Unit 7: Forces and Motion
Content Outline: Forms of Motion (7.3)

I. **Free Fall Motion**
- A. This form of motion only occurs in a vacuum or in outer-space (which is also a vacuum).
- B. The only force being applied to the mass object is gravity (g).
  1. All objects accelerate toward earth at the same rate of 9.8 m/sec^2.
  2. **Terminal Velocity**
     - a. Defined as the *constant* velocity of a falling object, when the force of *air resistance* is *equal to* in magnitude and *opposite* in direction to the force of gravity. (The speed has maxed out and is not increasing for a falling object. "terminal" means "end")
       - i. **Constant velocity –** the "maximum" speed; no acceleration is occurring. The velocity is *constant in amount.*
  3. **Net Force**
     - a. This is resultant value when the force of resistance (or drag) is *subtracted* from the force of gravity. At Terminal velocity, net force is equal to zero… meaning no acceleration is occurring. (Hence the term terminal= no acceleration).
- C. The size and shape of a falling object can affect the amount of resistance encountered in the fall. For example, a flat sheet of paper vs. a crumpled piece of paper. The crumpled falls faster because it encounters *less* resistance from air.
- D. The velocity of an object in Free fall can be calculated by: $\Delta v = g\ (9.8 m/sec^2) \times t$

II. **Projectile Motion**
- A. This type of motion is "created" when an object is *launched* into motion by an initial force that is *greater* than the force to *overcome* the force exerted on the object by gravity.
  1. This motion is always a curved path, as the object, and its motion, is *constantly* being *affected* by the force of Earth's gravity. (Earth is round or curved… so travel of an object will be curved or arched.)
- B. Remember, all objects accelerate *back toward earth* at a rate of 9.8 m/sec^2.
  1. This acceleration can be increased if there is an *initial force* added to the force of gravity. For example, you stand on top of your school and you throw a baseball as hard as you can toward the ground. It will travel *faster* than 9.8 m/sec^2 because you *added your arm strength (force)* to the force of gravity.
- C. Projectile motion has *two components* that must be considered.
  1. **Vertical motion** – this is motion that is occurring up and then down by an object. For example, you throw a ball up (against gravity) and it comes back down because of gravity.
  2. **Horizontal motion** this is distance travel *away, but parallel to the ground,* from you. For example, you throw a softball from second base to home plate (a distance of 84 feet 10 inches).
  3. These two components are *independent* (one does not affect the other) of each other. As any projectile will have *both* values in its travels.
  4. Velocity decreases on its way up, reaches zero, and the increases as it falls back to earth. You throw a ball up in the air. It moves fastest right as it leaves your hand. It slows down (decelerates) as it reaches its peak. At the peak, it is not moving (for a brief instance). Then it speeds up (accelerates) as it falls back toward earth.

III. **Centripetal (circular) Motion**
- A. This motion is a combination of two directions of *simultaneous* movement.
  1. The object is always moving *forward.*
  2. The object is also in *Free Fall* toward earth.

a. As earth is curved, the two motions combined always keeps the object aloft in what is referred to as an **orbit.**
b. The forces acting on the object are always changing and hence the direct is always changing in direction. [In other words, it does not travel in a straight line because it has unequal (changing) forces (gravity and velocity) acting on it.]

B. The object in motion is always *trying* to move toward the center (the most stable location).
1. This *circular force moving inward* is referred to as **centripetal force**.