

Momentum and Impulse

Momentum

- All moving objects have momentum
- Momentum is a property that depends on the mass and the velocity of the object.
- A train traveling at 20 km/h is harder to stop than a mosquito traveling at the same speed.
 - The mass of the train is bigger and therefore it has more momentum

- Small objects moving very fast are also hard to stop
 - A bullet shot from a gun has a very small mass, but its large speed gives it a large momentum
- Momentum therefore gives us an idea of how hard it is to accelerate (speed up, slow down, change direction) a **moving** object.

Momentum Equation

- The mathematical description of momentum is mass times velocity

$$p = mv$$

Impulse

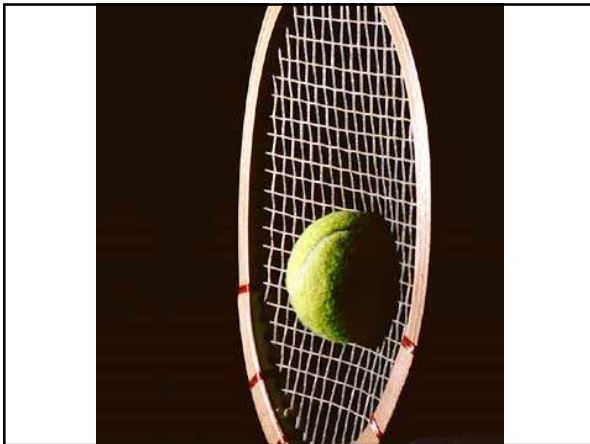
- If I want to change the momentum of an object then I need to change its velocity
 - Accelerate it
- Newton's second law tells us that we need a force to accelerate something
- So I need a force to change the momentum
- The force will be applied for a period of time
- This is referred to as impulse

- Some examples of impulse
 - Hitting a nail with a hammer
 - Hitting a baseball with a bat
 - Hitting a golf ball with a golf club
 - Car crashing into a wall

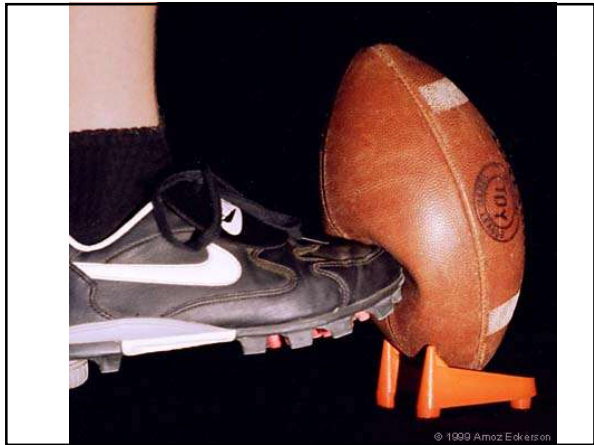
Relating Impulse to Momentum

- If I want to change the momentum I need an impulse
- I can get a bigger change in momentum by either increasing the force or increasing the time
- If a batter wants to hit a baseball further, he can either swing the bat with more force, or try to keep the bat in contact with the ball for a longer period of time

- The impulse is usually a very big force exerted for a very short time.
- The force is so big that it can deform the object for the short time that they are in contact
- Sometimes the deformation is temporary
 - Tennis ball hit with tennis racket
- Sometimes the deformation is permanent
 - Car hitting a wall











Car Crashes

- When a car crashes, it is decelerated to a stop in a fraction of a second
- This means that the momentum changes very quickly
- This needed an impulse
- The impulse would have a very large force and a very short time
- The force acts on the car and the people inside

Safety Features

- Safety features are added to cars to help reduce the effects of the large force on the people inside
 - Crumple zones
 - Seat belts
 - Air bags
