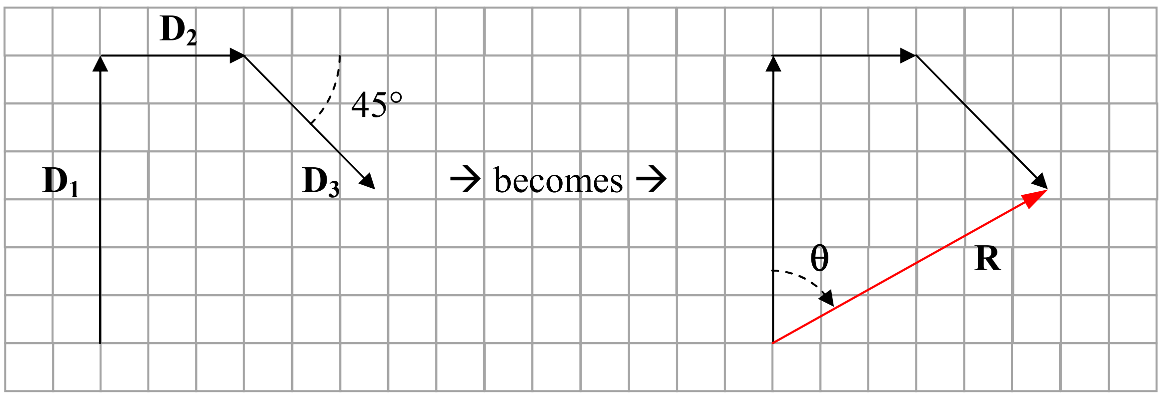
Example 2.
Add the displacements $D_1 + D_2 + D_3 = R$ where $D_1 = 6$ km north, $D_2 = 3$ km east, and $D_3 = 4$ km (45° S of E).

Assume north is 'up'. Use the scale 1 grid length = 1 km and:

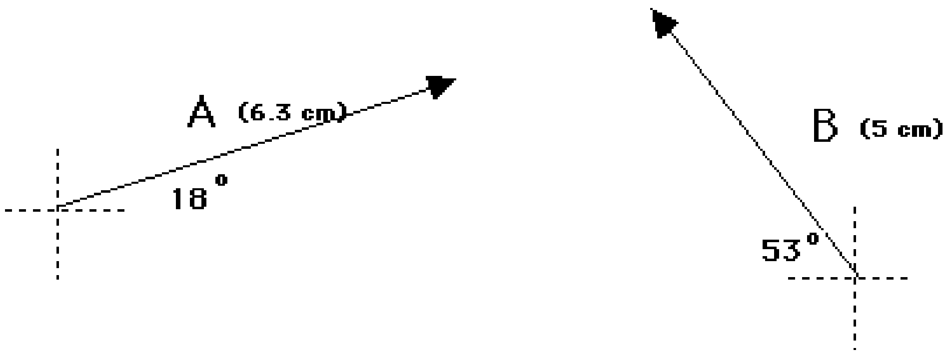
- draw the vector-sum tip-to-tail:
- draw the resultant **R**
- measure the length **R** and convert to kilometers
- measure the angle using a protractor
- report R.



- **R** should measure to be 6.7 km; θ = 63°

→R = 6.7 km at 63° E of N (or 27° N of E)

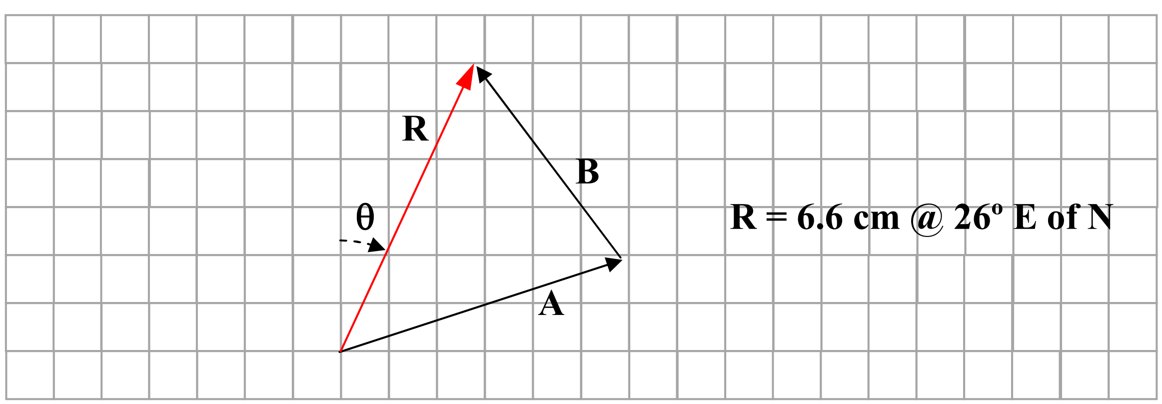
Example 3.
Given the vectors shown:



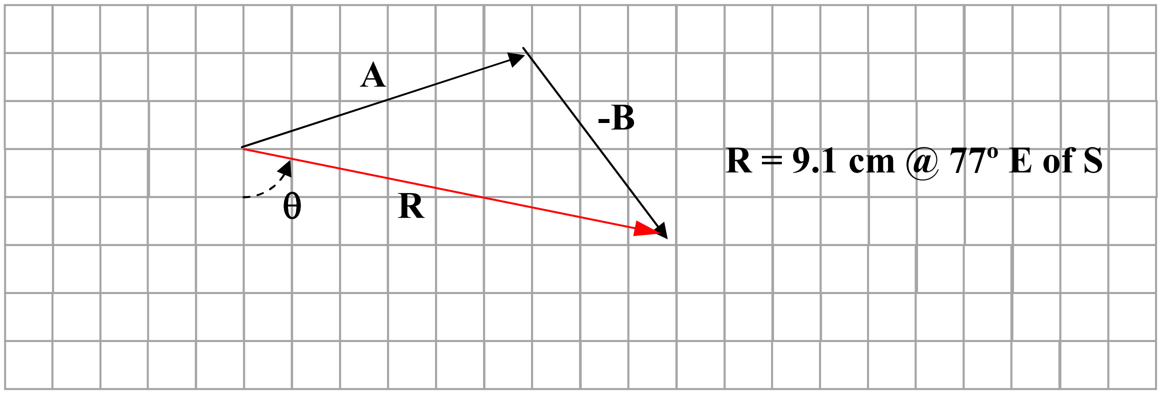
Draw diagrams and find R for:
(a) A + B = R
(b) A - B = R
(c) B - A = R

- **Scale: 1 grid length = 1 cm**

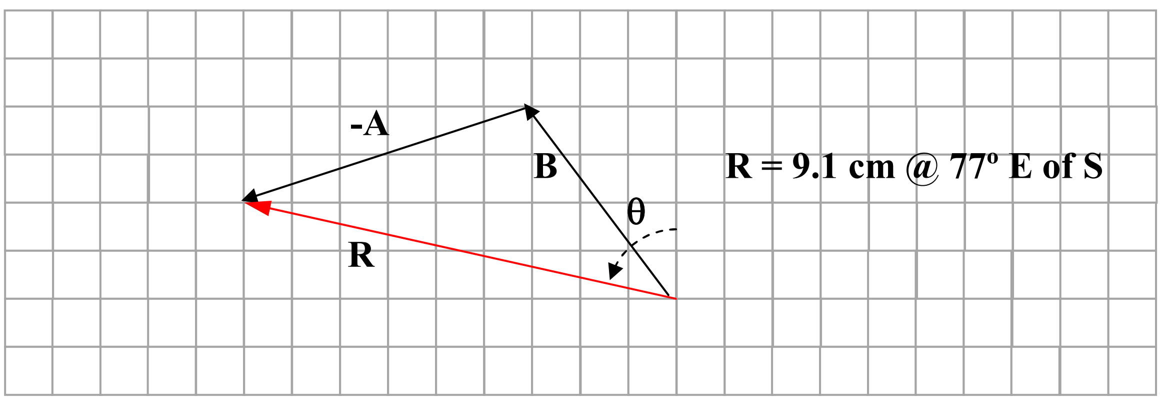
(a) A + B



(b) A - B



(c) B - A



Example 4.
A plane with an air speed of 105 m/s heads west when a 25 m/s north wind is blowing. What is the velocity of the plane relative to the ground?

N $\Uparrow$

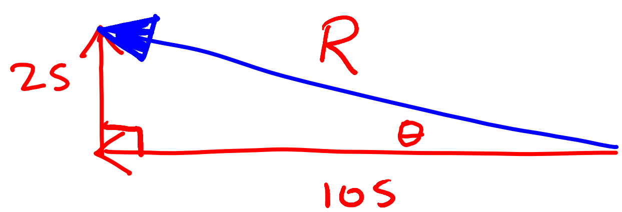
plane velocity

$\leftarrow$ 105 m/s

wind velocity

$\uparrow$ 25 m/s

To find resultant velocity, vector add plane velocity + wind velocity:



$$R = \sqrt{105^2 + 25^2} = 108 \text{ m/s}$$

$$\theta = \tan^{-1}\left[\frac{25}{105}\right] = 13^\circ$$

Answer: $\boxed{108 \text{ m/s @ } 13^\circ \text{ N of W}}$

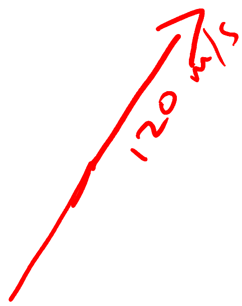
Example 5.
A plane is capable of 120 m/s is still air. Where must the pilot head the plane in order to end up going due north when there is a 35m/s west wind?

wind velocity

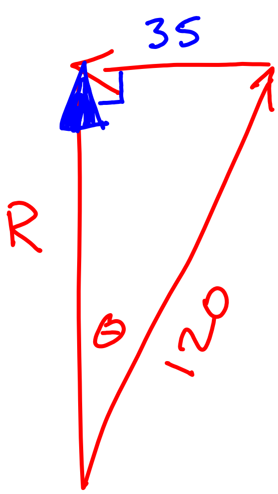
$\xleftarrow{\hspace{2em}}$

35 m/s

→ plane must point <u>northeast</u>, into the wind



→ vector-add wind velocity + plane engine velocity so that resultant velocity is directed due north:



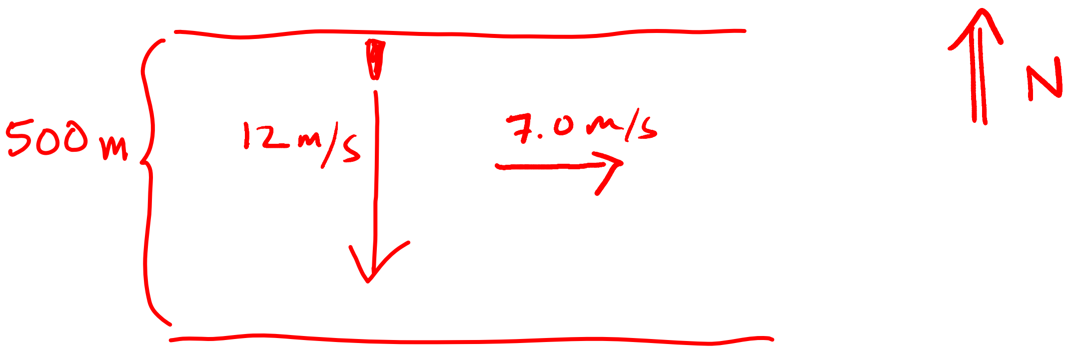
$$\theta = \sin^{-1}\left[\frac{35}{120}\right]$$

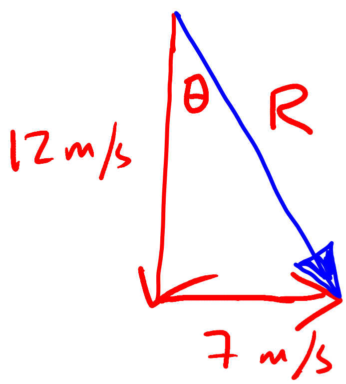
$$\boxed{\theta = 17^{\circ} \text{ E of N}}$$

Example 6.

A boat is capable of 12 m/s in still water. If a river flows at 7.0 m/s due east and is 500 m wide:

(a) What is the velocity of the boat relative to the shore if the boat heads south, perpendicular to the current?



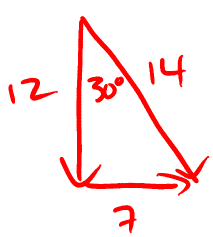


$$R = \sqrt{12^2 + 7^2}$$
$$= 14 \text{ m/s}$$
$$\theta = \tan^{-1}\left[\frac{7}{12}\right] = 30^\circ$$

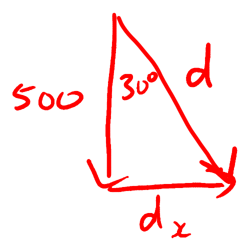
$$\boxed{R = 14 \text{ m/s @ } 30^\circ \text{ E of S}}$$

(b) How long would it take to cross the river?

velocity vectors



displacement vectors

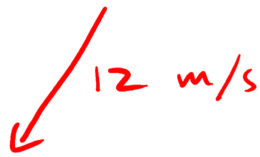


$$d = v_{av} t \qquad t = \frac{d}{v_{av}}$$
$$= \frac{500}{12}$$

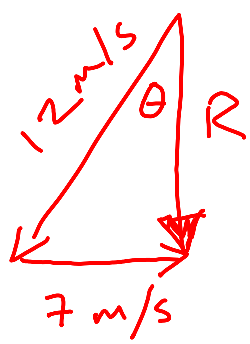
$$\boxed{t = 42 \text{ s}}$$

(c) Where would the boat have to aim in order to end up directly across from its starting point?

→ boat should aim into the current



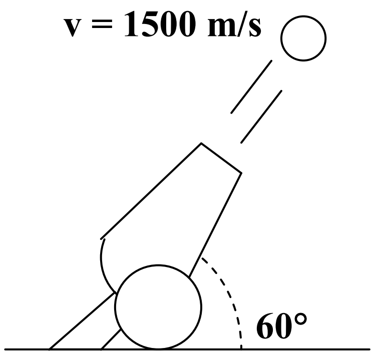
→ vector-add boat velocity + current velocity so that the resultant is directed due south (across the river)

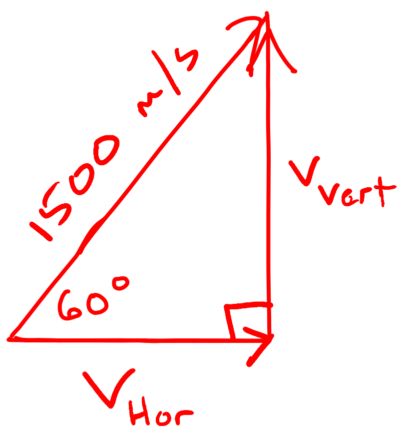


$$\theta = \sin^{-1}\left[\frac{7}{12}\right] = 36^\circ$$

Answer: $\boxed{36^\circ \text{ W of S}}$

Example 7.
A cannon is shot at a muzzle velocity of 1500m/s at an angle of 60º to the horizontal. What are the vertical and horizontal components of the velocity?





vertical component: $\dfrac{V_{vert}}{1500} = \sin 60°$

$V_{vert} = 1500 \sin 60°$

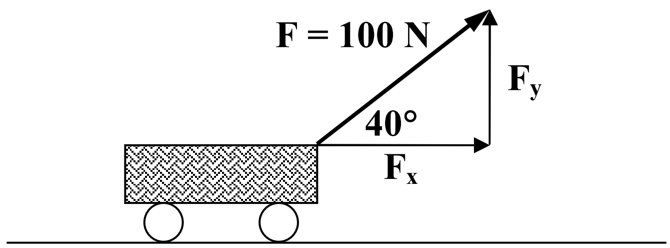
$\boxed{V_{vert} = 1.3 \times 10^3 \text{ m/s.}}$

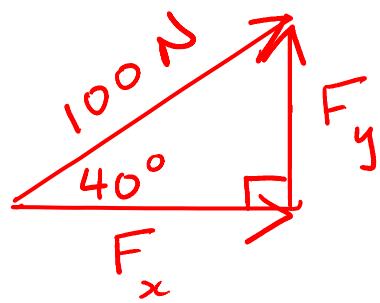
horizontal component: $\dfrac{V_{Hor}}{1500} = \cos 60°$

$V_{Hor} = 1500 \cos 60°$ $\boxed{V_{Hor} = 7.5 \times 10^2 \text{ m/s}}$

Example 8.

A boy pulls a wagon with a force of 100 N at 40 degrees to the horizontal. Find the pulling force (F_x) and the lifting force (F_y).





Pulling Force: $\dfrac{F_x}{100} = \cos 40°$

$F_x = 100 \cos 40°$

$\boxed{F_x = 76.6\ \text{N}}$

Lifting Force: $\dfrac{F_y}{100} = \sin 40°$

$F_y = 100 \sin 40°$

$\boxed{F_y = 64.3\ \text{N}}$