Lesson Video: https://www.loom.com/share/afbf20f798594279a6b0c1ee1aa8a447

PART 1: Physics – Vector Kinematics in 2-D – GRAPHICAL METHODS – Rivers and Airplanes

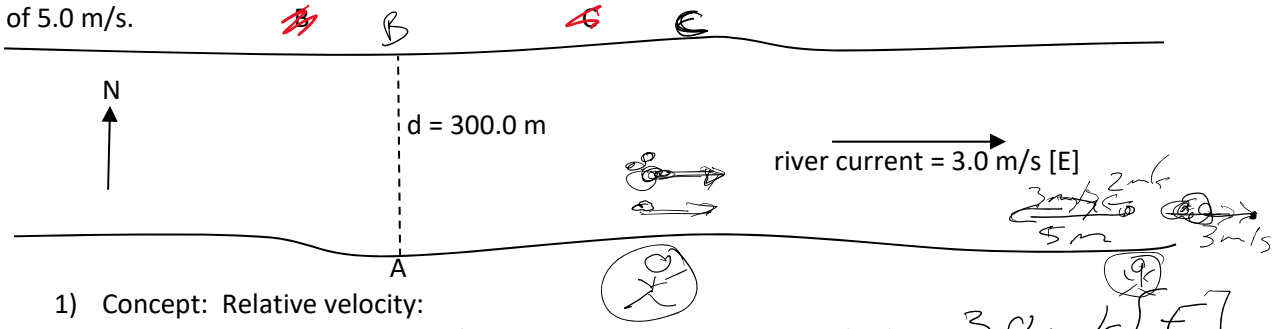
Drawing scale diagrams

Rivers/sailboats/airplanes – The same basic strategies are used for all (2-D vector addition)
Use GRAPHICAL METHODS (scale diagrams, ruler, and protractor) to solve problems 4 to 7.

Ch 3, 4

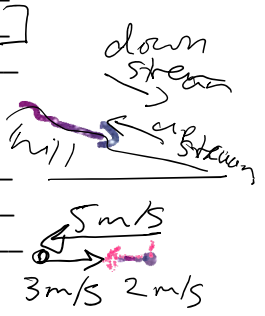
Examples of River Problems:

Parameters: A 300.0 m wide river flows with a current of 3.0 m/s [E]. In still water the boat can travel at a speed of 5.0 m/s.

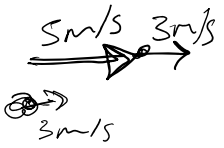


1) Concept: Relative velocity:
   a. What is the velocity of the water relative to the shore ($\mathbf{v_{ws}}$)? 3.0 m/s [E]
   b. What is the velocity of the shore relative to the water ($\mathbf{v_{sw}}$)? 3.0 m/s [W]
   c. What is the velocity of the water relative to the water ($\mathbf{v_{ww}}$)? 0.0 m/s

2) The boat heads directly upstream against current
   a. What is the boats' **heading**? West
   b. What is the velocity of the boat relative to the water ($\mathbf{v_{bw}}$)? 5.0 m/s [W]
   c. What is the velocity of the boat relative to the shore (land) ($\mathbf{v_{bs}}$)? 2.0 m/s [W]



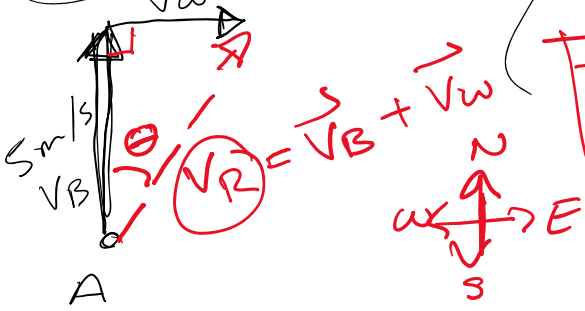
3) The boat heads directly downstream:
   a. What is the boats' heading? East
   b. What is the velocity of the boat relative to the water? 5.0 m/s [East]
   c. What is the velocity of the boat relative to the shore (land)? 8.0 m/s [East]



COMPLETE PROBLEMS 4 to 7 ON A SEPARATE PIECE OF PAPER USING SCALE DIAGRAMS:

4) The boat starts at the south shore (at point A) and heads directly North to get to the opposite shore: What is the resultant velocity of the boat? (magnitude and direction)

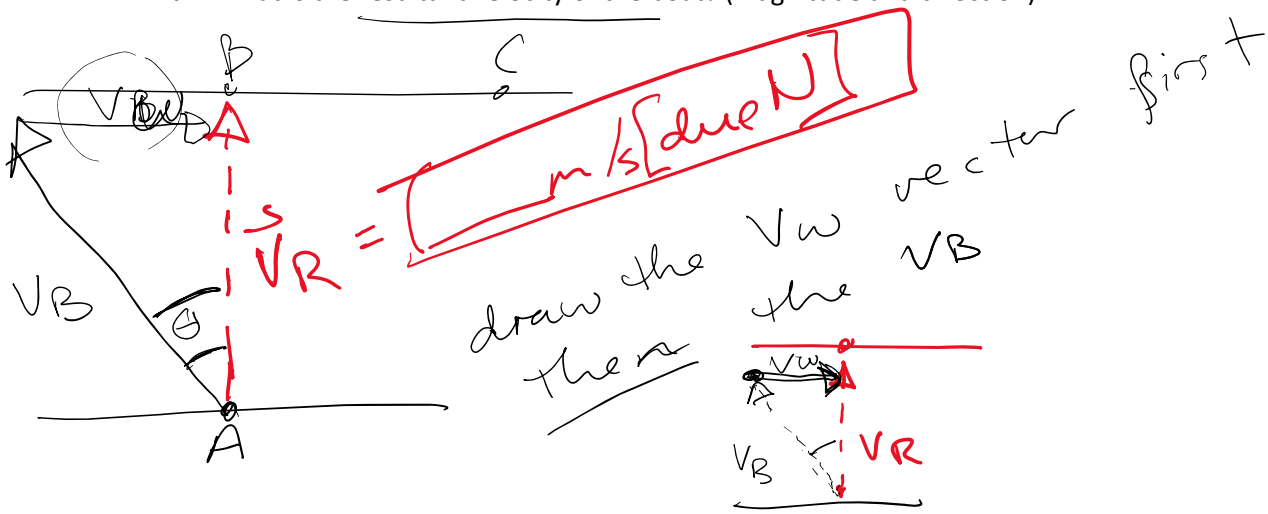
Sketch 1cm:1m/s you draw with ruler + protractor. to scale.



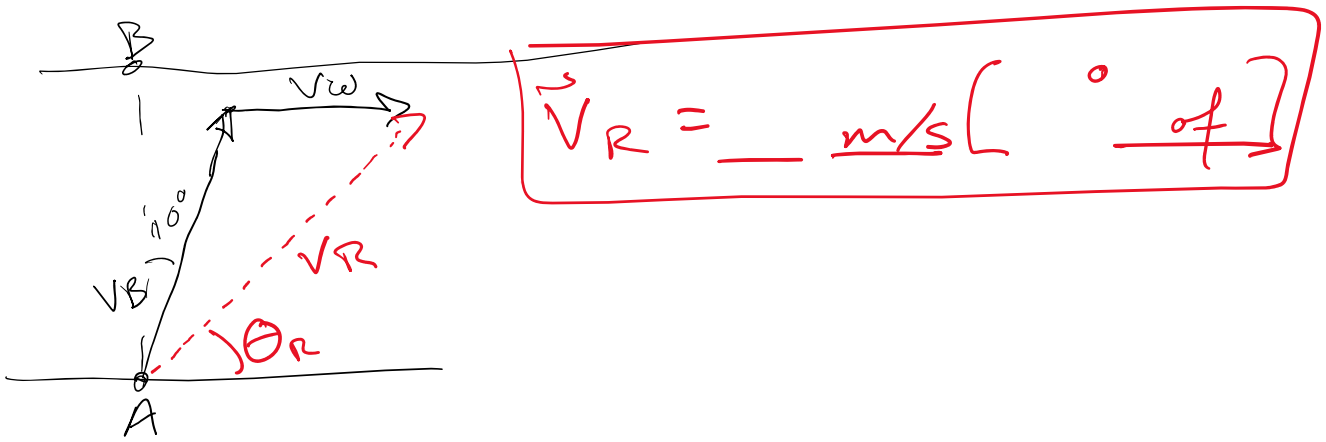
$\vec{V_R} = \vec{V_B} + \vec{V_W}$

$\vec{V_R}$ = ____ m/s [____ ° E of N]

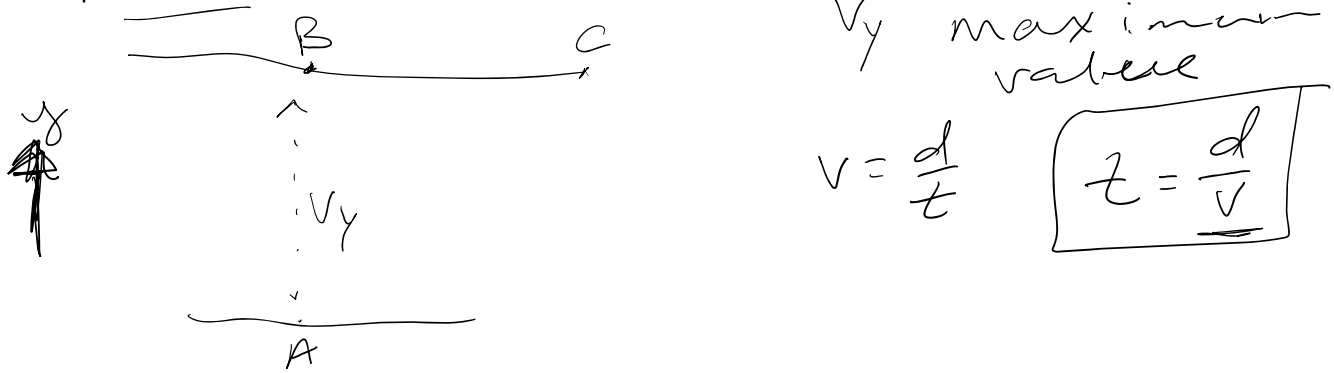
5) The boat starts at the south shore (at point A). The captain wants to travel directly across the river to opposite shore, covering the shortest possible distance (travelling directly from point A to B):
   a. In what direction should the captain head the boat? (heading)
   b. What is the resultant velocity of the boat? (magnitude and direction)



6) The captain heads 10.0 degrees East of North: What is the resultant velocity of the boat? (magnitude and direction)

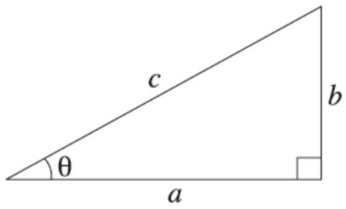


7) In what direction should the captain head the boat in order to reach the opposite shore in the shortest possible time?



Analytical Methods – *The mathematical tools and techniques that you need include:*

For Right-angled Triangles:

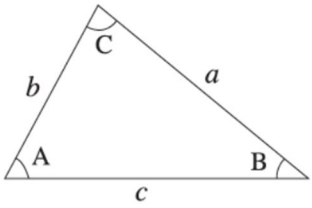


$$a^2 + b^2 = c^2$$

$$\sin\theta = \frac{b}{c} \quad \cos\theta = \frac{a}{c} \quad \tan\theta = \frac{b}{a}$$

$$\text{area} = \frac{1}{2}ab$$

For All Triangles:



$$\text{area} = \frac{1}{2}\text{base} \times \text{height}$$

Sine Law : $\dfrac{\sin A}{a} = \dfrac{\sin B}{b} = \dfrac{\sin C}{c}$

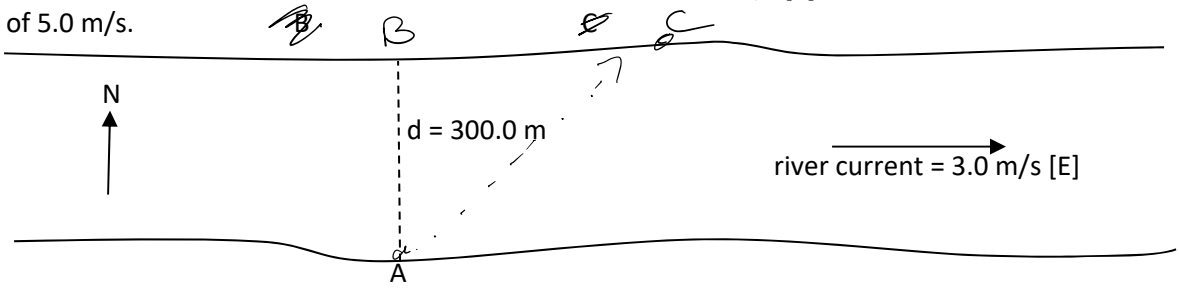
Cosine Law : $c^2 = a^2 + b^2 - 2ab\cos C$

PART2: Physics – Vector Kinematics in 2-D – ANALYTICAL METHODS – Rivers and Airplanes

Rivers/sailboats/airplanes – The same basic strategies are used for all (2-D vector addition) *Sketch* each situation to estimate results graphically. Then, solve mathematically using techniques such as trigonometry and Pythagorean theorem.

Examples of River Problems:

Parameters: A 300.0 m wide river flows with a current of 3.0 m/s [E]. In still water the boat can travel at a speed of 5.0 m/s.



1) The boat starts at the south shore (at point A) and heads directly North to get to the opposite shore:
   a. What is the resultant velocity of the boat? (magnitude and direction)

$V_R = \sqrt{V_B^2 + V_w^2} =$?

$\theta = \tan^{-1}\left[\frac{V_w}{V_B}\right] =$ _____

$V_R =$ _____ m/s [_____° E of N]

   b. How much time does it take to get to the opposite shore?

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

$t = \frac{d_y}{V_y} = \frac{300\text{ m}}{5.0\text{ m/s}} =$?

   c. How far downstream does the boat land? (distance from point B to point C)

x

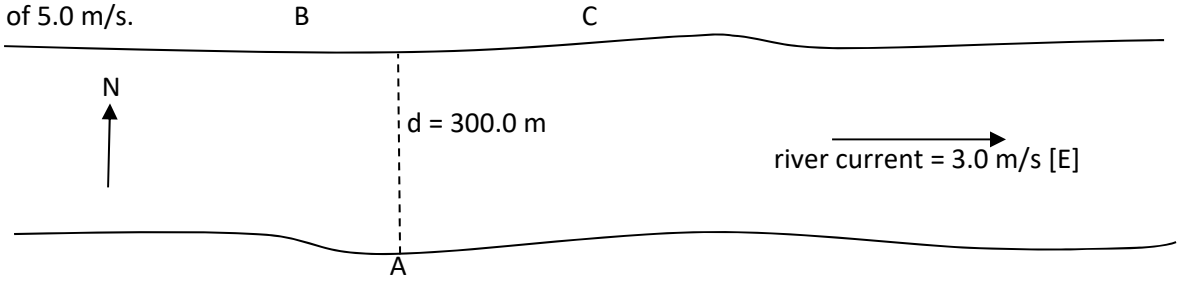
$V_x = \frac{d_x}{t}$

$d_x = V_x t$

$= (3.0\text{ m/s})(\quad)$

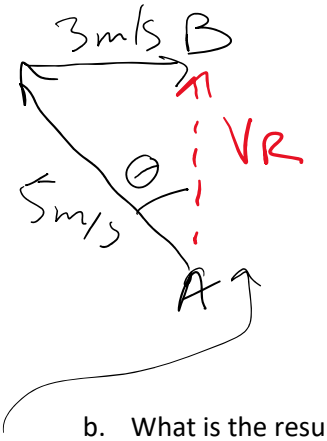
$d_x =$?

Parameters: A 300.0 m wide river flows with a current of 3.0 m/s [E]. In still water the boat can travel at a speed of 5.0 m/s.



2) The boat starts at the south shore (at point A). The captain wants to travel directly across the river to opposite shore, covering the shortest possible distance (travelling directly from point A to B):

   a. In what direction should the captain head the boat? (heading)



which trig function? to solve for θ?

θ = ? [ ]

angle

compass direction

   b. What is the resultant velocity of the boat? (magnitude and direction)

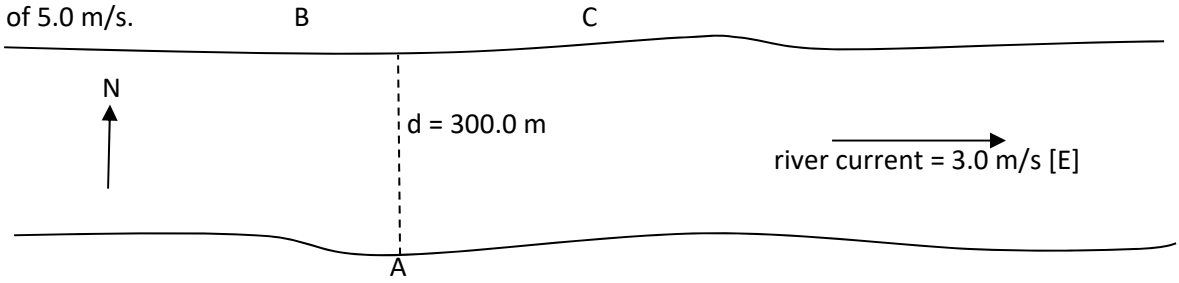
$V_R =$

Pythag.: ?

   c. How much time does it take to get to the opposite shore?

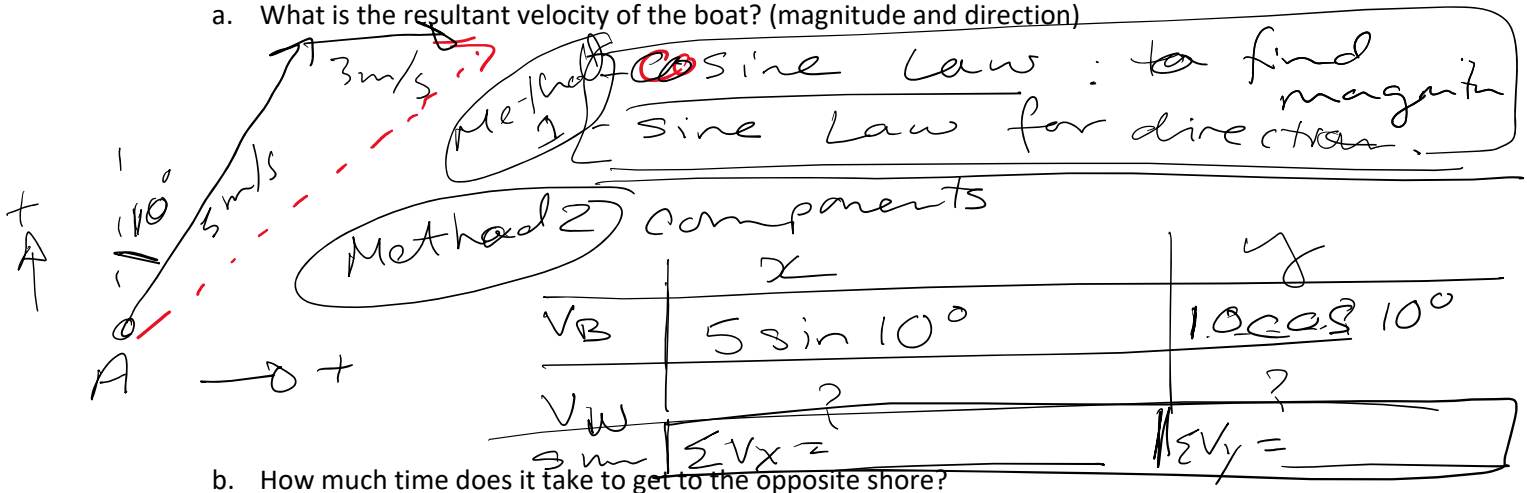
$$t = \frac{d_y}{V_y} = \frac{300m}{?} = \boxed{\quad}$$

Parameters: A 300.0 m wide river flows with a current of 3.0 m/s [E]. In still water the boat can travel at a speed of 5.0 m/s.



3) The captain heads 10.0 degrees East of North:

a. What is the resultant velocity of the boat? (magnitude and direction)



b. How much time does it take to get to the opposite shore?

$$t = \frac{d_y}{V_y} = \frac{300\text{m}}{\qquad}$$

c. How far downstream does the boat land? (distance from point B to point C)

$$d_x = V_x t$$

4) In what direction should the captain head the boat in order to reach the opposite shore in the shortest possible time?

no logical reasoning?