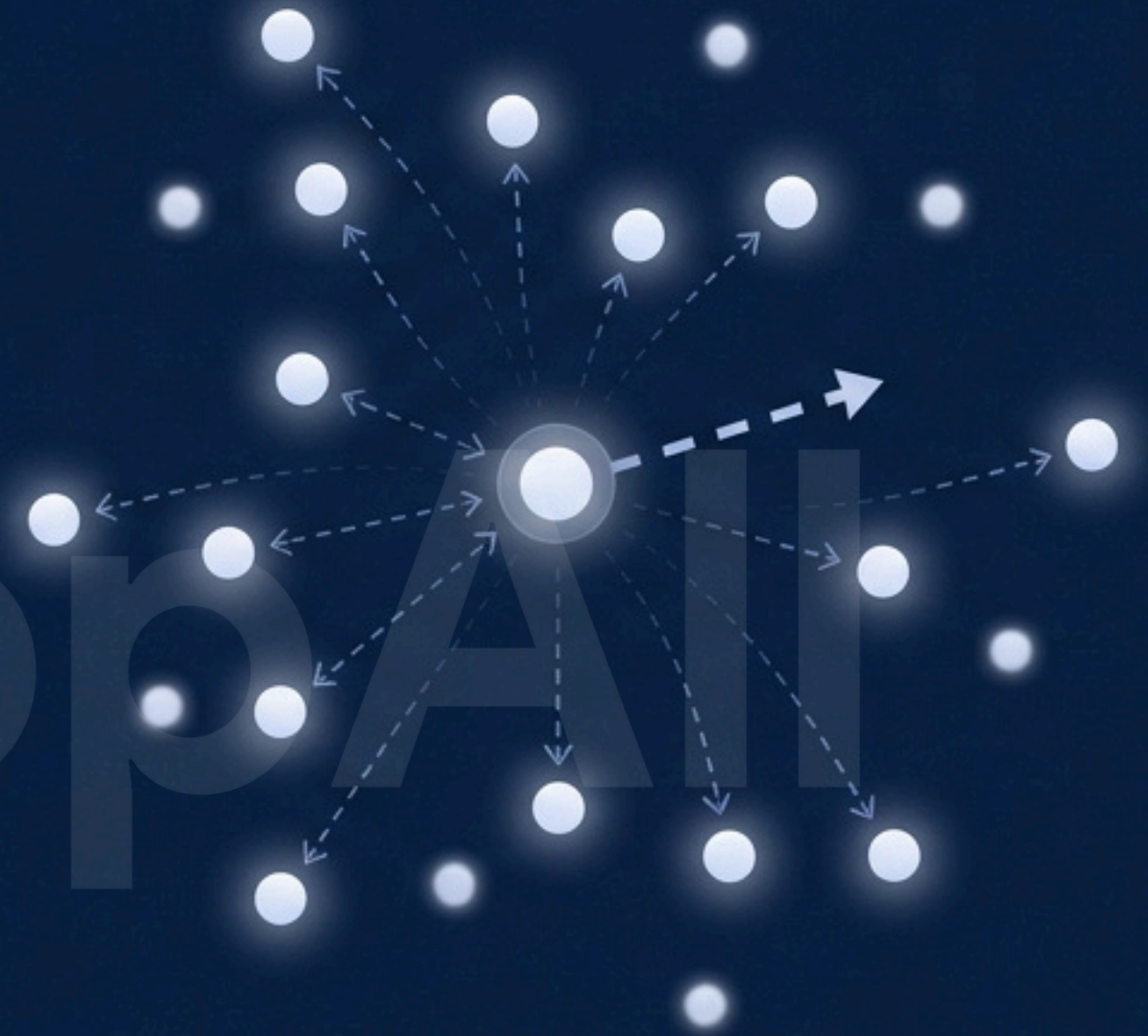
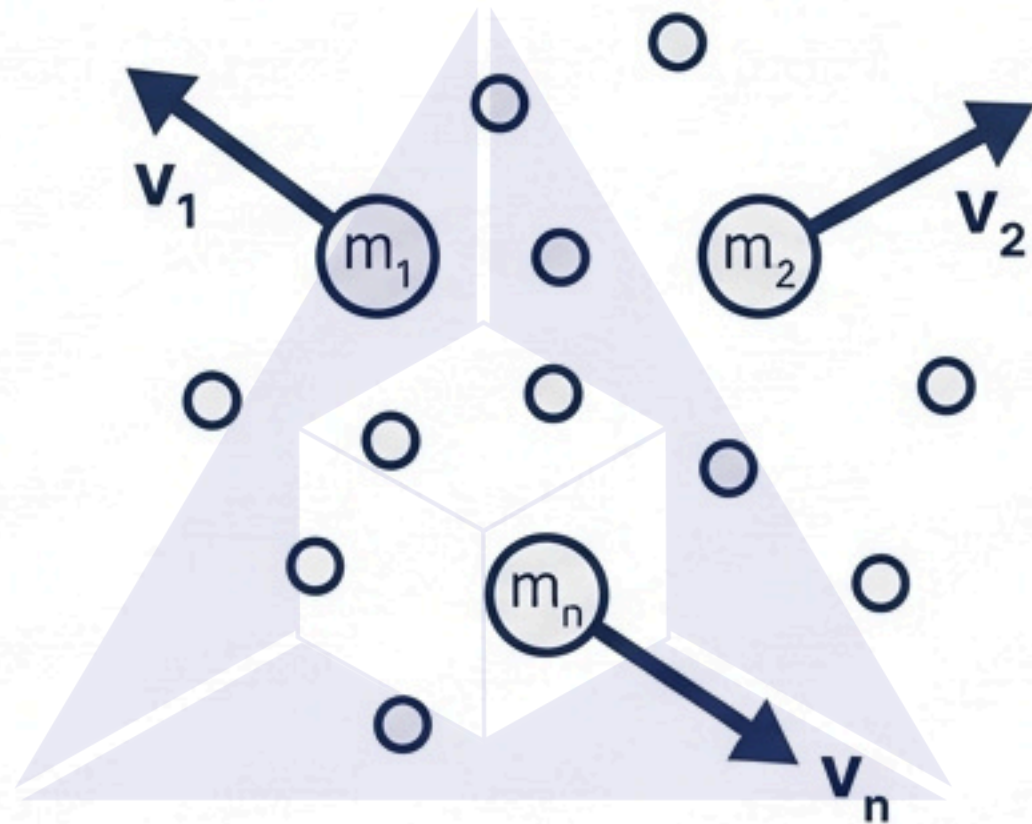


Linear Momentum of a System of Particles

From individual vectors to
Centre of Mass conservation.



Defining Total Momentum



Single Particle: $\mathbf{p} = m\mathbf{v}$

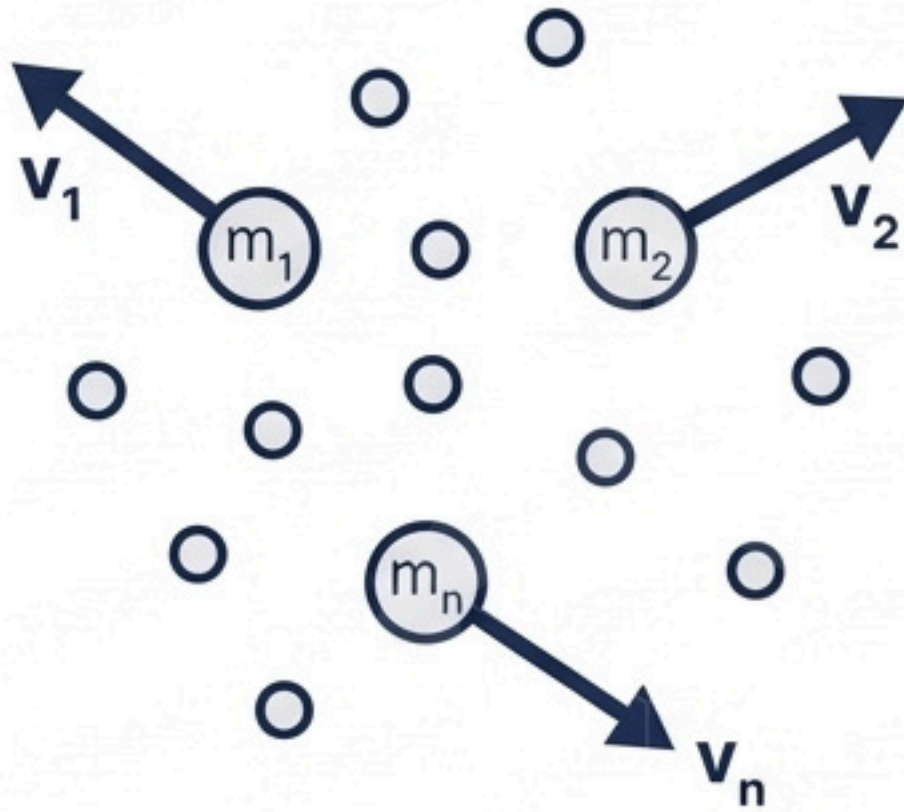
+

$$\mathbf{P} = \mathbf{p}_1 + \mathbf{p}_2 + \dots + \mathbf{p}_n$$

$$\mathbf{P} = m_1 \mathbf{v}_1 + m_2 \mathbf{v}_2 + \dots + m_n \mathbf{v}_n$$

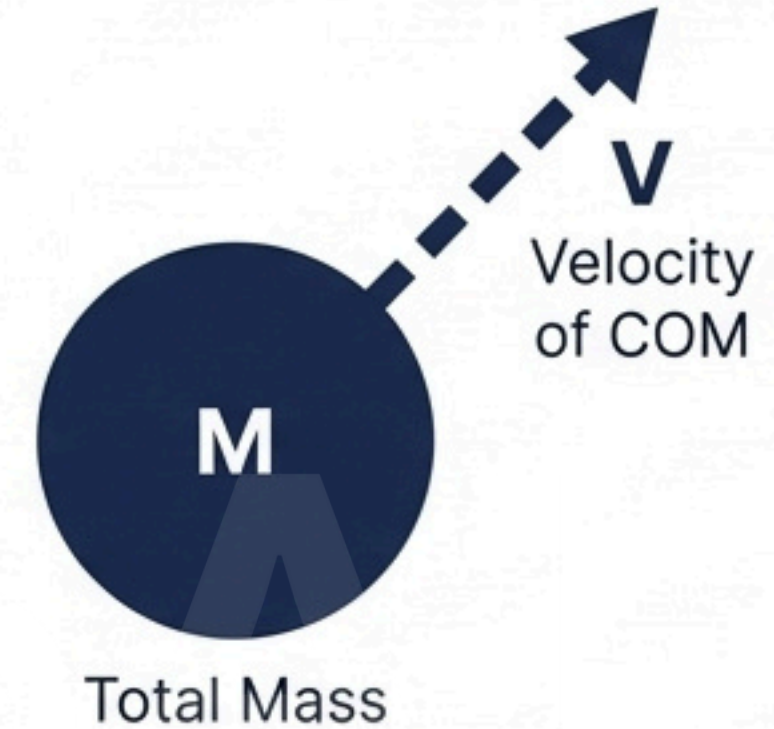
The linear momentum of a system is the precise vector sum of all individual particle momenta.

The Centre of Mass Linkage



System of n particles

EQUATES TO



Single Macro-Particle at COM

$$P = MV$$

The total momentum of a system equals the product of its total mass and the velocity of its centre of mass.

The Conservation Law

$$\frac{d\mathbf{P}}{dt} = \mathbf{F}_{\text{ext}}$$

Time rate of change of total momentum equals the net external force.

$$\text{IF } \mathbf{F}_{\text{ext}} = 0$$

Internal forces (particles interacting) cancel out. Only external forces matter.

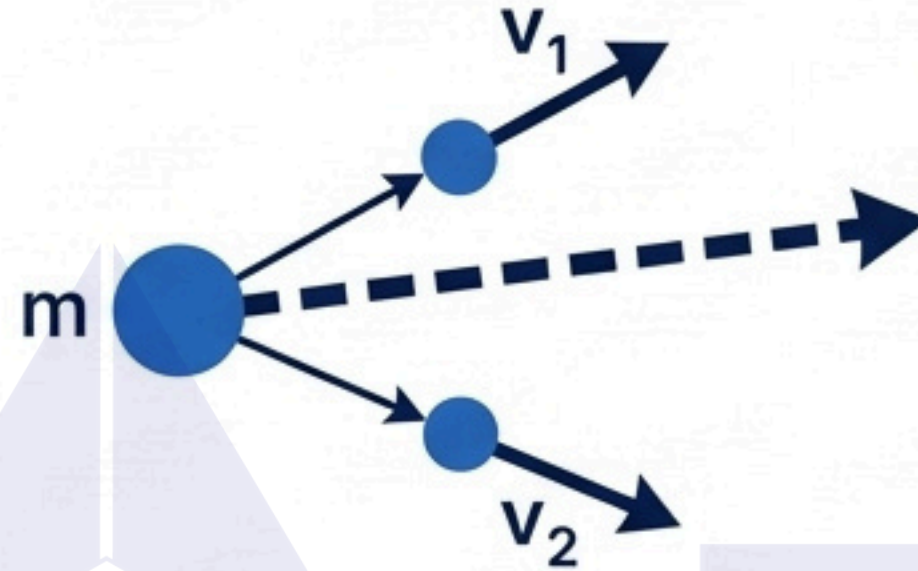
$$\text{THEN } \mathbf{P} = \text{Constant} \rightarrow \mathbf{V} = \text{Constant}$$

The COM moves uniformly in a straight line like a free particle.

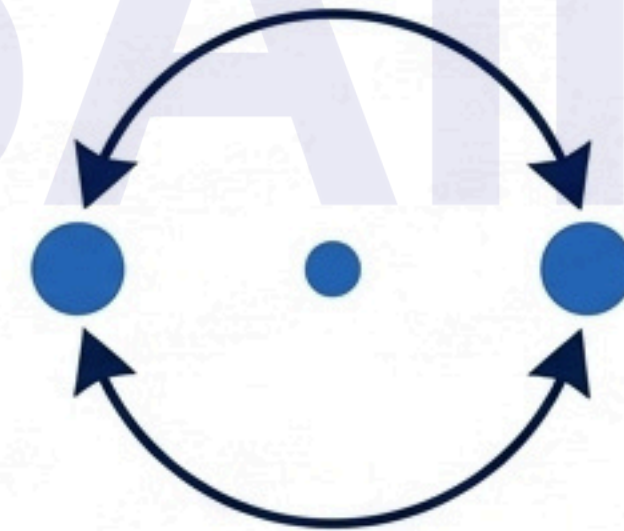
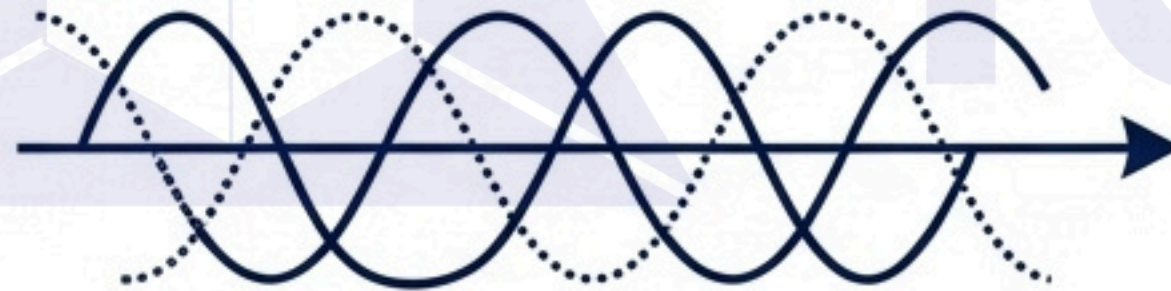
Laboratory Frame

Centre of Mass (COM) Frame

Radioactive
Decay



Binary Stars



Viewing complex systems from the COM frame simplifies chaotic trajectories into perfectly symmetric geometry.

Summary & NEET Prep Vault



Key Takeaways

- ✓ Total momentum is the vector sum:
 $\mathbf{P} = \mathbf{p}_1 + \mathbf{p}_2 + \dots$
- ✓ Macroscopic view: $\mathbf{P} = M\mathbf{V}$
- ✓ Motion of COM is entirely determined by external forces ($\mathbf{F}_{\text{ext}}$).

NEET Exam Traps

Trap 1: Explosions in mid-air.

Forces are internal. The COM continues its exact original parabolic path.

Trap 2: Internal motion. Individual particles may have wild, complex trajectories, but if $\mathbf{F}_{\text{ext}} = 0$, the COM always moves in a uniform straight line.

Mastering frames of reference is the key to solving complex mechanics problems instantly.