4.3

Newton's 2nd and 3rd Laws

Objectives

- **Describe** an object's acceleration in terms of its mass and the net force acting on it.
- **Predict** the direction and magnitude of the acceleration caused by a known net force.
- I**dentify** action-reaction pairs.

Using Newton's 2nd Law

- The acceleration of an object is directly proportional to the net force acting on the object and inversely proportional to the object's mass.

$$a = F/m$$

- OR…Newton's second law states the force equals mass times acceleration

$$F = ma$$

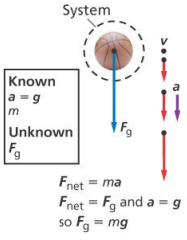
Thinking…

- F = ma ……. a = F/m
- Does it take more force to accelerate a dodgeball or bowling ball to 4 m/s^2?

Using Newton's 2nd Law

- In free-fall the only force acting on an object is the force of gravity (F_g)
- Looking at the figure and understanding that F=ma
- We can say that

  F_g = mg, because the only force acting on the ball is gravity

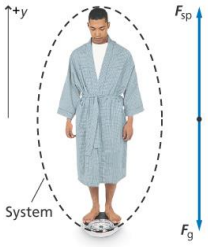


Question

- Would your <u>weight</u> be the same on the moon?

Using Newton's 2nd Law

- How does a scale work?
- How does a bathroom scale work?
- When you stand on the scale, the spring in the scale exerts an upward force on you because you are in contact with it.
- Because you are not accelerating, the net force acting on you must be zero.
- The spring force, F_{sp}, upwards must be the same magnitude as your weight, F_g, downwards.



Newton's 3rd Law

- Newton's 3rd Law states, for every action there is an equal and opposite reaction

Interaction Forces

- Suppose you and your friend are wearing rollerblades
- If you push your friend away from you, what is going to happen to you?
- Forces always occur in pairs
- There are called action-reaction forces

Action-Reaction Forces

- Action-reaction pairs do not imply that the net force on either object is zero.
- The action-reaction forces are equal and opposite, but either object may still have a net force on it. (Remember F=ma)

Consider driving a nail into wood with a hammer. The force that the nail exerts on the hammer is equal and opposite to the force that the hammer exerts on the nail. But there is a net force acting on the nail, which drives the nail into the wood.

Interaction Forces

Example Problem

- You lift a bottle off the ground.
- What are the forces acting on the bottle?
  - Gravity of Earth (Down), hand up
- What force does the bottle exert?
  - Hand down, (Earth up ?)