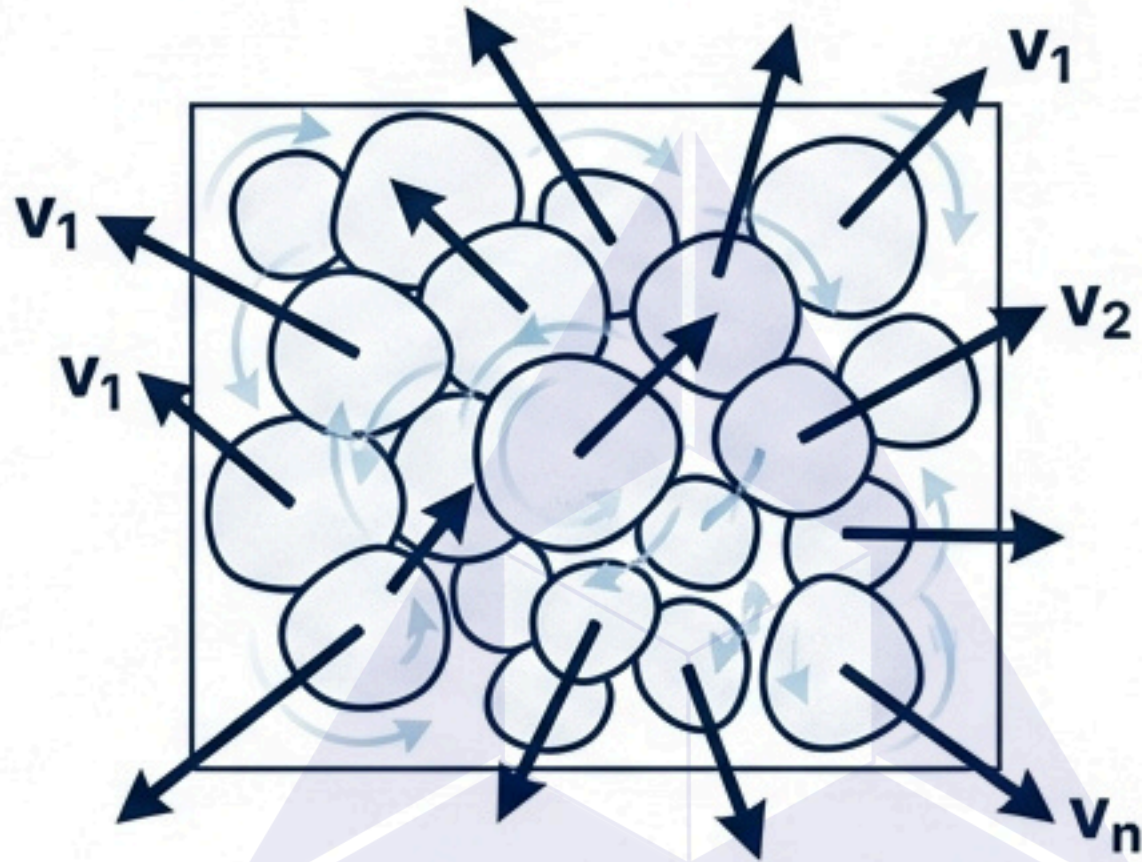


NEET PHYSICS / CLASS 11 • CHAPTER 6: SYSTEMS OF PARTICLES

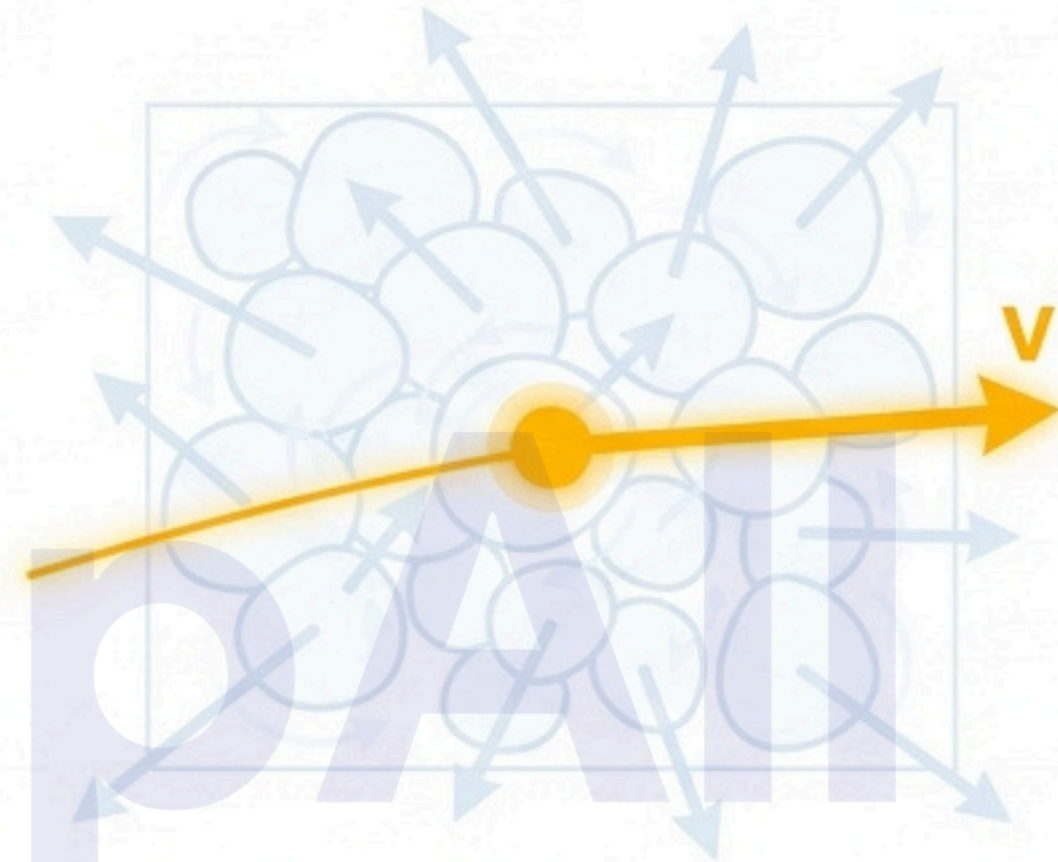
6.3 The Motion of Centre of Mass

*Finding the signal in the noise:
How complex systems move as one.*

The Illusion of Complexity



Extended bodies and particle systems are filled with chaotic internal motions, rotations, and vibrations.



But the Centre of Mass (COM) moves exactly as if all mass is concentrated at this single point.

$$MA = F_{ext}$$

The total mass (M) times the acceleration of the COM (A) equals the vector sum of all external forces. No knowledge of internal forces is required.

The Two Types of Forces

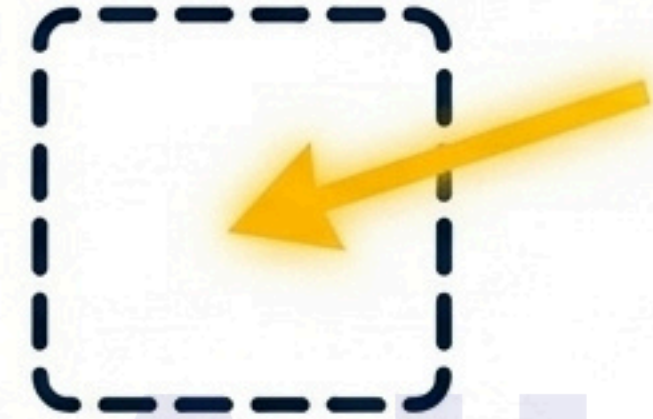


Internal Forces

Definition: Forces exerted by the particles of the system on one another.

Role: Causes internal motion, vibration, or structural explosions.

Impact on COM: ZERO. They cannot change the motion or acceleration of the Centre of Mass.



External Forces

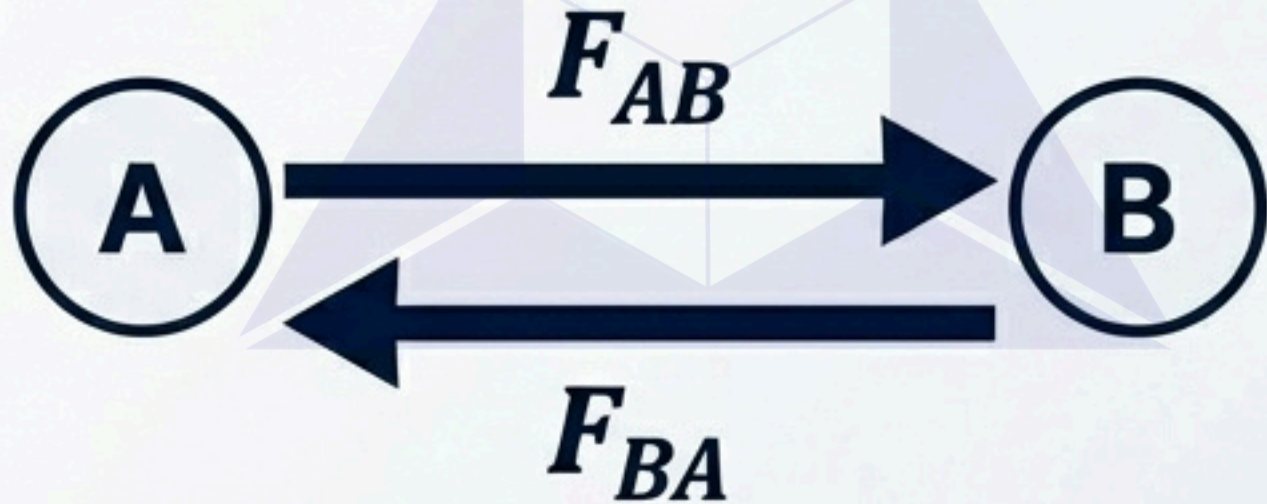
Definition: Forces exerted by bodies outside the system (e.g., Gravity, Applied friction).

Role: Pushes or pulls the system as a whole.

Impact on COM: TOTAL. These are the only forces that dictate the acceleration of the COM.

The Mathematical Disappearing Act

When summing all forces on a system, internal forces are technically included. So why do they vanish from $\mathbf{MA} = \mathbf{F}_{ext}$?



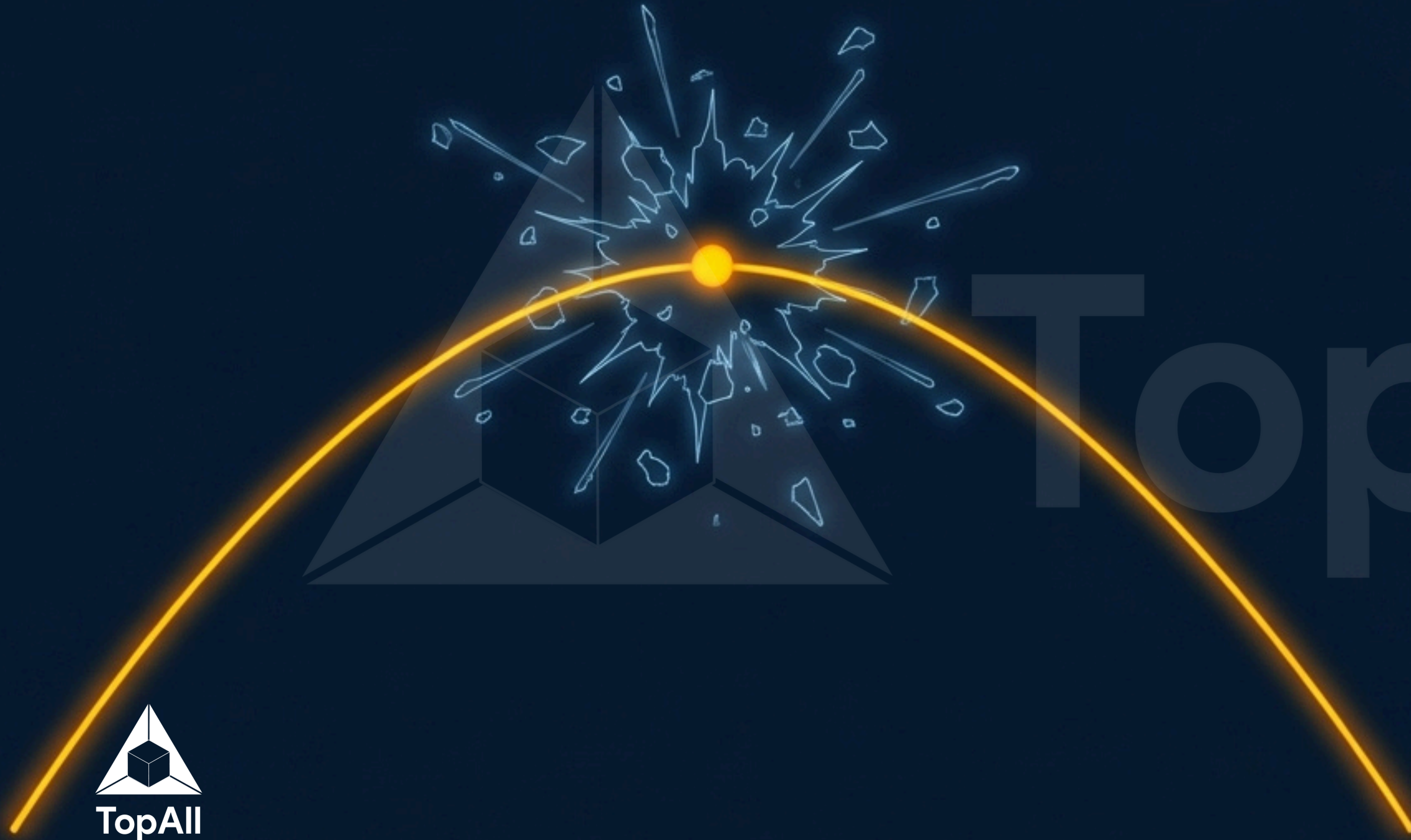
The Principle: Newton's Third Law

Internal forces always occur in equal and opposite action-reaction pairs.

When calculating the vector sum of all forces in the system, every single internal force perfectly cancels its partner.

Result: $\sum F_{int} = 0$

Proof in Action: The Exploding Projectile



The Event" in Inter

A projectile explodes mid-air into fragments. The explosion is driven purely by internal forces. The only external force acting on the system is gravity.

The Outcome" in Inter

Because the external force (Gravity) remains unchanged, the Centre of Mass continues on the exact same parabolic trajectory it would have followed if it never exploded.

Exam Success Panel: Motion of COM



The Master Equation: To find the translational motion of a system, treat all mass as concentrated at the COM: $\mathbf{MA} = \mathbf{F}_{ext}$.



Internal Independence: Internal forces (explosions, vibrations, part movements) sum to zero due to Newton's 3rd Law. They never affect COM acceleration.



The Projectile Rule: If an object breaks apart mid-flight, its COM continues on its original trajectory unless a new external force is applied.



Momentum Link: If the total external force is zero, the velocity of the COM remains constant, and total linear momentum is conserved.