

### 3.4: In Summary

---

1. The inertia of an object is a measure of its tendency to resist changes in its motion. It is quantified by the *inertial mass* (measured in kilograms).
2. A system of objects is called *isolated* (for practical purposes) when there are no *net* (or *unbalanced*) external forces acting on any of the objects (the objects may still interact with each other).
3. When two objects forming an isolated system collide in one dimension, the changes in their velocities are inversely proportional to their inertial masses:

$$\frac{\Delta v_1}{\Delta v_2} = -\frac{m_2}{m_1}.$$

This may be used, in principle, as a way to define the inertial mass operationally.

4. The inertial mass thus defined turns out to be exactly (as far as we know) proportional to the object's *gravitational mass*, which determines the gravitational force of attraction between it and any other object. For this reason, most often we measure an object's inertial mass simply by weighing it.
5. The *momentum* of an object of inertial mass  $m$  moving with a velocity  $\vec{v}$  is defined as  $\vec{p} = m\vec{v}$ . The total momentum of a system of objects is defined as the (vector) sum of all the individual momenta.
6. (**Conservation of momentum**) *The momentum of an isolated system remains always constant*, regardless of how the parts that make up the system may interact with one another.
7. In one dimension, the *center of mass* of a system of particles is a mathematical point whose  $x$  coordinate is given by Equation (3.3.1) above. (In more dimensions, just change the  $x$ 's in Equation (3.3.1) to  $y$  and  $z$  to get  $y_{cm}$  and  $z_{cm}$ .)
8. The center of mass of a system always moves with a velocity

$$\vec{v}_{cm} = \frac{\vec{p}_{sys}}{M}$$

where  $\vec{p}_{sys}$  is the total momentum of the system, and  $M$  its total mass.

9. It follows from 8 and 6 above that for an isolated system, the center of mass must always be at rest or moving with constant velocity. This result generalizes the law of inertia to extended objects, or systems of particles.

---

This page titled [3.4: In Summary](#) is shared under a [CC BY-SA 4.0](#) license and was authored, remixed, and/or curated by [Julio Gea-Banacloche](#) ([University of Arkansas Libraries](#)) via [source content](#) that was edited to the style and standards of the LibreTexts platform.