Momentum & Impulse

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Objectives

- Define momentum.
- Calculate the momentum of an object.
- Define impulse.
- Calculate the impulse applied to an object.

What is Momentum?

- Momentum is often mentioned in sports.
- If a team is on a roll, it is said to have momentum.
- If they do a few good things in a row, they are said to be gaining momentum.
- Having the momentum is a good thing, teams with it are hard to stop.

What is Momentum?

- Momentum has a similar meaning in Physics.
- It is basically "mass in motion", or
- "moving inertia".

- Can you guess the formula?
- p= ?

Momentum

- Momentum measures how hard it is to stop a moving object.
  - Vector quantity, symbol is p
  - Units are kg·m/s (or N·s)

$$p = m \cdot v$$

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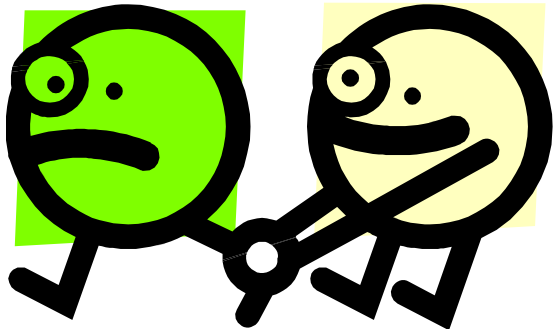
- Since all objects have mass, this means that in order to have momentum, they must have a velocity.
- The greater the mass, the greater the momentum.
- The greater the velocity, the greater the momentum.

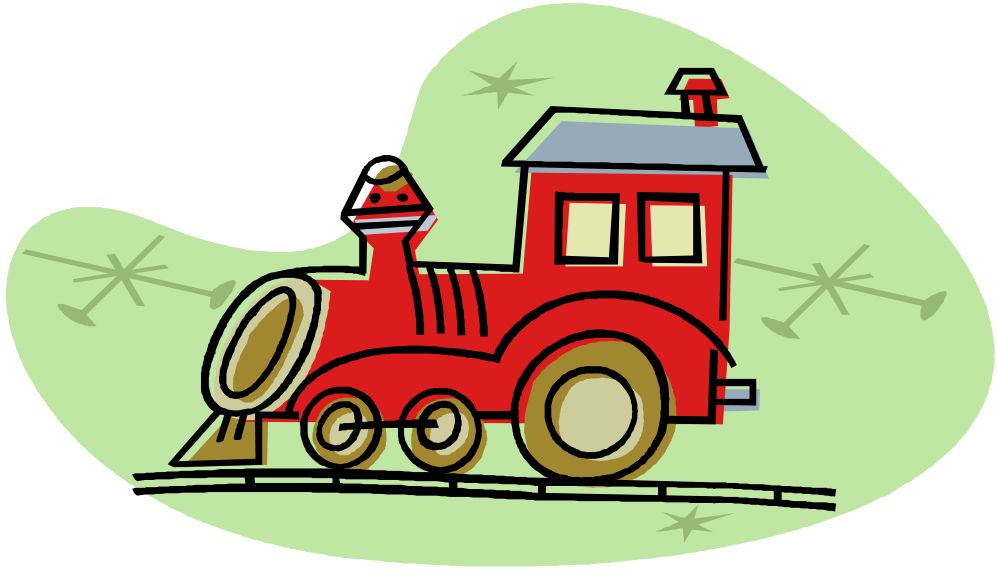
Save Your Friend?

- Pretend your friend is lying in the road, and an unattended car is rolling in neutral towards him/her.
- What could you do to save him/her?



Sample Problem

- Two Trains, Big Red an Little Blue, have the same velocity. Big Red, however, has twice the mass of little blue. Compare their momenta.



Sample Problem 2

- The magnitude of the momentum of an object is 64 kg·m/s. If the velocity of the object is doubled, the magnitude of the momentum of the object will be

1. 32 kg·m/s
2. 64 kg·m/s
3. 128 kg·m/s
4. 256 kg·m/s

Sample Problem 3 (pg. 209 #2)

- A 21 kg child is riding a 5.9 kg bike with a velocity of 4.5 m/s to the northwest.

a) What is the total momentum of the child and the bike together?

b) What is the momentum of the child?

c) What is the momentum of the bike?

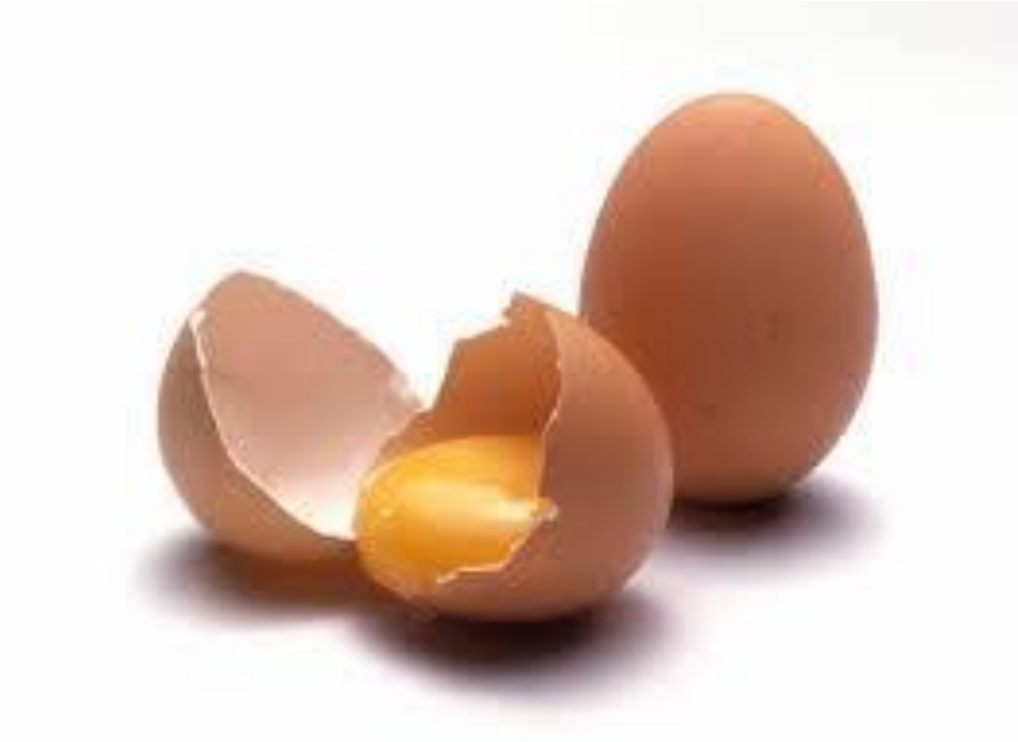
Impulse-Momentum Theorem

- As you observed in the previous problem, momentum can change. A change in momentum is known as an impulse (J).
- A change in momentum takes force and time.

$$J = \Delta p$$

$$F\Delta t = p_f - p_i$$

Dropping an Egg on a Plate vs Pillow



Sample Problem 4

- The D3A bomber, which had the momentum of 3.6×10^5 kg · m/s, comes to a halt on the ground. What impulse is applied?

Sample Problem 5

- A 6-kg block, sliding to the east across a horizontal, frictionless surface with a momentum of 30 kg · m/s, strikes an obstacle. The obstacle exerts an impulse of 10 N · s to the west on the block. Find the speed of the block after the collision.