Module #2: One-Dimensional Motion Equations and Free Fall

* Intro
  + Free fall = whenever any object is falling towards the earth without anything inhibiting its fall
* Relating Velocity, Acceleration, and Time
  + Three basic equations
  + Finding the first equation: (derivation)
    - What we already know:
      * a = ∆v/∆t
      * ∆v = v final – v initial
      * ∆t = t final – t initial
    - Therefore:
      * a = (v final – v initial) / (t final – t initial)
    - If we assume that t initial = 0 then
      * a = (v final – v initial) / (t final)
    - When we rearrange it using algebra
      * v final = v initial + at final
    - Rename v final as v
    - Rename v initial as vo
    - Equation : v = vo + at
  + Example 2.1 p.38-39
  + On Your Own 2.1 p.39
* Relating Velocity, Acceleration, and Displacement
  + Second equation derivation
    - What we already know
      * v = ∆x/∆t
      * ∆t = t final – t initial
    - Therefore
      * v = ∆x / (t final – t initial)
    - If we assume that t initial = 0 and t final = t
      * v = ∆x / t
    - Another average velocity equation
      * Vavg = (v + vo) / 2
    - Therefore
      * ∆x / t = (v + vo) / 2
    - Solve for t
      * t = (2 \* ∆x) / (v + vo)
    - Remember that another acceleration equation is
      * a = (v final – v initial) / (t final)
      * Rearranged to solve for t
        + t = (v – vo) / a
    - Therefore
      * (2 x ∆x) / (v + vo) = (v – vo) / a
    - Final equation :
      * v2 = vo2 + 2a \*∆x
  + Example 2.2 p.41-43
  + On Your Own 2.2 p.43
* Relating Displacement, Velocity, Acceleration, and Time
  + The area under a velocity vs. time graph is equal to the displacement caused by the motion
    - Read Ex p.44-45
  + We use the equations for the area under the curve and average velocity
    - Area 1 = vo \* t
    - Area 2 = ½ \*∆v\*t
    - ∆v = at
  + Therefore
    - ∆x = vot + ½ at2
  + Example 2.3p.46-47
  + OYO 2.3 p.47
* Using Our Equations for One-Dimensional Motion
  + Five Equations:
    - v = ∆x/∆t
    - a = ∆v/∆t
    - v = vo + at

Valid only when the acceleration is constant!

* + - v2 = vo2 + 2a \*∆x
    - ∆x = vot + ½ at2
  + Ex 2.4 p.48-50
  + OYO 2.4-2.6 p.50
* Free Fall
  + Two conditions must exist
    - All motion must occur in a straight line
    - The acceleration must be constant
  + Free fall is the motion of an object when it is falling solely under the influence of gravity
  + Thing fall when they are dropped because of gravity
  + Objects falling near the surface of the earth experience a constant acceleration of 9.8 m/sec2 straight down.
    - This value is called acceleration due to gravity, abbreviation “g”
  + The acceleration due to gravity is independent of the nature of the object experiencing free fall, as long as the object has mass.
  + CD video demo
  + Experiment 2.1 p.52-53
    - Materials = paper and textbook
  + Air resistance is the drag that air produces on objects traveling through it
    - When we neglect air resistance, all objects falling near the surface of the earth accelerate equally
    - Objects significantly affected by air resistance do not experience free fall
  + We assume that objects falling near the surface of the earth are not greatly
  + Reaction time is the time elapsed between recognizing an event and reacting to it
  + Experiment 2.2 p.54
    - Materials = rulers
    - Read through explanation until you reach the example
  + Ex 2.5 p.56
  + OYO 2.7 -2.8 p.56-57
* A More Detailed Look at Free Fall
  + Throwing a ball in the air is another example of free fall
    - While the ball has an initial velocity of 3.5m/s, the acceleration is -9.8m/s2
      * Since the velocity and acceleration have two different signs, the ball slows down
    - The ball will eventually be stopped
      * At the highest point in its journey
      * Velocity is 0
      * Acceleration is still -9.8
      * Only stops for an instant
    - Ball begins to fall
      * Velocity is now negative
      * Ball speeds up
    - If the ball is caught at the same height it was thrown from the final velocity will be equal to the initial velocity except the sign will be opposite because the ball is traveling in the opposite direction.
  + When an object is thrown upward in the presence of gravity, the object will reach its maximum height when the object’s velocity equals 0. In addition, when it returns to the height from which it was thrown, its velocity will be equal to and opposite of its initial velocity.
  + Ex 2.6 p.58-59
  + OYO 2.9-2.10 p.59
* Gravity and Air Resistance Learn 360 video
* Terminal Velocity
  + As an object’s velocity increases, the air resistance it experiences also increases
  + Increased air resistance decreases the acceleration that the object experiences
  + The air resistance eventually increases so much that the acceleration actually falls to zero
    - Velocity can no longer increase
  + Terminal velocity is the velocity a falling object has when, due to air resistance, its acceleration is reduced to zero. This is the maximum velocity a falling object subject to air resistance can achieve.
  + Experiment 2.3 p.60
    - Materials = textbook, 4 pieces of paper, goggles
    - Read rest of p.61 – 62 explanation of lab results
* Review questions 1-10 p.69
* Practice Problems 1-10 p.70