Physics 161

Lecture 8, Summary

Momentum

September 28, 2017

Lecture 8: learning objectives

This lecture

You will be able to define momentum and impulse and explain their relation.

You will be able to define inelastic, perfectly inelastic, and elastic collisions.

You will be able to apply the concept of conservation of momentum to collisions in one dimension.

Momentum and Impulse

Momentum:
The linear momentum of an object of mass m with velocity v is the product of the object's mass and velocity.

$$\vec{\mathbf{p}} = m\vec{\mathbf{v}}$$

Impulse:
The product of the constant force applied to an object with the length of time the force is applied.

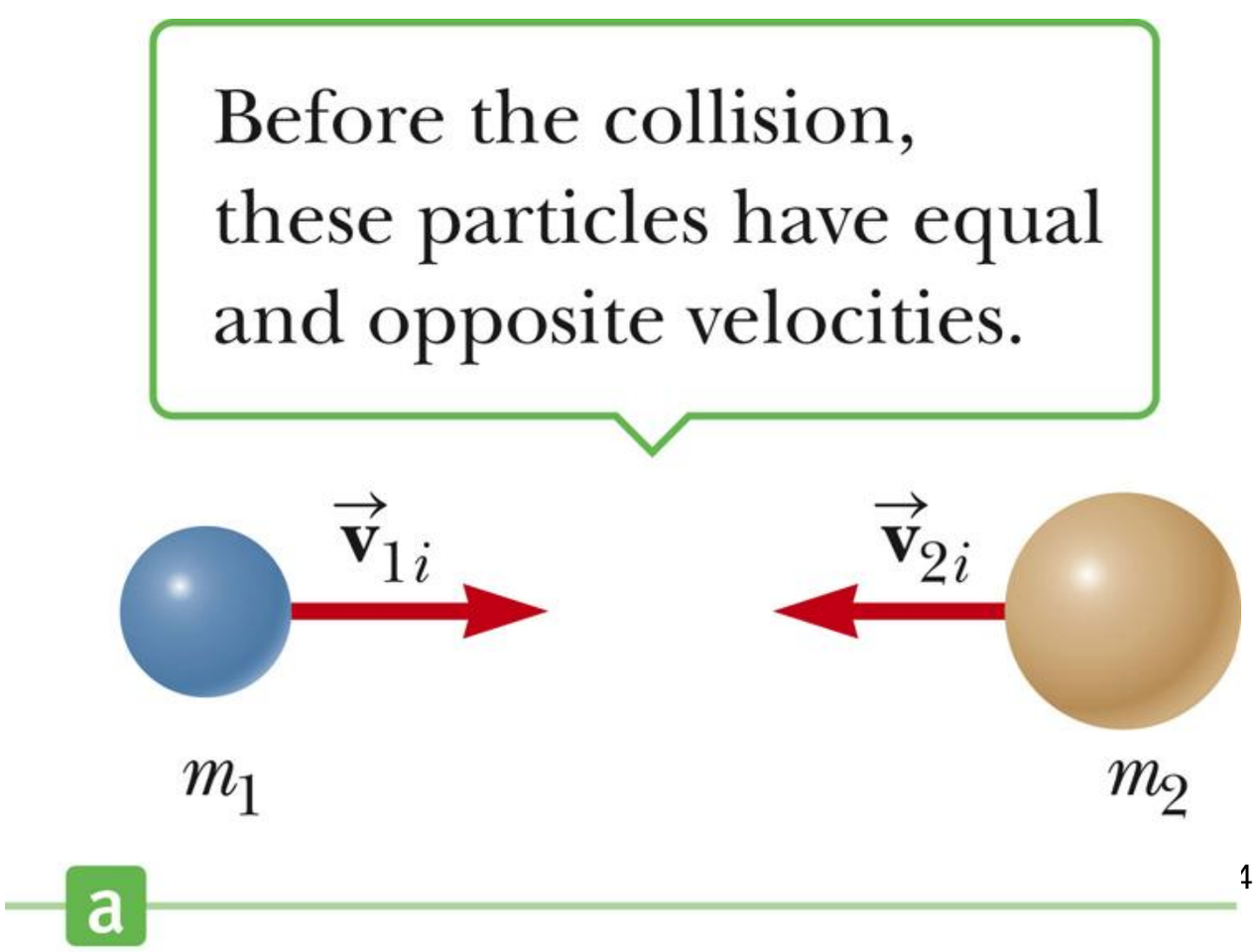
$$\vec{\mathbf{I}} = \vec{\mathbf{F}}\Delta t$$

Impulse-momentum theorem:
The impulse of a force acting on an object equals the change in momentum of that force.

Conservation of Momentum

Conservation of momentum:
When no net external force acts on a system, the total momentum of the system is conserved (i → f).

$$m_1\vec{\mathbf{v}}_{1\,i} + m_2\vec{\mathbf{v}}_{2\,i} = m_1\vec{\mathbf{v}}_{1\,f} + m_2\vec{\mathbf{v}}_{2\,f}$$

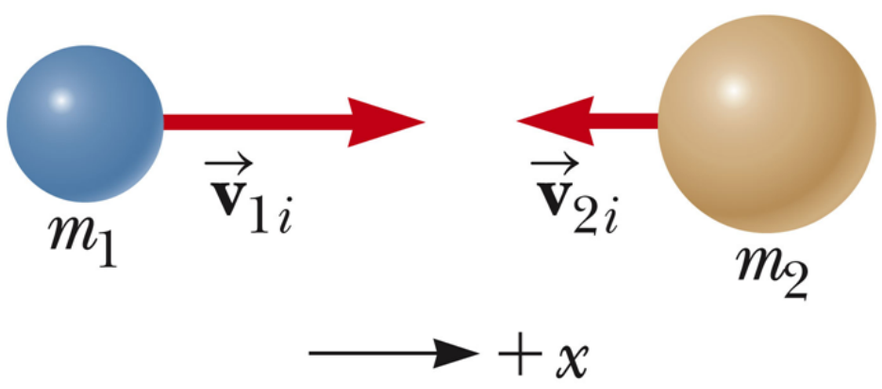


Perfectly Inelastic Collisions

Perfectly inelastic collisions:
Collision in which the objects stick together.
The total momentum is conserved, but kinetic energy is not conserved.

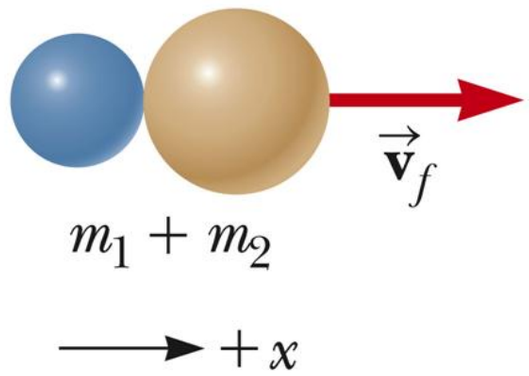
$$\vec{\mathbf{v}}_f = \frac{m_1\vec{\mathbf{v}}_{1\,i} + m_2\vec{\mathbf{v}}_{2\,i}}{m_1 + m_2}$$

Before a perfectly inelastic collision the objects move independently.



a

After the collision the objects remain in contact. System momentum ***is*** conserved, but system energy is ***not*** conserved.



b

Elastic Collisions

Elastic collisions:
Collision in which both kinetic energy and momentum are conserved.

$$m_1\vec{\mathbf{v}}_{1\,i} + m_2\vec{\mathbf{v}}_{2\,i} = m_1\vec{\mathbf{v}}_{1\,f} + m_2\vec{\mathbf{v}}_{2\,f}$$

$$\vec{\mathbf{v}}_{1\,i} - \vec{\mathbf{v}}_{2\,i} = -\left(\vec{\mathbf{v}}_{1\,f} - \vec{\mathbf{v}}_{2\,f}\right)$$

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