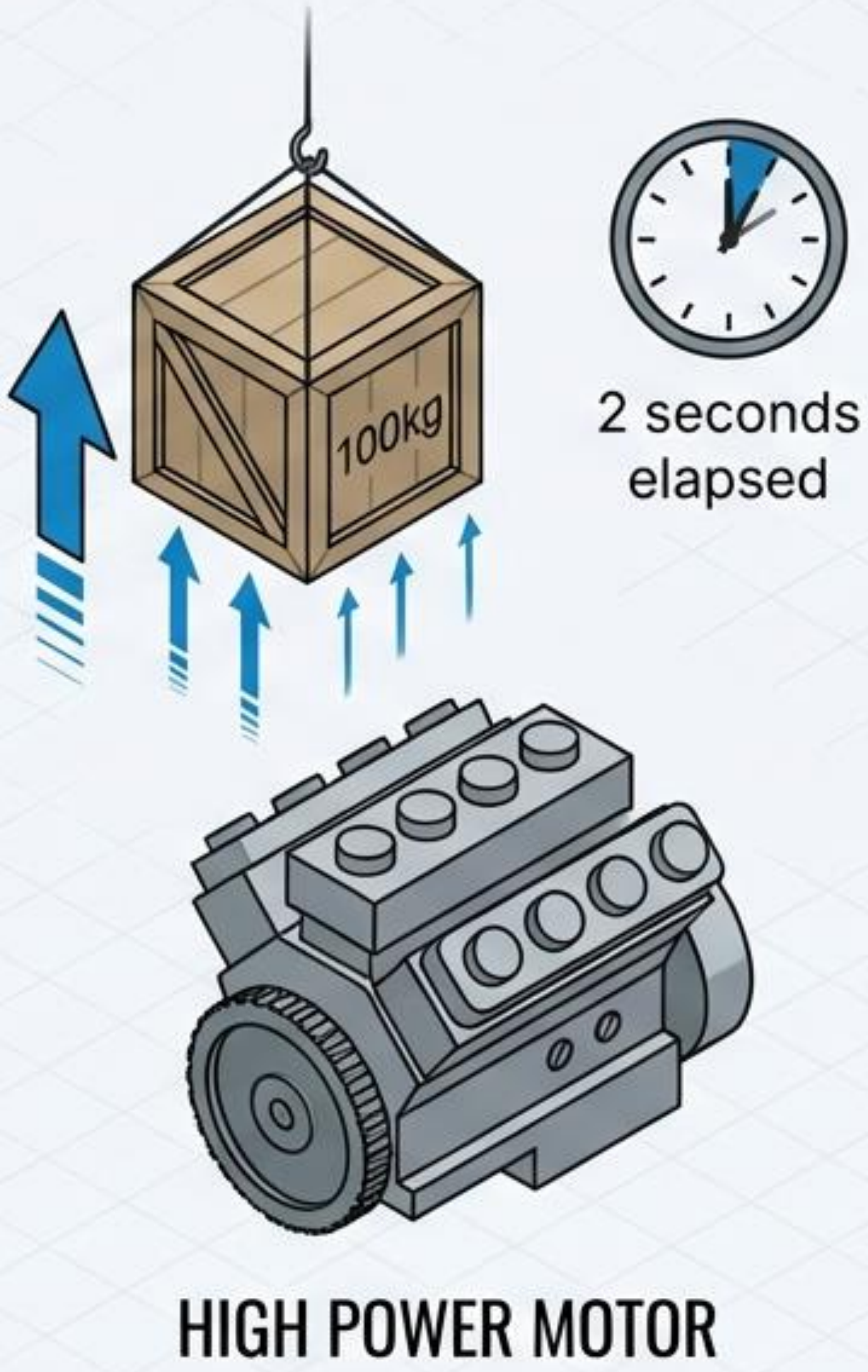
POWER: THE RATE OF WORK



$$P_{avg} = \frac{W}{\Delta t}$$

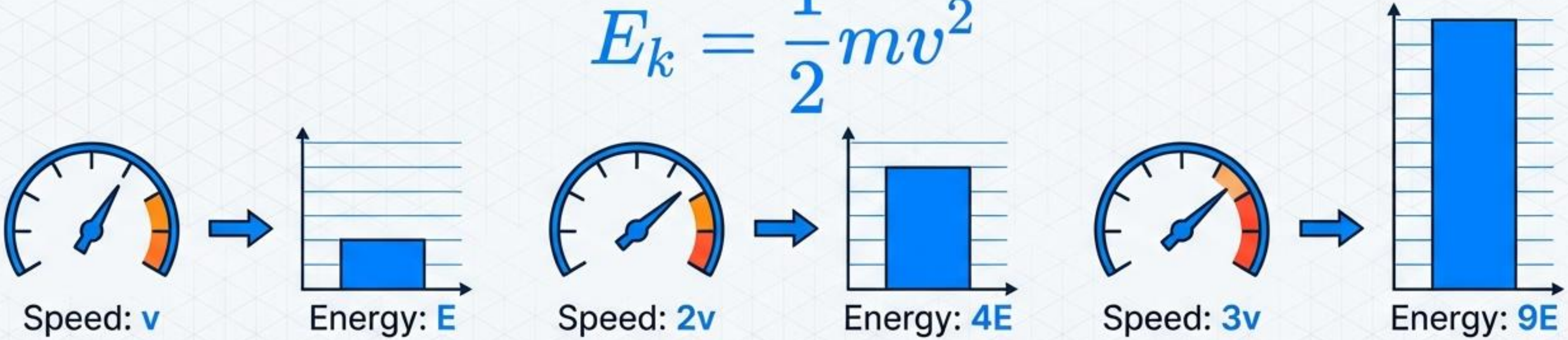
$$P = Fv$$

1 Watt = 1 Joule / second



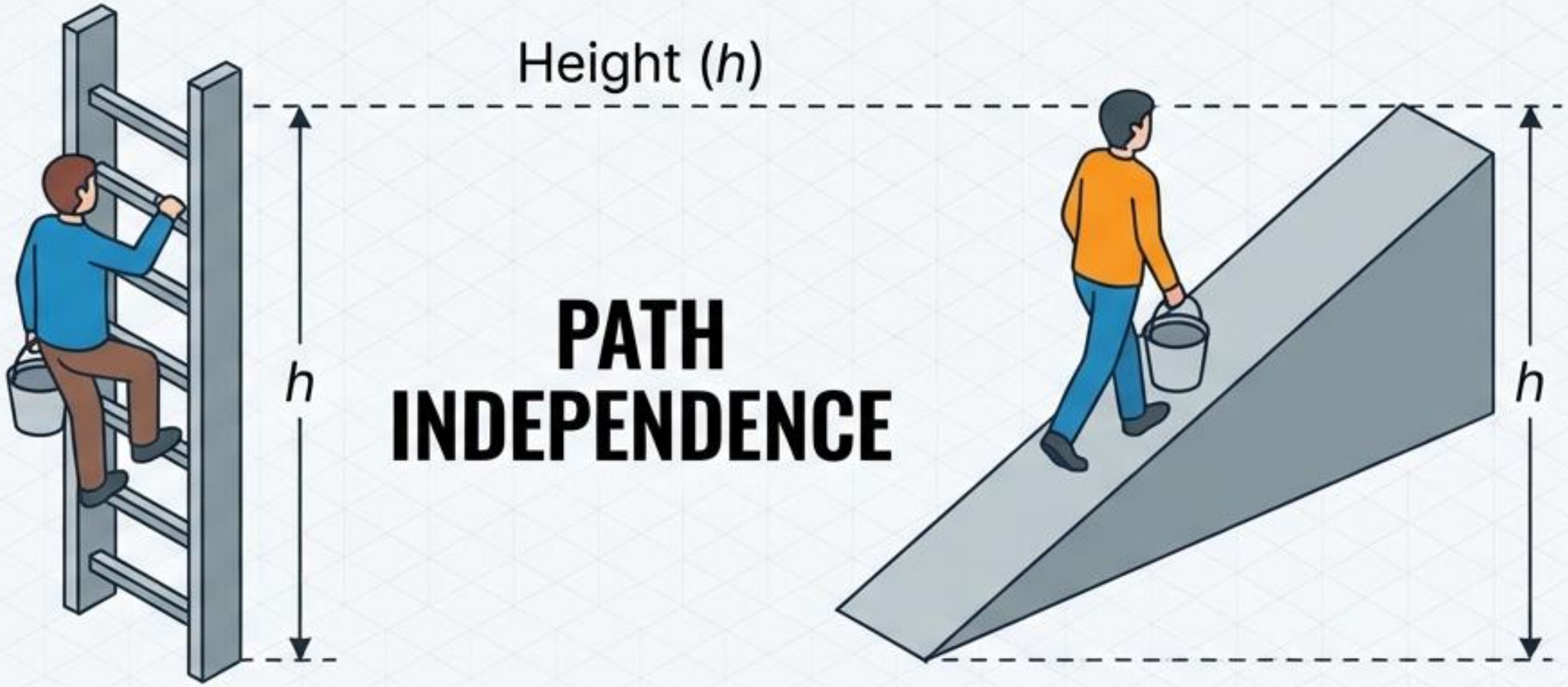
KINETIC ENERGY (E_k)

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



The Work-Energy Theorem: Work done = Change in Kinetic Energy ($W = \Delta E_k$).

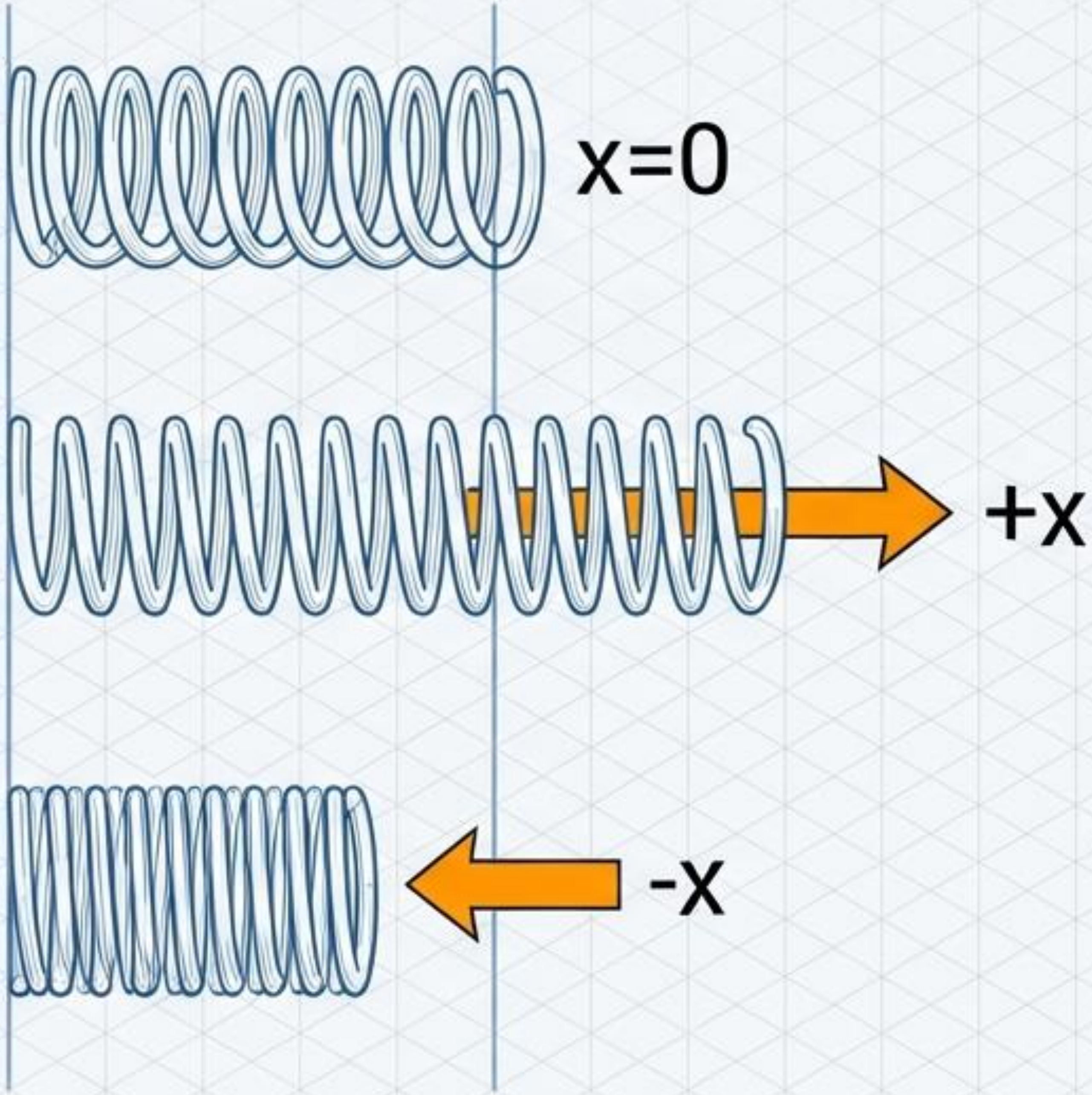
GRAVITATIONAL POTENTIAL ENERGY (E_p)

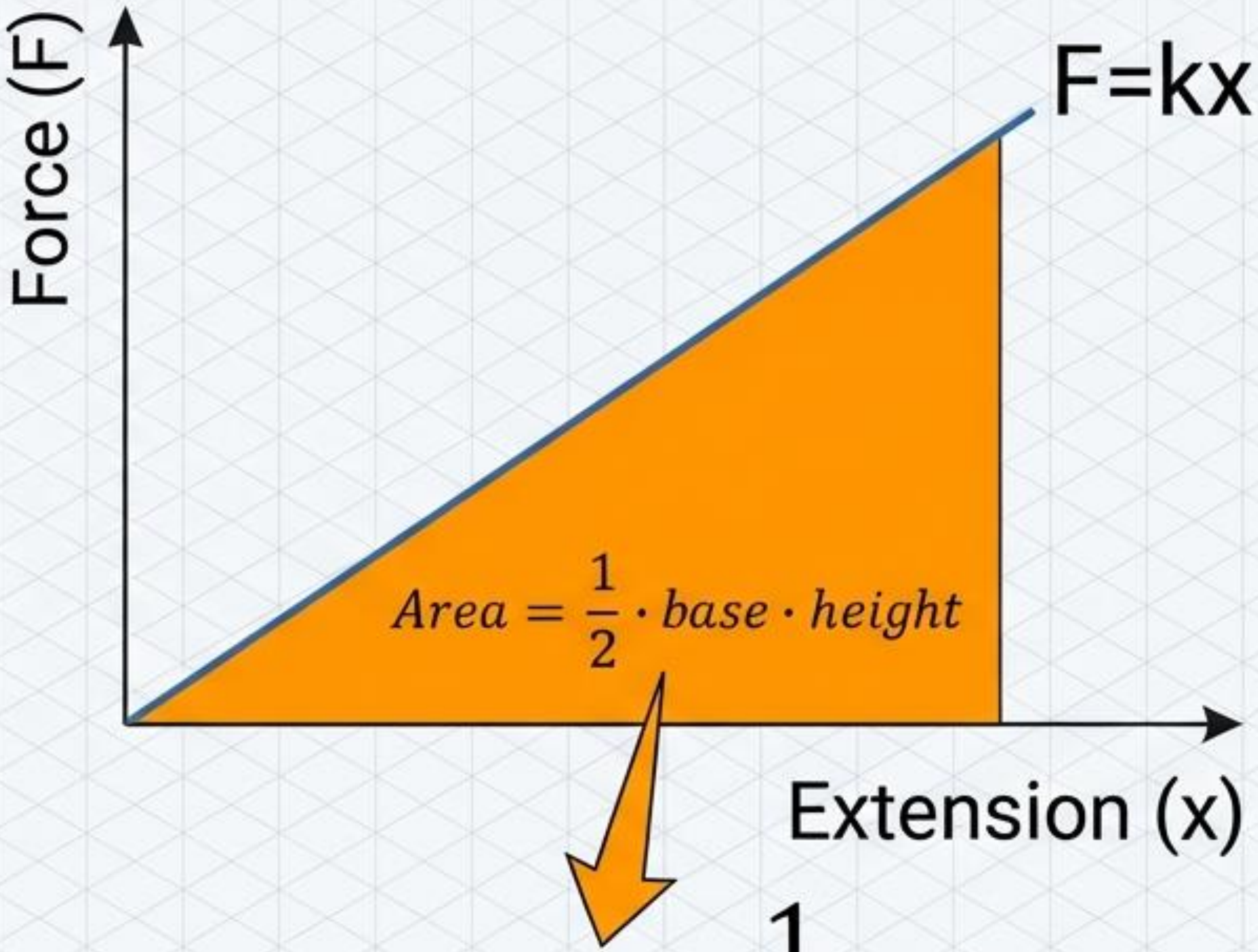


$$E_p = mgh$$

Gravity is a conservative force. Work depends only on the **vertical height change**, not the path taken.

ELASTIC POTENTIAL ENERGY ($E_{\mathrm{p,elastic}}$)

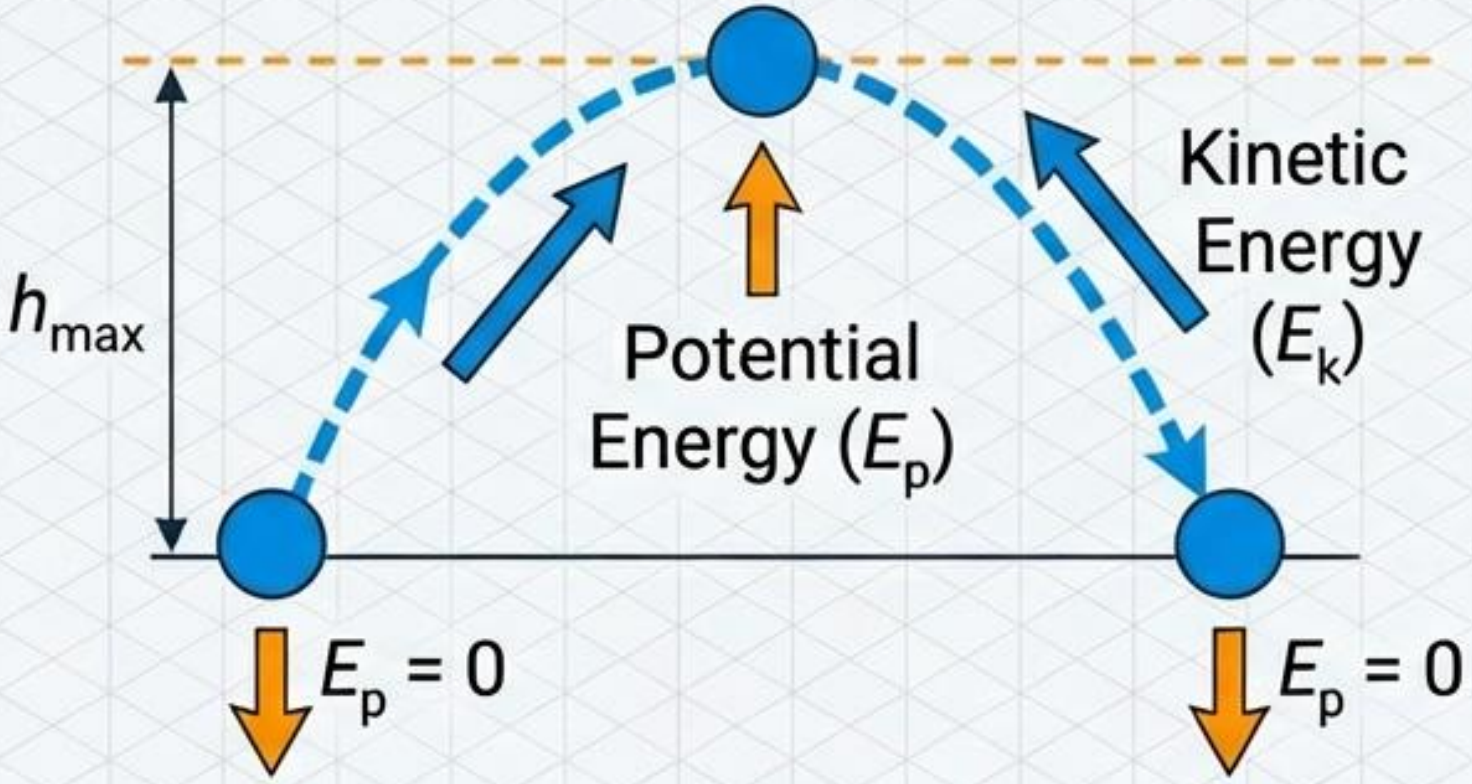




$$E_{\mathrm{p,elastic}} = \frac{1}{2}kx^2$$

CONSERVATIVE VS. NON-CONSERVATIVE FORCES

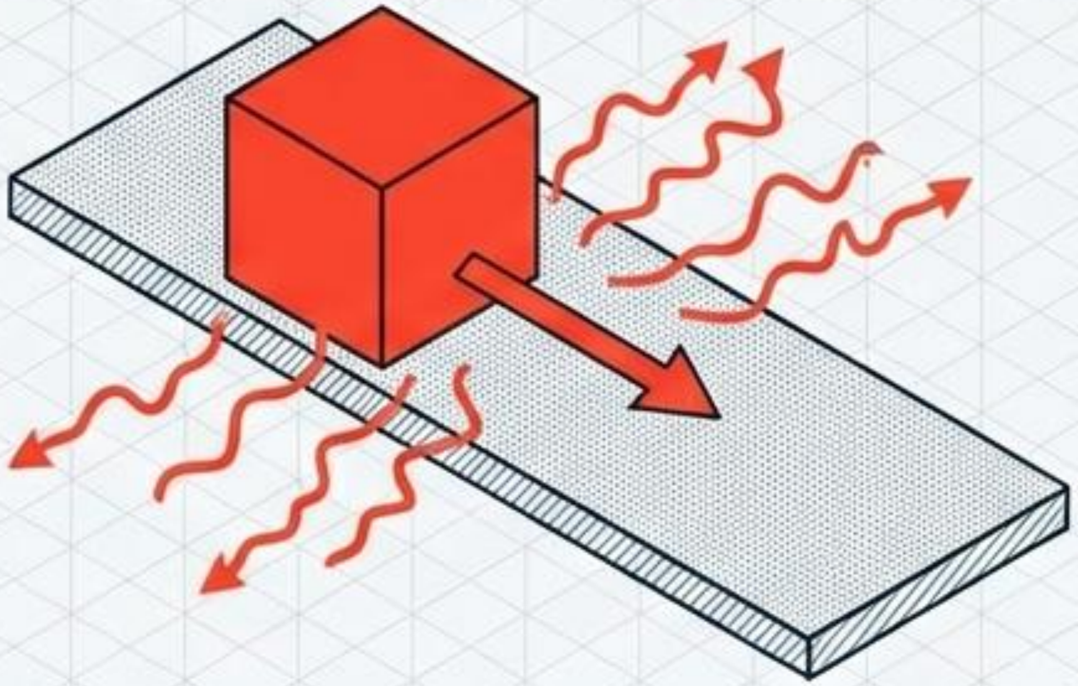
CONSERVATIVE



Energy Stored & Recoverable

- Gravity, Springs

NON-CONSERVATIVE

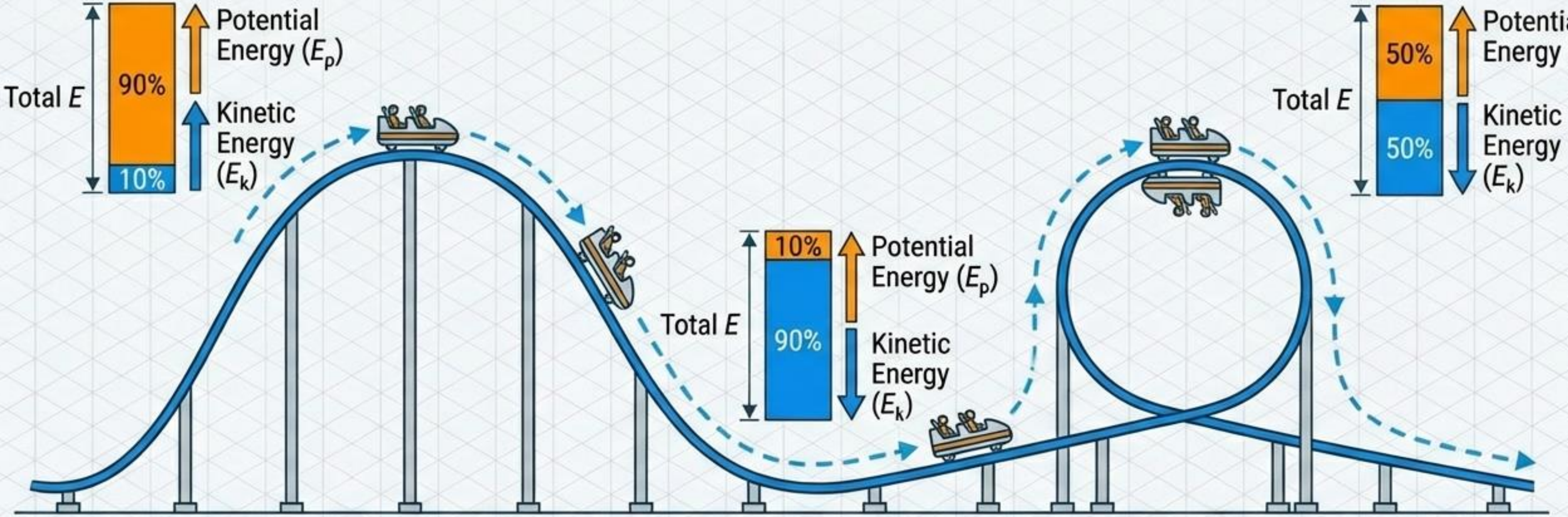


Energy Lost to Heat/Sound

- Friction, Air Resistance

Conservative forces allow reversibility. Non-conservative forces are irreversible.

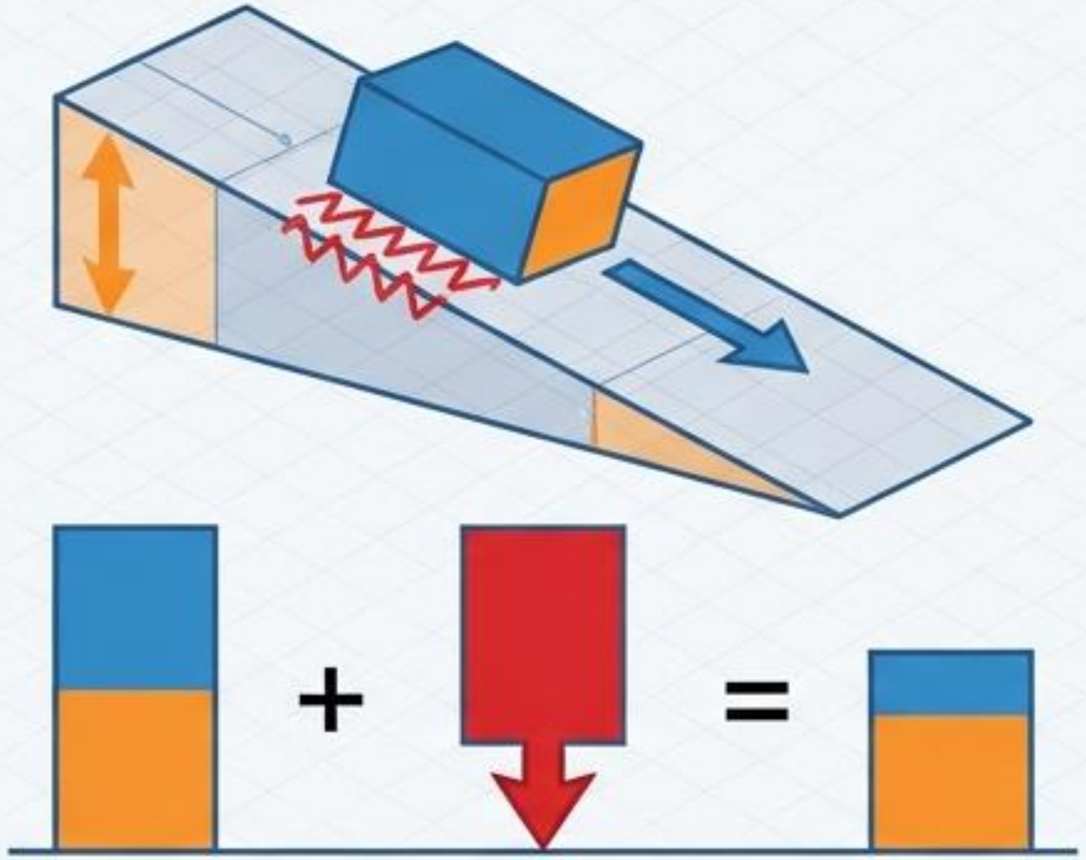
CONSERVATION OF MECHANICAL ENERGY



$$E_{total} = E_k + E_p = \text{Constant}$$

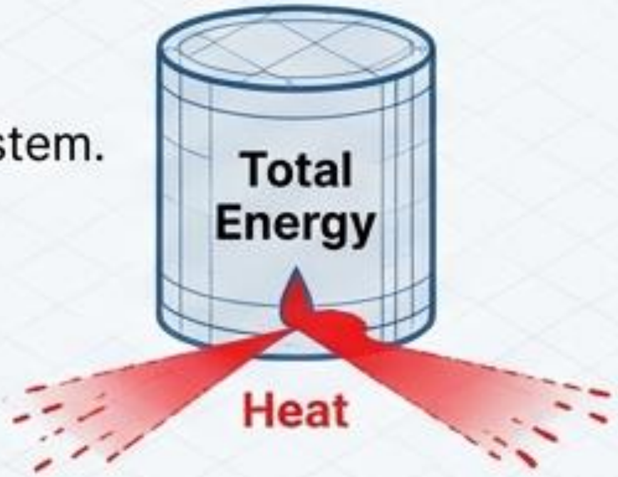
In the absence of friction, energy shapeshifts between speed and height, but the total never changes.

REAL WORLD: THE ENERGY BALANCE SHEET

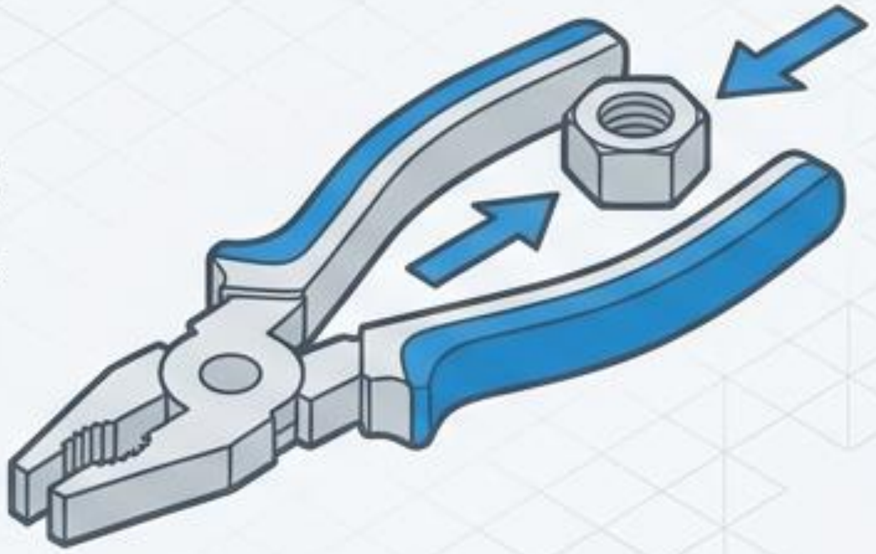


$$E_{start} + W_{friction} = E_{end}$$

Friction is a tax on the system. Work done by friction is always negative ($W < 0$).



SIMPLE MACHINES: TRADING FORCE FOR DISTANCE

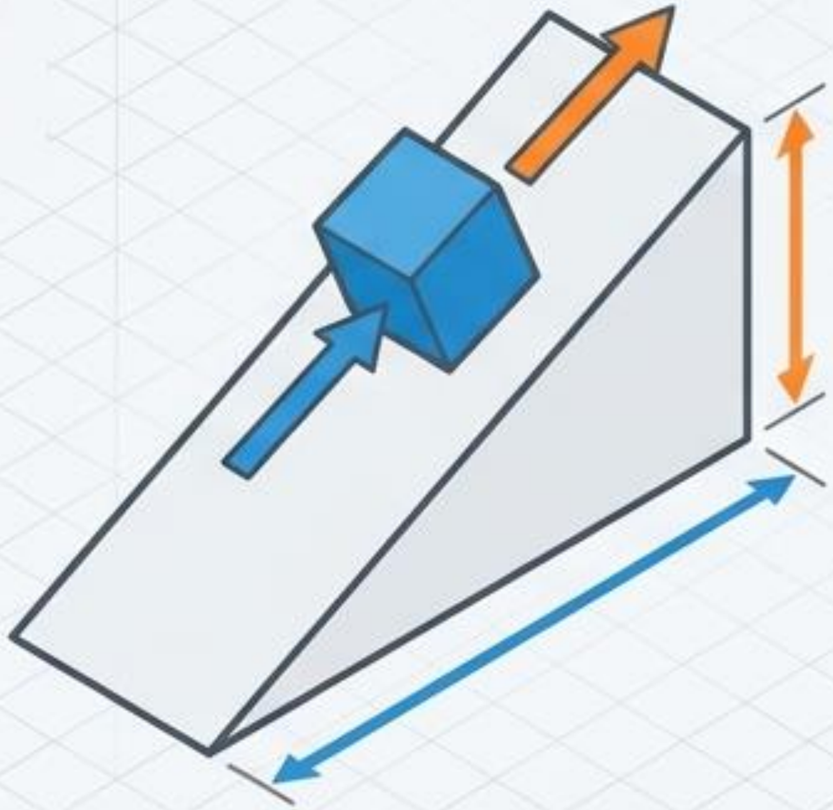


PLIERS:
Lever & Wedge

BICYCLE:
Wheel & Axle, Gear, Lever

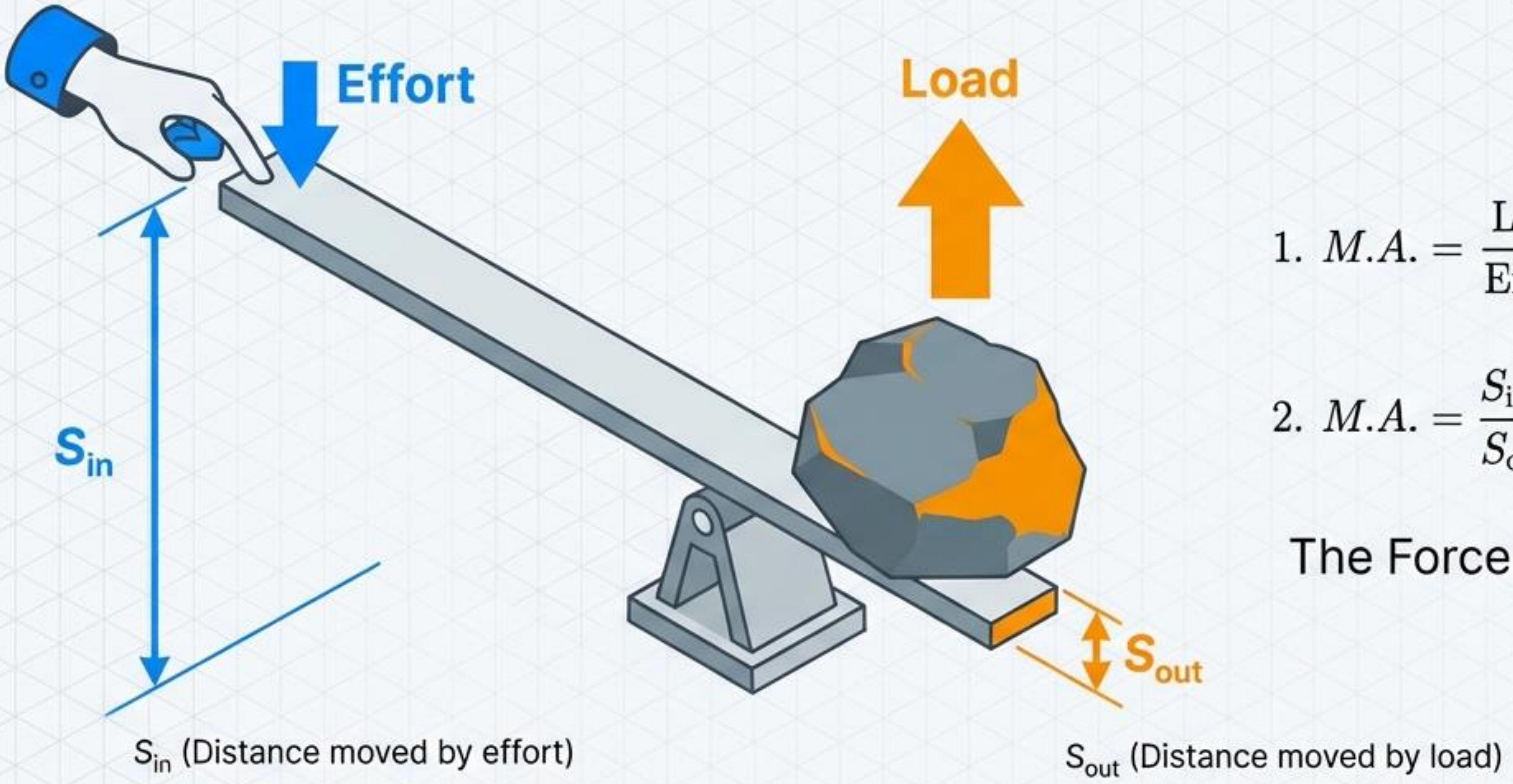
Machines do not reduce Work.
They reduce Force by increasing Distance.

WELL PULLEY:
Pulley



INCLINED PLANE:
Inclined Plane

MECHANICAL ADVANTAGE (M.A.)

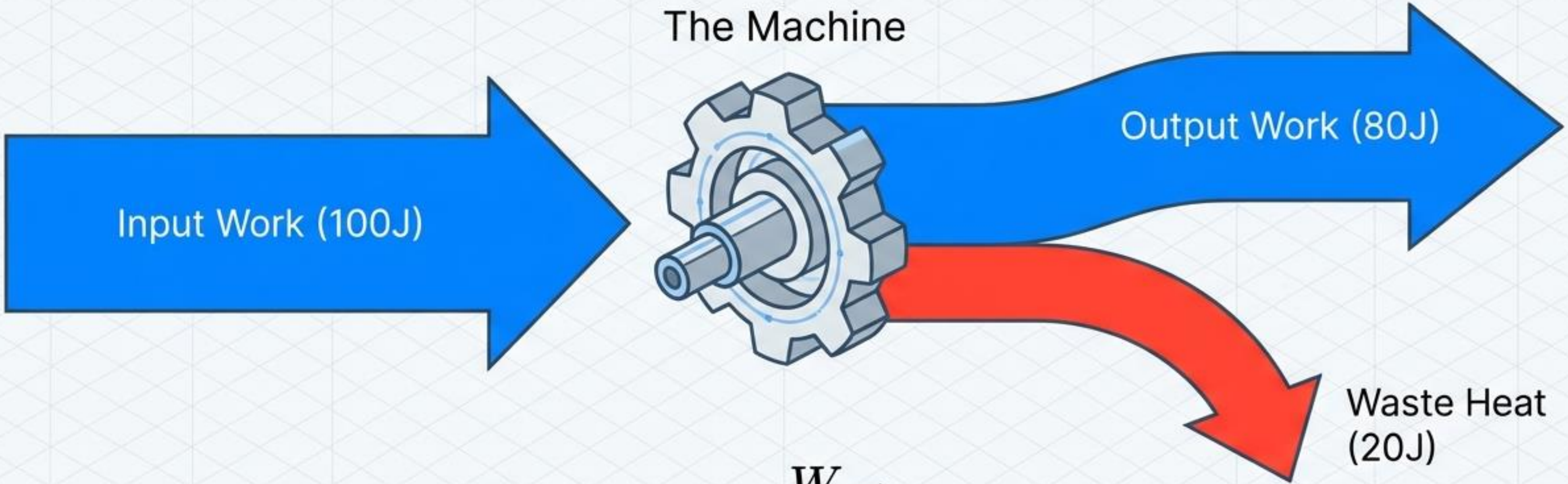


1. $M.A. = \dfrac{\text{Load Force}}{\text{Effort Force}}$

2. $M.A. = \dfrac{S_{\text{in}}\text{ (Distance moved by effort)}}{S_{\text{out}}\text{ (Distance moved by load)}}$

The Force Multiplier Ratio.

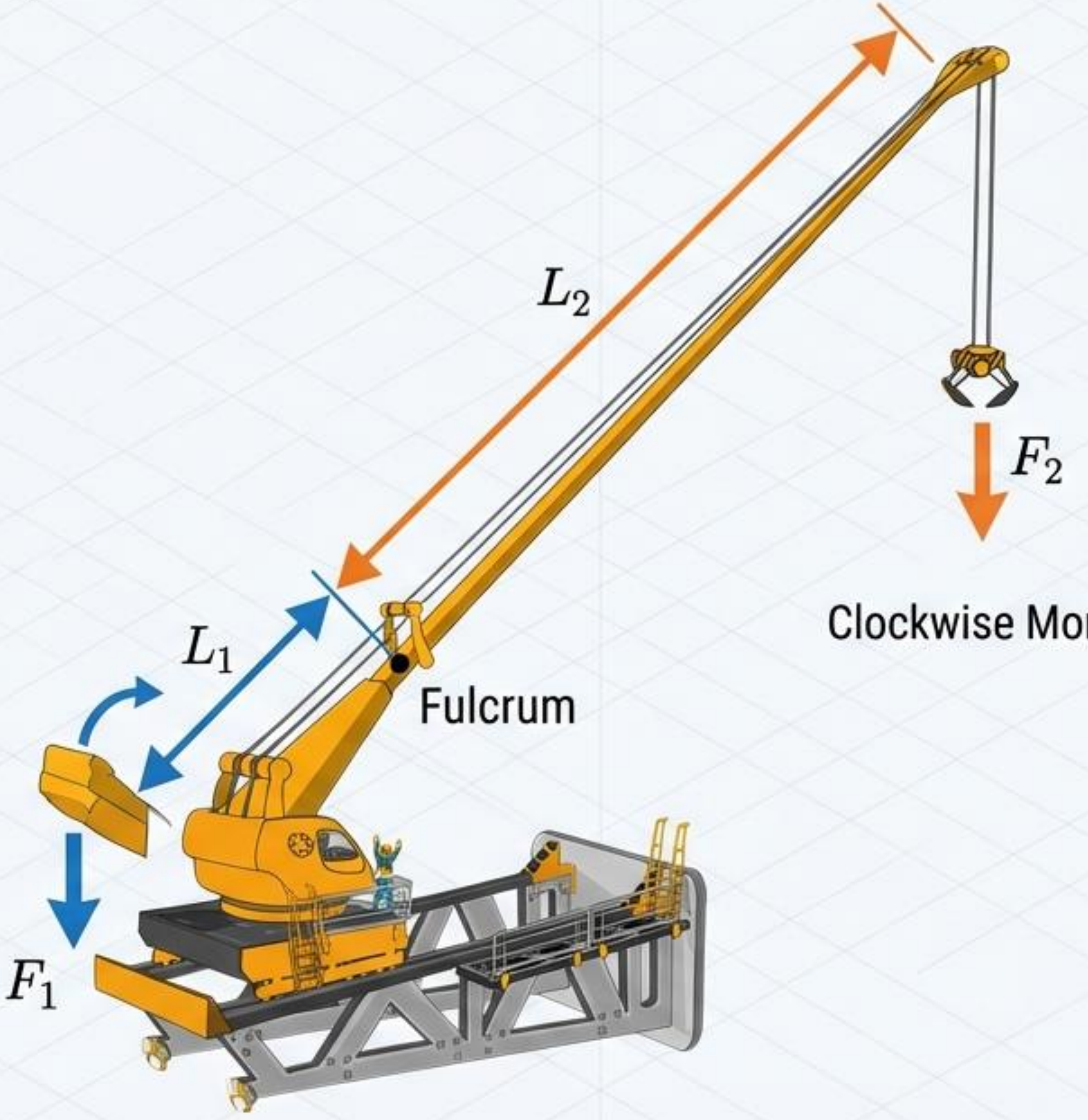
EFFICIENCY (ε)



$$\text{Efficiency} = \frac{W_{\text{out}}}{W_{\text{in}}} \times 100\%$$

In the real world, Efficiency is always < 100%.

EQUILIBRIUM IN MACHINES



Clockwise Moments = Counter-Clockwise Moments

$$F_1 L_1 = F_2 L_2$$

KEY EQUATIONS SUMMARY

ACTION

$$W = F\Delta x \cos(\theta)$$

$$P = W/t$$

CURRENCY

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

$$E_p = mgh$$

LAW

$$E_1 + W_{\text{ext}} = E_2$$

APPLICATION

$$M.A. = \text{Load}/\text{Effort}$$

$$Eff = W_{\text{out}}/W_{\text{in}}$$

Energy is neither created nor destroyed, only transformed.