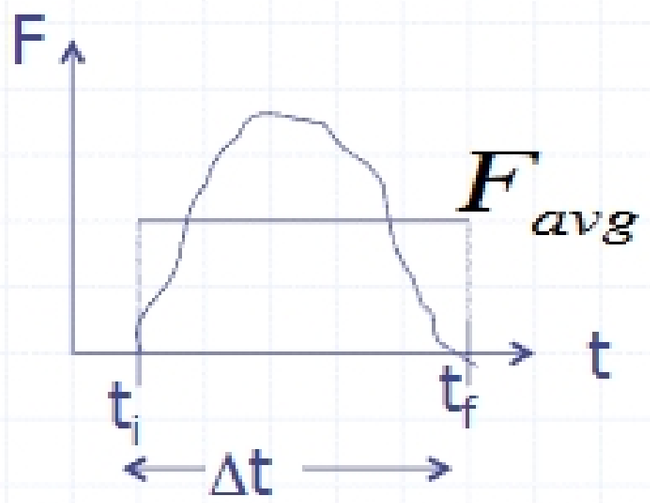
Chapter 9: Impulse, Momentum, and Collisions

- Up to now we have considered forces which have a constant value (does not depend on time) throughout the motion and no explicit time duration
- Now, lets consider a force which has a time duration (usually short) and with a magnitude that may vary with time – examples: a bat hitting a baseball, a car crash, a asteroid or comet striking the Earth, etc.
- It is difficult to deal with a time-varying force, so we might take the mean value



- Define a new quantity by multiplying the force by the time duration $\vec{F}_{avg}\Delta t = \vec{I} = \text{Impulse}$

  - a vector, points in the same direction as the force
  - has units of N s

- Define another quantity, but which gives a measure of the motion

$$m\vec{v} = \vec{p} = \text{linear momentum}$$

  - a vector, points in same direction as the velocity
  - units of kg m/s = N s

Example

A car of mass 760 kg is traveling east at a speed of 10.0 m/s. The car hits a wall and rebounds (moving west) with a speed of 0.100 m/s. Determine its momentum before and after the impact. Determine the impulse.

Solution:

Given: m = 750 kg,

$$\vec{\mathrm{v}}_i = 10.0 \ \frac{\mathrm{m}}{\mathrm{s}} \ \hat{x}$$

$$\vec{\mathrm{v}}_f = 0.10 \frac{\mathrm{m}}{\mathrm{s}} \ \text{west} = \text{-}0.10 \frac{\mathrm{m}}{\mathrm{s}} \ \hat{x}$$