



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

Marik Minge (Pixeb

• The mass of the train is bigger therefore, 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.





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• Momentum gives us an idea of how hard it is to accelerate (speed up, slow down, change direction) a **moving** object.





- Newton actually stated his second law of motion in terms of momentum: The net external force equals the change in momentum of a system divided by the time over which it changes.
 - The effect of a force on an object depends on how long it acts, as well as the strength of the force.
 - Impulse is defined as the strength of the force times the length of time that it is applied.

 $Impulse = F\Delta t$

- Impulse is a useful concept because it quantifies the effect of a force.
 - A very large force acting for a short time can have a great effect on the momentum of an object, such as the force of a racket hitting a tennis ball. A small force could cause the same change in momentum, but it would have to act for a much longer time.













Reducing Injury in a Car Crash

- When a car crashes, the velocity goes to zero in fractions of a second.
- This is a large change in momentum and thus a large impulse.
- Since the time is very short, there is a very large force on the car and its occupants.
- To reduce injury, this force needs to be reduced.
- The force can be reduced by lengthening the time of the collision.
- Safety features have been added to cars to lengthen the time of the collision.
 - Crumple zones





• Air bags

 A pillow of air slows the passenger down before hitting the car, thus reducing the force and lessening the injury.



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- Seat belt tensioners
 - The passenger is allowed to move forward at a controlled rate to lengthen the time of the collision and thus reduce injury from the seat belt.



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Conservation of Energy

- Conservation of energy is a fundamental concept of physics.
- Total energy is constant in any process. It may change in form or be transferred from one system to another, but the total remains the same.

Types of Energy

- All energy can be divided into two basic types
 - Kinetic
 - Energy of motion
 - Potential
 - Energy held by an object because of its position relative to other objects, stresses within itself, its electric charge, or other factors.

Kinetic

- Mechanical
 Moving objects
- Light
- Moving photons
- Electrical
 - Moving electrons
- Thermal/Heat
- Moving atoms
- Sound
- Moving air

Potential

- Gravitational
 Energy of position
- Chemical
 - Potential to burn
- Magnetic
 - Causes electrons
 to move
- Nuclear
 - Cause subatomic particles to move

Example

• Describe the energy transfers and transformations that occur on a ball that is dropped from some height above the earth.

- The ball starts with gravitational potential energy.
- As the ball falls, the gravitational potential energy is transformed into kinetic energy.
- When the ball hits the ground, the kinetic energy will be transferred to the earth, with some energy possibly being transformed into heat and sound.



