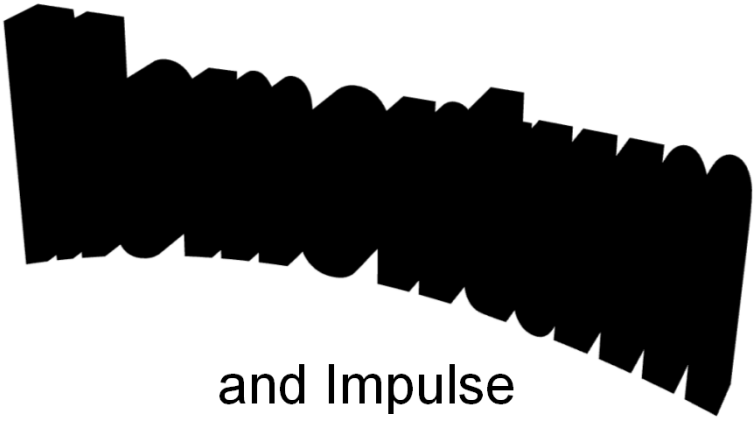

and Impulse

1

Which would be harder to stop?

Why ? The truck has more mass.

2

Which would be harder to stop?

Velocity = 5 m/s

Velocity = 30 m/s

Why ? The red car is traveling faster.

3

Momentum depends on

- Mass (kg)
- Velocity (m/s)

Specifically

Momentum = mass x velocity

or

p = m x v

4

Momentum

- The strength of an object's motion
- A vector quantity
- Determined by both the object's mass and velocity
- Momentum (p) = mass (m) x velocity (v)

5

How do we change momentum?

- Change velocity..accelerate object.
  - How?
- Apply a force.
  -
- Restating Newton's 2nd Law

$$F = ma = m\frac{\Delta v}{t} = \frac{\Delta p}{t}$$

6

Impulse

- Defined as the change in momentum
- Impulse – momentum theorem:
  - The impulse exerted on a body is equal to the change in the object's momentum

$$F\Delta t = \Delta p$$
$$F\Delta t = mv - mv_o$$
$$\Delta p = mv - mv_o$$

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Changing an Object's Momentum

- What if we need to stop something quickly?
  –
- What if there is a force limitation? (ie. Pain, egg toss)
  –

8

Airbags

- How does an air bag use this concept of impulse to decrease the amount of force on your body?

9

Stopping Distances

- The larger an object is, the harder it is to stop.
- If the same force is applied, a larger object will take more time to stop. This additional time means that it will travel a larger distance before stopping.

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Momentum/Impulse Example

- A 1400 kg car moving east with a velocity of 15.0 m/s collides with a utility pole and is brought to rest in 0.30 seconds.
  - Draw a velocity - time graph for the car.
  - What is the force exerted on the car in the collision?

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Impulse/Momentum Example 2

- A 0.45 kg volleyball travels west with a velocity of 4.0 m/s over the net. The ball is bounced back with a velocity of 7.0 m/s east. If the player applies a force of 13.0 N on the ball, how long was the player in contact with the ball?
- Draw a Velocity vs. Time graph for the volleyball

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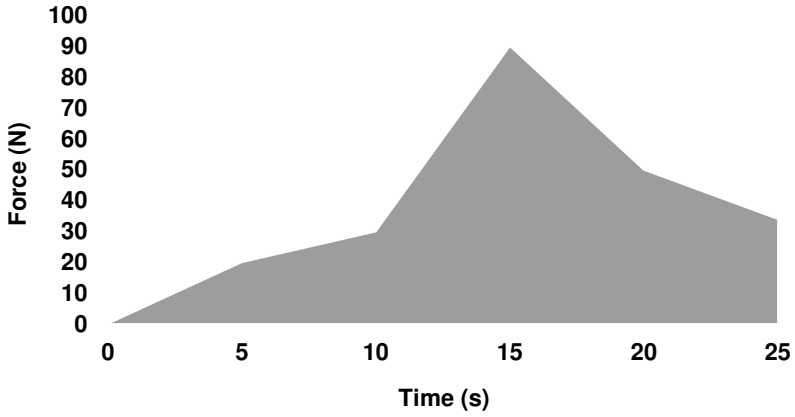
Interpreting Graphs



Use unit analysis to find the quantity that can be found using the area under the curve.

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Interpreting Graphs

$$Area = F \times t$$

$$Area = N \times s$$

$$Area = kg \cdot \frac{m}{s^2} \times s$$

$$Area = kg \cdot \frac{m}{s}$$

$$Area = mass \times velocity = momentum$$

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Law of Conservation of Momentum

- The total momentum of the objects in a system does not change
- The momentum of any one object can change but the momentum lost by one object must be gained by the other objects
- Since momentum is a vector quantity, it may be necessary to find the components of a momentum vector to determine if it is conserved.
- Momentum is always conserved in an isolated system.

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Law of Conservation of Momentum

When momentum is conserved, the following is true:

- total momentum of all objects before collision = total momentum of all objects after collision

- $(m_1v_1 + m_2v_2)_{before} = (m_1v_1 + m_2v_2)_{after}$

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Example

- Two bumper cars are heading towards each other on a straight and level track. Car 1 has a mass of 1450 kg and is traveling at a velocity of 5.4 m/s. Car 2 has a mass of 1650 kg and is traveling at a velocity of 2.2 m/s. After the collision, Car 1 continues on its original path with a velocity of 1.3 m/s. What is the final velocity of car 2?

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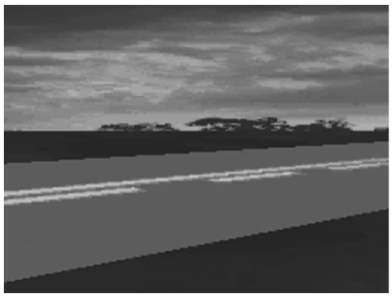
Types of collisions



An elastic collision is one in which both momentum and energy are conserved.

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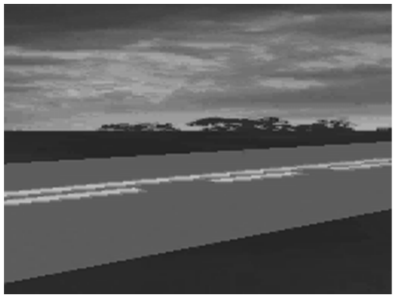
Types of collisions



An inelastic collision is one in which momentum is conserved but energy is not.

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Perfectly Inelastic Collisions

- When using the conservation of momentum with a perfectly inelastic collision, the two masses before the collision are combined after the collision and they both move together with the same velocity.
- $m_1v_1 + m_2v_2 = (m_1 + m_2)\ v_f$

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Example 2

- A 30 g bullet is shot into a stationary 1kg wood block. The bullet embeds itself into the block and they both travel with a velocity of 8.0 m/s. What is the original velocity of the bullet?

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