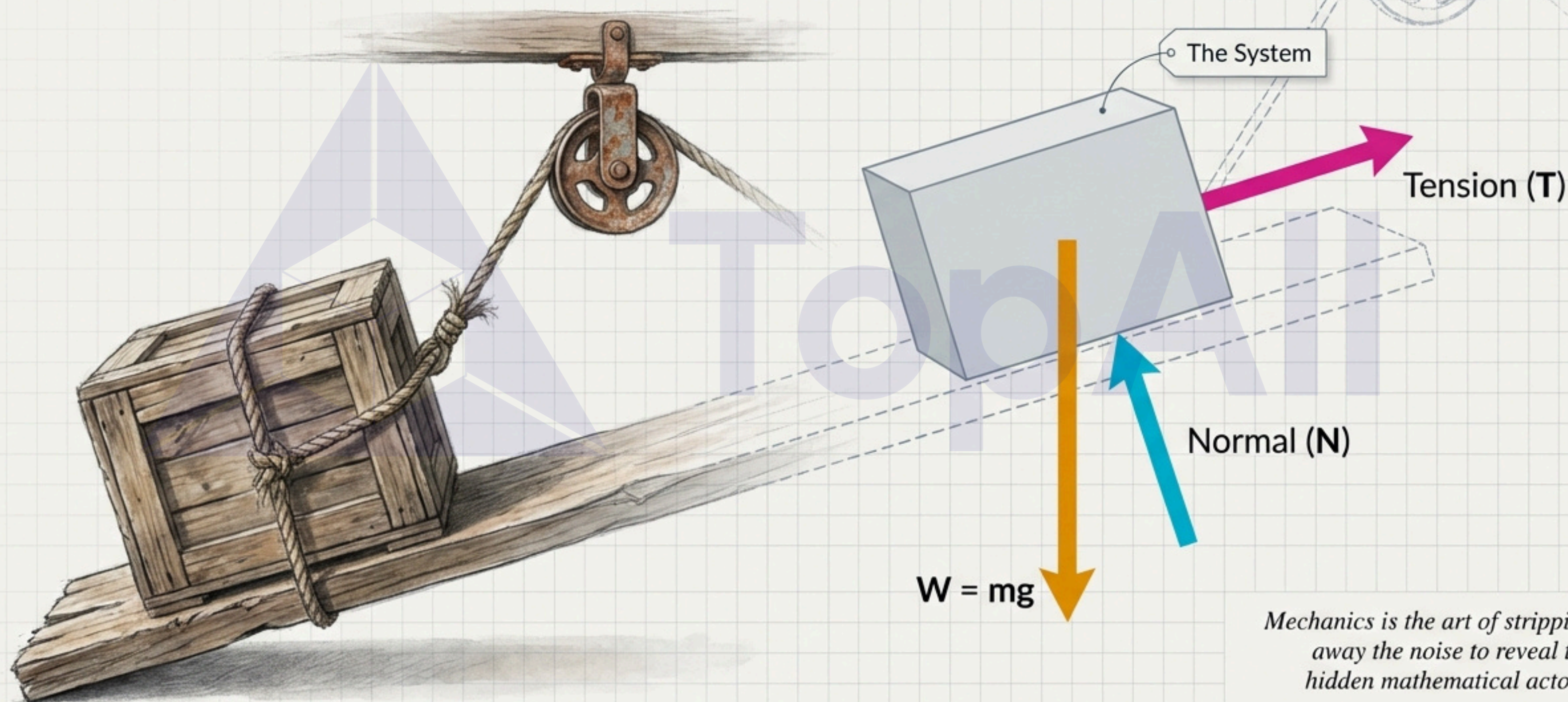


The Invisible Actors

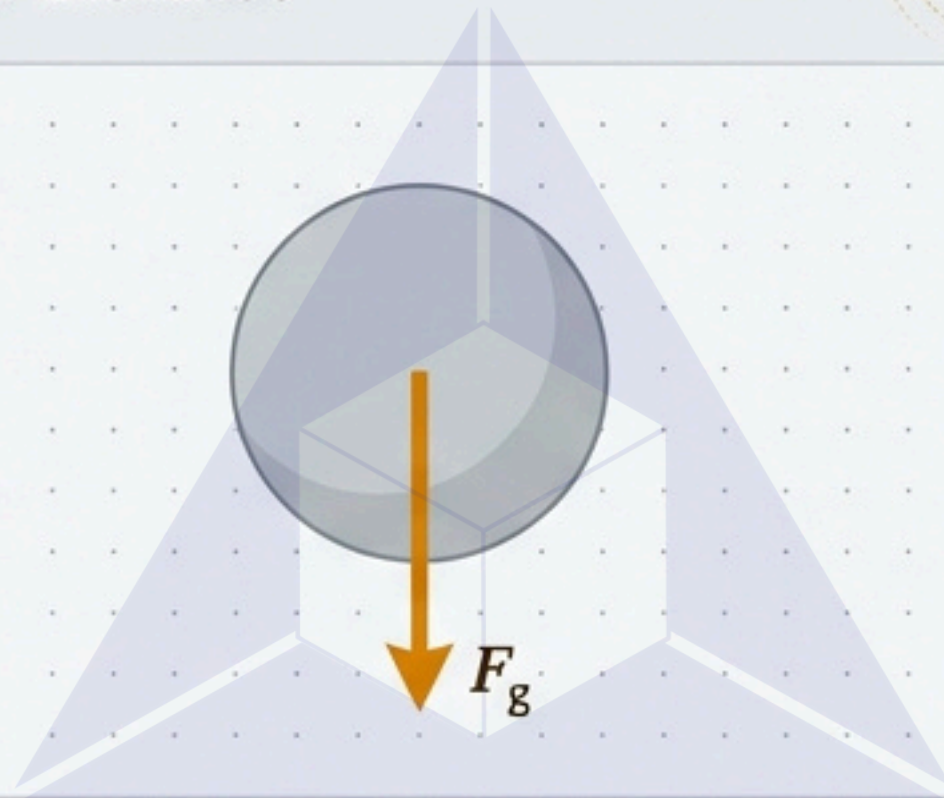
A Field Guide to Common Forces in Mechanics | Class 11 Physics – Chapter 4.9



The Force Family Tree

Non-Contact Forces

Action-at-a-Distance



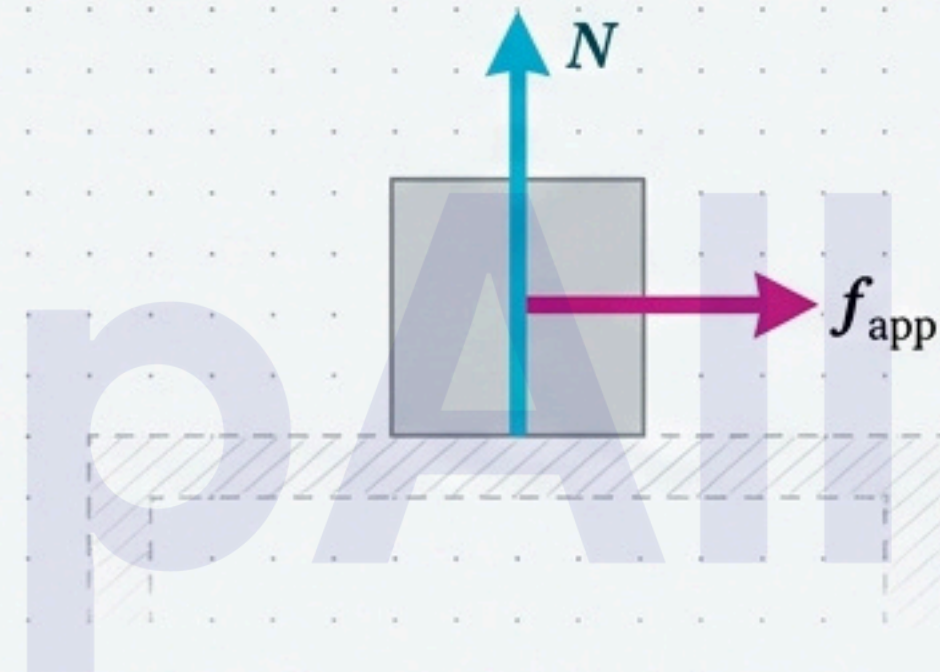
Interaction: Field-based (No physical touch required).

Origin: Fundamental forces of nature.

Key Example: Gravitational force. Every object on Earth experiences the downward pull of gravity ($W = mg$).

Contact Forces

Solid & Fluid Interactions



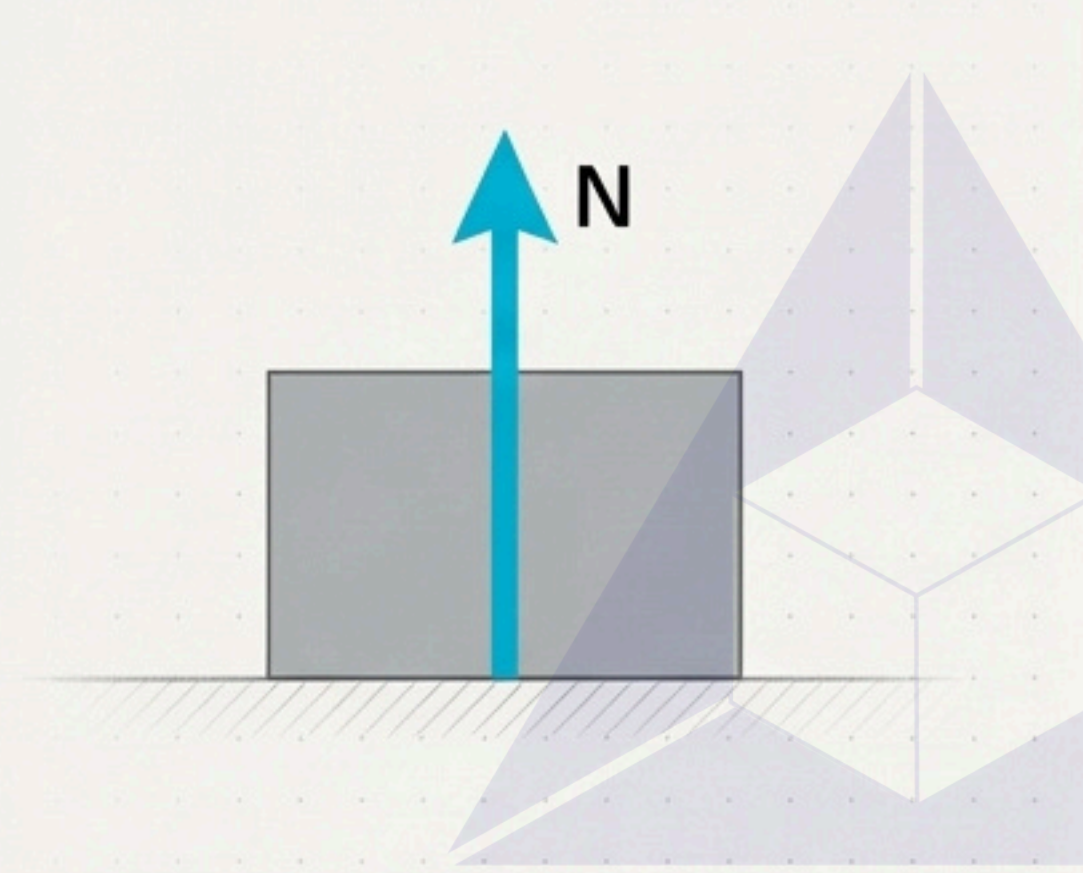
Interaction: Physical touch required.

Origin: Macroscopic manifestations of microscopic electrical forces between charged molecular constituents.

Key Examples: Normal Reaction, Friction, Tension, Spring Force, Buoyancy.

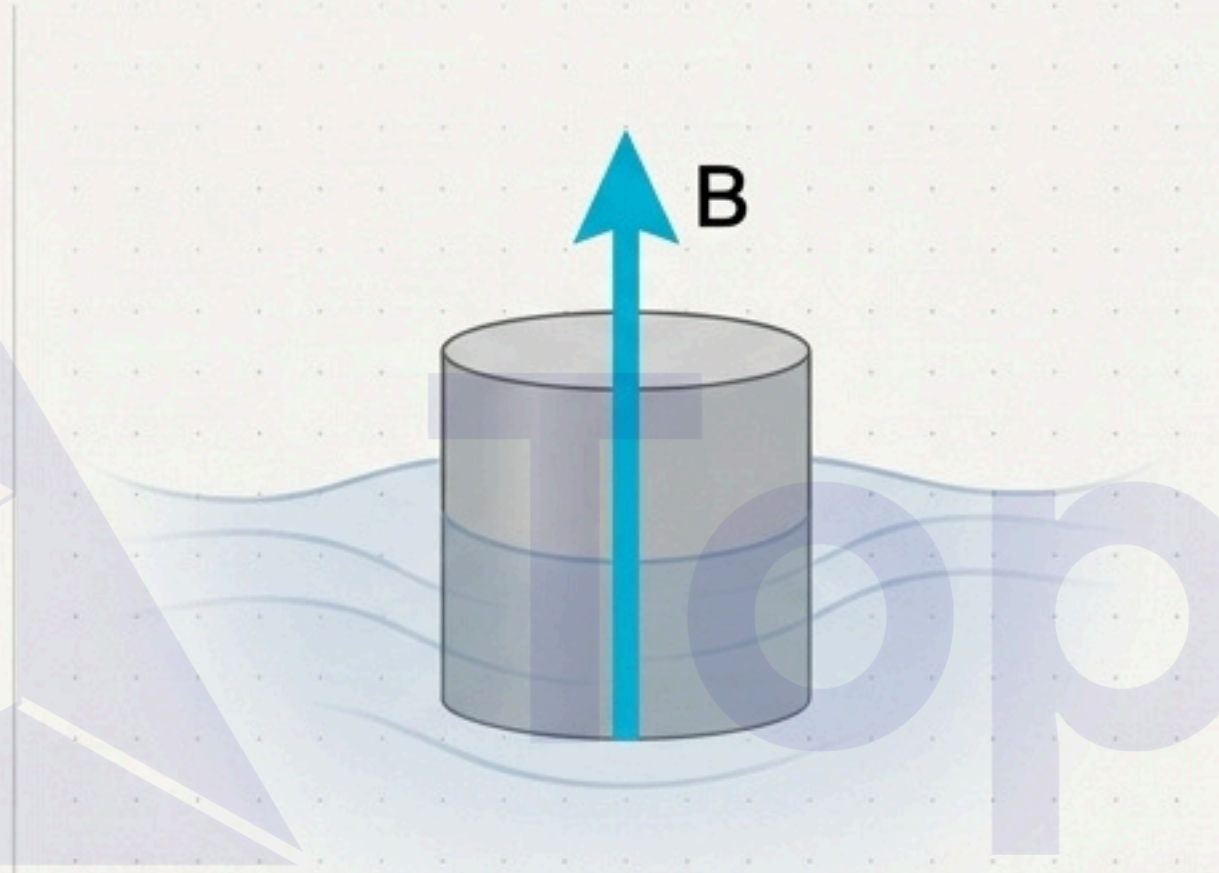
The Contact Multiverse

How contact forces manifest across different physical boundaries.



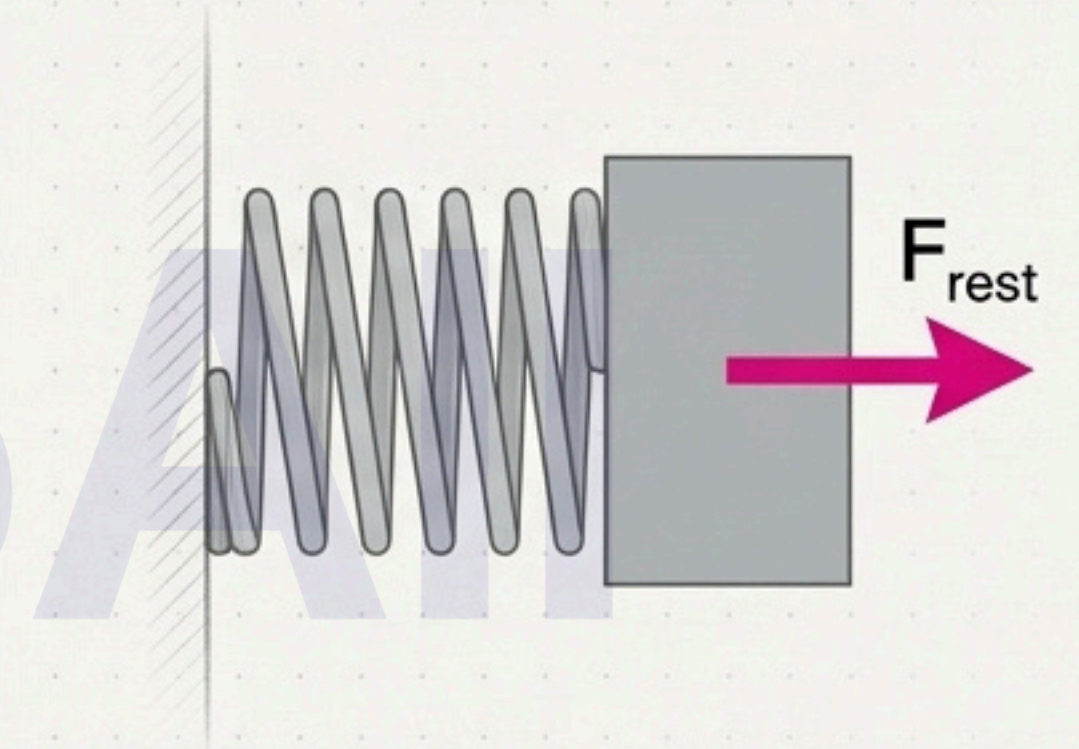
Normal Reaction (N)

The mutual contact force component perpendicular to the interacting surfaces. It balances gravity to maintain equilibrium.



Buoyancy & Drag

Solids immersed in fluids experience an upward contact force equal to the weight of the displaced fluid.



Restoring Force

When a solid is compressed or extended, internal contact forces generate a resistance against the deformation.



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$$E=mc^2$$



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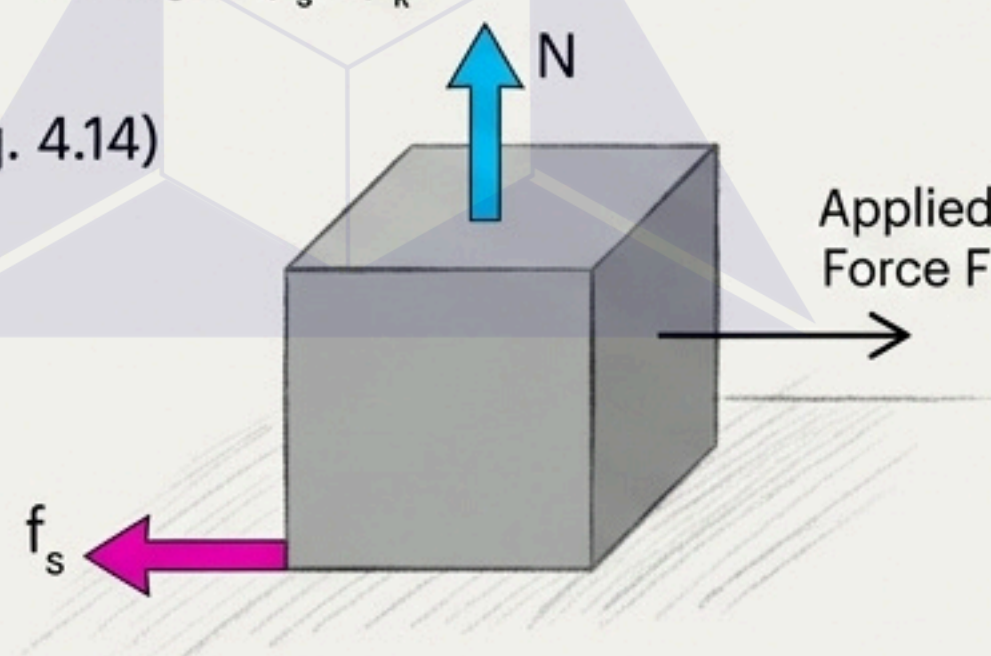
Key Highlights

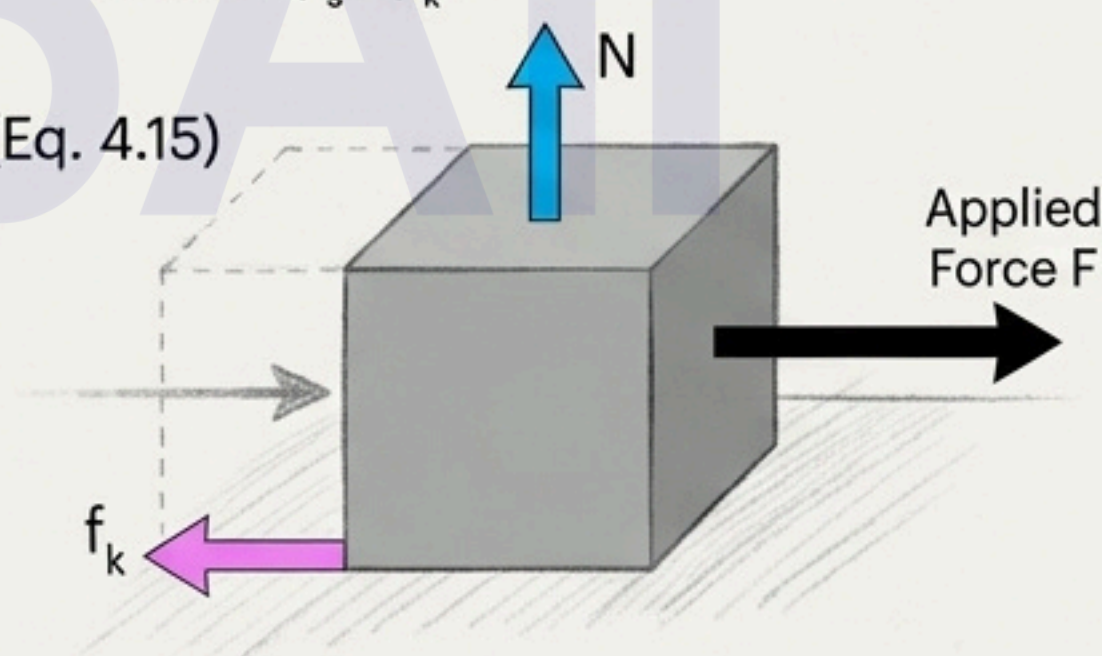
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Friction: The Resistance of Surfaces

The component of contact force parallel to surfaces, opposing impending or actual relative motion.

Friction States Cards	
Static Friction (f_s)	
Trigger condition	Opposes impending relative motion.
Mathematical Nature	Self-adjusting inequality. Matches applied force up to a breaking point.
Relative Strength	Stronger ($\mu_s > \mu_k$)
$f_s \leq \mu_s N$ (Eq. 4.14) 	

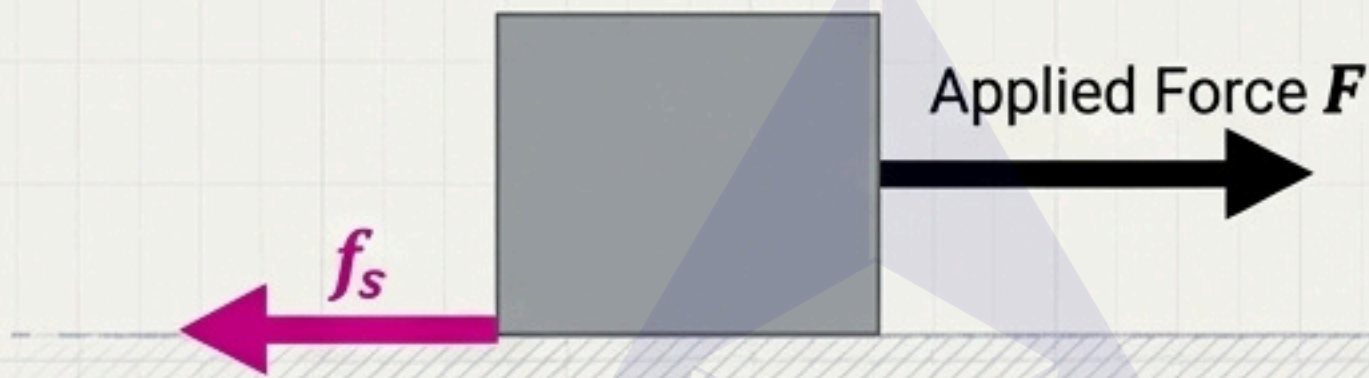
Friction States Cards	
Kinetic Friction (f_k)	
Trigger condition	Opposes actual relative sliding motion.
Mathematical Nature	Constant value. Remains steady regardless of velocity.
Relative Strength	Weaker ($\mu_s > \mu_k$)
$f_k = \mu_k N$ (Eq. 4.15) 	

Friction is an empirical property depending on the nature of the surfaces in contact (coefficient μ), not on the macroscopic area of contact.

The Friction Threshold

The transition from static hold to kinetic slip.

State 1: Impending Motion (The Build-Up)

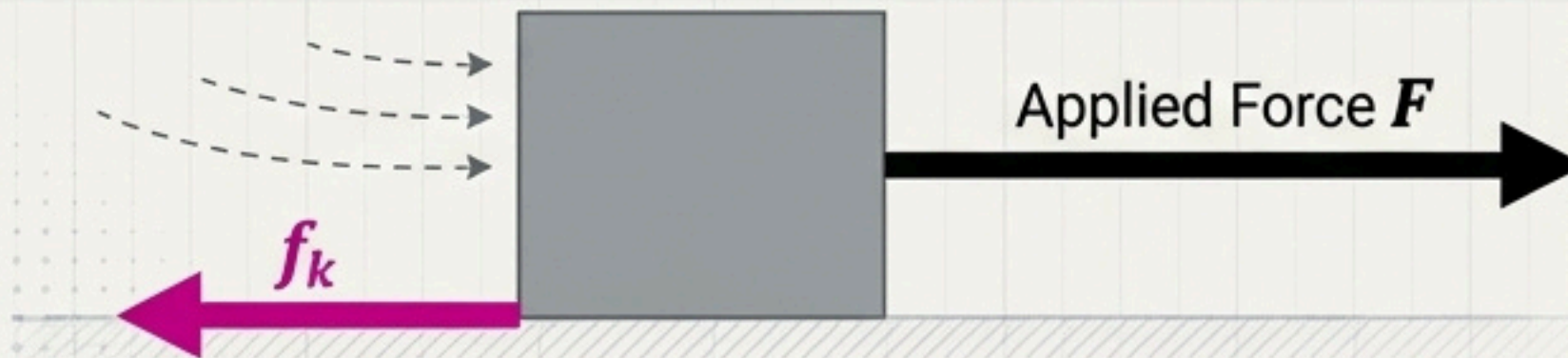


As applied force increases, static friction self-adjusts to match it exactly. The body remains at rest.

$$f_s \leq \mu_s N$$

Maximum Static Limit: $(f_s)_{\max} = \mu_s N$ (Eq. 4.13)

State 2: Actual Motion (The Breakaway)

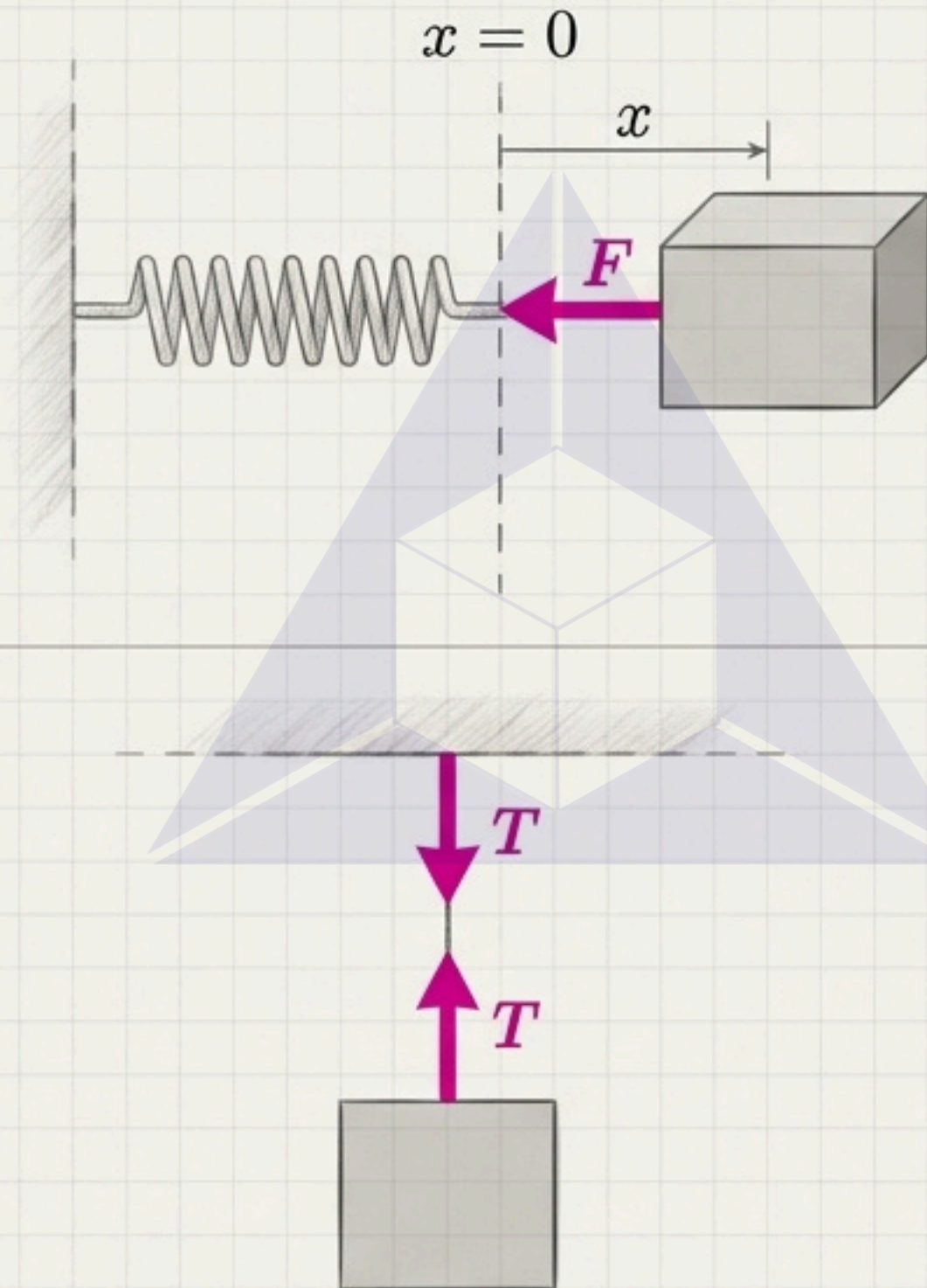


Force exceeds the threshold. Relative motion begins. Friction drops to a constant kinetic value.

$$f_k = \mu_k N$$

$$a = \frac{F - f_k}{m}$$

Tethers and Coils: Tension & Springs



The Spring Model

Spring Force: $F = -kx$

The negative sign is physical geometry. The restoring force F always points in the exact opposite direction to the displacement x from the unstretched state.

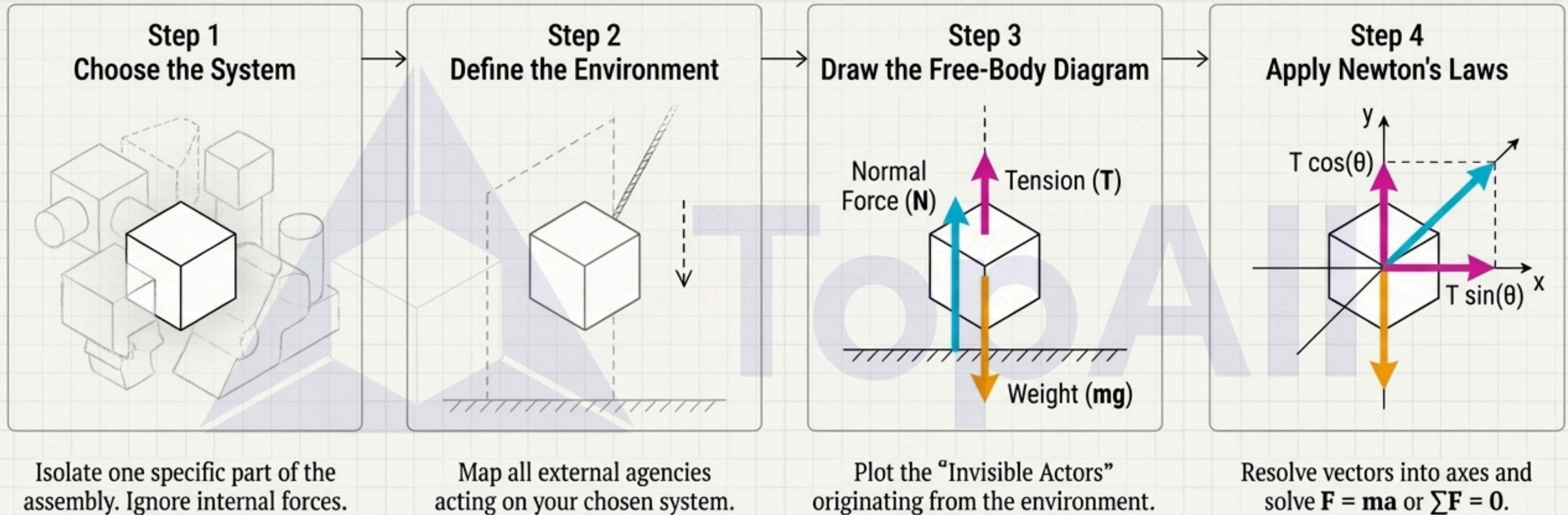
The String Model

Tension: T

The restoring force inside an inextensible string. Tension is constant throughout a massless string. Rule of thumb: Tension always pulls, never pushes.

Turning Confusion Into Equations

The hardest part of mechanics is choosing the right body, the right forces, and the right viewpoint.



Mechanics becomes manageable when you stop staring at the whole setup and start isolating the right part.
Good Free-Body Diagrams are not decoration—they are the solution path.



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