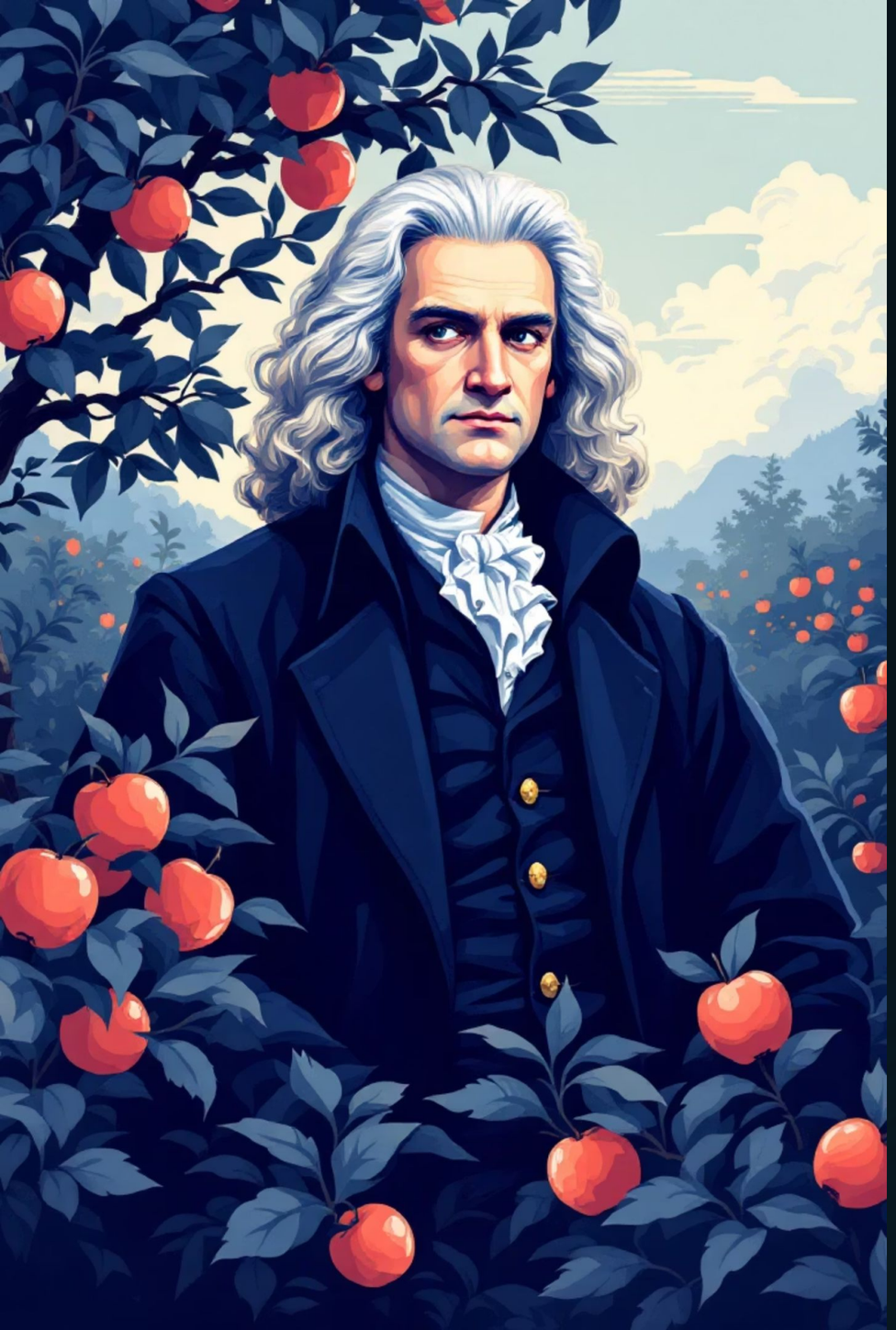
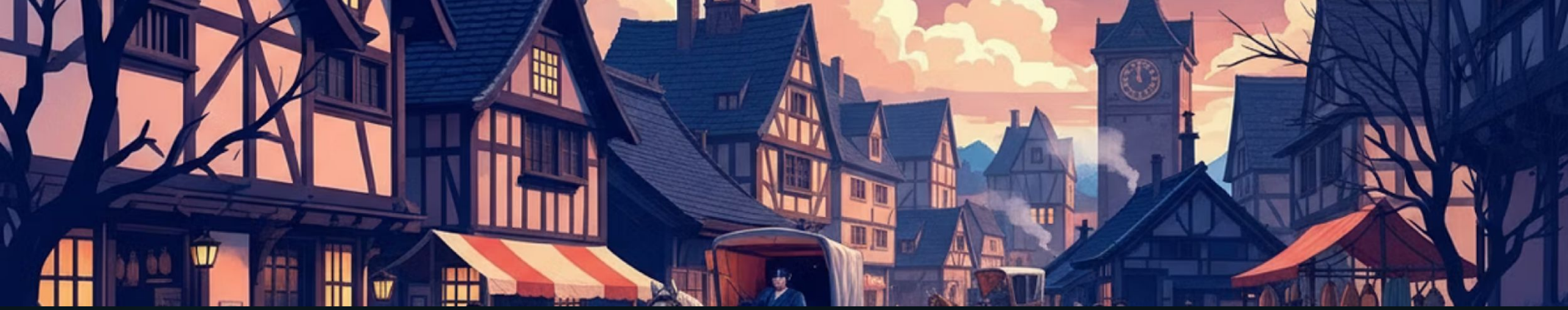
Laws of Motion



Newton's Laws of Motion

In the 17th century, Isaac Newton's profound curiosity forever changed our understanding of motion, driven by observation, imagination, and wonder.



A World Before Newton

The Prevailing Belief

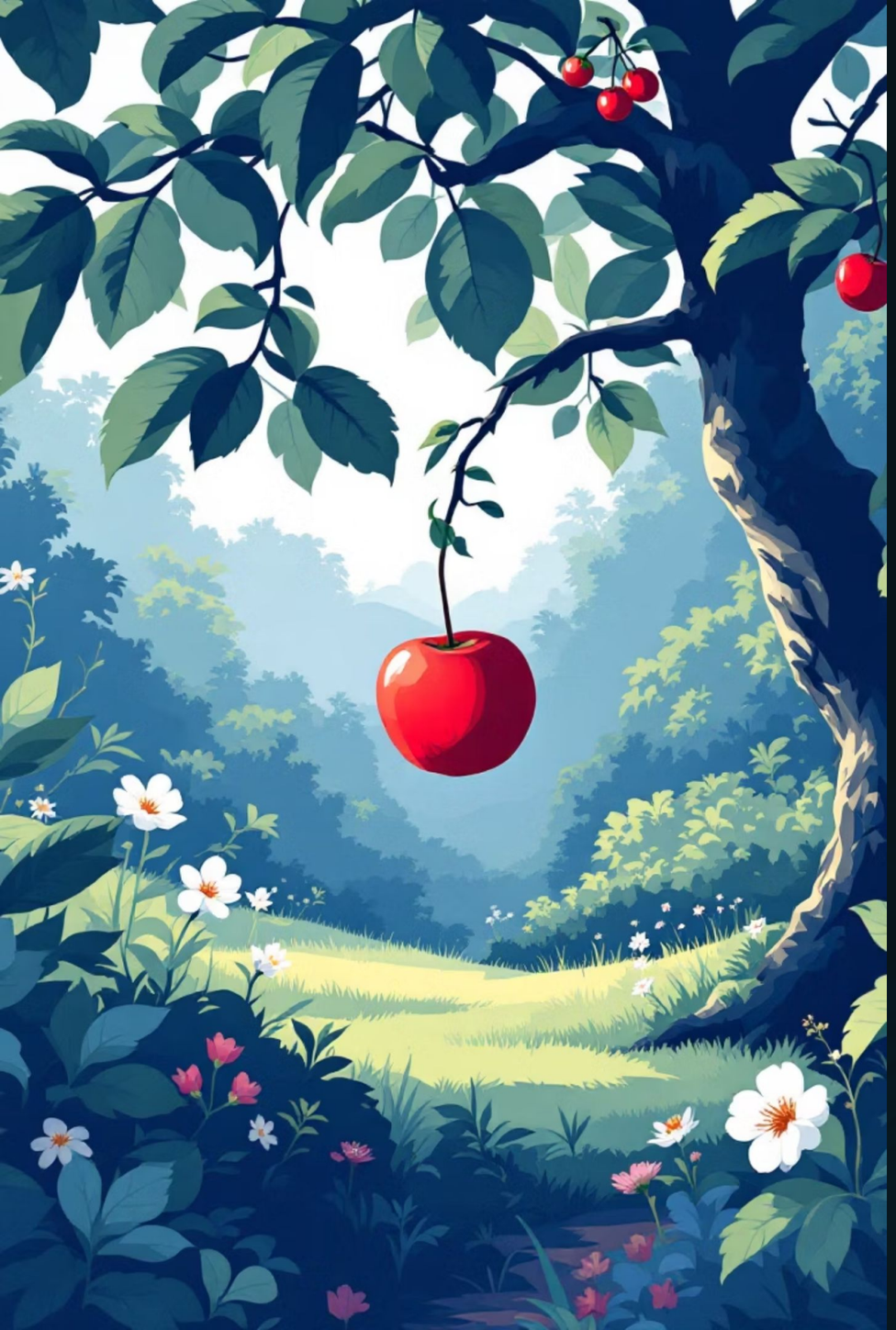
In the 1600s, most believed Aristotle's ancient wisdom:

- "An object needs a force to keep it moving."
- This view seemed logical and went unquestioned for nearly 2,000 years.

A Different Mind

Then came young **Isaac Newton**, who questioned everything. He didn't just accept what he saw; he asked *why?*

Newton sought to uncover the true principles governing movement and stillness.



The Apple That Changed Everything

A falling apple sparked an extraordinary question for Newton:

> "Why did the apple fall downward? Why not sideways or upward? Could the same force pulling the apple down also be pulling the Moon toward Earth?"

This revolutionary idea suggested **the same natural laws** govern both Earth and the heavens. Years of observation led him to three elegant statements explaining nearly all motion in the universe.

Three Laws of Motion

The First Law: The Law of Inertia

The First Law: The Law of Inertia

Newton's Statement

"Every object continues in its state of rest or uniform motion in a straight line unless acted upon by an external force."

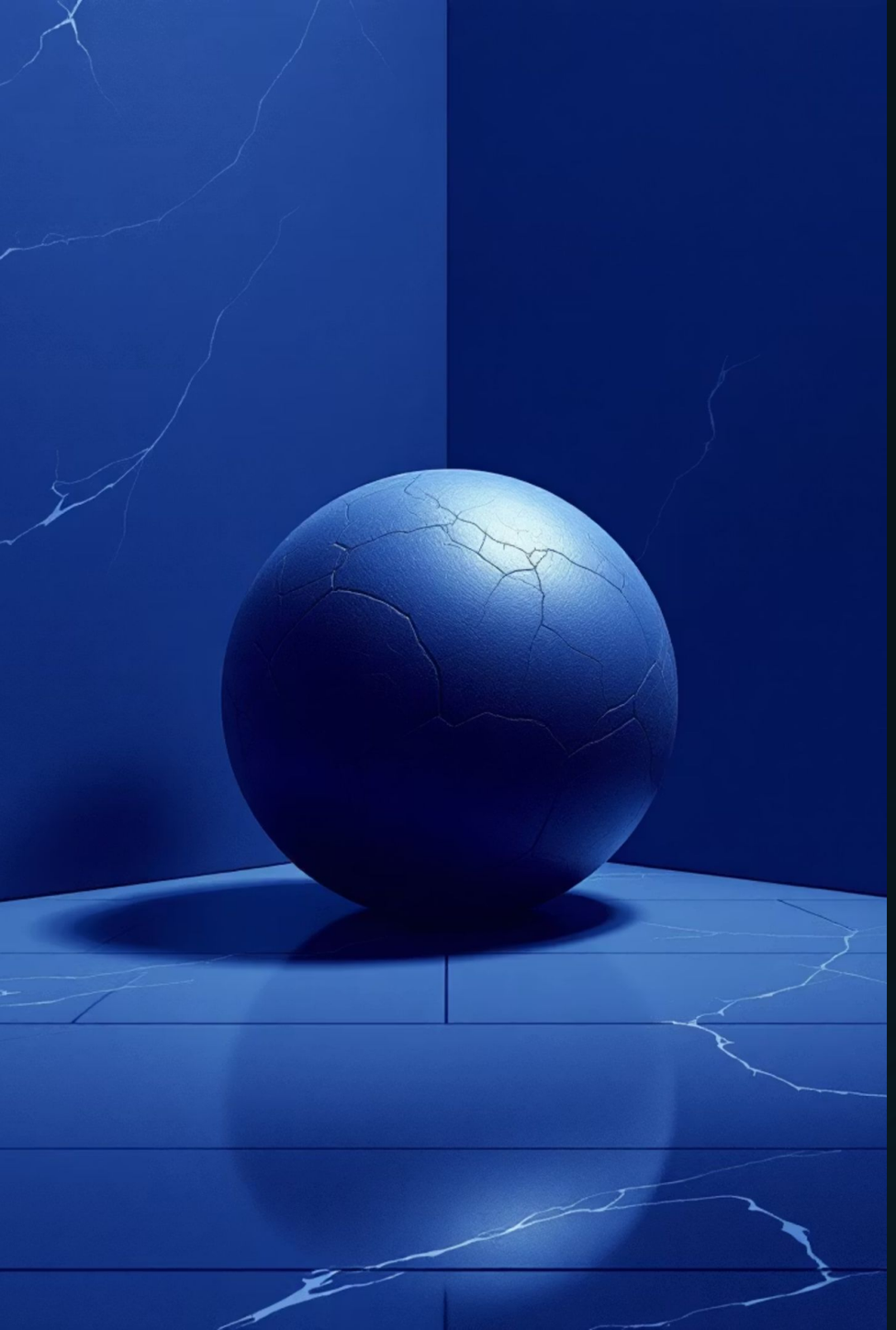
What It Means

- Objects resist changes to their state of motion.
- They stay at rest or keep moving at constant velocity.
- An external force is needed to alter this state.

The Key Concept

This resistance is called **inertia**.

- It signifies nature's preference for stability.



Discovering Inertia Through Observation

- Newton observes a heavy cannonball resting.
- A gentle kick moves it barely.
- A harder strike rolls it briefly, then stops.
- On a smooth marble floor, the same ball rolls much farther.
- Smoother surfaces allow longer movement.

The Revelation

Motion isn't from the initial push, but the **absence of resistance**. Without friction or obstacles, the ball would roll indefinitely.

Inertia in the World Around Us

Ships on Water

Ships glide effortlessly on calm water, even without rowing, due to minimal resistance.

Spinning Tops

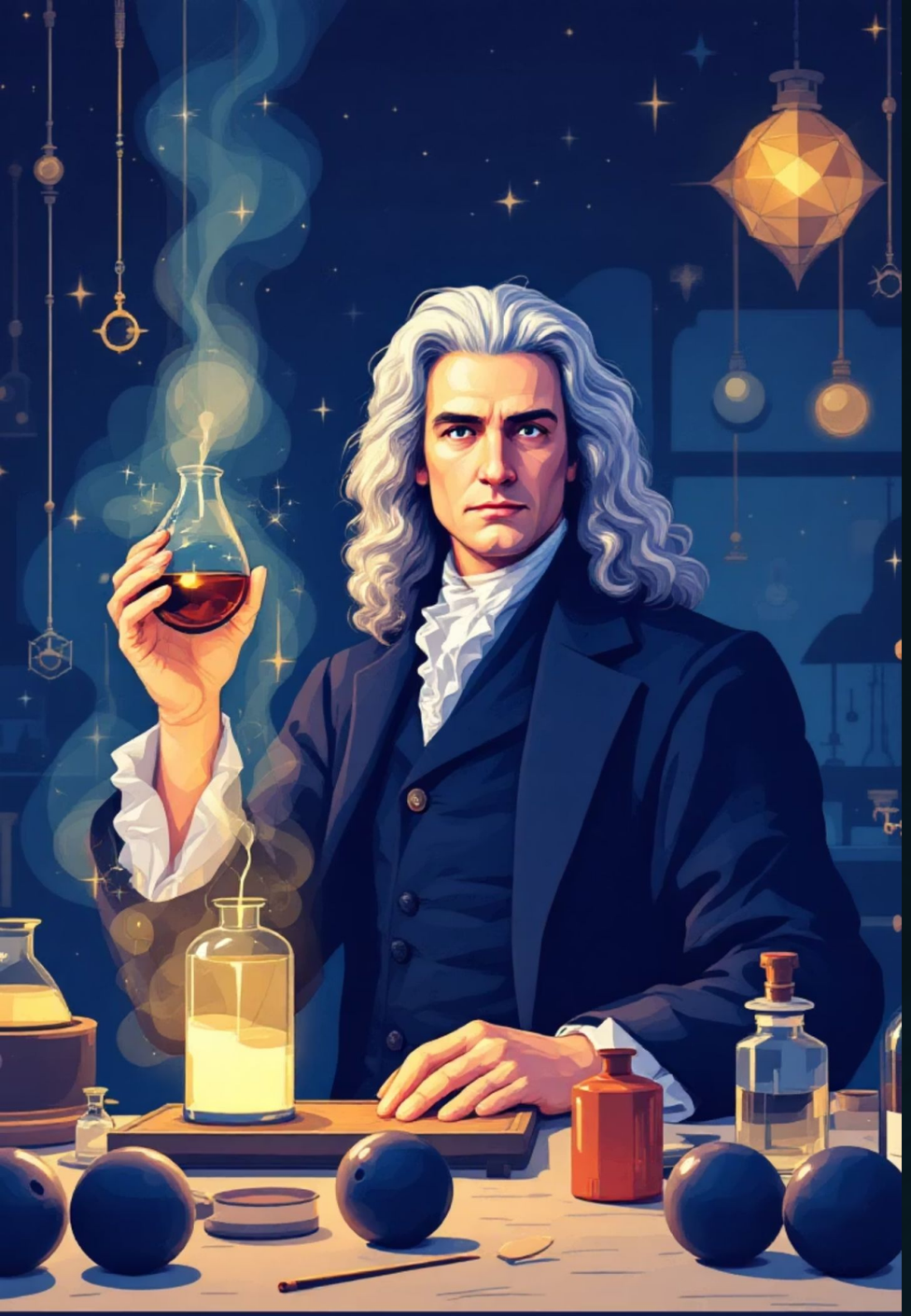
A top spins until air resistance and friction slowly stop its elegant whirl.

Moon's Orbit

The Moon continuously orbits Earth; the vacuum of space offers no resistance to its eternal motion.

Inertia is nature's fundamental tendency to resist changes in motion or rest, seeking stability.

The Second Law: The Law of Force and Acceleration



The Second Law: Force and Acceleration

If inertia keeps things constant, what changes motion?

Newton's answer: **Force.**

1

Force's Impact

Greater force means greater change in motion.

2

The Formula

Newton's elegant form: **F = m × a**

3

Key Principle

Force directly links mass and acceleration.

Understanding Force, Mass, and Acceleration

Imagine Newton's cannonball experiment: he pushed two cannonballs (small and large) with the same force.

- The small one rolled quickly.
- The heavy one barely moved.

Revelation: For the same force, acceleration depends entirely on mass.

To achieve equal acceleration, greater force is needed for greater mass.

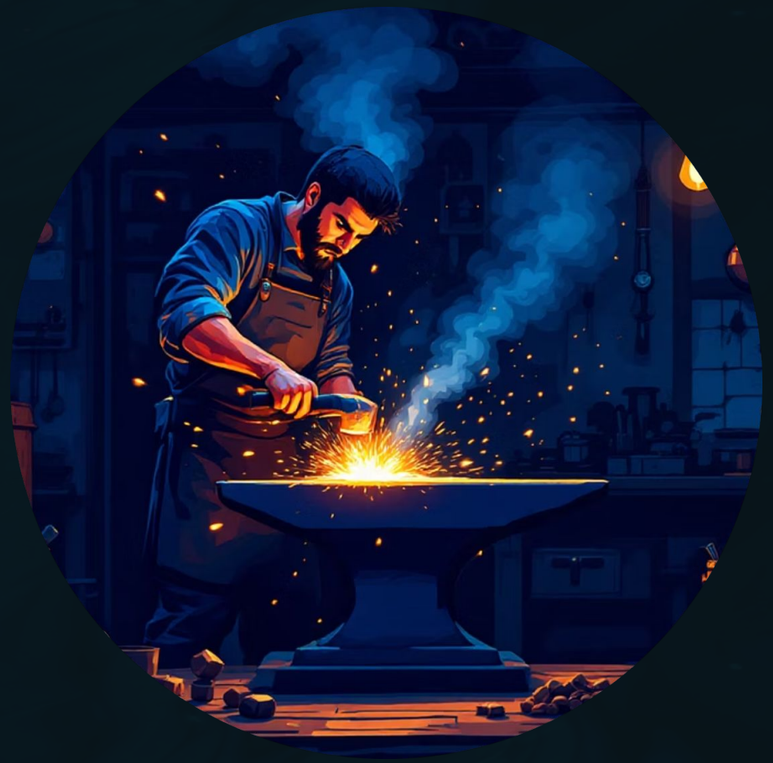
3

Connected Variables

Force, mass, and acceleration in perfect relationship

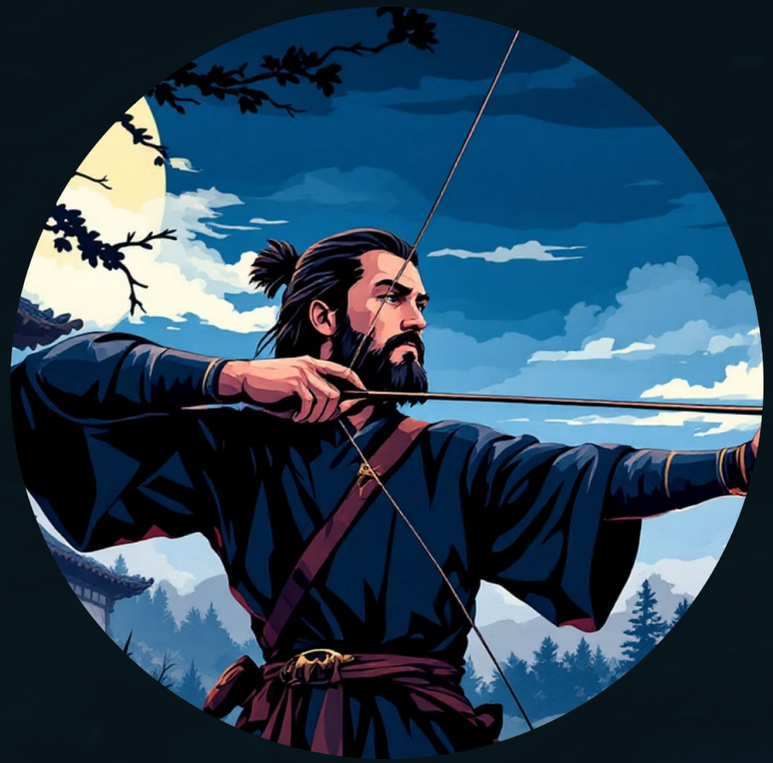
This law elegantly connects three fundamental quantities: the foundation of all mechanics.

The Second Law in Everyday Life



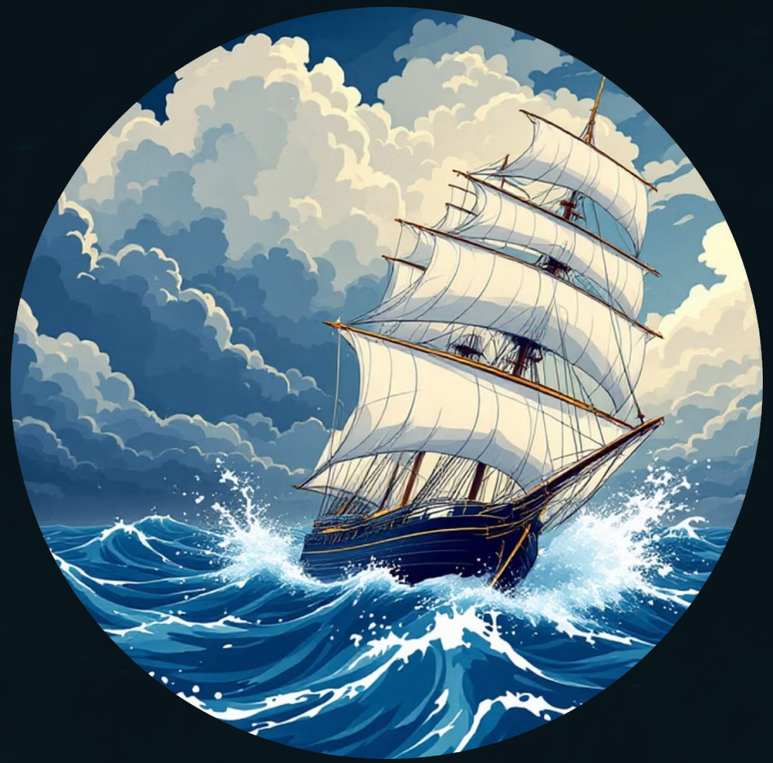
The Blacksmith's Craft

- Light tap: small iron bends easily.
- Powerful blows: greater force needed to shape a sword.



The Archer's Skill

Drawing the bowstring tighter increases force, sending the arrow faster and farther.



The Power of Wind

Gentle wind moves a leaf, but a storm's wind can propel large ships across oceans.

Motion changes only when force acts. The magnitude of this change depends on both the force applied and the object's mass – this is the **Second Law of Motion**.

The Third Law:
The Law of Action and Reaction

The Third Law: Action and Reaction

> *"For every action, there is an equal and opposite reaction."*

Perfect Balance

Every force creates an equal and opposite reaction.

Newton's Observation

Newton felt equal, opposite force when pressing two stones together.

This law reveals universal balance and reciprocity. Every interaction maintains nature's elegant symmetry.

Content for Next Lecture

- More understanding about 1st Law
- Numericals on 2nd Law of Motion

Thank you