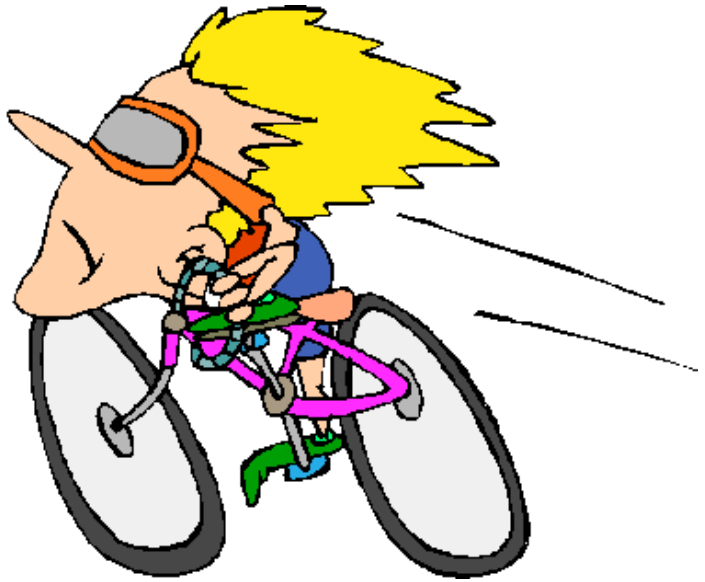
Ch 11 Forces
Book p. 342

11.1 Forces Change Motion

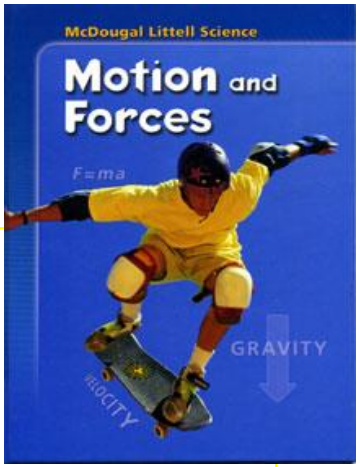


Newton's 3 Laws of Motion

1.

2.

3.



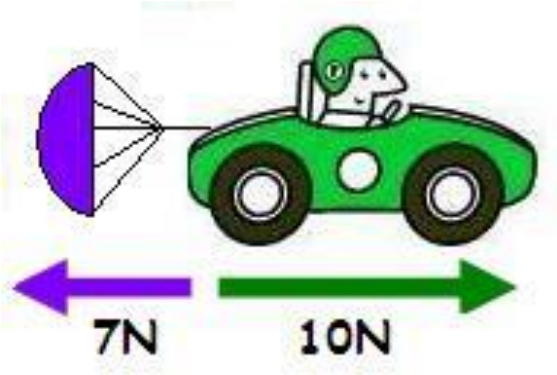
- A force is a push or pull (examples: friction, gravity)
- Newton (N) is the unit for force

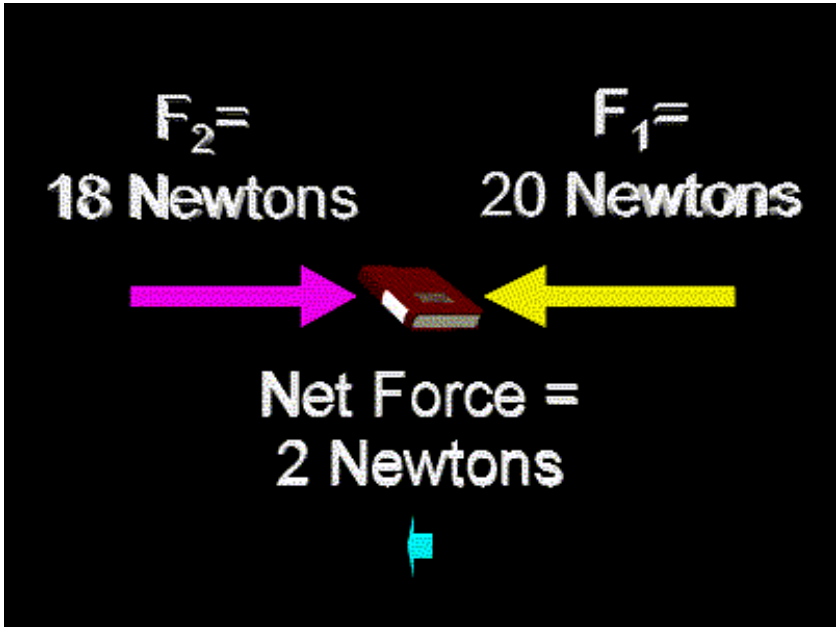
  - Some require contact between objects, such as friction
  - Some act at a distance,

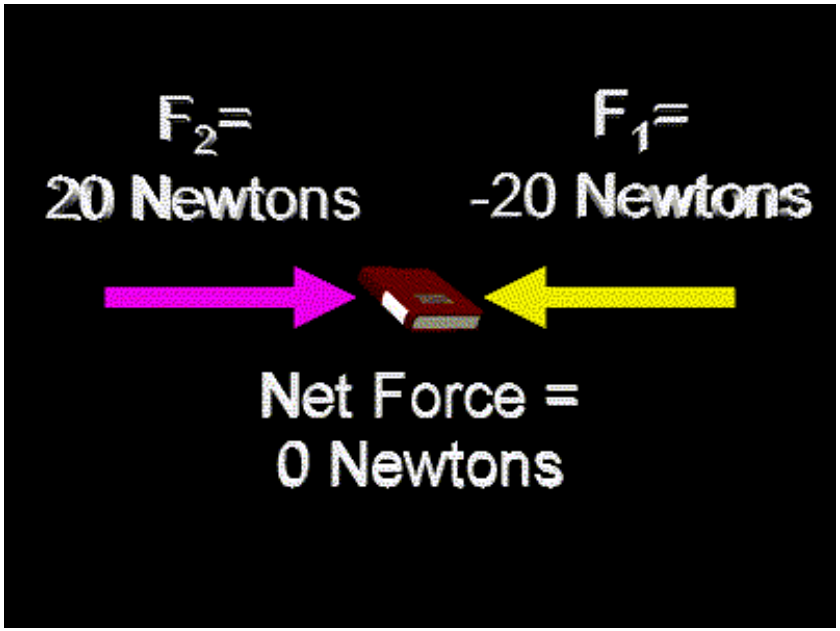
  such as gravity & electromagnetic forces

Net Force

- Total force that affects an object when multiple forces are combined
- It depends on:
  - Direction
  - Size of individual forces



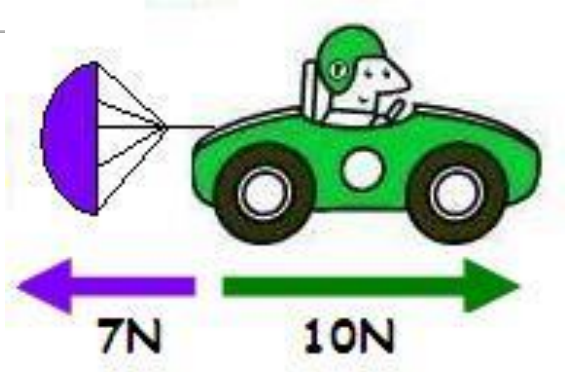

F_2=
18 Newtons
F_1=
20 Newtons
Net Force =
2 Newtons


F_2=
20 Newtons
F_1=
-20 Newtons
Net Force =
0 Newtons

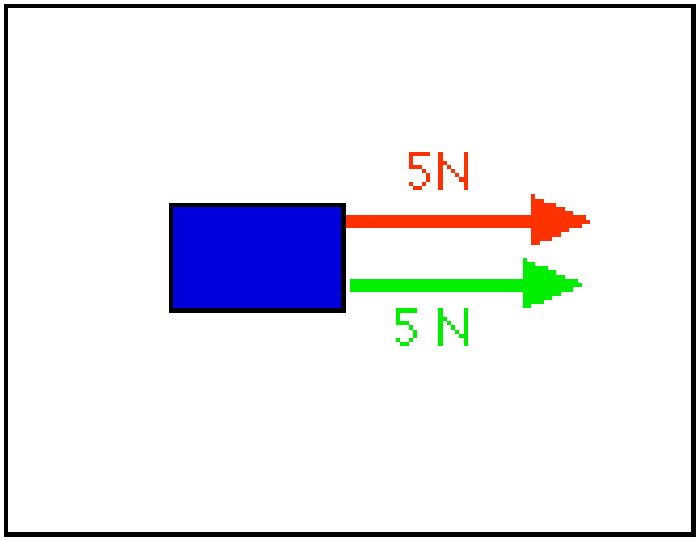
Measuring Net Force

If the forces are going in opposite directions you subtract the forces to get the net force. The net force will go in the direction of the greater forces.

Net force = 10N-7N = 3N to the right



If the forces are in the same direction you add the forces. The box will move to the right with a net force of 10N (5N+5N)

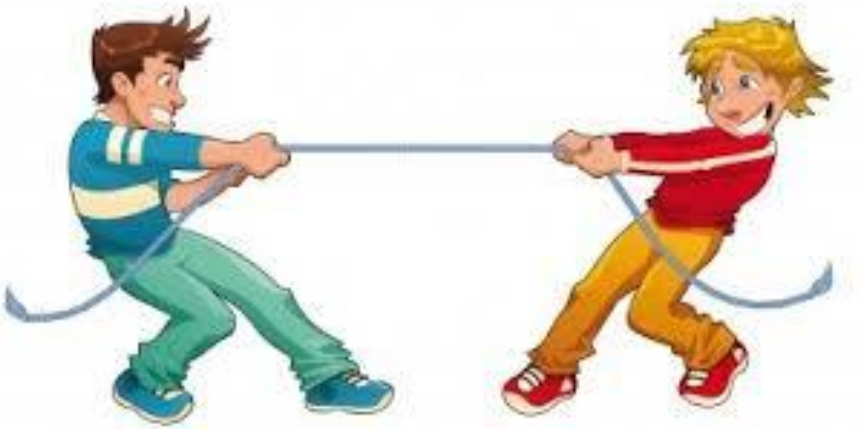


What is the net force? What direction?

What is the net force? What direction?

Balanced Forces

Same amount of force in opposite directions



Essay Question

**Discuss how to calculate net force in opposite & in the same directions. Discuss what a balanced force is. Give lots of examples!!

Newton's 1st Law of Motion (Inertia)

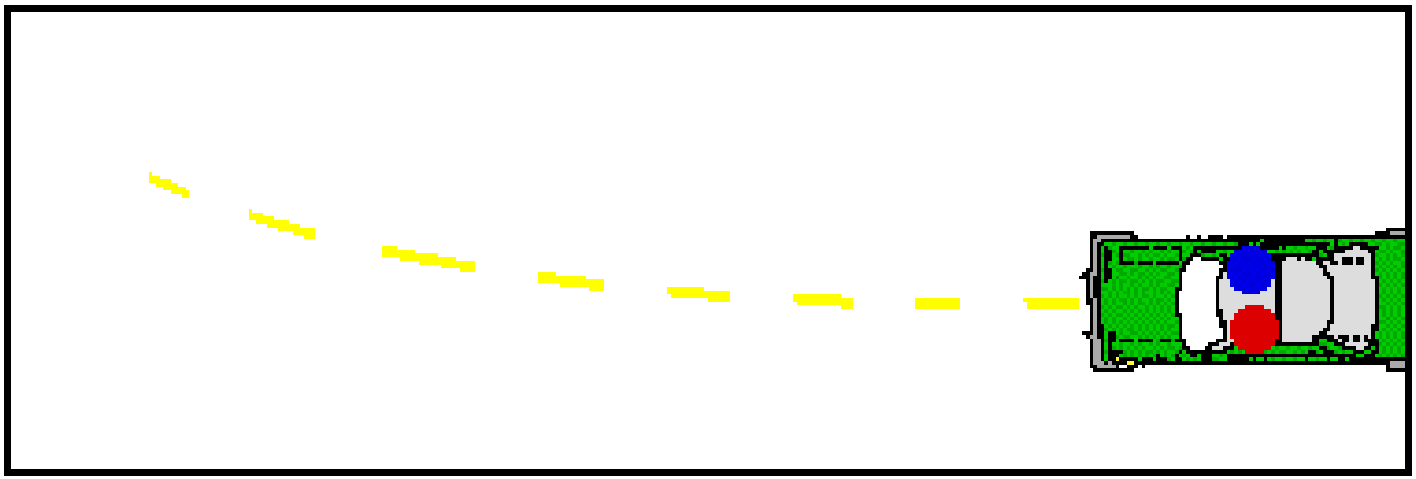
- Something stays at rest or in motion until another force acts upon it

---

  - Relates to force & motion
  - Objects with no net force acting on them have either constant or zero velocity
  - Force is needed to start or change motion

Inertia

- Resistance to change
  - Resistance to change in motion
  - Directly proportional to the object's mass



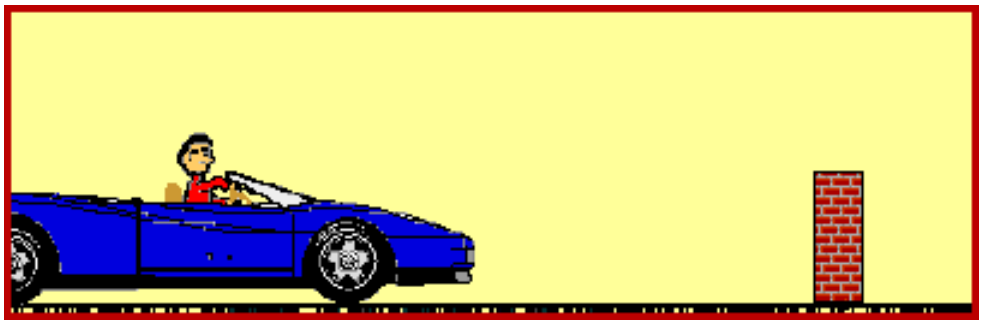
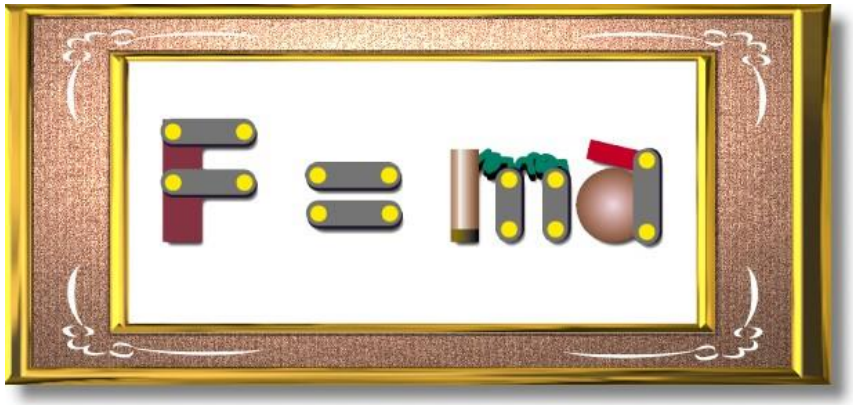


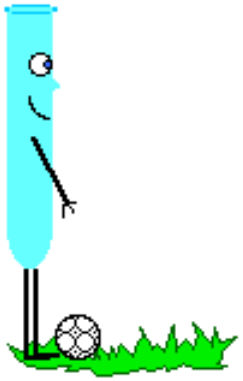
Table Cloth Trick!

Put a penny on a piece of paper & try this!!

11.2 Force & mass determine acceleration

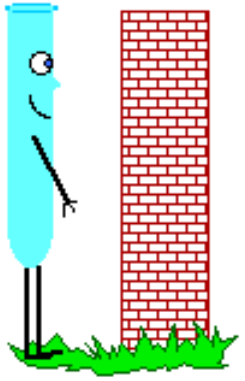
Newton's 2nd Law of Motion—an object's acceleration is affected by its mass & the amount of force acting on it





Acceleration—change in velocity (increase /decrease in speed or change in direction)

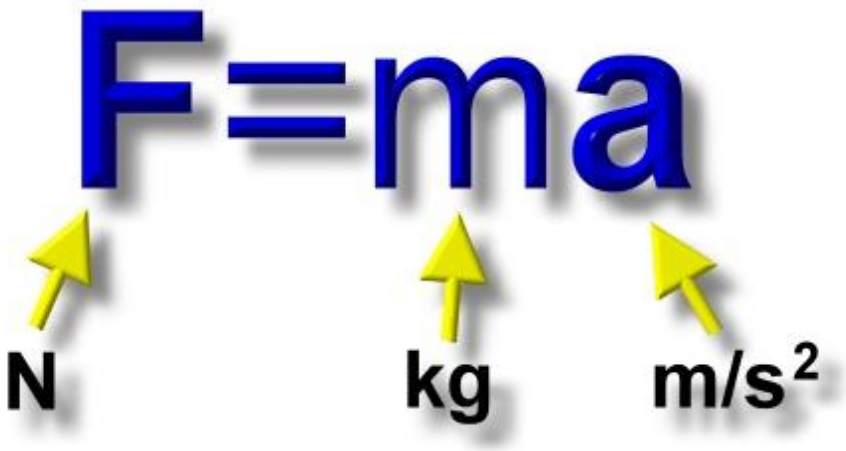
- More force = greater acceleration (direct correlation)
- More mass = lower acceleration (inverse correlation)
- Acceleration is in the same direction as the net force acting on it



F = MA

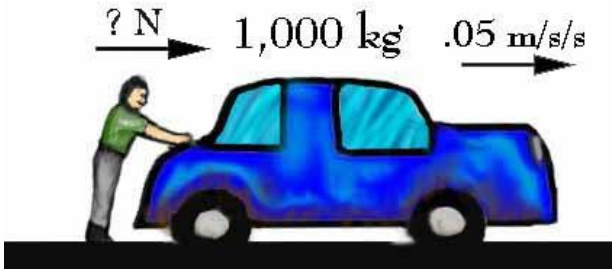
$(kg) \times (m/s^2) \rightarrow (kg\text{-}m/s^2)$

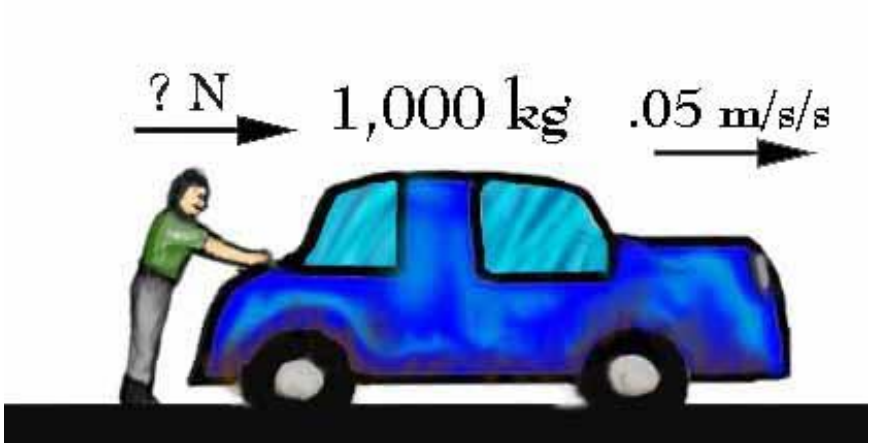
Newton = unit for force (mass must be in kg & acceleration must be m/s *squared)*



Calculate Force

1. mass = 20 kg, a = 4 m/s squared
2. mass = 20 g, a = 2 cm/s *squared*
3. m = 1000 kg, a = .05 m/s squared

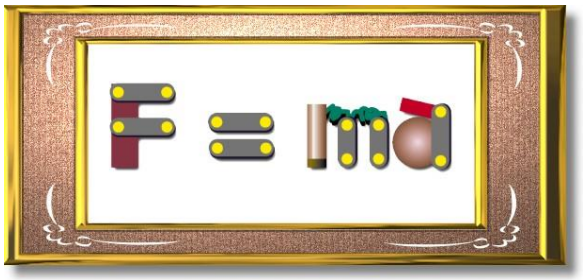




F=1,000 X 0.05

Answer = 50 Newtons

You can calculate acceleration or mass if you solve for each:



1. Calculate acceleration

   force = 12 N, mass = 4 kg

2. Calculate mass

   force = 15 N, a = 5 m/s *squared*

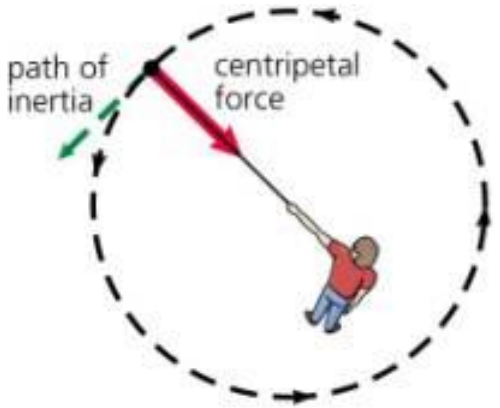
3. Calculate acceleration

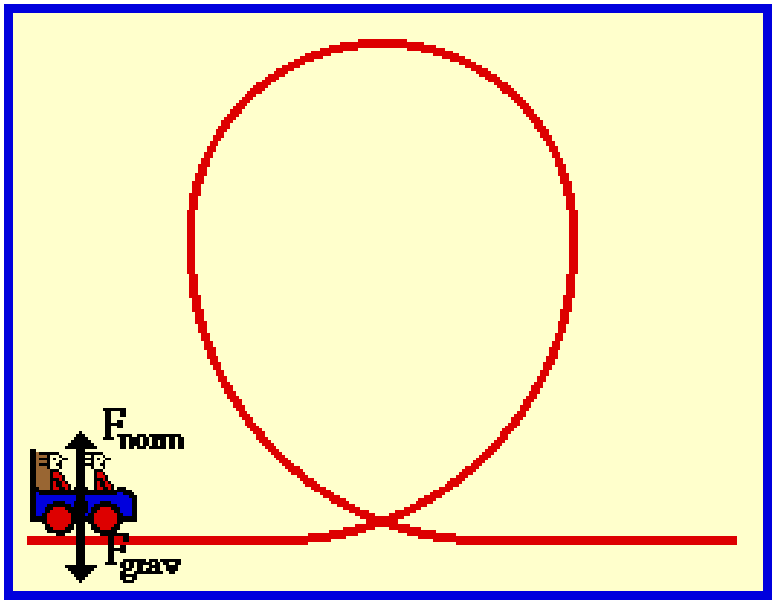
   f = 10 N, m = 2 g

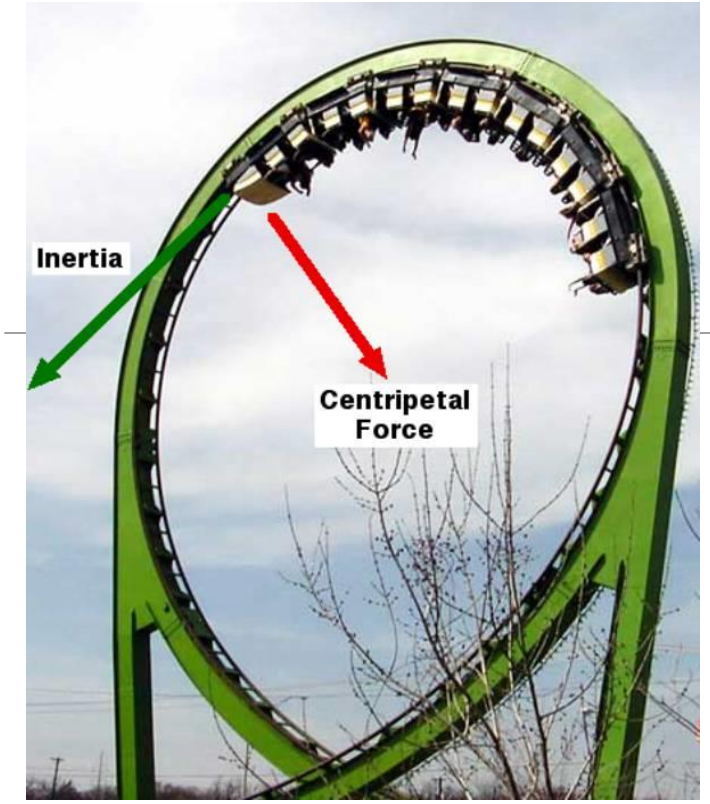
Forces can change the direction of motion

- A force can change the direction of an object without changing its speed if the force acts at right angles to the motion
- When this happens continuously,

the object is pulled into a circular motion & is referred to as a centripetal force



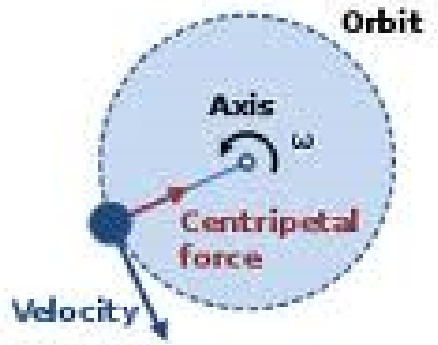

F_{norm}
F_{grav}


Inertia
Centripetal Force

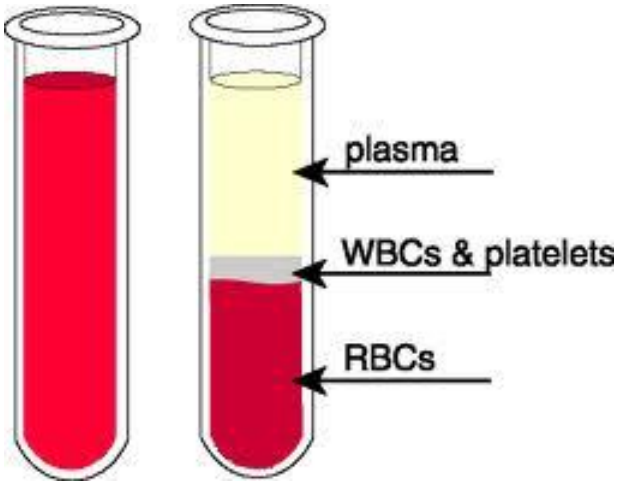
Centripetal Force = $\frac{(\text{mass} \cdot \text{speed } sq)}{\text{radius}}$

Calculate CF for each:

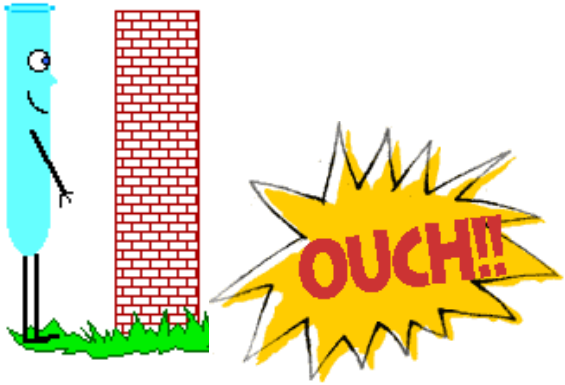
1. mass = 2 kg, speed = 2 m/s, r = 10 kg
2. m = 5 kg, s = 5 m/s, r = 2 kg
3. m = 12 kg, s = 5 m/s, r = 10 kg



Blood spins in centrifuges to separate the mixture



11.3 Forces act in pairs



Newton's 3rd Law of Motion—for every action, there is an equal opposite reaction

---

- The 2 forces are:
  - Equal
  - In opposite directions
  - Occur simultaneously

Example

- When you push down on a table, the force from the table's resistance increases instantly to match your force

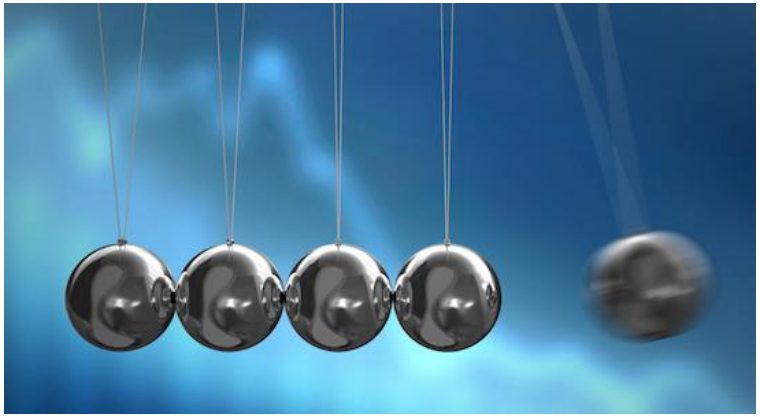
Newton's 3 laws describe & predict motion

- Allows the calculation of motion in objects
- Explains changes in the motion of objects, such as a squid moving forward when squirting water backward

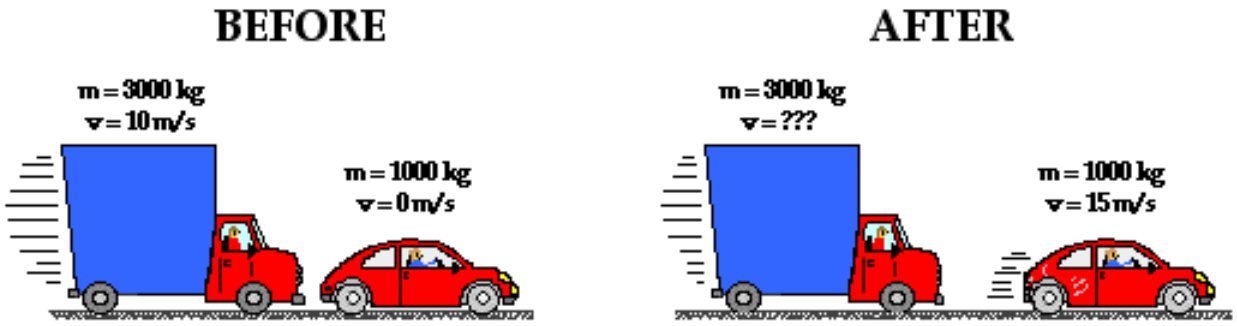
11.4 Forces transfer momentum

angular momentum

- Objects in motion have momentum
- Momentum--inertia for *moving objects*
- Moving objects tend to keep moving at a constant velocity
- Momentum is a vector (has both size & direction)



Momentum = Mass X Speed

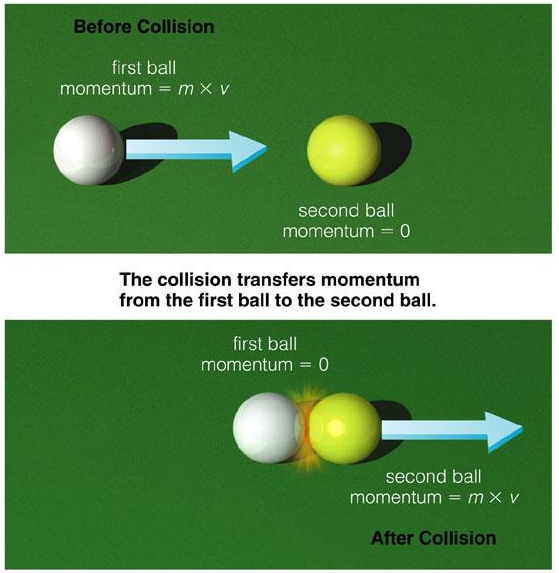


- Adding momentum of 2 objects is similar to adding net forces
- A force changes the object's momentum
- When objects collide, the velocity of each will change

Velocity—speed & direction

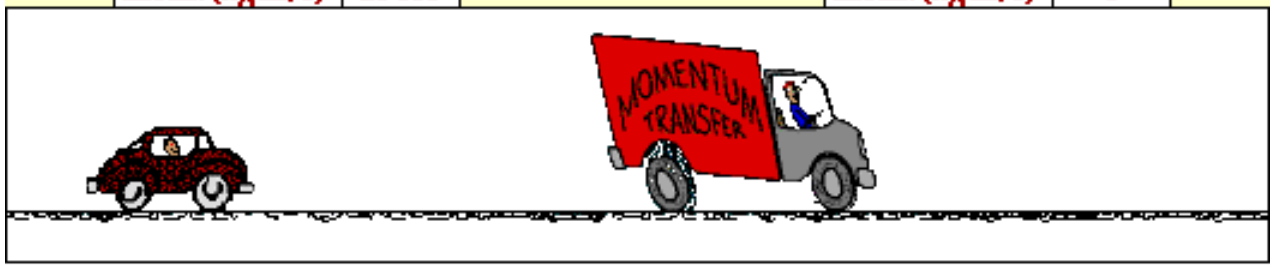
Momentum is transferred during a collision

- Colliding objects exert equal & opposite forces on each other while in contact
- Forces during collision will change the velocity of each object



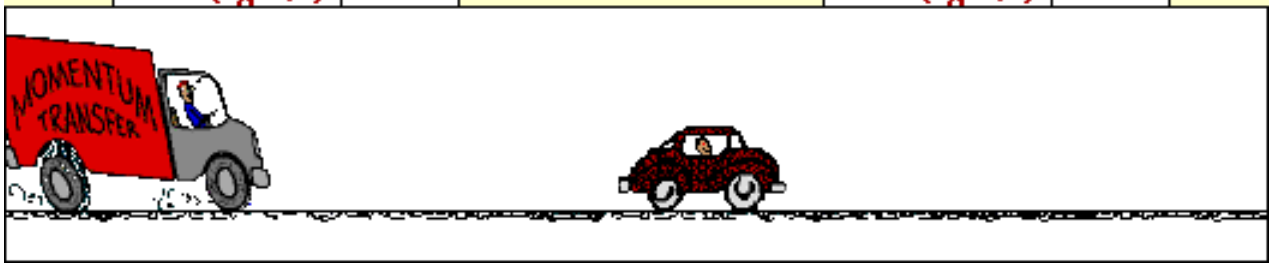
Car	
mass (kg)	1000
vel. (m/s)	20.0
mom. (kg m/s)	20 000

Truck	
mass (kg)	3000
vel. (m/s)	0.0
mom. (kg m/s)	0

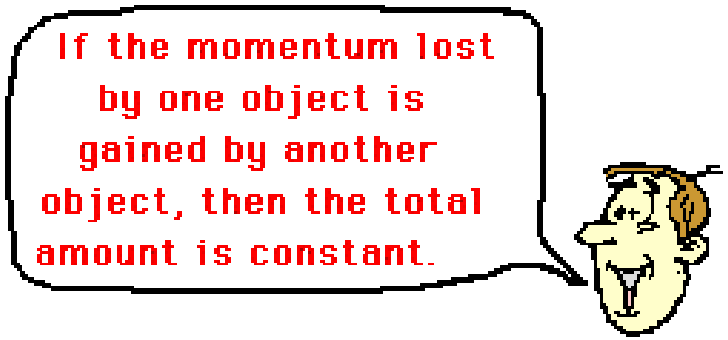


Truck	
mass (kg)	3000
vel. (m/s)	20.0
mom. (kg m/s)	60 000

Car	
mass (kg)	1000
vel. (m/s)	0.0
mom. (kg m/s)	0



Momentum is conserved



- If no forces act on an object, the total momentum will not change
- Example
  - In a collision, forces are equal, opposite, & act over the same period of time
  - So momentum is zero