

Traditional: 3-05

Themed: 10-05

Projectile Motion

Adding Vectors Mathematically to
find Resultants

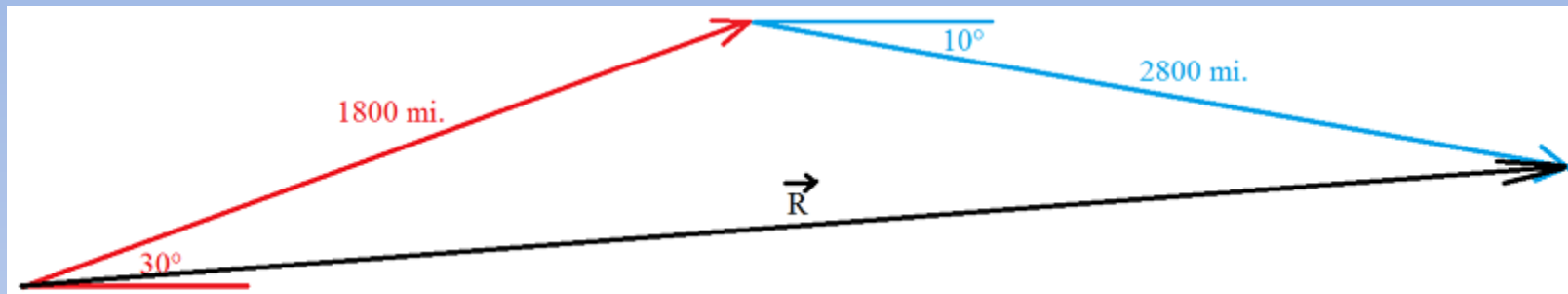
Finding Resultants Mathematically

- Make a sketch
- Resolve each vector for X and Y
- IMPORTANT: Keep + or – correct
- Sum all X values in X column & Y values in Y column
- Find, R, the resultant vector using
 - Pythagorus
 - Trig

Finding Resultants Mathematically

- Example: Alex takes a trip to France! On the first part of his trip, his displacement is 1800 miles, 30° N of E. On the second part of his trip, his displacement is 2800 miles, 10° S of E. Find the resultant, R, that describes his overall displacement.

Find Resultant: Draw a picture, make a table



- Graphically:
 - Add head-to-tail
 - R: from tail of 1st to head of 2nd
 - Order doesn't matter (parallelogram rule)
- Mathematically:
 - Call 1st vector P and 2nd Q
 - Resolve P and Q
 - Find total X and Y
 - Pythag finds magnitude of R
 - Trig finds angle of R

$$\begin{aligned} P_x &= 1800 \cos 30^\circ = +1559 \text{ mi} \\ P_y &= 1800 \sin 30^\circ = +900 \text{ mi} \\ Q_x &= 2800 \cos 10^\circ = +2757 \text{ mi} \\ Q_y &= 2800 \sin 10^\circ = -486 \text{ mi} \end{aligned}$$

	X	Y
P	+1559	+900
Q	+2757	-486
Tot	+4316 mi	+414 mi

$$\text{Pythagoras: } R^2 = X^2 + Y^2 = 4316^2 + 414^2, R = 4336 \text{ mi}$$

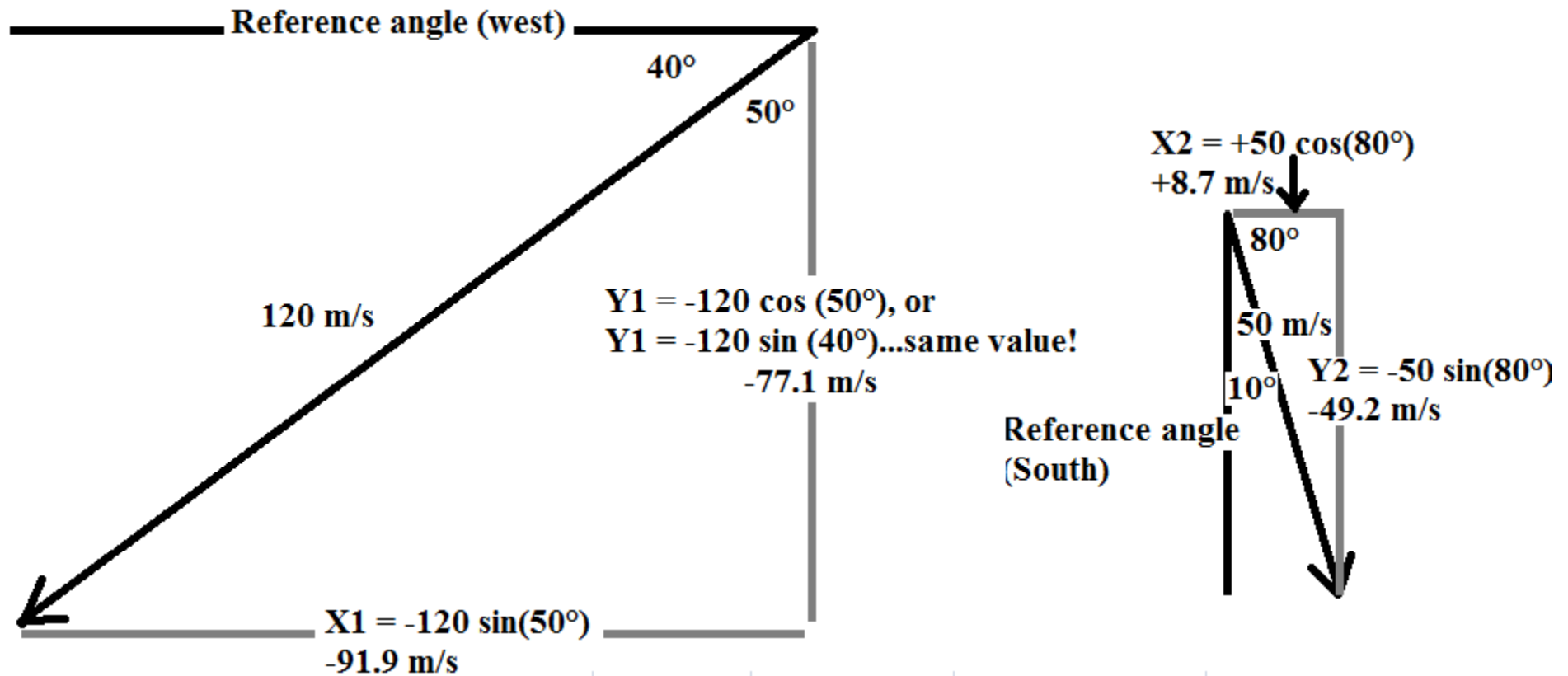
$$\Theta = \text{Tan}^{-1}(414/4316) = 5.5^\circ$$

$$R = 4336 \text{ mi}, 5.5^\circ \text{ N of E}$$

Try another?

- These problems are so much fun, they're like Saturday at your BFF's house!
- Relative to the wind it's in, a plane is flying at 120 m/s, 40° S of W. The wind velocity is 50 m/s, 10° E of S. What is the ground velocity of this plane?

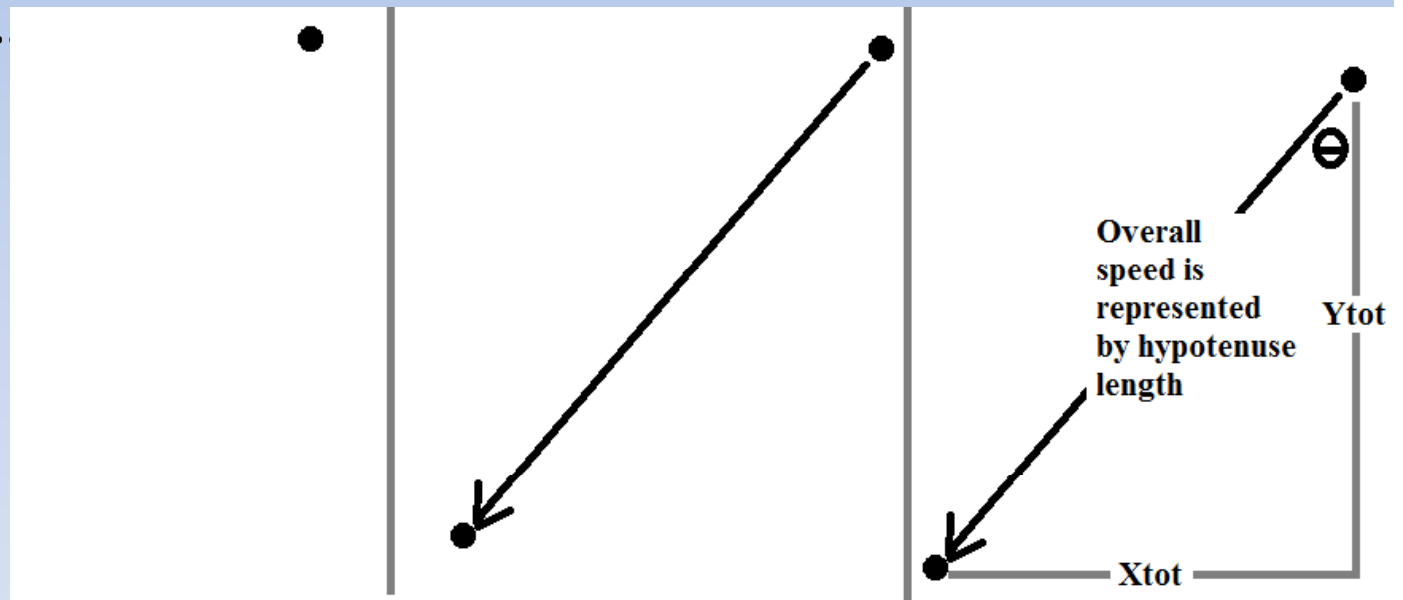
Relative to the wind it's in, a plane is flying at 120 m/s, 40° S of W. The wind velocity is 50 m/s, 10°E of S. What is the ground velocity of this plane?



	X	Y
1	-91.9	-77.1
2	+8.7	-49.2
Tot	-83.2	-126.3

Now, how do I make a vector from my total results?

- First, look at your totals. Your X total is negative, so your resultant (total) will have to go left. Leave room for going left.
- Second, Your Y total is negative, so your resultant will have to go downward. Leave room for going downward.
- To have room to go left and downward, pick a starting point up and right...



$$\text{Speed: } R = \sqrt{(83.2^2 + 126.3^2)} = 151.2 \text{ m/s}$$

$$\text{Direction: } \Theta = \tan^{-1}(83.2/126.3) = 33.4^\circ$$

$$\text{Resultant} = 151.2 \text{ m/s } 33.4^\circ \text{ W of S}$$

Uno mas?

- Want to: Amaze your friends? Strike fear in your enemies? Get the attention of that person you have a crush on? Adding vectors to find resultants will do all that and more!
- A river flows at 4.5 m/s, 60° N of W. A boat moves relative to the river at 6.0 m/s, 30° S of E. What's the velocity of boat relative to the shore?

	X	Y
1	-2.25	+3.90
2	+5.20	+3.00
Tot	+2.95	+6.90

Speed: 7.50 m/s

Direction: $\theta = 66.9^\circ$ S of E...SAME as $\theta = 23.1^\circ$ E of S

Resultant = 7.50 m/s 66.9° S of E