



LECTURE SERIES

Physics for Physics Teacher 1

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Force and Law of Motion

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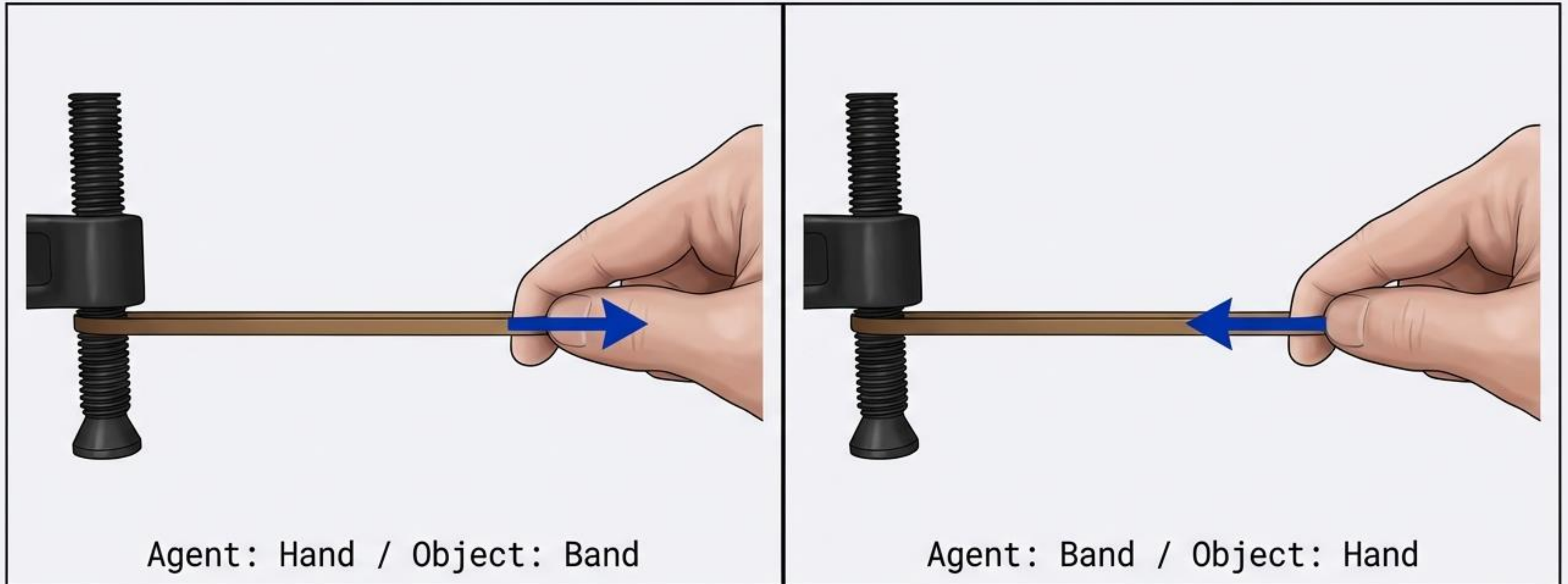
FORCE AND MOTION

The Invisible Script
of the Universe.



FORCE IS AN INTERACTION

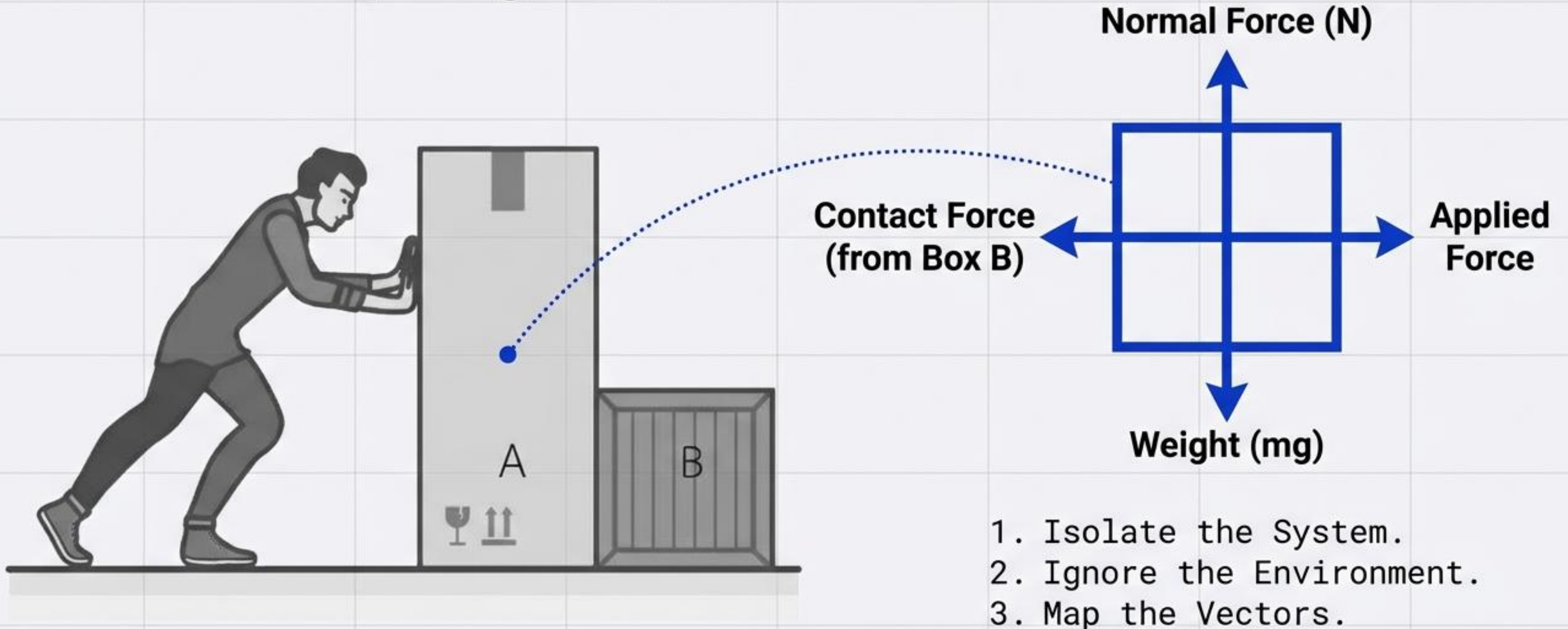
It is never just a push. It is a pair.



Force has magnitude and direction. Forces always come in pairs.

VISUALIZING THE INVISIBLE

The Free Body Diagram (FBD)





THE MATH OF MOTION

Finding the Resultant Force (Sigma F)

Head-to-Tail Method



Parallelogram Method



If vectors are perpendicular:
 $F^2 = F_x^2 + F_y^2$

The Resultant replaces all
acting forces.



THE RESISTANCE

Mass & Inertia



High Inertia
High Resistance to Change
Mass (m) = Quantitative Measure



Low Inertia
Easy to Accelerate

Inertia is the stubbornness of matter. Mass is the measure of that stubbornness.

NEWTON'S FIRST LAW

The Law of Inertia

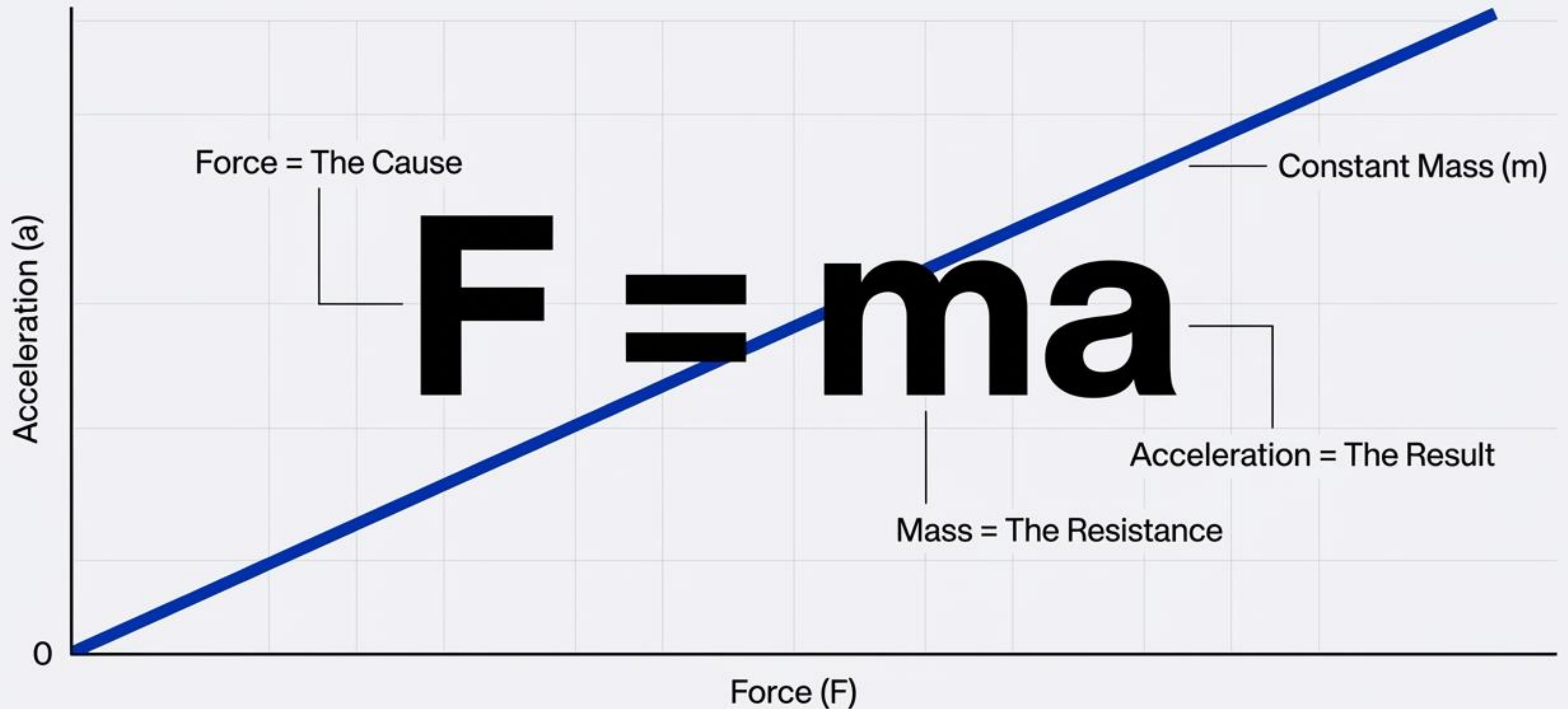


$$\Sigma F = 0 \leftrightarrow a = 0$$

THE MYTH: If it moves, something is pushing it.
THE REALITY: If nothing stops it, it moves forever.

NEWTON'S SECOND LAW

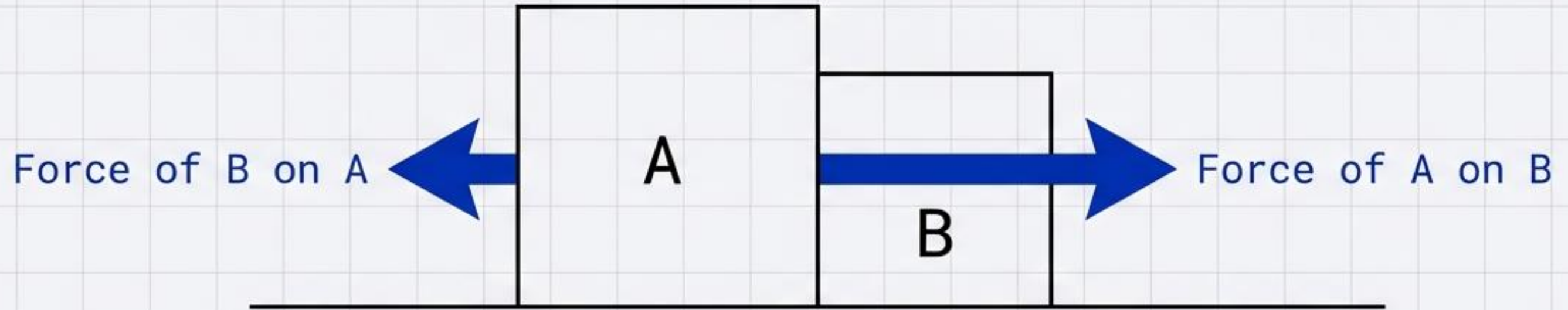
The Equation of Power





NEWTON'S THIRD LAW

The Mirror (Action = Reaction)

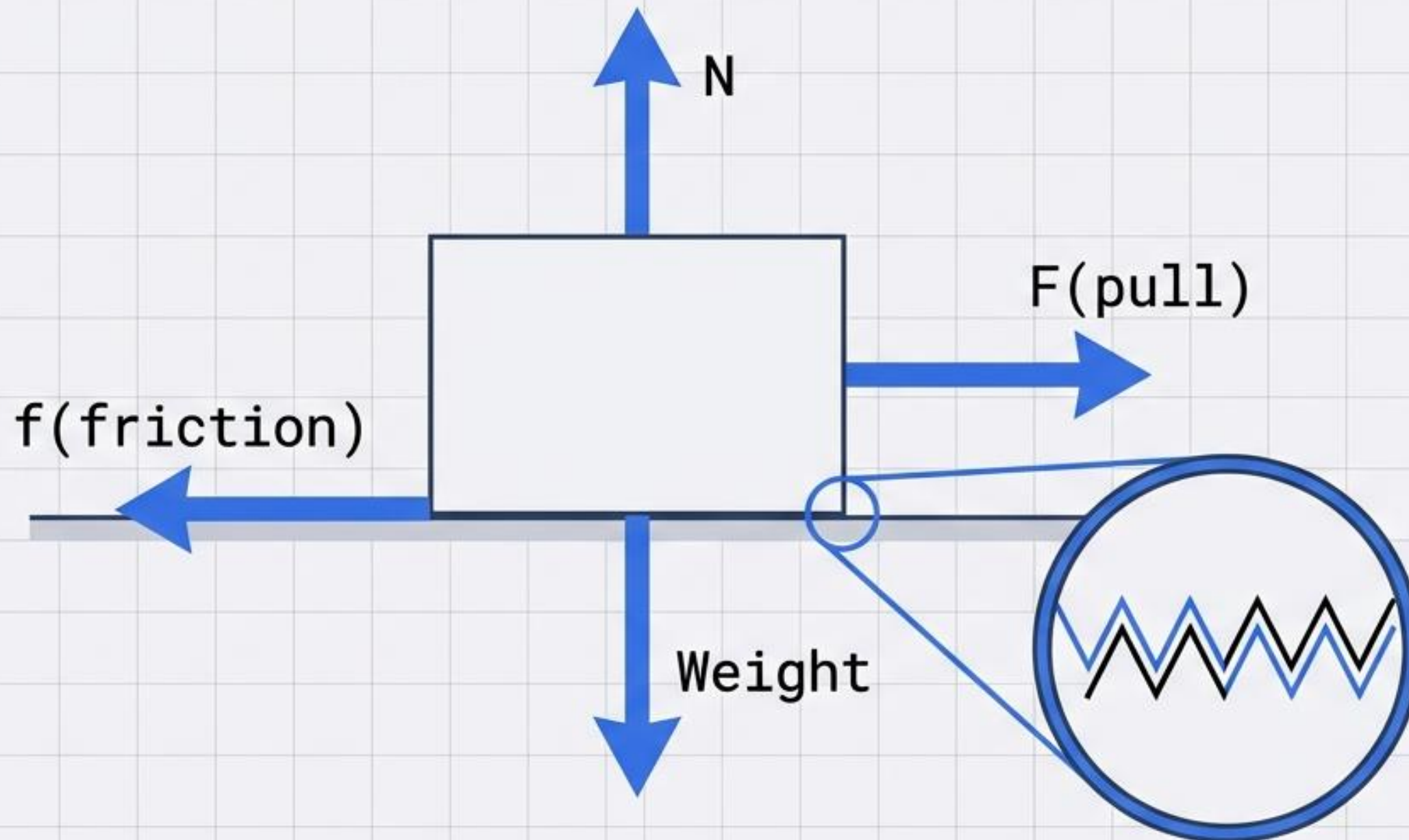


$$\mathbf{F(\text{Action}) = - F(\text{Reaction})}$$

CRITICAL DISTINCTION: These forces act on DIFFERENT objects.
They do not cancel out.

THE GREAT OPPOSER

Friction (f)



Static Friction (f_s):
The Gripper.
($f_s \leq \mu_s N$)

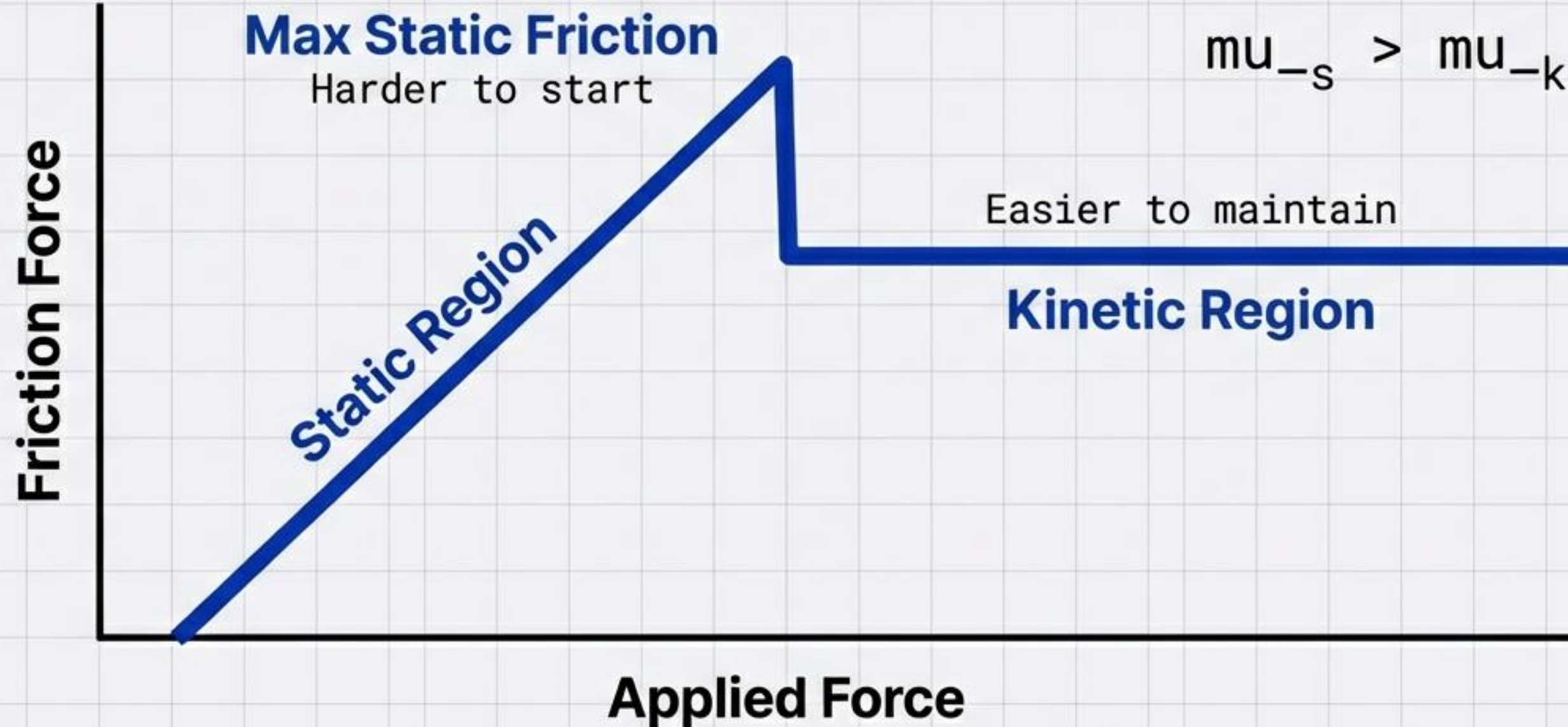
Kinetic Friction (f_k):
The Slider.
($f_k = \mu_k N$)

Direction: Always
opposes relative motion.



THE BARRIER TO MOTION

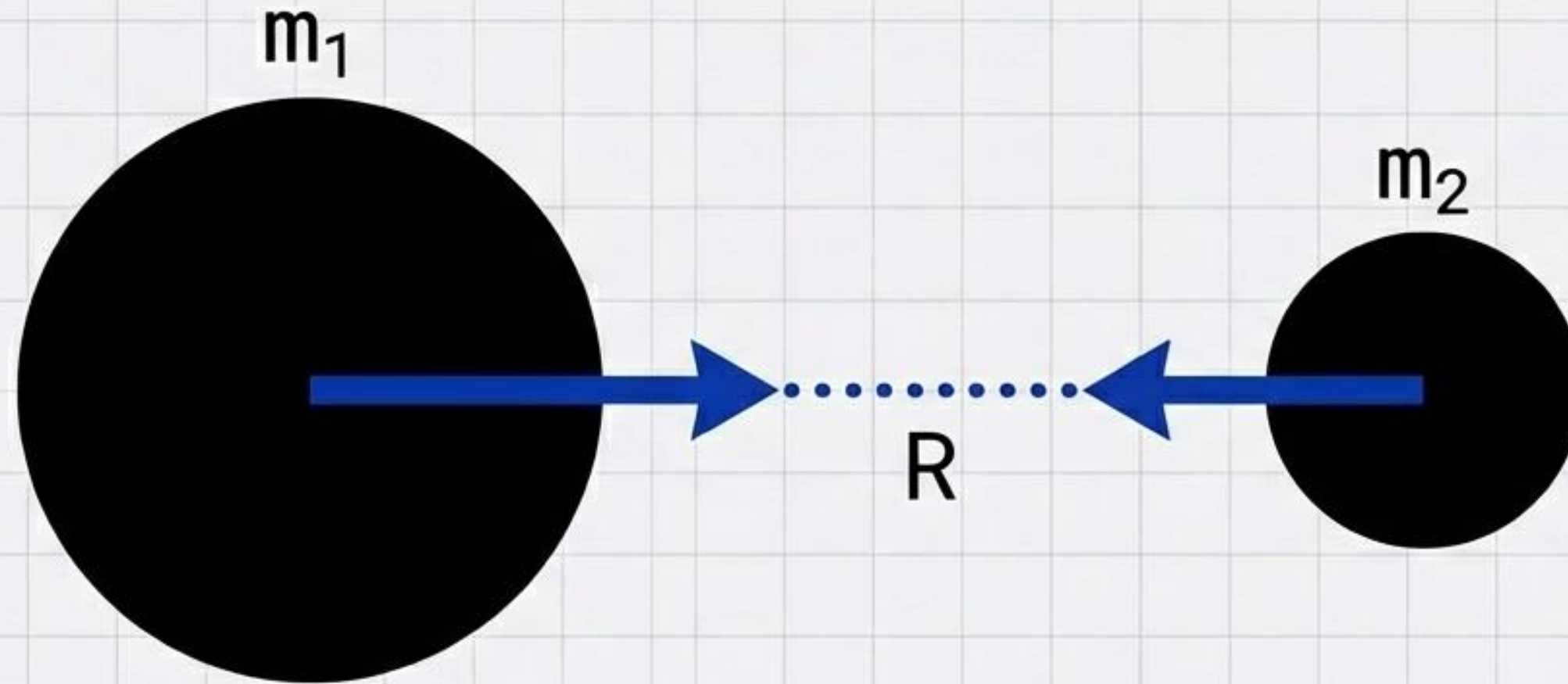
Static vs. Kinetic Friction





THE UNIVERSAL GLUE

Newton's Law of Universal Gravitation



Every mass attracts every other mass.

Inverse Square Law:
Double the distance,
quarter the force.

$$F = G * \frac{m_1 * m_2}{R^2}$$

WEIGHT IS A FORCE, MASS IS IDENTITY

Location matters.

EARTH



Mass = m

Weight = mg

$g = 9.8 \text{ m/s}^2$

MOON



Mass = m (Unchanged)

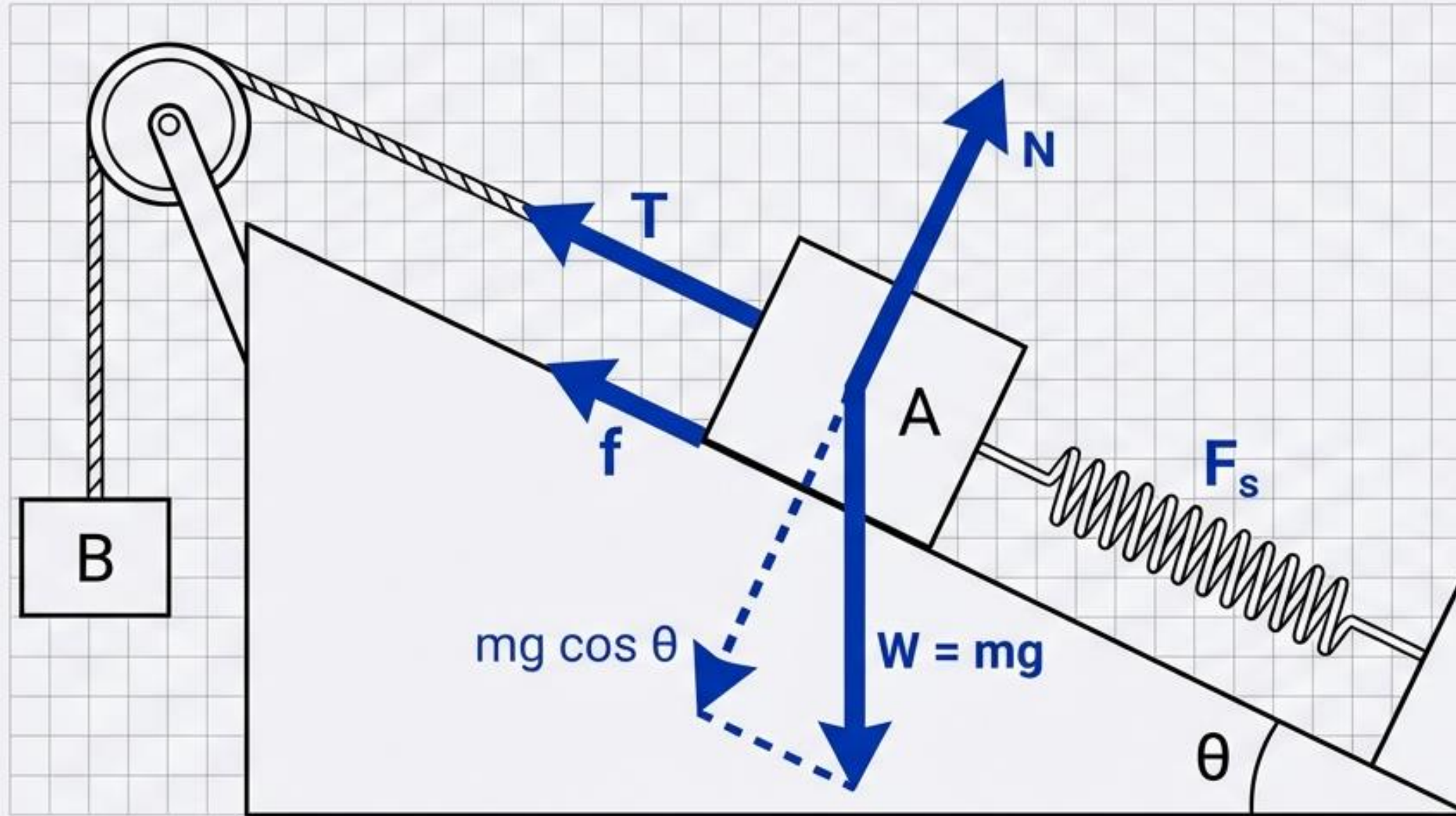
Weight = $mg / 6$

$g = 1.6 \text{ m/s}^2$

Mass is intrinsic. Weight is circumstantial.

PUTTING IT ALL TOGETHER

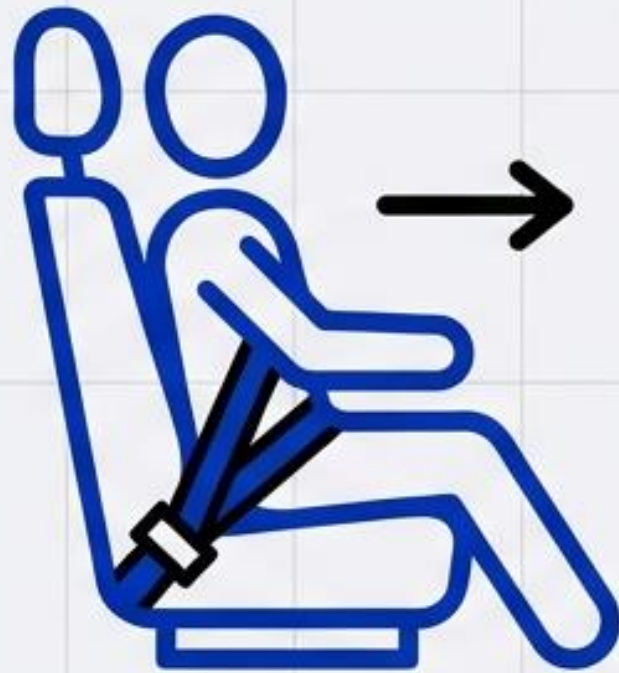
The Inclined Plane



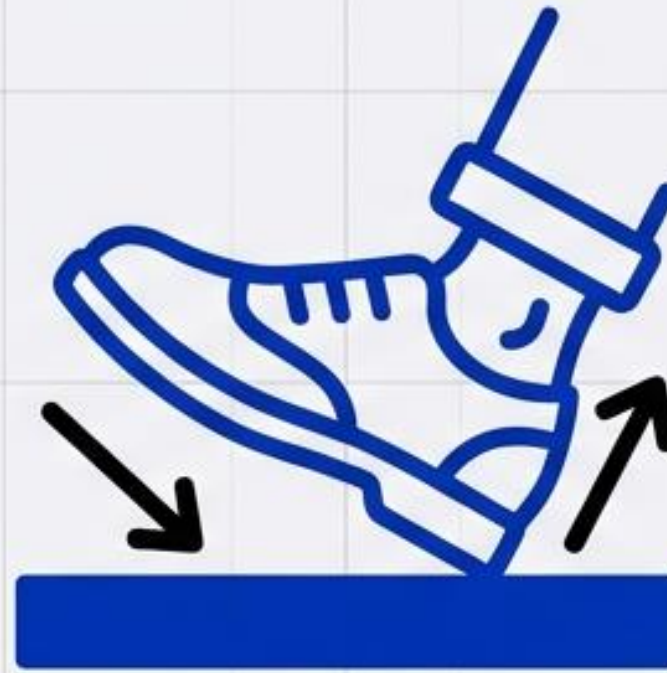
$$\Sigma F(y) = 0$$

$$\Sigma F(x) = ma$$

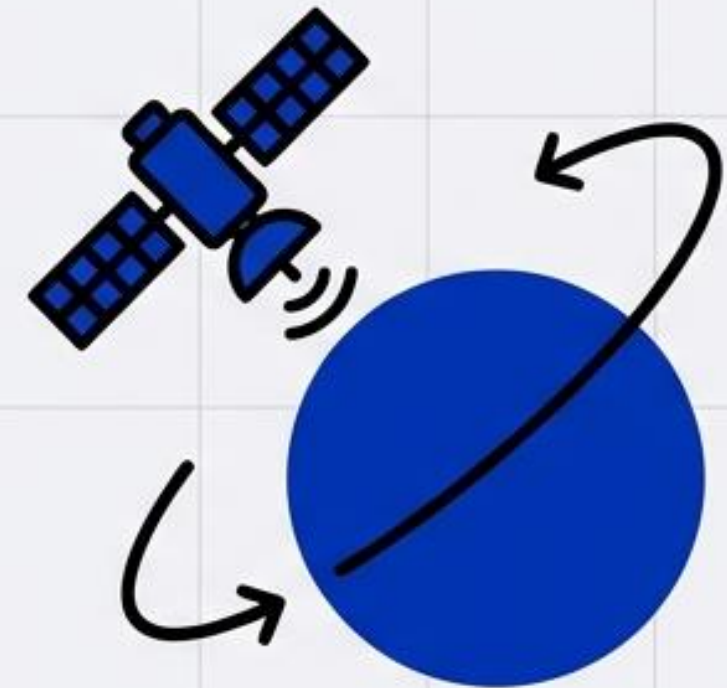
PHYSICS IN THE REAL WORLD



Inertia
(1st Law)



Action/Reaction
(3rd Law)



Gravitation

From seatbelts to satellites, the script remains the same.



THE USER MANUAL FOR REALITY

Summary of Chapter 3

1st Law (Inertia)

$$\Sigma F = 0$$

2nd Law (Dynamics)

$$F = ma$$

3rd Law (Interaction)

$$\text{Action} = -\text{Reaction}$$

Weight

$$W = mg$$

Friction

$$f = \mu N$$

Gravity

$$F = Gmm/r^2$$

Force is the cause. Motion is the effect. Newton's Laws are the bridge.