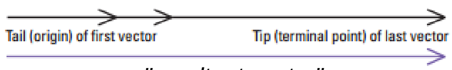
1.8 Vectors in One and Two Dimensions

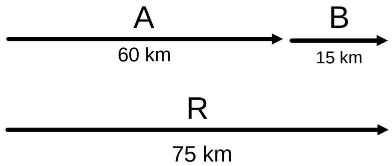
Vector Addition in One Dimension

We add vectors acting in the same dimension (ie. vertical or horizontal) by placing the vector arrows **head to tail** and adding their magnitudes.



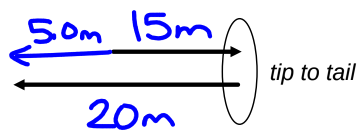
"resultant vector"

Ex.) A car drives East for 60 km, then stops and continues driving East for another 15 km. What is the resultant distance the car has driven?



* Vectors are always added ***tip to tail.***

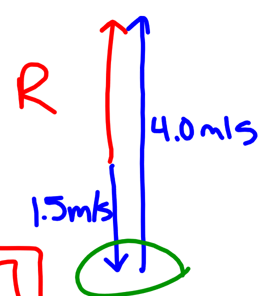
Ex.) An animal walks 15 m to the right, and then stops and walks 20 m left. What is the resultant displacement?



$R = 15 + {}^{-}20 = -5.0\,m$

*Note: The resultant is not drawn tip to tail. That's okay.

Ex.) A person is walking down the up escalator at 1.5 m/s. The escalator goes up at 4.0 m/s. To an observer watching the motion, what is the persons resultant velocity?

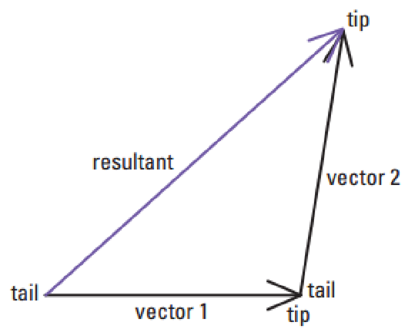


$R = {}^{+}4.0 + {}^{-}1.5$

$R = 2.5\,m/s\,[up]$

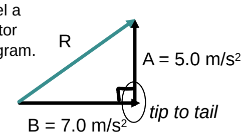
Vectors in Two Dimensions

Follow the "tip to tail" rule with two dimensional vectors and use trig/ Pythagorean Theorem to solve.

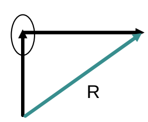


Ex.) An Acceleration vector, A, of 5.0 m/s^2 is pointed vertically up. Another, B, is pointed horizontally right at 7.0 m/s^2. What is the resultant acceleration?

Step 1: Draw and label a vector diagram.



OR



Step 2: Use Pythagorean Theorem to solve for R.

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

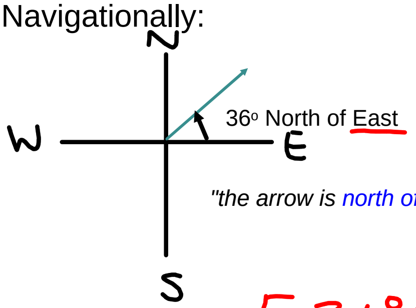
$$R=\sqrt{A^2+B^2}$$

$$R=\sqrt{5.0^2+7.0^2}$$

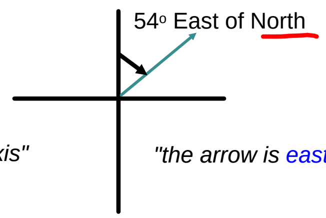
$$\boxed{R=8.6\ m/s^2}$$

However, this isn't our final answer because we don't have a direction. In order to find direction we need to calculate the angle of the resultant. There are two common ways to do this:

1. Navigationally:



"the arrow is north of the east axis"

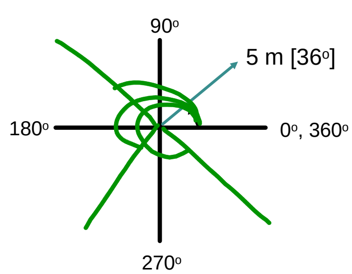


"the arrow is east of the north axis"

E 36°N

Math 20-1 Trig

2. The Polar Coordinates Method:



Measure the angle counter-clockwise with respect to the x-axis.

the arrow is 36° from the x-axis

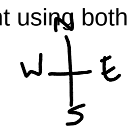
Pg. 73 Practice Problem #1

Pg. 74 Practice Problems #1-3.

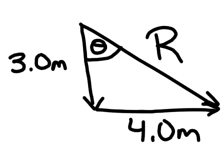
Pg. 75 # 6, 7, 9.

Pg. 78 Skills Practice #1.

Ex.) Add the following vectors. Express the direction of the resultant using both the navigational system and the Polar Coordinate system.



a) 3.0 m South and 4.0 m East



$R = \sqrt{3.0^2 + 4.0^2}$

$R = 5.0m$

$\tan\theta = \frac{4.0}{3.0}$

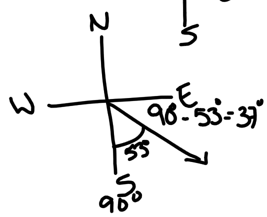
$\tan^{-1}(4.0 \div 3.0)$

$\theta = 53^\circ$

Navigator:

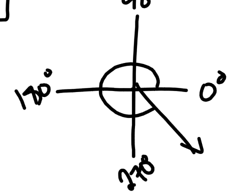
5.0m [53° E of S]

5.0m [37° S of E]

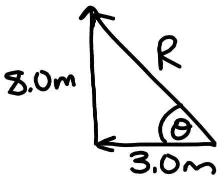


Polar:

5.0m [323°]



b) 3.0 m W and 8.0 m N.



$R = \sqrt{8.0^2 + 3.0^2}$

$R = 8.5m$

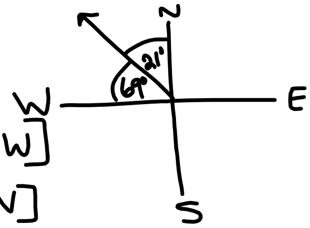
$\tan\theta = \frac{8.0}{3.0}$

$\theta = 69°$

Navigator:

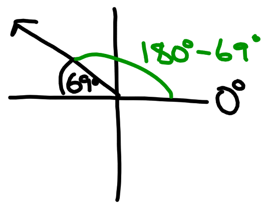
8.5m [69° N of W]

8.5m [21° W of N]

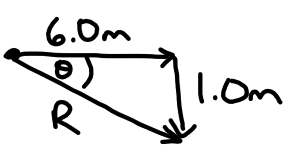


Polar:

8.5m [111°]



c) 6.0 m right and 1.0 m down.



$R = \sqrt{6.0^2 + 1.0^2}$

$R = 6.1m$

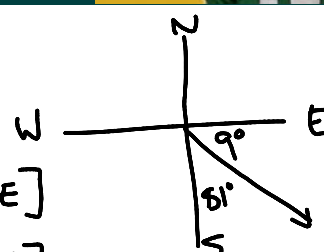
$\tan\theta = \frac{1.0}{6.0}$

$\theta = 9°$

Navigator:

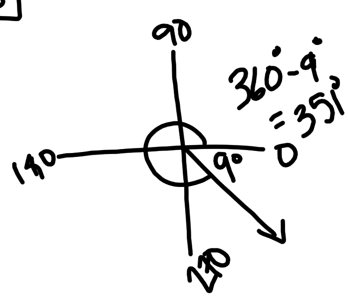
6.1m [9° S of E]

6.1m [81° E of S]



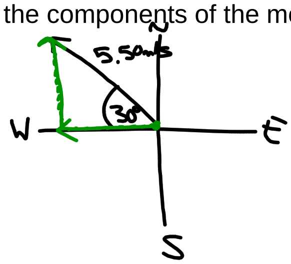
Polar:

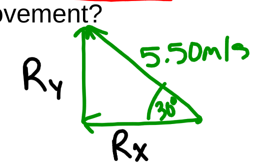
6.1m [351°]



The process we have been practicing is taking two vectors and adding them together to find the resultant. Now we need to study how we start with the resultant and find the vector components.

Ex.) A crow flies at an angle of 30º N of W with a velocity of 5.50 m/s. What are the components of the movement?





$\sin 30^\circ = \frac{R_y}{5.50}$

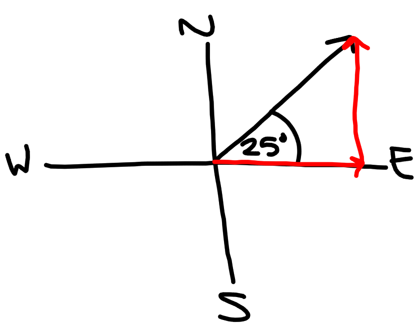
$5.50 \times \sin(30^\circ)$

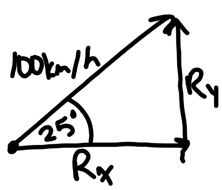
$R_y = 2.75\ m/s\ [N]$

$\cos 30^\circ = \frac{R_x}{5.50}$

$R_x = 4.76\ m/s\ [W]$

Ex.) Determine the North and East velocity components of a car travelling at 100 km/h at 25º N of E.



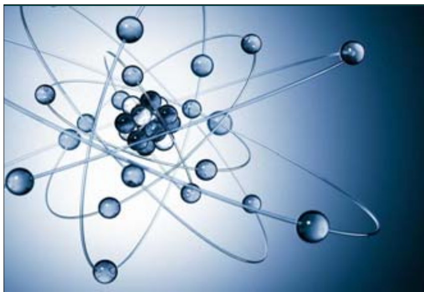


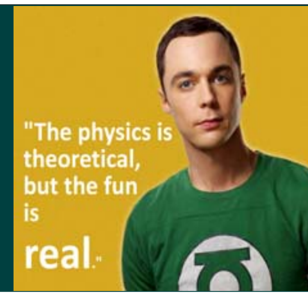
$\sin 25^\circ = \frac{R_y}{100}$

$R_y = 42.3\ km/h\ [N]$

$\cos 25^\circ = \frac{R_x}{100}$

$R_x = 90.6\ km/h\ [E]$





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