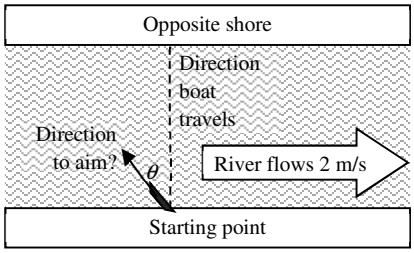
4.29 In still water a boat can travel at 10 m/s. This boat is travelling up and downstream in a river flowing with speed 2 m/s (relative to the earth). Assume the river flows due east ($\hat{\imath}$).

a) Determine the upstream and downstream velocities of the boat relative to the earth. I know the answers are pretty obvious but please try to use this as an opportunity to use the notation mentioned above.
b) Suppose the boat travels upstream (due west) for 10 s then immediately turns around and travels downstream (due east) for 10 s. Determine the displacement, distance traveled, average velocity, and average speed of the boat relative to the earth.
c) Now the boat travels upstream for 96 m then downstream for 96 m. Determine the total travel time. Also determine the displacement, distance traveled, average velocity, and average speed of the boat relative to the earth.

4.30 In still water a boat can travel at 10.0 m/s. This boat is to cross a river which is running at 2.00 m/s to the east. Answer the following questions:



a) At what angle θ should the boat aim to travel straight across the river to the opposite shore?
b) Assume the boat travels due north across the flowing river. If the shore is 50.0 m away, how long will it take to get there?
c) On the way back to the first shore, the boat aims so that it crosses the river as quickly as possible. In which direction should the boat aim & how much faster is this crossing than the previous?

4.31 At time $t = 0$ a bat is distance d due south of the origin flying at speed v heading 60° east of north. At the same instant, a moth located distance d due east of the origin is flying with speed $v/2$ due west. Assume the speeds listed are measured by a stationary observer.

a) Determine the <u>speed</u> of moth relative to the bat.
b) Determine an equation for the position of the moth relative to the bat as a function of time.
c) **Mega-Challenge:** At $t = 0$ the bat begins to accelerate with constant rate a. What direction must the bat accelerate to intercept the moth? Where will they intersect and at what time?

Note: it is interesting to read about the sonar jamming techniques employed by moths to counter bat attacks.

4.31½ A train is traveling to the right with a constant speed of $20.0\,\frac{\text{m}}{\text{s}}$ *relative to the earth*. A baseball player throws a ball with an initial speed of $40.0\,\frac{\text{m}}{\text{s}}$ *relative to the train*. At what angle should the player aim to throw the ball if she wants the ball to leave her hand with a launch angle of $30.0°$ *relative to the stationary ground*.