Week 3: **Vectors**

SI Leader: Stephen Iota (siota001@ucr.edu)
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Review: Motion in 1D with Constant Acceleration

$$v(t) = v_i + at \tag{1}$$

$$x(t) = x_i + v_i t + \frac{1}{2}at \tag{2}$$

$$v(t)^2 = v_i^2 + 2a(x(t) - x_i) \tag{3}$$

$$x(t) = x_i + \frac{1}{2}(v_i + v(t))t \tag{4}$$

$$x(t) = x_i + v(t)t - \frac{1}{2}at^2 \tag{5}$$

Note: $x_i = x_0 = x(t = 0)$; similarly $v_f = v(t = t_f)$.

1 Optimize Throwing Distance.

I'd like to throw a ball as far as I can in the $\hat{x}$ direction. At what angle ϕ should I "launch" the ball to maximize its distance traveled? Use v_0 as the magnitude of the ball's initial velocity.

Hint: Use eq 2 to write down the ball's motion in both the $\hat{x}$ and $\hat{y}$ direction. Then solve for the ball's time of flight as a function of your launch angle, i.e. $t_f(\phi)$.