# Warm Up: Kinematics in 2D and 3D

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## 1 Memory

1. $y(t) = -\frac{1}{2}gt^2 + v_{i,y}t + y_i$ ... Accelerating system vertically.
2. $x(t) = v_{i,x}t + x_i$ ... Constant velocity horizontally.

## 2 Kinematics in 2D and 3D

1. Imagine a system propagating through 3D space with a velocity vector $\vec{v} = (2t-1)\hat{i} + 2\hat{j} + (-3t+2)\hat{k}$. (a) Is the object accelerating? Why or why not? (b) Write the acceleration vector by taking the derivative.

2. Suppose a system is thrown into the air, accelerating downwards due to gravity, but proceeding horizontally at constant velocity.

   - Modify the $y(t)$ and $x(t)$ equations in the memory bank to include the fact that the system starts at the origin, so $y_i = 0$ and $x_i = 0$ for $t = 0$.

   - Solve the $x(t)$ equation for $t$:

   - Substitute $t$ into the $y(t)$ equation, to obtain a function like $y(x)$:

   - Let $v_{i,x} = v_i \cos\theta$, and $v_{i,y} = v_i \sin\theta$, where $\theta$ is the angle of the throw relative to the ground.

   - Solve the quadratic equation $y(x)$ to find where $y = 0$.