Physics **Velocity as a Vector**

Solve problems 1- 4 *both analytically and graphically*. Your graphs should be large–a a *minimum* of about 1/2 page in size. Answer #4 with a full-page vector diagram; the analytical solution is extra credit.

1) Mr. Robinson's dinghy, which goes 12 km/h in a lake, is crossing a river, 10 km wide that has current of 5 km/h. The boat constantly "heads" *across* the river — that is, *perpendicular to the current*.

a) Draw a vector diagram representing the components of the boats velocity.
b) How *fast* and in what direction does the boat go in relation to a point on the bank?
c) How *far* does the boat go *across* the river in 0.1 hr?
d) How *far* does it go *downstream* in 0.1 hr?
e) How *far* does it go from its starting point on the bank in 0.1 hr?
f) How *long* would it take the boat to cross the river if there were no current?

2) During a storm, a ship's captain sets the course of his ship due east to reach a port 30 km away in 3 hours. At the end of 3 hours, his ship was 40 km south of its intended destination.

a) What was the resultant velocity of the ship relative to a point on the shore?

b) Nonetheless, the captain still wants to travel due east at 10 km/h. What course should the captain steer his ship to offset the above situation in order to do so?

3) Imagine playing catch with a baseball on Mr. Robinson's yacht, *Robinson Cruise-O* in McCovey Cove. Suppose you throw a ball from the bow (front) of his yacht to the stern (rear) in apparent disregard of the motion of *Robinson Cruise-O* at a constant velocity, *v*, relative to a buoy in the Cove.

a) If *Robinson Cruise-O* is sailing due east 15 km/h and the ball is thrown from the stern to the bow at 15 km/h relative to the boat, what is the velocity of the ball relative to a buoy?

b) If, on the other hand, the ball is thrown from the bow to the stern a 15 km/h, while *Robinson Cruise-O* is still going 15 km/h, how fast is the ball going relative to the buoy?

4) A pilot wishes to fly an airplane to an airport due east, 300 km away, in 45 minutes.

a) If a 300-km/h jet stream is blowing from the northwest (at an angle of 45° west of north), what should the pilot's ground speed (plane's speed relative to the ground) and direction be?

b) What would be his air speed (plane's speed relative to the air) an direction? Hint 1: Solve this problem graphically. Hint 2: Draw a vector diagram of the components the make-up the plane's speed. Hint 3: The components are *not* 90° to each other. Hint 4: Analytical method requires the Law of Cosines or the Law of Sines.

5) In all of the previous two problems, we emphasized that the swimmers or airplane pilots must *head* in directions other than those in which they actually want to travel. Now we ask, *how* does the swimmer or pilot actually maintain a heading in a given direction? That is, *describe a method* a swimmer could actually use to maintain a heading directly across the river or a pilot to navigate themselves while flying?