Momentum

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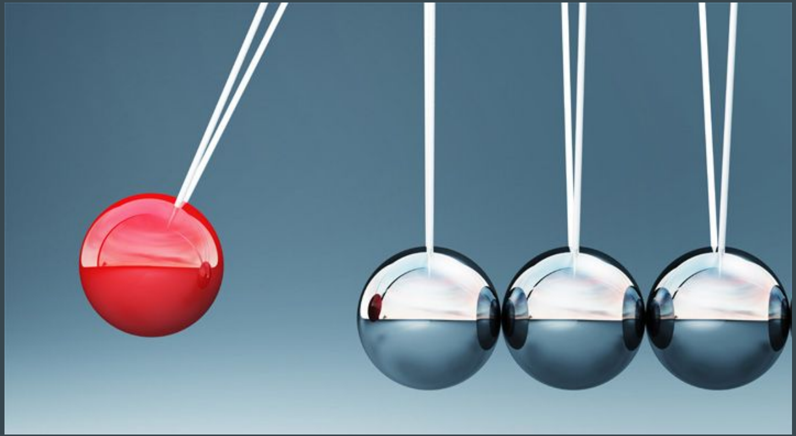
Equations and Definitions

p = mv

Momentum(kg-m/s)=mass(kg) [velocity(m/s)]

- System- set of objects that interact with each other
- Isolated system- system in which forces present are those between the objects of the system
- Momentum is a vector, so direction matters



Impulse

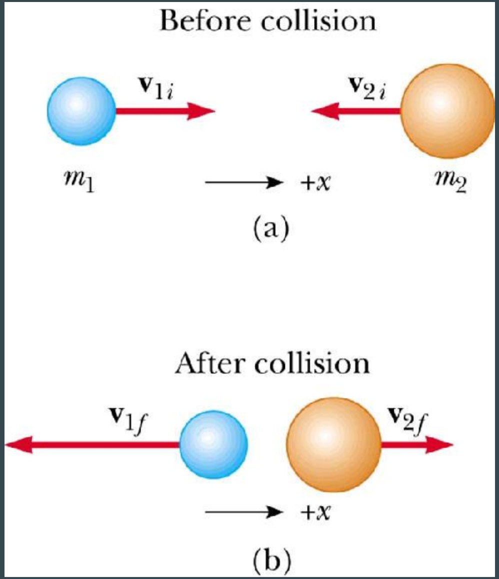
- Change in momentum: impulse (J)
- $J = \Delta p = F_{net}\Delta t$
- Impulse equation equivalent to Newton's 2nd Law

Impulse is when two objects collide and they both deform

Elastic Collision

- Elastic- able to resume its normal shape spontaneously after contraction, dilation, or distortion (maintains original shape)
- Plastic- easily shaped or molded
    - Kinetic Energy is conserved in an elastic collision

$$1/2m_1v_1+1/2m_2v_2=1/2m_1v_1'+1/2m_2v_2'$$



Conservation of Momentum and Kinetic Energy

Conservation of Momentum

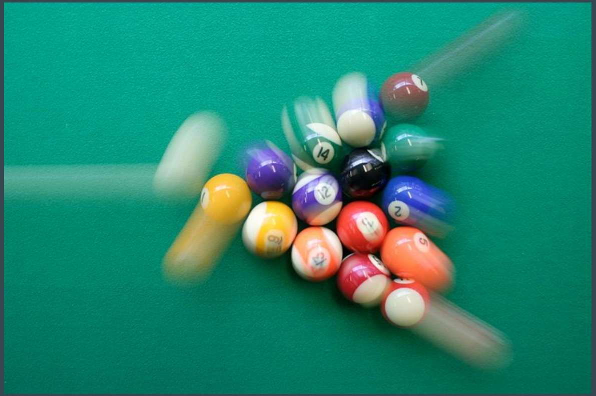
- $m_1v_1+m_2v_2=m_1v_1'+m_2v_2'$

The momentum of the system is conserved throughout the reaction

Conservation of Kinetic Energy (Elastic Collisions)

- $1/2m_1v_1^2+1/2m_2v_2^2=1/2m_1v_1'^2+1/2m_2v'^2$

When solving for elastic collisions begin with the Conservation of Momentum equation and then move to the Conservation of Kinetic Energy equation if needed



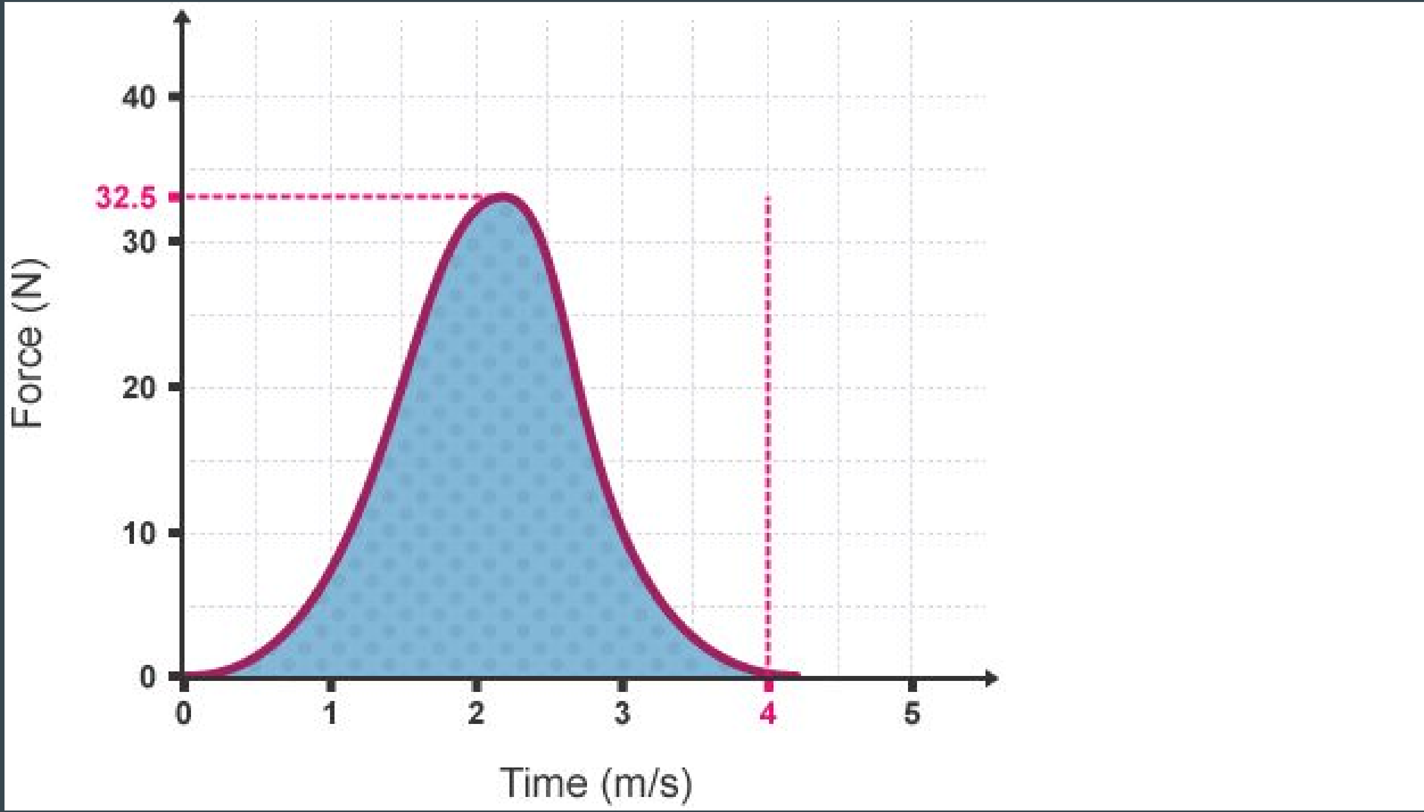
Inelastic Collision

- Perfectly Inelastic- objects stick together after colliding
- Inelastic Collisions- kinetic energy is not conserved, but total vector momentum and total energy is conserved
- Explosions are reversed inelastic collisions

$$m_1v_1+m_2v_2=(m_1+m_2)v_f$$

$$KE_f < KE_i$$

Force vs Time Graph



Area underneath curve is impulse (J)

Center of Mass

- Extended bodies can undergo rotation, vibration, etc. on top of translation
- General motion: motion that is not pure translational motion
- Center of Mass (**CM**) is unique point where:
  - All mass considered to be concentrated
  - Motion behaves as though all mass converged into point
  - Net force can be applied w/o rotating object
  - Object can be balanced
- Interchangeable w/ Center of Gravity (**CG**)

Common Mistakes

- Pay attention to the direction in which the forces are acting --particularly when an object is decelerating.
- For word problems look out for words like ¨continues¨ and ¨rebounds,¨ as well as compass directions (north, south, east, west).
- Make sure you differentiate between elastic and inelastic collisions. The collision is inelastic if the objects end up sticking together and traveling together. It is elastic if the objects collide then move separately at different velocities or in different directions.

Elastic Collision Problem

A 0.5 kg ball moving at 28 m/s hits a 0.25 kg ball initially at rest. How fast do both balls go after the collision?

- First understand that this is an **elastic collision**, NOT an inelastic collision because the two balls do not stick together afterwards. So, the right equation to use is
conservation of momentum $m_1v_1+m_2v_2=m_1v_1'+m_2v_2'$
- Then, figure out that you're trying to find the velocity (v) of each ball.
- Your known values are the masses of the two balls and the initial velocities. Note that even though it's not directly stated, it is implied that the second ball's initial velocity is 0 because it is at rest.
- Once you plug in your known values, you are left with two unknowns: v_1' & v_2'

Elastic Collision Problem Cont.

- Since you still have two unknowns, you have to use the conservation of kinetic energy equation $1/2m_1v_1^2+1/2m_2v_2^2=1/2m_1v_1'^2+1/2m_2v_2'^2$
- You can remove mass from each part of the equation
- After you substitute in all your values, you are left with a second equation with two unknowns: v_1' & v_2'
- Now that you have a system of equations, you can solve for each velocity through basic algebra.

Inelastic Collision Problem

Question- A 150kg hockey player is at rest standing near the goal. A 140kg hockey player on the other team speeding at 13m/s **collides and sticks to** the first player in a **perfectly inelastic collision.**

How fast are the two hockey players moving **after** the collision

1. Understand that this is an inelastic problem because the two objects stick together. Therefore you will be using the equation- $m_1v_1+m_2v_2=(m_1+m_2)v_f$
2. Know what you are solving for. The problem is asking for the final velocity, so **v_f** will be the unknown. m_1 /m_2 /v_2 are known, and the v_1 is at rest so the value would be 0.

(When solving the problem be sure to continue your units all the way down and follow PEMDAS)

3. When you arrive at your answer make sure you label the unit as m/s

Practice Questions

https://PollEv.com/multiple_choice_polls/8WOQZ1RskA72tfy/web

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