Physics A - PHY2048C

Momentum and Collisions

10/14/2019

My Office Hours:

Thursday 2:00 - 3:00 PM

212 Keen Building

Warm-up Questions

1. In preparation for today's class, did you read the textbook sections on Impulse and Momentum?
2. What is the magnitude of the momentum of a 3000-kg truck traveling at 10 m/s?
3. Explain the concept of *impulse* in nonmathematical language.
4. Automobiles are designed with "crumple zones" intended to collapse in a collision. Why?

Outline

1. Review: Momentum and Impulse
2. Conservation of Momentum

Energy and Momentum

We found that the total energy of a closed system is conserved.

We introduce now another property called *momentum:*

- The total momentum of a closed system of particles is also conserved.

  Energy and Momentum Conservation is one of the most important discoveries in physics.

The momentum of a particle depends on its mass and velocity:

$$\vec{p} = m\vec{v} \qquad \text{Units are kg m/s,}$$

where direction of the momentum is the same as the velocity.

Force and Momentum

Assume the force and acceleration of an object are constant:

$$\vec{F} = m\vec{a} = m\frac{\Delta\vec{v}}{\Delta t} = m\frac{\vec{v}_f - \vec{v}_i}{\Delta t} = \frac{\Delta\vec{p}}{\Delta t}$$

The force can be related to the momentum:

$$\text{Impulse} = \vec{F}\,\Delta t = \Delta\vec{p}$$

This is called *impulse theorem.* Impulse is a vector quantity:

- Its direction is parallel to the total force.
- The same impulse can be obtained in different ways:
  1. A large force acting for a short time.
  2. A small force acting for a long time.

Graphical Analysis of Impulse

Impulse = $F\,\Delta t$

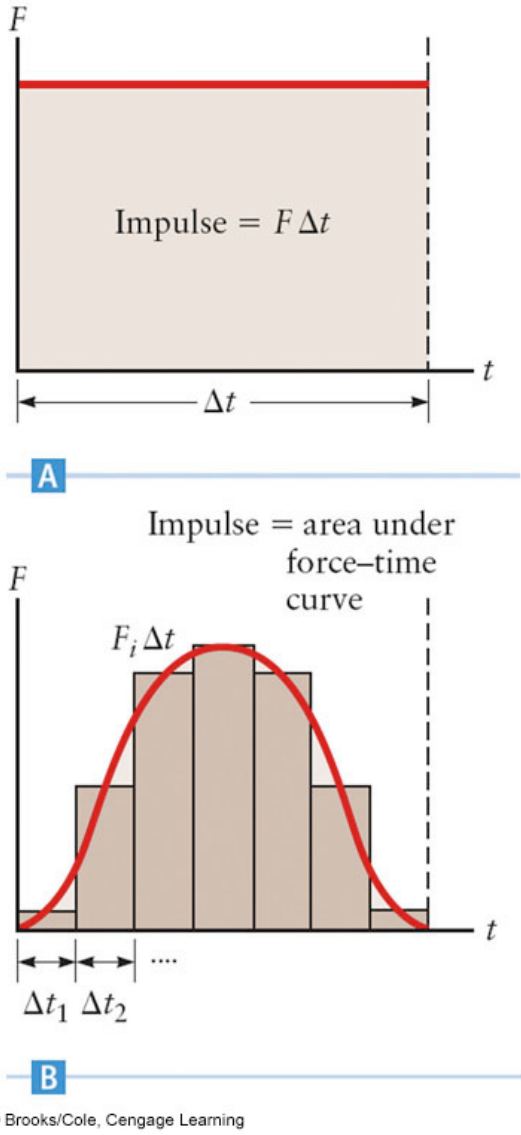
or the area under the $F - \Delta t$ diagram.

It may be difficult to calculate the form of the force-time curve. Often the time interval is very small.

Example:

Bat hitting a ball:

$$\vec{F}_{\text{ave}}\,\Delta t = \Delta\vec{p}$$



Outline

1 Review: Momentum and Impulse

2 Conservation of Momentum

Conservation of Momentum

Impulse and momentum concepts can be applied to collisions:

- The total momentum just before the collision is equal to the total momentum just after the collision.
- The total momentum of the system is conserved.