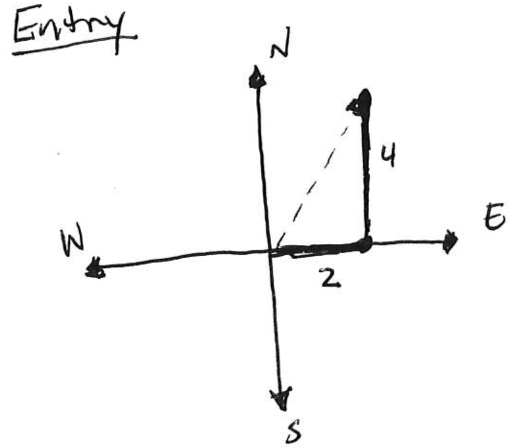
9/20 & 9/19

Entry



Final Position: 2 miles East, 4 miles North

(2, 4)

Distance: 2 miles + 4 miles = 6 miles

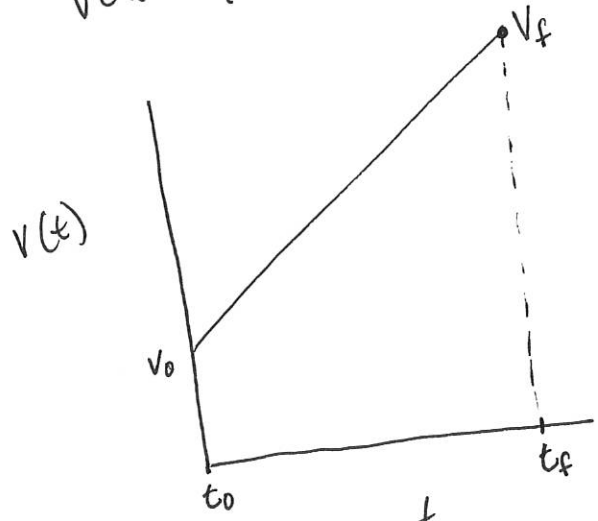
Displacment: $2^2 + 4^2 = 20$ $\quad \sqrt{20} = 2\sqrt{5}$ miles

Derivation of Kinematic Equations

In our last class we determined that the curved position vs. time graph had a general form of: $Ax^2 + Bx + C = f(x)$ or specifically for our graph: $At^2 + Bt + C = S(t)$

However we weren't sure what A, B, and C were.

Today we figure that out, first we need to look at the following velocity vs. time graph



the equation for this line is:

$V(t) = at + V_0$

a = acceleration $= \frac{\Delta V}{\Delta t}$ is the slope of the line

But we want displacement (ΔS) what can we do to get there?

well the area under this graph is $V(t) \cdot t$ or $V \cdot t$, $V = \frac{\Delta S}{\Delta t}$ and $t = \Delta t$ if $t_0 = 0$ (which it does here) so $\frac{\Delta S}{\cancel{\Delta t}} \cdot \cancel{\Delta t} = \Delta S$ displacement!

So we will calculate the area under the curve

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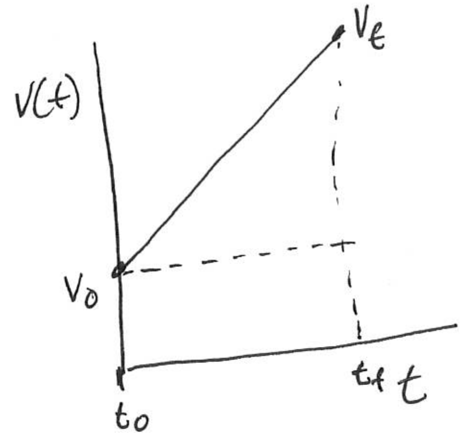

To calculate the area under the curve you can use the formula for a trapezoid or divide the area into two shapes, a triangle and a rectangle.

we will divide it into two shapes

Rectangle → $L \times W = \text{Area}$, $L = t_f$, $W = V_0$ → $V_0 t_f$

triangle → $\frac{1}{2} b \times h = \text{Area}$, $b = t_f$, $h = V_f - V_0$ → $\frac{1}{2}(V_f - V_0)t_f$

Total Area $= V_0 t_f + \frac{1}{2}(V_f - V_0)t_f$ ← Distribute t_f & $\frac{1}{2}$

Remember Area $= \Delta S = V_0 t_f + \frac{1}{2}V_f t_f - \frac{1}{2}V_0 t_f$

$\Delta S = \frac{1}{2}V_0 t_f + \frac{1}{2}V_f t_f$ ← Combine like terms

$\Delta S = \frac{1}{2}t_f(V_0 + V_f)$

Now we will return to the $V(t) = at + V_0$ equation and write it at t_f: $V(t_f) = V_f = at_f + V_0$

Now we are going to make the left side of the equation look like the ~~[illegible]~~ ΔS equation above. Remember whatever we do to one side we do to the other.

$V_f + V_0 = at_f + V_0 + V_0 = at_f + 2V_0$

$\frac{1}{2}(V_f + V_0) = \frac{1}{2}at_f + \frac{1}{2} \cdot 2V_0 = \frac{1}{2}at_f + V_0$

$\frac{1}{2}t_f(V_f + V_0) = \frac{1}{2}at_f^2 + V_0 t_f$ almost there! ~~[illegible]~~

$\Delta S = \frac{1}{2}at_f^2 + V_0 t_f$

~~[illegible]~~

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... $\Delta s = s_f - s_0$

$$s_f - s_0 = \frac{1}{2} a t_f^2 + v_0 t_f$$

$$s_f = \frac{1}{2} a t_f^2 + v_0 t_f + s_0$$

$s_f = s(t_f)$ so the general form would be...

$$s(t) = \frac{1}{2} a t^2 + v_0 t + s_0$$

$A = \frac{1}{2} a \qquad B = v_0 \qquad C = s_0$