UNDERSTANDING FORCES

How forces shape the world around us

🔍 Big Idea

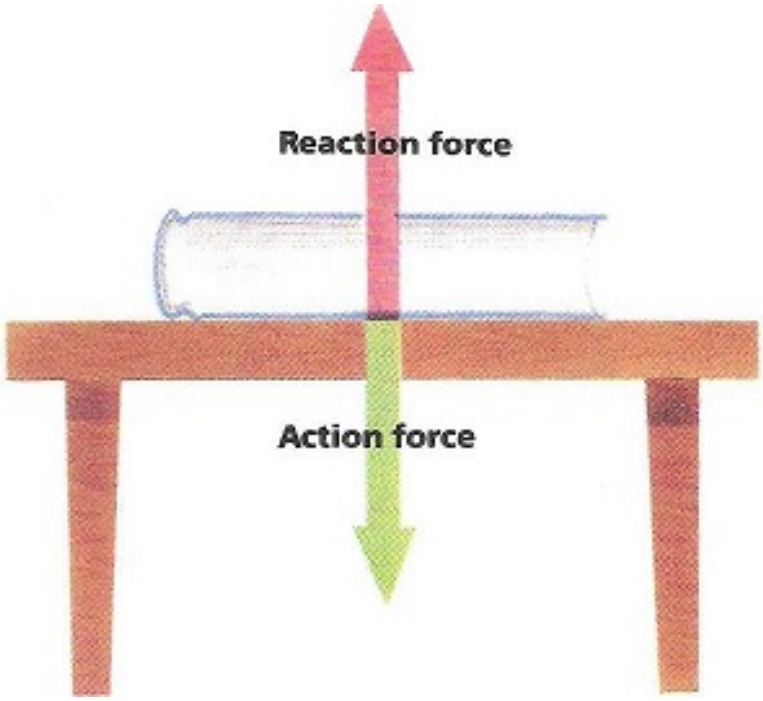
Forces explain how and why objects move or stay still. They are the invisible interactions shaping everything from walking to floating to launching rockets.

🌍 Real-Life Connection

Every time you ride a bicycle, balance on a chair, let go of a balloon, or open a door, you're applying the laws of forces. Physics quietly shapes your entire day.

Key Concepts

- Forces change motion, shape, and energy.
- Forces always come in interactions (action-reaction pairs).
- Systems stay balanced when forces and moments are in equilibrium.

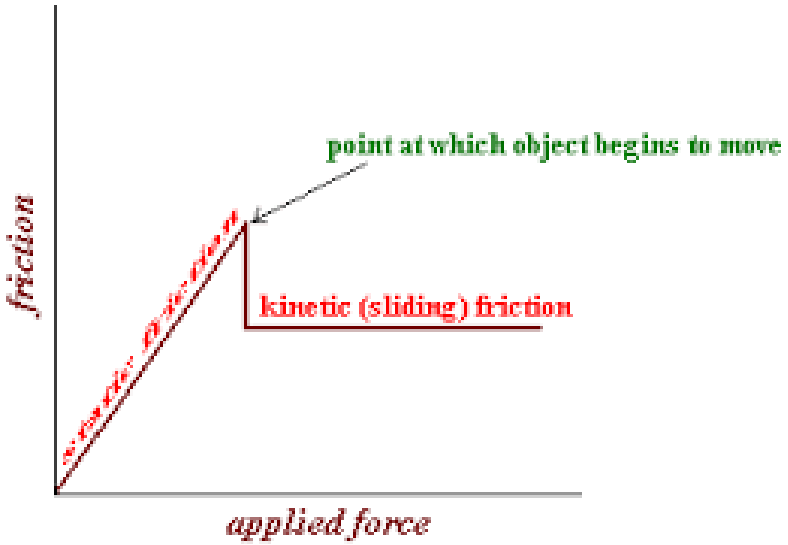


IB Key Concept: Forces describe the relationships between objects and their environments.

Core Physics Summary

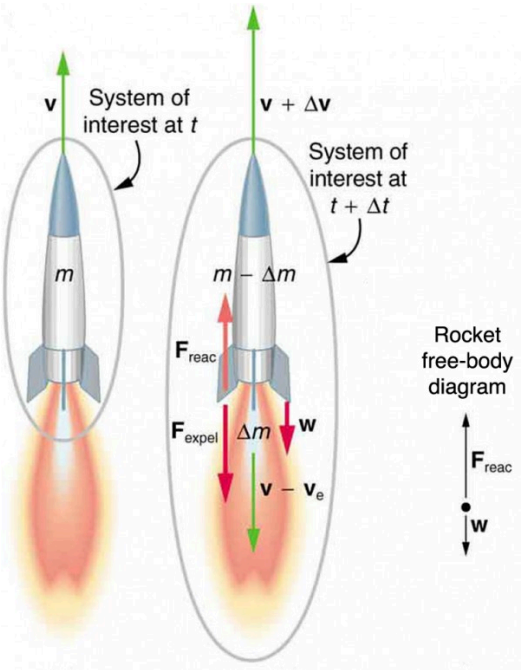
Newton's Three Laws of Motion:

1st law: Objects stay at rest or move at constant speed unless a net force acts.



2nd law: The net force causes acceleration:
Force (N)
Mass (kg)
Acceleration (m/s^2).

3rd law: Every action has an equal and opposite reaction.

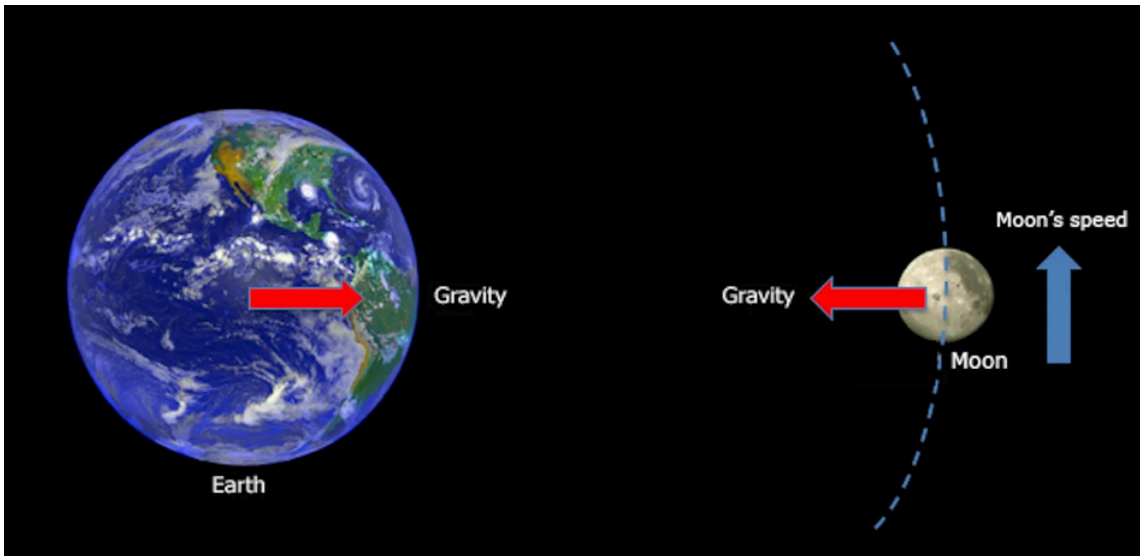


Friction, Drag, Air Resistance:

- Friction opposes motion on surfaces.
- Drag/air resistance opposes motion in fluids (air or water).
- Streamlined shapes reduce drag.

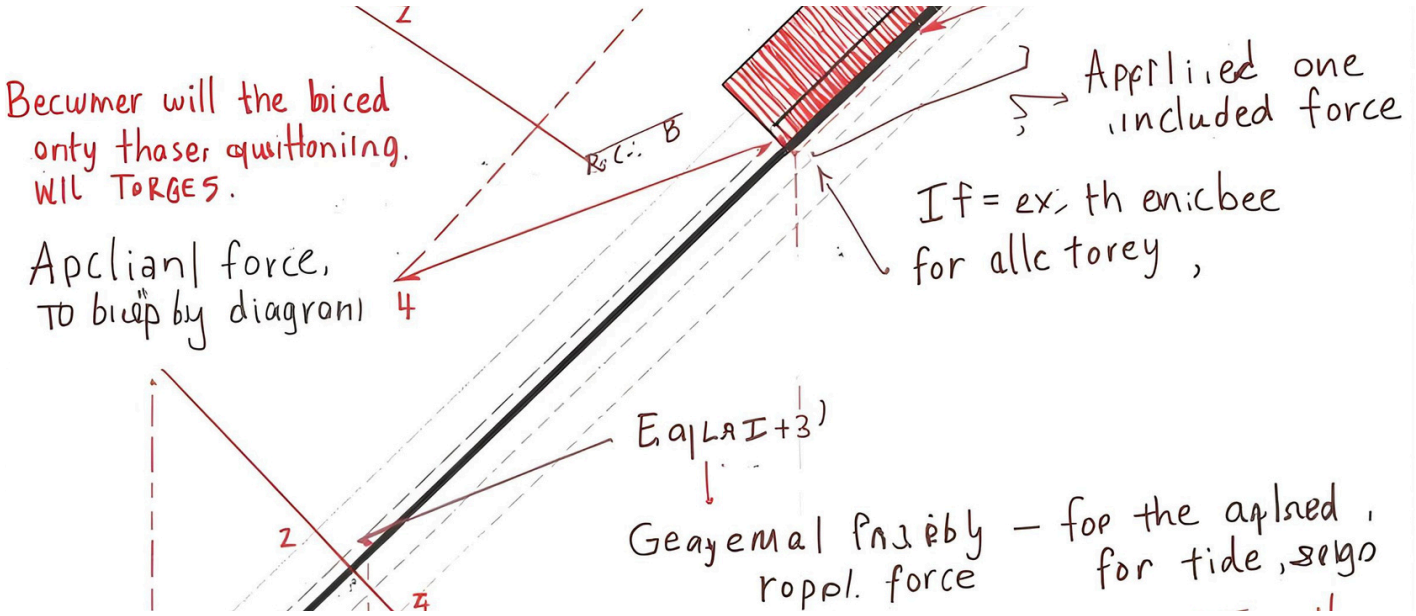
Weight, Mass & Gravitational Field Strength:

Mass (kg): amount of matter; does not change with location.
Weight (N): force due to gravity:
Gravitational field strength (≈9.8 N/kg on Earth).



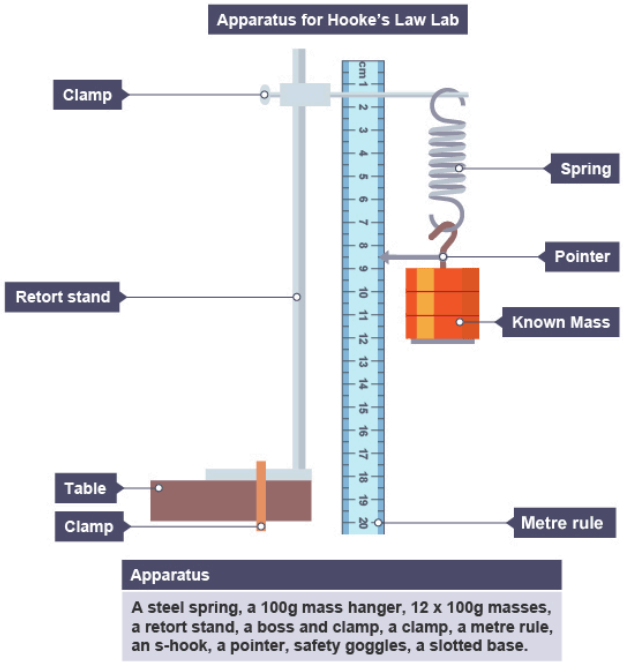
Free-Body Diagrams (FBDs):

Show all forces acting on one object: weight, normal force, friction, tension, etc.



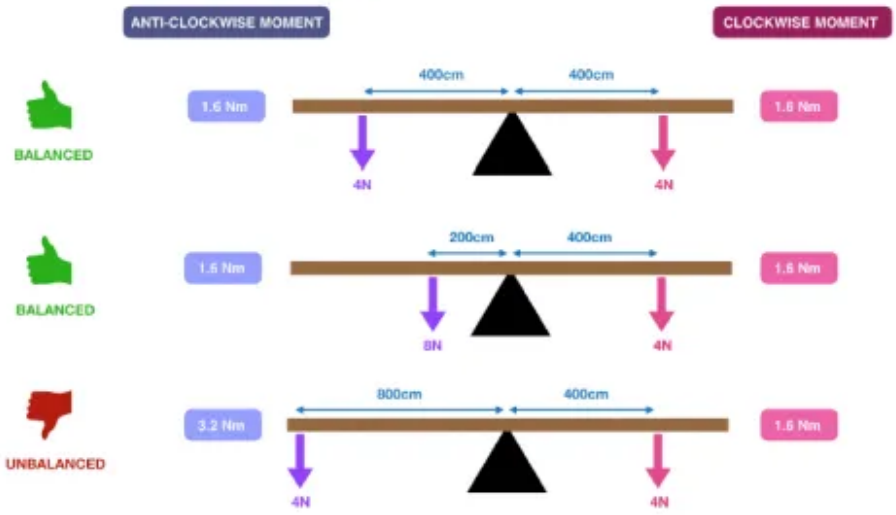
Hooke's Law & Spring Constant:

Stretching a spring:
spring constant (N/m)
extension (m)



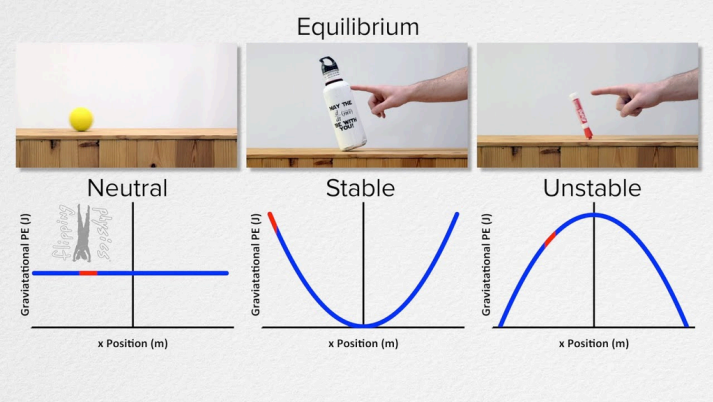
Moments & Principle of Moments:

An object is balanced when:



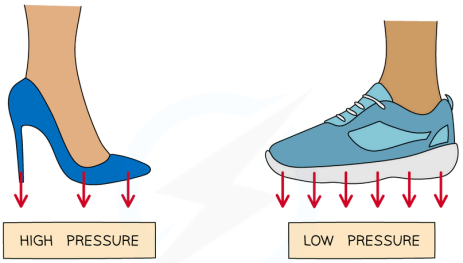
Equilibrium & Centre of Gravity:

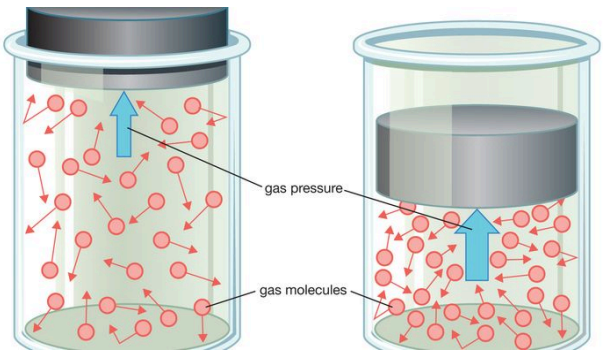
An object in equilibrium has:
Zero net force
Zero net moment
A low centre of gravity increases stability.



Pressure in Solids, Liquids & Gases:

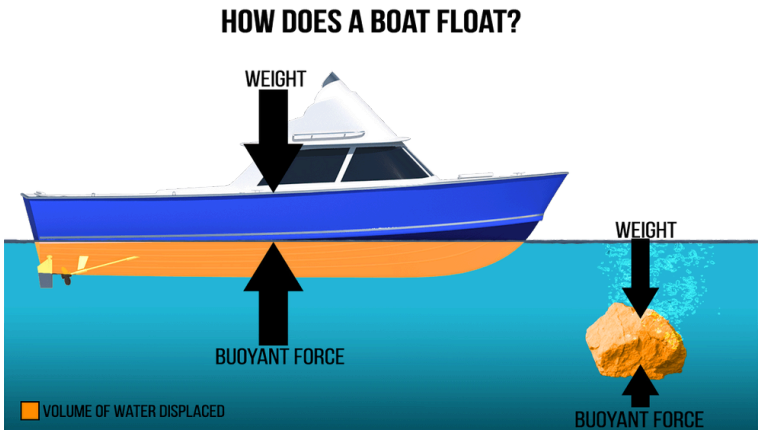
- In solids, pressure is force per area and does not spread out because solids cannot flow.
- liquids, pressure increases with depth.
- Gases exert pressure by particle collisions.





Buoyant Force (Upthrust)-Archimedes' Principle:

Upthrust equals the weight of displaced fluid.
If upthrust > weight → object floats.

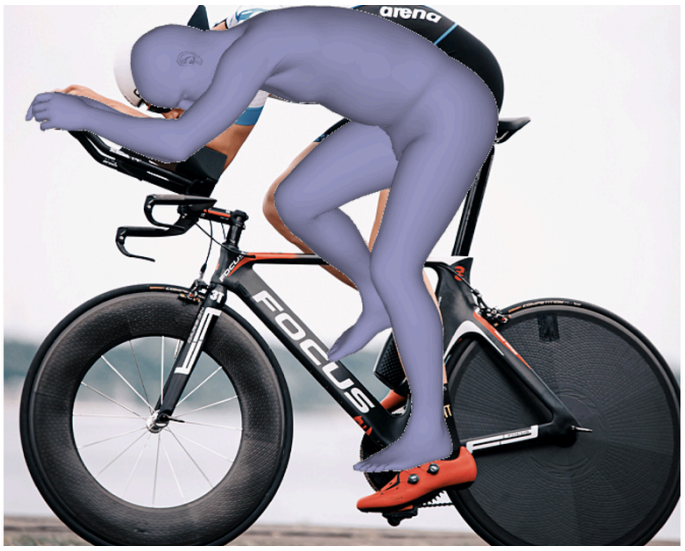


Everyday Example

When you stand on soft ground, your shoes sink slightly because the pressure under your feet is high. Snowshoes spread your weight over a larger area, reducing pressure so you don't sink. This is the same reasoning engineers use when designing large ships—they float by displacing enough water to match their weight.

Think & Reflect

Why do cyclists lower their body and wear streamlined helmets during races? What would happen to your weight but not your mass if you travelled to the Moon?



🎯 Summary

Summary: Forces help us make sense of motion, balance, floating, and everyday interactions. Understanding how forces act and relate to each other allows us to design safer buildings, faster vehicles, and more efficient tools. Physics reveals the hidden interactions shaping every movement in our world.

Next Step: To explore worked problems, exam-style questions, and deeper analysis, check LumiKnow Premium Physics Notes.