Day 4

- Vectors
  - Quantities that are represented with both magnitude and direction
    - Scalar(only magnitude)
      - Temp
      - Time
      - Volume
      - Mass
    - Vectors
      - Velocity
      - Displacement
      - Acceleration
      - Force (gravity, electro magnetic)
  - Displacement vectors –how did you get from here to there?
    - Tip, tail
    - A, 2a, -2a
    - Adding vectors: tip to tail
  - Component form
    - i, j unit vectors
      - $\hat{i}$ vector one unit long in the direction of the x-axis
      - $\hat{j}$ vector one unit long in the direction of the y-axis
    - Show 3i + 4j starting at origin then same vector not at the origin – Portable!!
    - How long is this vector? Magnitude Formula – Pythagorean theorem
      - If $\vec{v} = a\hat{i} + b\hat{j}$ then, $\|\vec{v}\| = \sqrt{a^2 + b^2}$
      - *You Try It*

        Section 13.1 1,5,15 Answers in Text

    - Write components for a vector from (-1,3) to (4,5)
      - Do this "by hand" first and then state "Final – initial"
      - How long is this vector?
      - Then find a vector that is 10 units long in this same direction.
      - *You Try It*

        Section 13.1 3, 29 Answers in Text
    - How can we tell if 2 vectors are parallel?
      - Are these parallel?
        - A = 2**i** - 3**j** + **k** and B = -8**i**+12**j** – 4**k**
        - A = 6**i** + 2**j** and B = 3**i** + 4**j**
  - Example: Boat travels 2 miles at angle of 37°. Write this displacement vector in component form.
    - D = 1.6**i**+1.2**j**
      - *You Try It*

- All of what we said can be extended to 3D with the unit vector $\hat{k}$, parallel to the z-axis.

- Vector multiplication: Dot Product and Cross Product
  - Dot Product (scalar product)
    - Geometric Form: $\vec{v} \cdot \vec{w} = \|\vec{v}\| \, \|\vec{w}\| \cos(\theta)$, where θ is the angle between the two vectors
    - Component Form: $\vec{v} \cdot \vec{w} = v_1 w_1 + v_2 w_2 + v_3 w_3$, given $\vec{v} = v_1\hat{i} + v_2\hat{j} + v_3\hat{k}$ and $\vec{w} = w_1\hat{i} + w_2\hat{j} + w_3\hat{k}$.
    - To see why these forms are equivalent watch this video with guest lecturer James Lang
  - Find $\vec{v} \cdot \vec{w}$ if $\vec{v} = \hat{i} + 3\hat{j}$ and $\vec{w} = 5\hat{i} + 2\hat{j}$
  - What is the dot product of two vectors that are perpendicular? Why?
  - Is the dot product always positive? Why?
  - Find the angle between $\vec{v} = \hat{i} + 3\hat{j}$ and $\vec{w} = 5\hat{i} + 2\hat{j}$.
  - *You Try It*

    Are $\vec{v} = 3\hat{i} + 2\hat{j} - 6\hat{k}$ and $\vec{w} = -12j - 3\hat{k}$
    - perpendicular?
    - Parallel?
    - Is the angle between the two vectors bigger or smaller than $90°$? Answer this without a calculator!
    - Use a calculator to find the angle between **v** and **w**.

    Answer Video