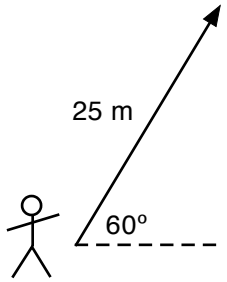
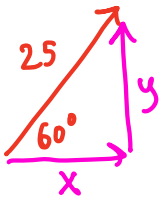
ABRHS PHYSICS (CP) NAME: KEY

Vector Word Problems 1

1. You are looking for something you dropped in an empty parking lot. You finally find what you are looking for 25 meters away from you at an angle of 60° N of E. You walk over in 20 seconds.



   a. What are the components of your distance vector? (Worded another way: How far East and how far North did you move?)



$\cos 60° = \frac{x}{25}$ $\quad \sin 60 = \frac{y}{25}$

$x = 25 \cos 60$ $\quad y = 25 \sin 60$

$x = 12.5$ m $\quad y = 21.7$ m

   b. What was your velocity (as a magnitude and direction.)

$V = \frac{d}{t}$ $\quad d = 25$ m $\quad t = 20$ s

$V = \frac{25}{20}$ $\quad V = 1.25$ m/s @ 60° N of E

↑ same direction

   c. Using your answer to part a, what are the horizontal and vertical components of your velocity?

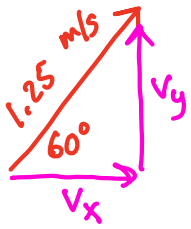
Since $V = \frac{d}{t}$ we can say $V_x = \frac{x}{t}$ & $V_y = \frac{y}{t}$

$\therefore \quad V_x = \frac{x}{t} \quad V_y = \frac{y}{t}$

$V_x = \frac{12.5}{20}$ $\quad V_y = \frac{21.7}{20}$

$V_x = 0.63$ m/s $\quad V_y = 1.08$ m/s

   d. Using your answer to part b, what are the horizontal and vertical components of your velocity? (Fingers crossed that you get the same answer as above. ☺)



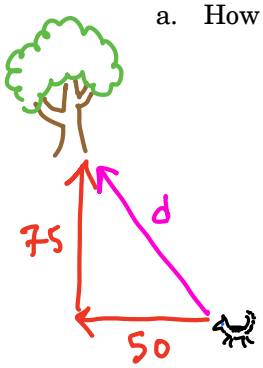
$\cos 60 = \frac{V_x}{1.25}$ $\quad \sin 60 = \frac{V_y}{1.25}$

$V_x = 1.25 \cos 60$ $\quad V_y = 1.25 \sin 60$

$V_x = 0.63$ m/s $\quad V_y = 1.08$ m/s

2. A dog is sitting next to its owner in a field when it notices a squirrel at the base of a tree. The tree is located 50 meters to the West and 75 meters North of the dog's original position. The dog takes off after the squirrel, reaching the tree in only 12 seconds.

   a. How far away is the tree from the dog's original position?



$d^2 = 75^2 + 50^2$

$d^2 = 5625 + 2500$

$d^2 = 8125$

$d = \sqrt{8125}$

$d = 90.1$ m

Vector Word Problems 1

b. What were the components of the dog's velocity?

$V_x = \frac{x}{t}$ $\quad V_y = \frac{y}{t} = \frac{75}{12}$

$V_x = \frac{50}{12}$ $\quad V_x = 4.17$ m/s* (west) $\quad \boxed{V_y = 6.25 \text{ m/s}}$

c. Using your answer from part a, how fast was the dog running?

$V = \frac{d}{t} = \frac{90.1}{12}$

$\boxed{V = 7.5 \text{ m/s}}$

* should probably call it −4.17 m/s.

d. Using your answer from part b, how fast was the dog running?

$V^2 = V_x^2 + V_y^2$ $\quad V^2 = 56.5$

$V^2 = (4.17)^2 + (6.25)^2$ $\quad V = \sqrt{56.5}$

$V^2 = 17.4 + 39.1$ $\quad \boxed{V = 7.5 \text{ m/s}}$

3. A plane flies for 20 minutes with a velocity with the components 75 m/s West and 50 m/s North.
   a. What are the components of the distance vector? (Worded another way: how far West and North did the plane travel?)

$(20 \text{ min})\left(\frac{60 \text{ s}}{1 \text{ min}}\right) = 1200 \text{ s}$

$V_x = \frac{x}{t}$ $\quad \boxed{x = 90{,}000 \text{ m}}$ $\quad 50 = \frac{y}{1200}$

$75 = \frac{x}{1200}$ $\quad V_y = \frac{y}{t}$ $\quad \boxed{y = 60{,}000 \text{ m}}$

b. How fast is the plane traveling?

$V^2 = V_x^2 + V_y^2$ $\quad V^2 = 8125$

$V^2 = (75)^2 + (50)^2$ $\quad \boxed{V = 90.1 \text{ m/s}}$

c. Using your answer from part a, how far away from its starting point is the plane?

$d^2 = x^2 + y^2$ $\quad d^2 = 11{,}700{,}000{,}000$

$d^2 = (90{,}000)^2 + (60{,}000)^2$ $\quad \boxed{d = 108{,}000 \text{ m}}$

yes, I rounded off the answer...

d. Using your answer from part b, how far away from its starting point is the plane?

$V = \frac{d}{t}$

$90.1 = \frac{d}{1200}$ $\quad \boxed{d = 108{,}000 \text{ m}}$

Vector Word Problems 1

4. A cruise ship travels with a constant velocity of 25 km/h at an angle of 35° N of E for 8 hours.
   a. What was its displacement in that time? (i.e. how far did it travel?)

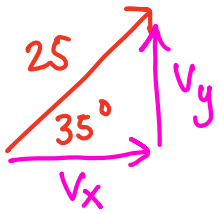
$V = \frac{d}{t}$

$25 = \frac{d}{8}$

$d = 200$ km

Note: this works b/c km/h & hours both use "hours"

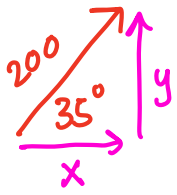
   b. What were the components of its velocity?



$\cos 35 = \frac{V_x}{25}$ $\quad V_x = 25 \cos 35$ $\quad V_x = 20.5$ km/h

$\sin 35 = \frac{V_y}{25}$ $\quad V_y = 25 \sin 35$ $\quad V_y = 14.3$ km/h

   c. What were the components of its displacement?



$\cos 35 = \frac{x}{200}$ $\quad x = 200 \cos 35$ $\quad x = 164$ km

$\sin 35 = \frac{y}{200}$ $\quad y = 200 \sin 35$ $\quad y = 115$ km

$V_x = \frac{x}{t}$ $\quad 20.5 = \frac{x}{8}$ $\quad x = 164$ km

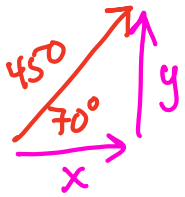
$V_y = \frac{y}{t}$ $\quad 14.3 = \frac{y}{8}$ $\quad y = 114$ km

rounding difference...

5. A plane is flying with a constant velocity of 300 km/h at 70° N of E. How far North does it travel in 1.5 hours? (*Two steps to this one!*)

$V = \frac{d}{t}$

$300 = \frac{d}{1.5}$ $\quad d = 450$ km



$\sin 70 = \frac{y}{450}$ $\quad y = 450 \sin 70$ $\quad y = 423$ km

6. A car has a velocity of 22 m/s W and 17 m/s S. After 3 minutes, how far has it traveled? (*Two steps to this one!*)

$V^2 = V_x^2 + V_y^2$

$V^2 = (22)^2 + (17)^2$ $\quad V^2 = 773$ $\quad V = 27.8$ m/s

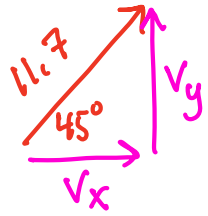
(3 min)(60 s/min) = 180 s

$V = \frac{d}{t}$ $\quad 27.8 = \frac{d}{180}$ $\quad d = 5005$ m

7. A bird flew 3500 meters exactly NE* in 5 minutes. What was the eastern component of its velocity? (*Two steps to this one!*)
   * *exactly NE means 45° N of E, or 45° E of N*

(5 min)(60 s/min) = 300 s

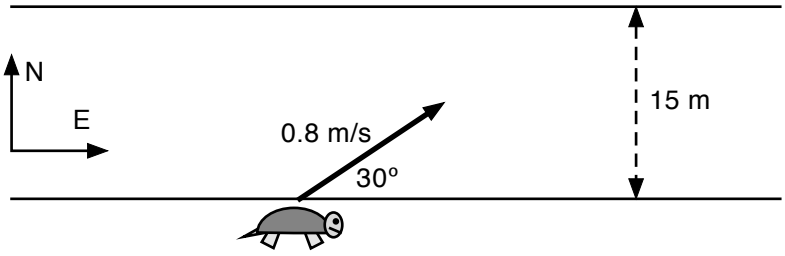
$V = \frac{d}{t}$ $\quad V = \frac{3500}{300}$ $\quad V = 11.7$ m/s



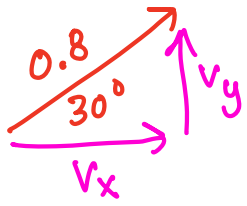
$\cos 45 = \frac{V_x}{11.7}$ $\quad V_x = 11.7 \cos 45$ $\quad V_x = 8.25$ m/s

See below for alternate solutions

Vector Word Problems 1



8. A turtle is trying to cross a road that is 15 meters wide (shown above.) Being a turtle however, it does not go straight across. Instead, the turtle moves with a velocity of 0.8 m/s at an angle of 30° N of E.
   a. What are the horizontal and vertical components of the velocity of the turtle?

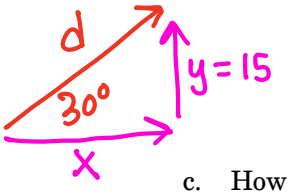


$\cos 30 = \frac{V_x}{0.8}$ $\quad V_x = 0.8 \cos 30$ $\quad \boxed{V_x = 0.69 \text{ m/s}}$

$\sin 30 = \frac{V_y}{0.8}$ $\quad V_y = 0.8 \sin 30$ $\quad \boxed{V_y = 0.4 \text{ m/s}}$

   b. How long does it take the ~~turtle to cross the road?~~ *(Be careful!)*

Careful! The 15 m is a "y"



So $V_y = \frac{y}{t}$ $\quad 0.4 = \frac{15}{t}$ $\quad t = \frac{15}{0.4}$ $\quad \boxed{t = 37.5 \text{ s}}$

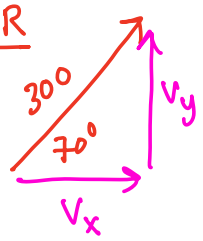
   c. How far sideways (East) does the turtle move in this time?

$V_x = \frac{x}{t}$ $\quad 0.69 = \frac{x}{37.5}$ $\quad \boxed{x = 25.9 \text{ m}}$

Answers:

1. a) x=12.5 m & y=21.7 m	*b) 1.25 m/s @60° N of E*	*c&d) v_x=0.63 m/s & v_y=1.08 m/s*
2. a) 90.1 m	*b) 4.17 m/s W & 6.25 m/s N*	*c&d) 7.51 m/s*
3. a) x=–90,000 m & y=60,000 m	*b) 90.1 m/s*	*c&d) 108,000 m*
4. a) 200 km	*b) 20.5 km/h E & 14.3 km/h N*	*c) 164 km E & 115 km N*
5) 423 km		
6) 5005 m		
7) 8.25 m/s		
8. a) v_x=0.69 m/s & v_y=0.4 m/s	*b) 37.5 s*	*c) x=26 m*

5) OR



$\sin 70 = \frac{V_y}{300}$

$V_y = 300 \sin 70$

$V_y = 282$ km/h

$V_y = \frac{y}{t}$

$282 = \frac{y}{1.5}$ $\quad$ $y = 423$ km

6) OB

$V_x = \frac{x}{t}$ $\quad$ $V_y = \frac{y}{t}$

$22 = \frac{x}{180}$ $\quad$ $17 = \frac{y}{180}$

$x = 3960$ m $\quad$ $y = 3060$ m

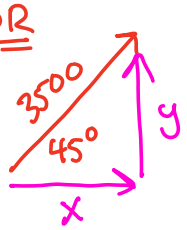
$d^2 = x^2 + y^2$

$d^2 = (3960)^2 + (3060)^2$

$d^2 = 25,045,200$

$d = 5005$ m

7) OR



$$\cos 45 = \frac{x}{3500}$$

$$x = 3500 \cos 45$$

$$x = 2475 \text{ m}$$

$$V_x = \frac{x}{t} = \frac{2475}{300}$$

$$V_x = 8.25 \text{ m/s}$$