BACKGROUND

Confusion arises whenever an object is moving relative to some frame of reference which, itself, is in motion. Some examples are a person swimming through moving water, a bird flying through a gust of wind, and an object that has been thrown from a moving vehicle. In each of these cases, the velocity of the moving object, in relation to the frame of reference of the earth, is determined by means of vectors.

INSTRUCTIONS

Solve each of the following problems using a technique similar to the chain rule discussed in class.

RECALL: $${}_p\vec{v}_g = {}_p\vec{v}_a + {}_a\vec{v}_g$$

where ${}_p\vec{v}_g$ = velocity of plane wrt ground

${}_p\vec{v}_a$ = velocity of plane wrt air (airspeed)

${}_a\vec{v}_g$ = velocity of plane air wrt ground (windspeed)

1. The pilot of a light plane heads due north at an air speed of 400 km/h. A 60 km/h wind is blowing from the west.

(a) What is the plane's velocity with respect to the ground?

(b) How far off course would the plane be after 2.5 h, if the pilot had hoped to travel due north but had forgotten to check the wind velocity?

{404 km/h[N8.5°E], 150 km[E]}

2. A swimmer can swim at a speed of 1.80 m/s in still water. If the current in a river 200 m wide is 1.00 m/s[E], and the swimmer starts on the south bank and swims so that she is always headed directly across the river, determine,

(a) the swimmer's resultant velocity, relative to the river bank. {Hint: use ☞ ${}_s\vec{v}_g = {}_s\vec{v}_w + {}_w\vec{v}_g$ }

(b) how long she will take to reach the far shore.

(c) how far downstream she will land (from the point opposite her starting point).

{2.06 m/s[N29°E], 111 s, 111 m[E]}

3. A swimmer on the south shore of a river wishes to swim to a dock due north of his starting point. His maximum swimming speed in still water is 4.0 km/h, and there is a current in the river flowing at 2.5 km/h towards the west.

(a) In what direction must he set out and continue swimming through the water?

(b) If the river is 2.0 km wide, how long does it take him to make the crossing?

{[N39°E], 0.64 h}

4. A canoeist paddles "north" across a river at 3.0 m/s. (The canoe is always kept pointed at right angles to the river.) The river is flowing east at 4.0 m/s and is 100 m wide.

(a) What is the velocity of the canoe relative to the river bank? {Hint: use ☞ ${}_c\vec{v}_b = {}_c\vec{v}_w + {}_w\vec{v}_b$ }

(b) Calculate the time required to cross the river.

(c) How far downstream is the landing point form the starting point?

{5.0 m/s[N53°E], 33 s, 133 m}