NEWTON'S FIRST LAW: INERTIA

STATIC EQUILIBRIUM

TRANSFORMATION

NEWTON'S SECOND LAW: F=ma

THIRD LAW: ACTION-REACTION

ESCAPE VELOCITY: 11.2 km/s

ESCAPE VELOCITY: 11.3 km/s

FORCE & MOTION

From Earth to the Cosmos: A visual guide to universal mechanics.

THRUST
$F_{thrust} > F_{gravity}$

POTENTIAL ENERGY

GRAVITY

NEWTON'S FIRST LAW: INERTIA

ENERGY CONVERSION

ORBITAL TRAJECTORY

CONSERVATION OF ENERGY

MOMENTUM EXCHANGE

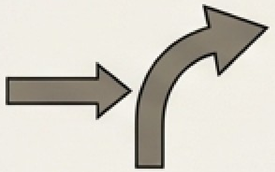
ACTION & REACTION

DEFINING THE PHYSICAL REALM

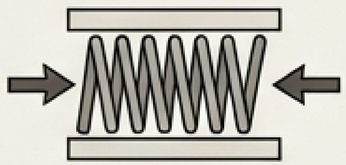
FORCE

A push or pull acting on an object.

Change Speed



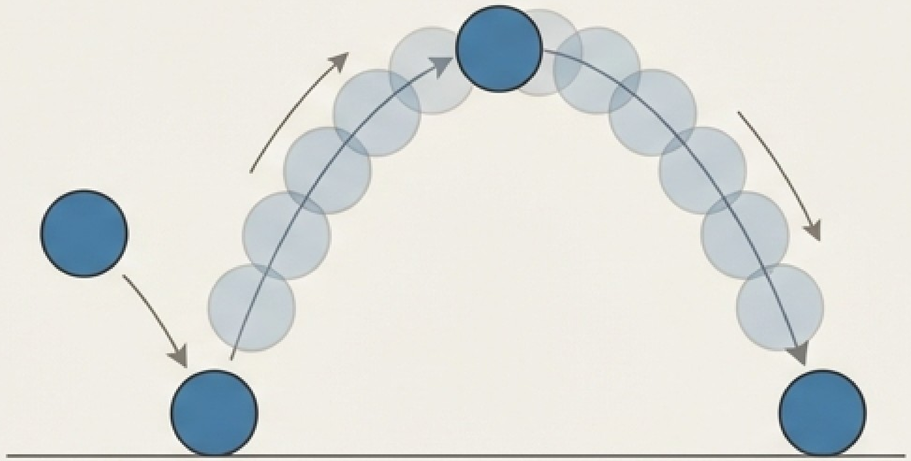
Change Direction



Change Shape

MOTION

The change in an object's position with respect to time.



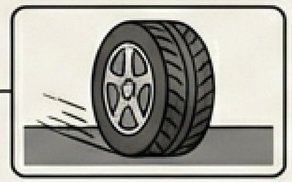
These are the building blocks for every interaction in the universe.

THE SPECTRUM OF FORCES

FORCES

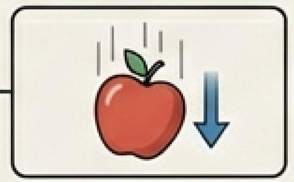
CONTACT FORCES
Requires physical interaction

Muscular Force

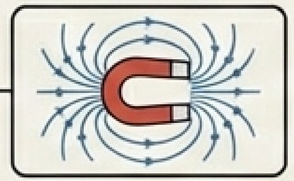


Frictional Force

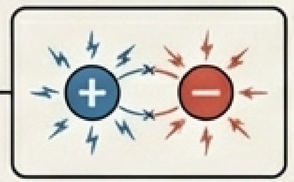
NON-CONTACT FORCES
Action at a distance



Gravitational Force



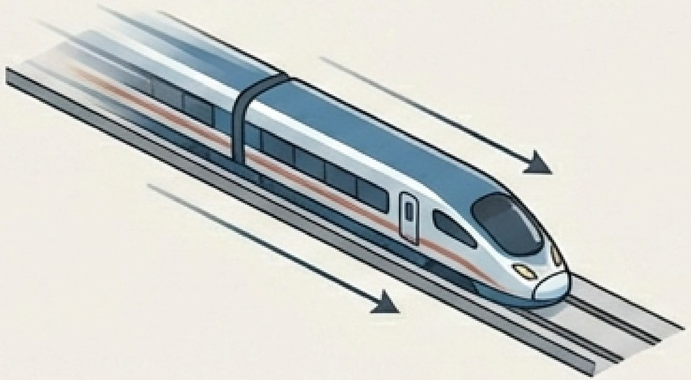
Magnetic Force



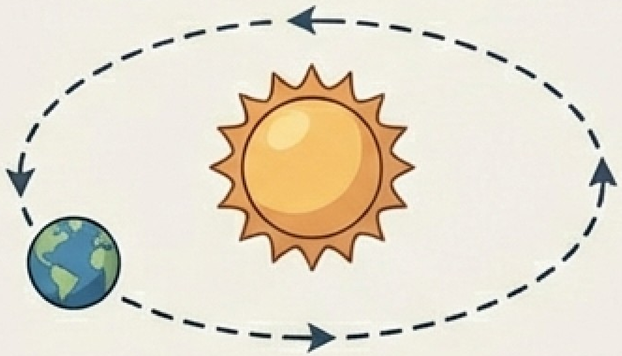
Electrostatic Force

THE CHOREOGRAPHY OF MATTER

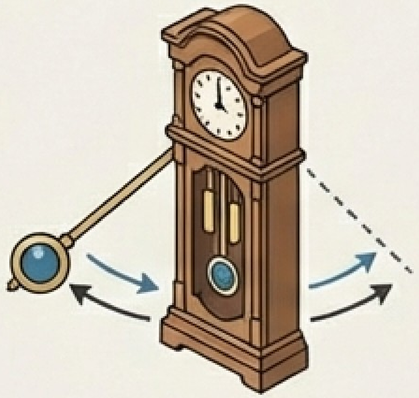
RECTILINEAR MOTION



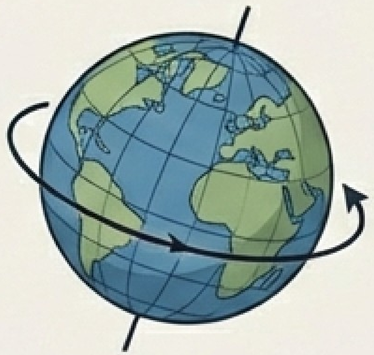
CIRCULAR MOTION



PERIODIC MOTION



ROTATIONAL MOTION



NEWTON’S THREE LAWS

01. INERTIA

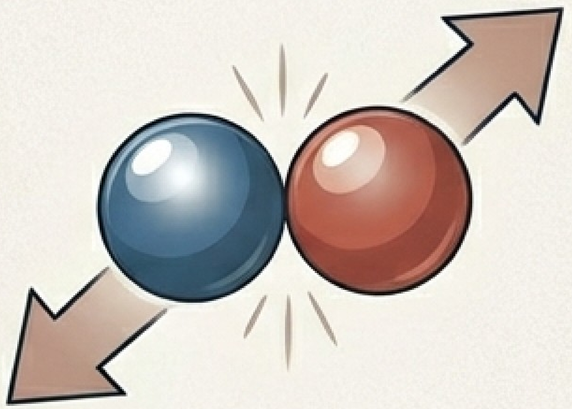
An object remains at rest or in uniform motion unless acted upon by an external force.

02. THE MATH

$$F = m \times \vec{a}$$

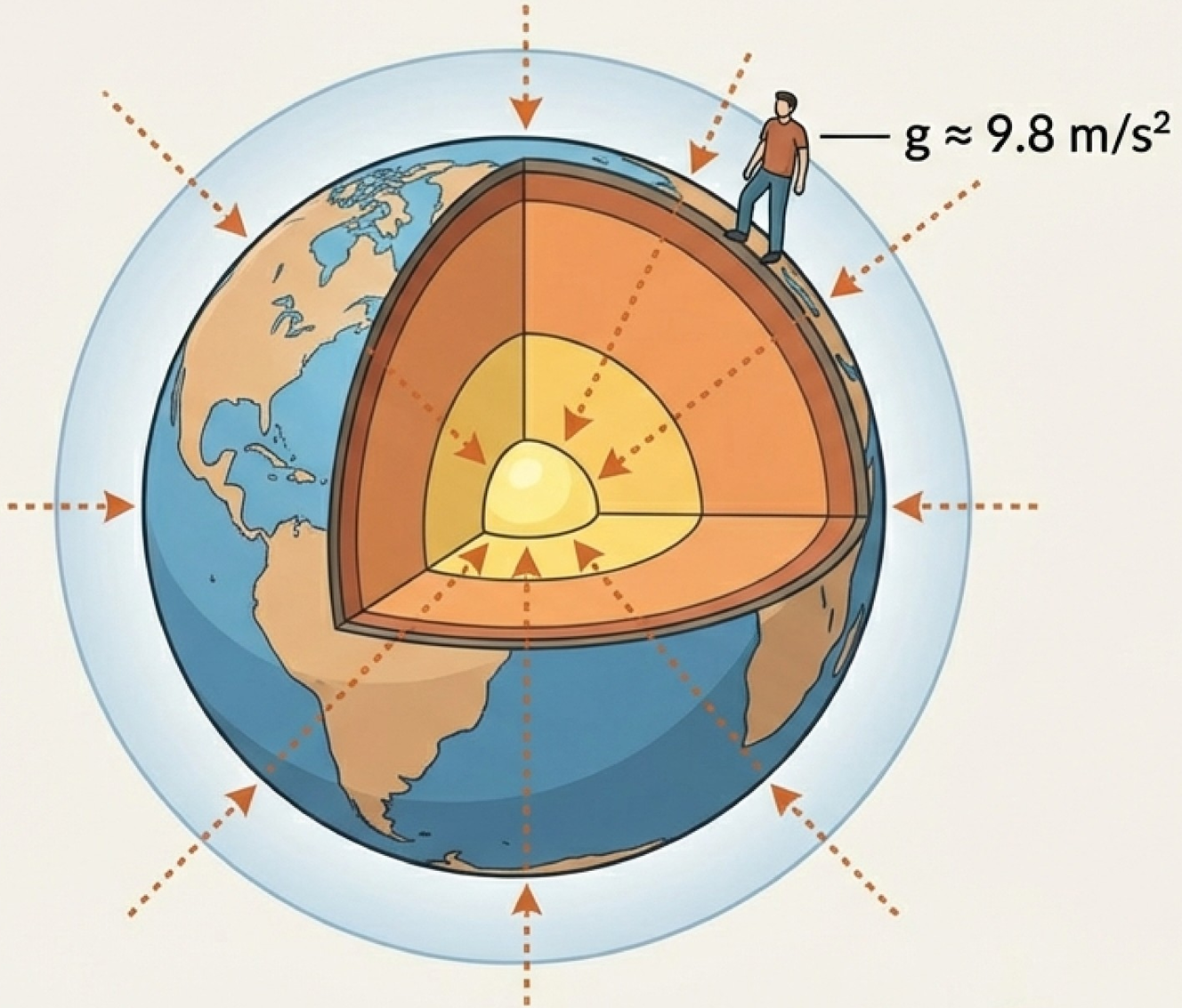
Force equals Mass times Acceleration. The greater the mass, the more force needed.

03. THE EXCHANGE



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

THE ANCHOR: EARTH'S GRAVITY



- **Attraction:** Pulls all objects toward the center.
- **Stabilization:** Holds the atmosphere and oceans in place.
- **Phenomena:** Falling rain, flowing rivers, weight of objects.

FORCES SHAPING THE ENVIRONMENT

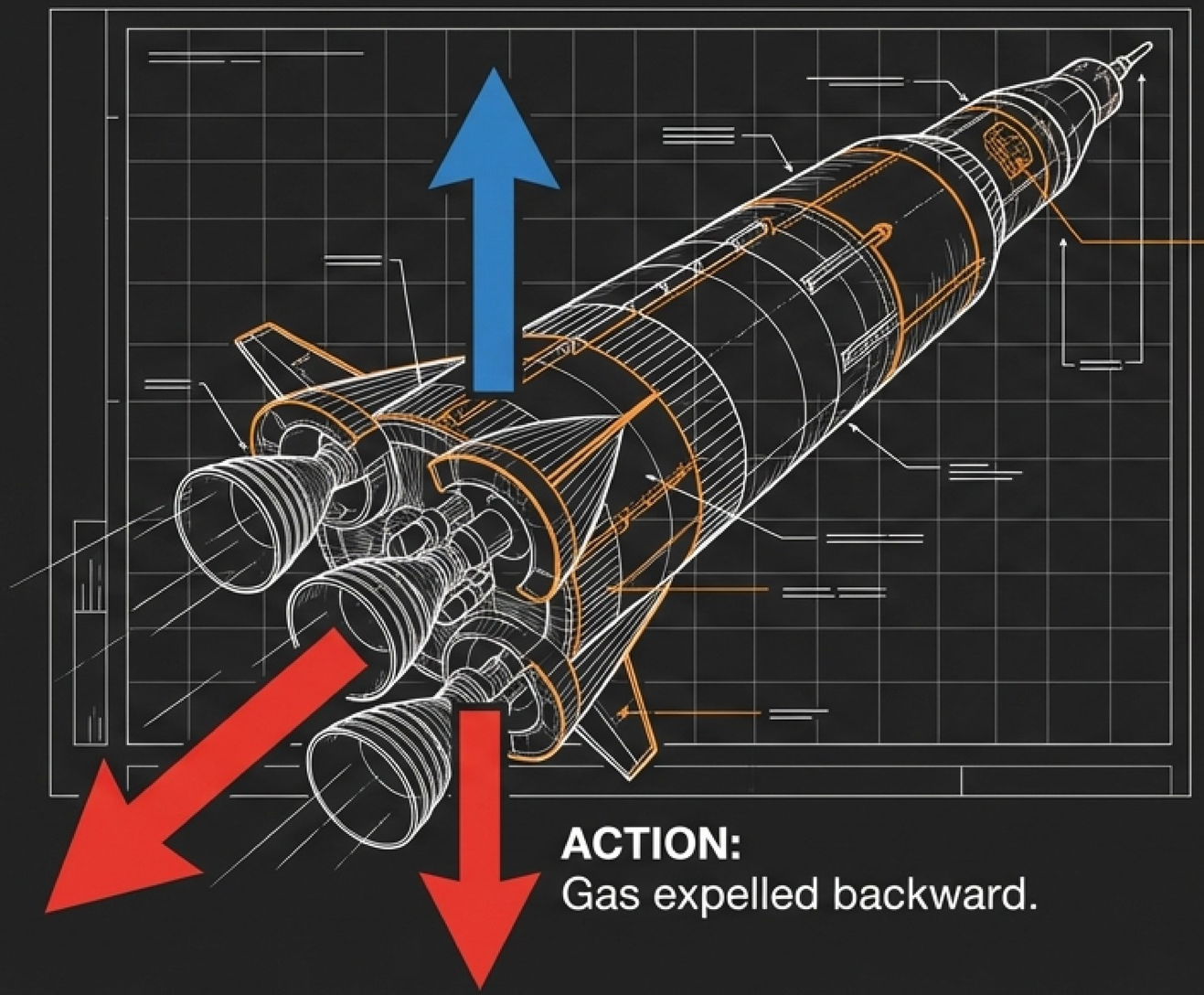
Water Cycle: Gravity pulls precipitation down.

River Flow: Gravity drives water from high to low elevation.

Atmosphere: Pressure gradients drive air movement.

Tides: Moon's gravitational pull shifts water mass.

ESCAPING THE ANCHOR



REACTION:
Rocket moves forward.

ACTION:
Gas expelled backward.

ESCAPE VELOCITY

= 11.2 km/s

The specific speed required to break free from Earth's gravitational pull.

THE VOID: MOTION IN SPACE

Condition: No Air Resistance.

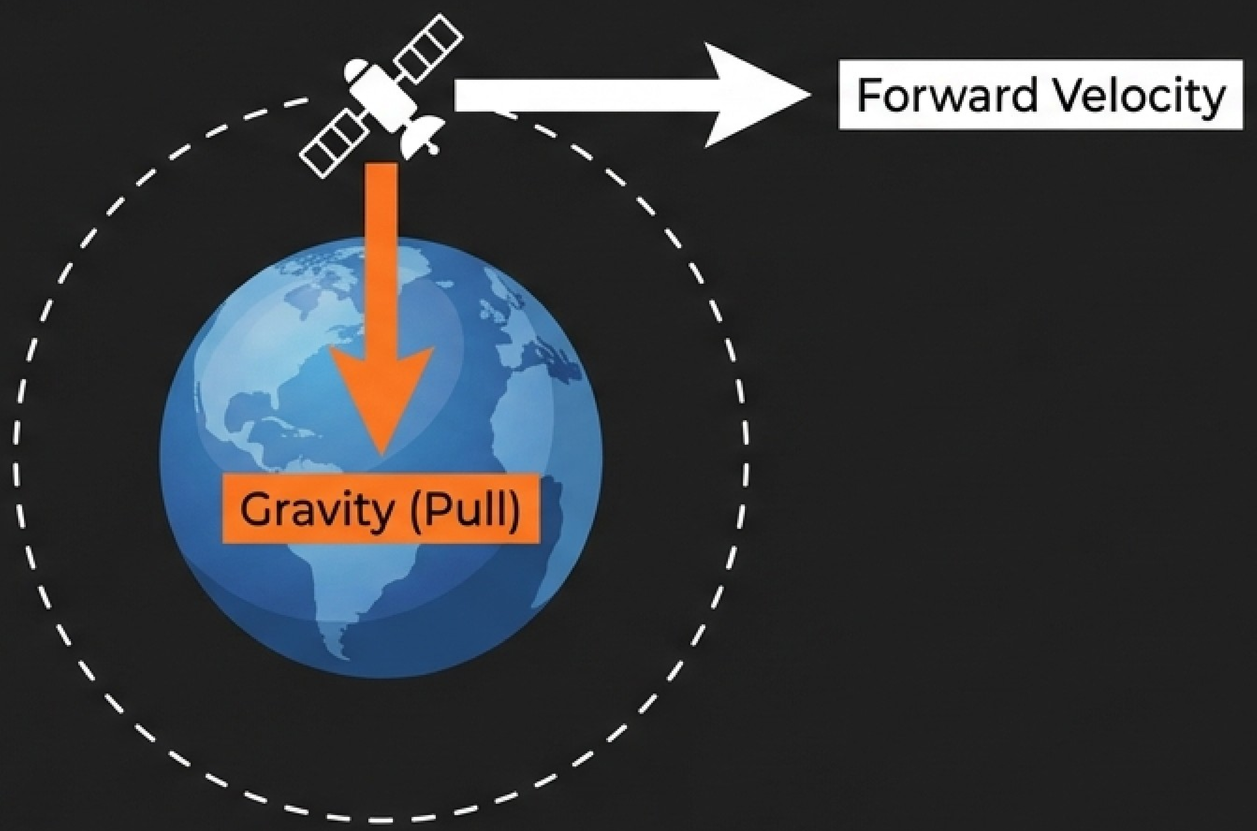
Consequence: Newton's First Law (Inertia).
Result: Perpetual motion. Once moving, an object travels indefinitely without further propulsion.

THE FREE FALL: UNDERSTANDING MICROGRAVITY

MYTH: There is zero gravity in space.

REALITY: Astronauts float because they are in a constant state of free fall. They are falling at the same rate as their vessel.

THE BALANCING ACT: ORBITAL MECHANICS



Orbit is not the absence of gravity; it is the perfect balance between falling down and moving forward.

THE GRAVITY GRADIENT

Gravity is infinite in range but dilutes over vast distances.

VERIFYING THE MECHANICS

What is Earth's escape velocity?

11.2 km/s

Why do astronauts float?

Free Fall / Microgravity

(Not zero gravity)

What keeps a satellite in orbit?

Balance of Gravity & Forward Motion

THE UNIVERSAL RULEBOOK

FORCE

A push or pull that changes speed, direction, or shape.

EARTH CONSTANTS

Gravity (g) ≈ 9.8 m/s². The force that anchors atmosphere and oceans.

SPACE CONSTANTS

Escape Velocity ≈ 11.2 km/s. The speed needed to break the anchor.

ORBIT

A perpetual free fall where forward velocity balances gravitational pull.

“Force connects the falling apple to the orbiting satellite.”