Module #3: Two-Dimensional Vectors

* Introduction
  + Much of the motion that occurs in real life is two-dimensional
  + Two-dimensional motion = motion that occurs in a plane
* Vectors
  + Contain information about direction
  + Think about two-dimensional motion in terms of an x/y graph
  + Arrows represent two-dimensional vectors
    - The length of the arrow is called the magnitude of the vector
    - Arrow points out the direction
  + We can use the Pythagorean theorem to calculate the arrow’s length (magnitude)
  + The angle between the positive x-axis and the arrow is unique for each possible direction that the arrow can point.
    - Describes the direction that the arrow points
  + Functions
    - Tan (Ө) = opposite side of the triangle / adjacent side of the triangle
      * Gives you the tangent of the angle
      * Use inverse tangent to calculate the angle
        + Ө = tan-1
    - Make sure that your calculator is in degrees mode (instead of radians)
* Adding and Subtracting Two-Dimensional Vectors: The Graphical Approach
  + Two approaches: graphical and analytical
  + Graphical method
    - When adding vectors graphically, take the tail of the second vector and place it at the head of the first vector.
    - The vector that then completes the triangle by starting at the tail of the first and pointing to the head of the second represents the sum of the two vectors.
    - You can move a vector anywhere you want, as long as you do not change its magnitude (length) or direction (angle).
    - Example 3.1 p.76
    - When subtracting vectors, take the vector being subtracted and make it point in precisely the opposite direction. Then add that vector to the first. The vector that then completes the triangle by starting at the tail of the first and pointing to the head of the second represents the difference between the two vectors.
    - Example 3.2 p.77
    - OYO 3.1-3.2 p.78
* Vector Components
  + Analytical method
  + All two-dimensional vectors have x- and y- components
    - X-component = vector distance along the x-axis
    - Y- component = vector distance along the y-axis
  + Calculating the magnitude of vector A
    - A = √Ax2 + Ay2
  + Calculating the direction of vector A
    - Ө = tan-1 (Ay/Ax)
  + Experiment 3.1 p.80-81
    - Goggles, clay, pencil, wooden ruler, plain paper, pen, protractor
  + Coordinate planes:

I

II

IV

III

* + - If the vector is in region 1
      * The angle that your calculator gives is defined properly
    - If the vector is in region 2
      * The angle that your calculator gives you is negative
      * Need to convert it to our definition
      * Add 180 degrees (ex: -60 + 180)
    - If the vector is in region 3
      * Needs to be converted
      * Add 180 degrees
    - If the vector is in region 4
      * Needs to be converted
      * Add 360 degrees
    - To determine which coordinate your vector is in
      * Look at the signs of the vector components
      * +y +x = I
      * +y -x = II
      * -y -x= III
      * -y +x = IV
    - Example 3.3 p.83
    - OYO p.85 #3.3-3.4
* Determining a Vector’s Components from Its Magnitude and Direction
  + If you know a vector’s magnitude and direction…
    - To calculate the y-component
      * Ay = A \* sin(Ө)
    - To calculate the x-component
      * Ax = A \* cos(Ө)
  + Example 3.4 p.86
  + OYO p.86 #3.5
* Adding and Subtracting Two-Dimensional Vectors: The Analytical Approach
  + In order to add and subtract vectors, you must first break them down into their x- and y- components
  + Add or subtract the vector components just like you add or subtract numbers
  + Breaking the problem down into two one-dimensional problems
  + Example 3.5 p.87-90
  + OYO p.90 #3.6-3.7
* Applying Vector Addition to Physical Situations
  + Experiment 3.2
    - Materials: ruler, pencil, protractor
    - Set of sample calculations in solutions and test guide (sol. to practice problems)
  + Figure 3.2 p. 92
    - The Wind’s Effect on an Airplane
  + Example 3.6 p.93
  + OYO p.95 #3.8-3.9