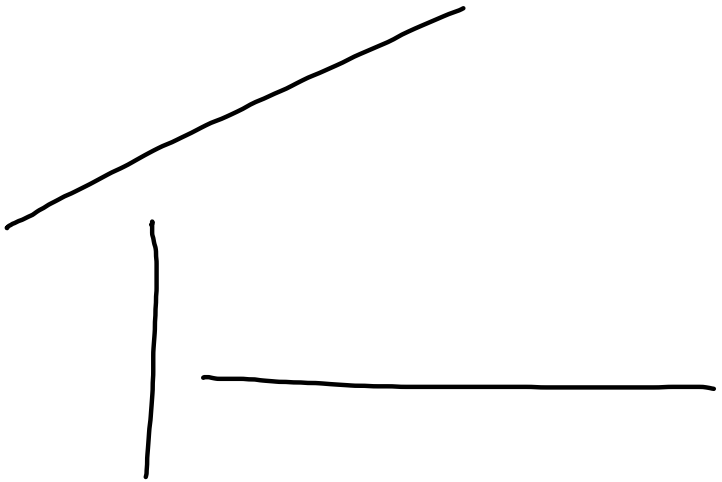
# Lesson 3

Still on Chapter 2

Motion problems

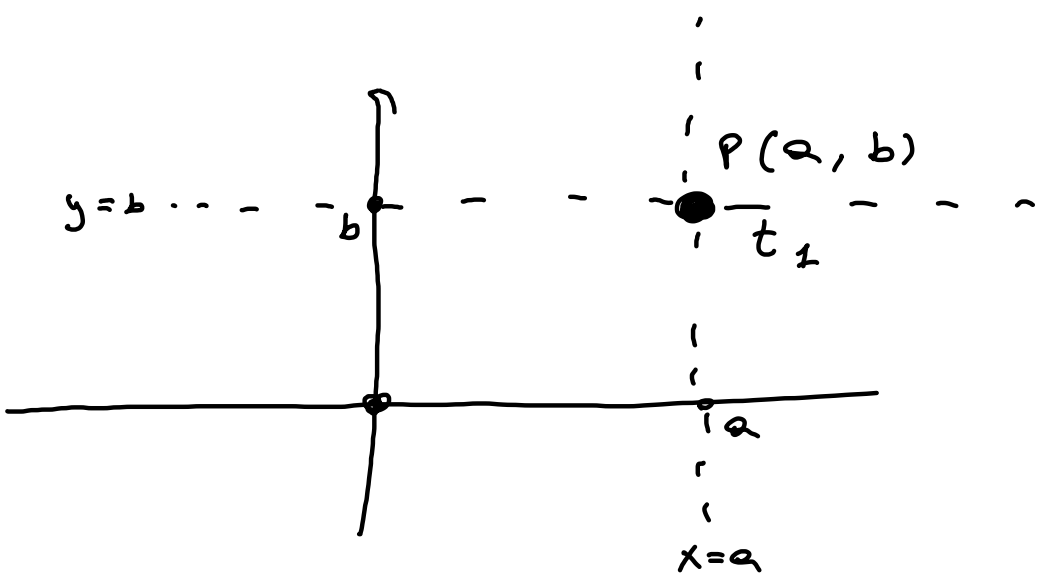


# Recall

a, b, $t_1$, v constant numbers
t variable

If an object is moving with constant velocity $v$ and at time $t_1$ it is at $(a, b)$ then the position of the object at time $t$ is:

- $\boxed{x(t) = a + v(t - t_1), \quad y(t) = b}$ object is moving along horizontal line $y = b$.
- $\boxed{x(t) = a, \quad y(t) = b + v(t - t_1)}$ if object is moving along vertical line $x = a$.




$$y(t) - y(t_1) = v(t - t_1)$$

$$d = v\,t$$

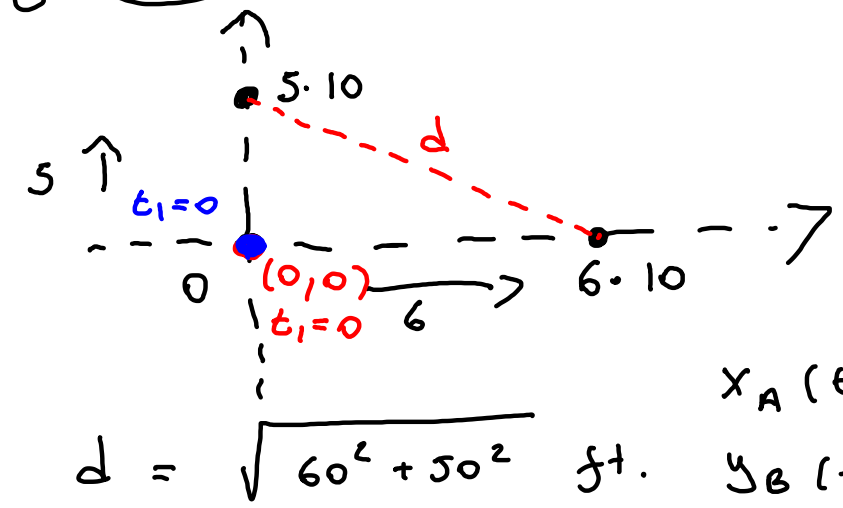
Length of time

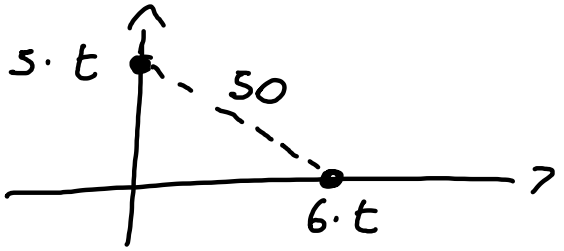
# Example

Ann and Bob start moving at the same time from the same location. Ann moves East at 6 feet/sec. Bob moves North at 5 feet/sec.

What is the distance between Ann and Bob 10 sec later ?

When is the distance between Ann and Bob 50 feet ?




$d = \sqrt{60^2 + 50^2}$ ft.

$t=0$ origin

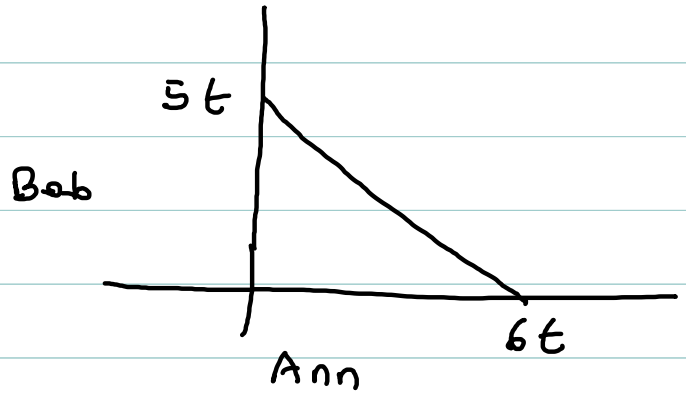
$t=10$

$x_A(t) = 0 + 6(t-0)$ $\quad x_B(t) = 0$

$y_B(t) = 0$ $\quad y_B(t) = 0 + 5(t-0)$

$(6t, 0)$ $\quad (0, 5t)$

$50 = \sqrt{(6t)^2 + (5t)^2}$




When is distance between Ann and Bob equal to 50 feet?

Ann $(6t, 0)$ Bob $(0, 5t)$

$$50 = \sqrt{(6t)^2 + (5t)^2}$$

$$50 = \sqrt{36t^2 + 25t^2} = \sqrt{61t^2}$$

$$2500 = 61t^2$$

$$\frac{2500}{61} = t^2$$

$$\pm\sqrt{\frac{2500}{61}} = t, \text{ discard negative } \boxed{t = \sqrt{\frac{2500}{61}}} \text{ sec}$$

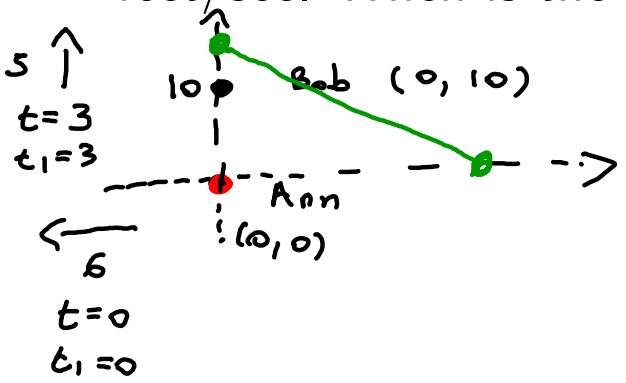
## Algebra question

Is $\sqrt{x^2} = x$?

# What if Ann and Bob start at different times from different locations ?

$t = 0$

Bob is standing 10 feet North of Ann, when Ann starts moving ~~East~~ WEST at 6 feet/sec. 3 seconds later Bob, starts moving North at 5 feet/sec. When is the distance between Ann and Bob 50 feet ?




$x_A(t) = 0 - 6(t-0)$

$y_A(t) = 0$

$(-6t, 0)$

$t \geq 0$

$x_B(t) = 0$

$y_B(t) = 10 + 5(t-3)$

$(0, 10+5(t-3))$

$t \geq 3$

$$50 = \sqrt{(-6t-0)^2 + (10+5(t-3))^2}$$

solve for $t$

$$50 = \sqrt{36t^2 + (10 + 5(t-3))^2}$$

① square both sides

$$2500 = 36t^2 + (10 + 5(t-3))^2$$

② simplify inside

$$2500 = 36t^2 + (5t - 5)^2$$

③ Expand square : recall $(a+b)^2 = a^2 + 2ab + b^2$, $(a-b)^2 = a^2 - 2ab + b^2$

$$2500 = 36t^2 + 25t^2 - 50t + 25$$

④ move 2500 to the right and simplify

$$0 = \underbrace{61}_{a} t^2 \underbrace{- 50}_{b} t \underbrace{- 2475}_{c}$$

⑤ Use quadratic formula

recall the solutions of $ax^2 + bx + c = 0$ are $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ if $b^2 - 4ac \geq 0$

$$t = \frac{50 \pm \sqrt{50^2 + 4 \cdot 61 \cdot 2475}}{2 \cdot 61} \simeq -5.97,\ 6.79$$

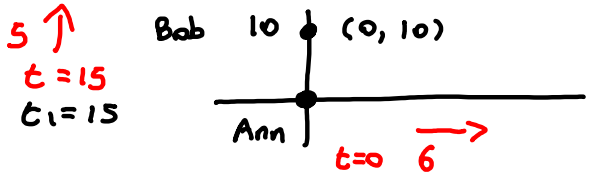
For our problem, the negetive solution would be a time before Ann and Bob start moving so it does not make sense so

$\boxed{t = 6.79 \text{ sec}}$

# Tricky version

Bob is standing 10 feet North of Ann, when Ann starts moving East at 6 feet/sec. 15 seconds later Bob , starts moving North at 5 feet/sec. When is the distance between Ann and Bob 50 feet ?

$t = 0$




Ann

$x_A(t) = 6t$

$y_A(t) = 0$

valid for $t \geq 0$

$(6t, 0)$

Bob

$x_B(t) = 0$

$y_B(t) = 10 + 5(t-15)$

valid for $t \geq 15$

$(0, 10+5(t-15))$

We want $d((6t,0)\ (0, 10+5(t-15))) = 50$

$$50 = \sqrt{(6t-0)^2 + (0-(10+5(t-15))^2}$$

do the algebra .... $t = 5, 5.66$ DISCARD BOTH

Can I accept these solutions ? NO

Are there any solutions? We will finish on Wed