Warm Up: Kinematics in 2D and 3D

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1 Memory

1. $\vec{v} = \Delta\vec{x}/\Delta t$ ... Average velocity.
2. $\Delta\vec{x} = \vec{v}\Delta t$ ... Rearranged, solved for displacement.
3. $y(t) = -\frac{1}{2}gt^2 + v_{i,y}t + y_i$ ... Displacement if constantly accelerating with $-g$.
4. $v(t) = -gt + v_i$ ... Velocity equation if there is constant acceleration.

2 Kinematics in 2D and 3D

1. Imagine a system propagating through 3D space with a position vector $\vec{x} = (2t^2 - t)\hat{i} + 2t\hat{j}$. (a) What is the average velocity between $t = 0$ and $t = 2$ seconds? (b) If the object starts at the origin at $t = 0$, what is the displacement at $t = 2$? (c) What angle does the displacement make with the x-axis?

2. Suppose a system is thrown straight up into the air. The initial vertical velocity is $v_{i,y} = 10$ m/s.
   - What is the speed at the apex of the trajectory?
   - How long does the system spend in the air?
   - Consider the same system, but now the initial velocity is at a 45 degree angle with respect to the horizontal. If $v_i = 10$ m/s, this means that $v_{i,y}$, the vertical component of the initial velocity, is not 10 m/s (see Fig. 1).
   - How long does the system spend in the air?

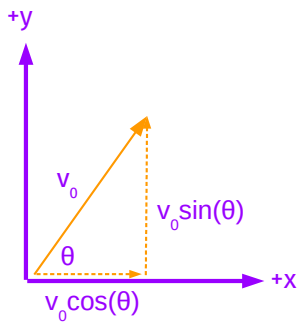

Figure 1: The initial velocity, if tilted at an angle, broken into components.