

Warm Up: Estimation, Vectors, Velocity, Acceleration

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1 Memory Bank

1. $\vec{v} = v_x \hat{i} + v_y \hat{j}$... Definition of a vector in terms of \hat{i} and \hat{j} components (representing the x-direction and y-direction).
2. $\vec{v} + \vec{w} = (v_x + w_x)\hat{i} + (v_y + w_y)\hat{j}$... Vector addition: the \hat{i} -components add with each other, and the \hat{j} -components add with each other.
3. $|\vec{v}| = \sqrt{v_x^2 + v_y^2}$... The magnitude of the vector
4. $v_x = |\vec{v}| \cos \phi$, $v_y = |\vec{v}| \sin \phi$... The x and y-components of the vector
5. Definition of average velocity:

$$\vec{v} = \frac{\Delta \vec{x}}{\Delta t} \quad (1)$$

$$\Delta \vec{v} = \vec{v}_f - \vec{v}_i \quad (2)$$

$$\Delta t = t_f - t_i \quad (3)$$

6. Definition of acceleration:

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} \quad (4)$$

2 Exercises

1. An athlete competes in the 1600 m track race. He completes the run in 4 minutes, 10 seconds. What is his average speed?
2. Suppose this race was run in a straight line, and we define the starting line as the origin in a 2D coordinate system where East corresponds to the positive x-axis and North corresponds to the positive y-axis. If the run continues in a straight line to the North West, what are v_x and v_y , the components of the average velocity of the runner?
3. For the race in the previous exercise, estimate the number of heartbeats of the runner.
4. Suppose the runner starts the race at rest, and takes 10 seconds to reach the velocity in exercise 1. What is the **acceleration** of the runner?
5. Finally, what are a_x and a_y , the components of the acceleration vector?