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Momentum

gpb video: Physics 601

Phys Std:

- What is momentum?
- What is the equation for momentum?
- How is momentum changed?
- What is impulse?

- Mass in motion

- $\vec{p} = \vec{v}m$ units: kg*m/s

(Direction comes from velocity → direction of motion)

- An impulse is needed
→ an impulse changes momentum; likewise, a change in momentum causes an impulse
- Impulse is “force applied over a time interval” (i.e. hitting a golf ball exerts a force on the ball for a certain time. “Following through” increases the time interval and therefore increases the impulse. This increases the momentum of the ball by making it travel faster)

impulse = Force x time

impulse = a change in momentum

$$\vec{F}t = \Delta\vec{v}m \quad \leftarrow \text{impulse eqn}$$

units: kg*m/s or N*s

ex #1: If the contact time doubles (force remaining constant), the impulse doubles, and the change in momentum doubles

Padding increases the time interval during collisions, thereby decreasing the impact force.

ex #2: Quadrupling the time interval, decreases the impact force by 1/4.

ex #3: A 20 kg object is moving at 5 m/s when a force brings it to a stop in 0.05 seconds. If brought to a stop in 0.1 seconds instead, the required force to stop it would be halved the resulting impulse would be same & the resulting change in momentum would be same.


ex #4: A 2 kg object moving at 3 m/s encounters a 20 N force over a 0.1 second time interval.

- a) The impulse experienced by the object is 2 N·s
- b) The momentum change experienced by the object is 2 kg·m/s
- c) The final momentum is 4 kg·m/s

- Why do bouncing objects experience a greater momentum change?


- because of the direction change

Example:

1 kg

 clay

$\vec{v}_i = +5 \frac{m}{s}$
 $\vec{v}_f = 0 \frac{m}{s}$

$\Delta \vec{v}m = (0 \frac{m}{s} - 5 \frac{m}{s})(1 kg)$
 $= -5 kg \cdot \frac{m}{s}$

1 kg

 rubber

$\vec{v}_i = +5 \frac{m}{s}$
 $\vec{v}_f = -5 \frac{m}{s}$

$\Delta \vec{v}m = (-5 \frac{m}{s} - 5 \frac{m}{s})(1 kg)$
 $= -10 kg \cdot \frac{m}{s}$

**Since $\Delta v m$ is greater, impact force is greater

- Is momentum conserved during collisions?

- Yes, as long as the system is closed and isolated from external forces.

- Is energy conserved during collisions?

- Only in ELASTIC COLLISIONS, where objects bounce off of each other
- Energy is not conserved in INELASTIC COLLISIONS, where objects stick to each other