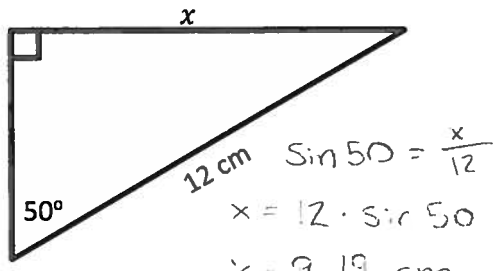
Section 3.2: Vectors and Formulas?!

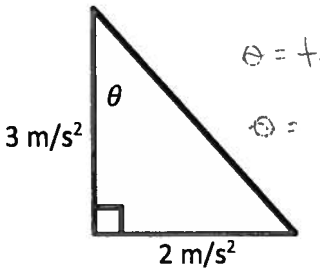
A quick SOH CAH TOA warm-up. Solve the triangles below for x and θ.



$\sin 50 = \frac{x}{12}$

$x = 12 \cdot \sin 50$

$x = 9.19$ cm



$\theta = \tan^{-1}\left(\frac{2}{3}\right)$

$\theta = 33.7°$

So far, we've been plugging vectors into formulas by representing them as numbers which can be positive or negative.

In 2D, things get more complicated. For example, how would you write the following vector as a number?

32 m/s [10° north of west]

you can't

So, in 2D, rather than plugging numbers into our equations, we'll have to plug in arrows.

Example: After accelerating at 4 m/s² south for 3 seconds, a hovercraft full of eels ends up traveling at 30 m/s east. What velocity did it start with?

$\vec{V_f} = 30$ m/s east

$\vec{V_i} = ?$

$\vec{a} = 4$ m/s² south

$\vec{d} =$

$t = 3$ s

$\vec{V_f} = \vec{V_i} + \vec{a}t$

$\vec{V_f} - \vec{a}t = \vec{V_i}$

(30 east) − (4 south)(3) = $\vec{V_i}$

30 east − 12 south = $\vec{V_i}$

30 east + 12 North = $\vec{V_i}$

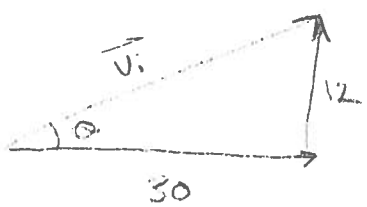
Magnitude

$a^2 + b^2 = c^2$

$\sqrt{30^2 + 12^2} = c$

$\sqrt{900 + 144} = c$

$32.3 = c$



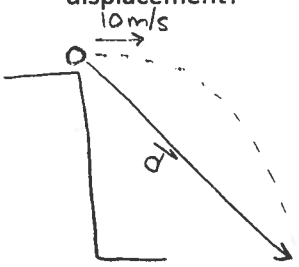
$\theta = \tan^{-1}\left(\frac{12}{30}\right)$

$\theta = 21.8$

$\vec{V_i} = 32.3$ m/s

Final answer: 32.3 m/s [21.8° North of East]

Example: A cannonball is fired horizontally off a cliff at 10 m/s. If it hits the ground 5 s later, what is its displacement?



$\vec{V_f}$ =

$\vec{V_i}$ = 10 m/s right

$\vec{a}$ = 9.8 m/s² down

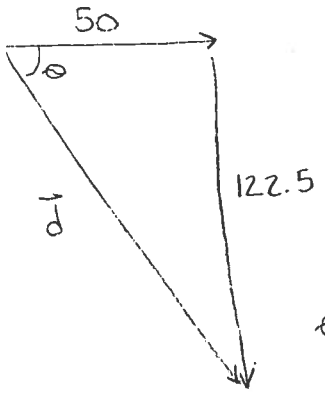
$\vec{d}$ = ?

t = 5 s

$\vec{d} = \vec{V_i}t + \frac{1}{2}\vec{a}t^2$

$\vec{d}$ = 10 right (5) + ½ (9.8 down) (5^2)

$\vec{d}$ = 50 right + 122.5 down



$50^2 + 122.5^2 = C^2$

$2500 + 15006.25 = C^2$

$17506.25 = C$

$C = 132.3$

$\theta = \tan^{-1}\left(\frac{122.5}{50}\right)$

$\theta = 67.8$

Final answer: 132.3 m/s [67.8 below horizontal]