

Momentum

11.4

Momentum

- *A quantity defined as the product of the mass and velocity of an object*
- *Mass in motion*
 - *At same velocity a wrecking ball has more momentum than tennis ball*
- SI units $\text{kg}\cdot\text{m/s}$
- Vector- has size & direction

LINEAR MOMENTUM

$$P = MV$$

MOMENTUM EQUALS THE
MASS MULTIPLIED BY
THE VELOCITY
OF THE OBJECT

Practice Problems

Calculate the momentum of the following objects:

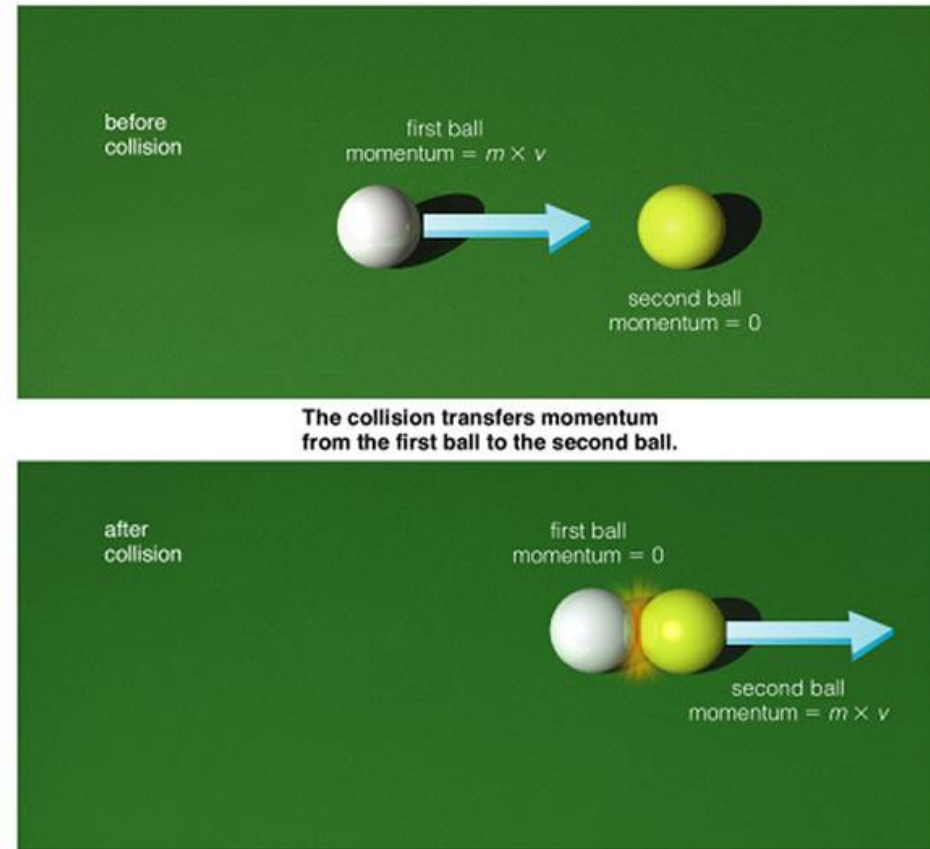
- a. A 75 kg speed skater moving forward at 16 m/s
 - b. A 135 kg ostrich running north at 16.2 m/s
 - c. A 5.0 kg baby on a train moving eastward at 72 m/s
 - d. Calculate the velocity of a 0.8 kg kitten with a momentum of 5 kg•m/s forward.
- * Remember to list knows, wanted and the equation!

Collisions

- Collision: a situation in which two objects in close contact exchange energy and momentum.
- ex: car rear-ending your car
- If 2 objects *with different masses* collide, the one with less mass has a greater change in velocity
- ex. Bowling ball & tennis ball
- Colliding objects make up a system

Conservation of Momentum

- *The total amount of momentum in an isolated system is conserved*
- Newton's third law
 - Action force is the cue ball
 - Reaction force is the billard ball on the cue ball
 - Billard ball started moving; cue ball stopped moving



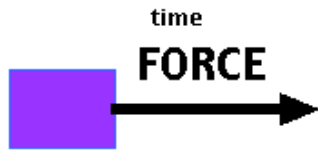
Conservation of Momentum Cont.

- To find the total momentum:

Same direction- add; different directions- subtract
(direction important!)

- crash test momentum conserved but some energy goes into bending metal
 - Cars move together w/ momentum equal to original momentum
- Momentum conserved whenever only forces on objects are action/reaction force pairs
 - Ex fire hose and water... firemen (outside force)
 - Momentum not conserved when outside force present.



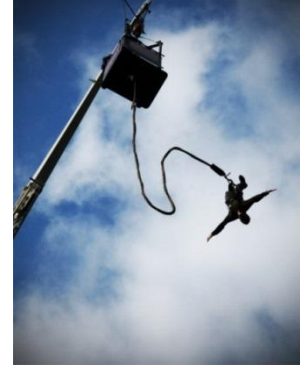


$$\text{Impulse} = (\text{FORCE})(\text{time})$$



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Impulse



- A change in momentum-usually involving a change in time to increase or decrease the force of impact
- Extending the time for change in momentum makes the impact of the force less!
- examples: Catcher pulling his glove back when catching a baseball
 - bungee jumpers



Momentum Videos

- <https://www.youtube.com/watch?v=y2Gb4NIv0Xg>
- <https://www.youtube.com/watch?v=hTZI-kpppuw>
- (impulse demo)
<https://www.youtube.com/watch?v=7RSUjxiZnME>
- https://www.youtube.com/watch?v=2UHS883_P60