PROBLEM 1 – 10 points

Stephanie loves to kayak. When she kayaks on a large lake, which has no current, she paddles a distance of 8.0 km in 2.0 hours at a constant speed.

One day, Stephanie decides to kayak on a river that has a constant current of 2.0 km/h. Stephanie paddles against the current for a while, and then turns around and travels with the current for a while, returning to the same point from which she started. This trip takes a total time of 2.0 hours (the same time as her trip on the lake), and Stephanie always paddles at the same constant speed, relative to the water, that she maintains when kayaking on the lake.

All the questions below pertain to Stephanie's trip on the river.

[5 points] (a) The total distance Stephanie travels on this trip is …

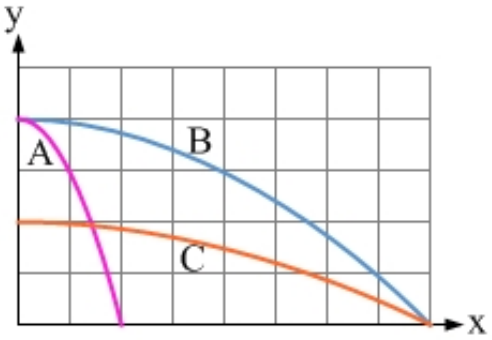
[ ] less than 8.0 km [ ] 8.0 km [ ] more than 8.0 km

Briefly explain your answer. Give us a conceptual explanation, not a calculation.

[3 points] (b) How much time did Stephanie paddle before turning around?

[2 points] (c) How far, relative to her starting point (which is a fixed point on the riverbank) did Stephanie travel before turning around?

PROBLEM 2 – 10 points



The trajectories of three projectiles, A, B, and C, are shown in the figure. All three projectiles are launched horizontally, with no initial vertical component of velocity. Projectile C is launched from a lower point than are projectiles A and B, but C travels the same distance horizontally as projectile B. All three projectiles are influenced only by gravity after launch.

[4 points] (a) Rank the projectiles based on their times of flight, from largest to smallest.

[ ] A=B>C [ ] A>B>C [ ] B>A>C [ ] B>C>A [ ] B=C>A

Briefly justify your answer:

[2 points] (b) Rank the projectiles based on the magnitude of the vertical component of their velocity just before reaching the ground (the *x* axis), from largest to smallest.

[ ] A=B>C [ ] A>B>C [ ] B>A>C [ ] B>C>A [ ] B=C>A

[2 points] (c) Rank the projectiles based on the magnitude of the horizontal component of their velocity, from largest to smallest.

[ ] A=B=C [ ] B=C>A [ ] B>C>A [ ] C>B>A [ ] C>B=A

[2 points] (d) Rank the projectiles based on the magnitude of their accelerations while they are in flight, from largest to smallest.

[ ] A=B=C [ ] A=B>C [ ] A>B>C [ ] B>A>C [ ] B>C>A

PROBLEM 3 – 10 points

A projectile is launched from ground level on flat ground. The initial velocity has a magnitude of v_i at an angle of 60° above the horizontal. The horizontal component of the initial velocity is v_{ix} and the vertical component of the initial velocity is v_{iy}.

Answer TRUE or FALSE for the following statements, which deal with the special case in which the projectile starts and ends at the same height.

(a) Keeping v_i fixed but increasing the launch angle by 5 degrees will increase the time of flight.

[ ] TRUE [ ] FALSE

(b) Keeping v_i fixed but increasing the launch angle by 5 degrees will increase the range.

[ ] TRUE [ ] FALSE

(c) Keeping v_{iy} fixed and increasing v_{ix} will increase the time of flight.

[ ] TRUE [ ] FALSE

(d) Keeping v_{ix} fixed and increasing v_{iy} will increase the time of flight.

[ ] TRUE [ ] FALSE

(e) Keeping v_{ix} fixed and increasing v_{iy} will increase the range.

[ ] TRUE [ ] FALSE

PROBLEM 4 – 10 points

You are flying a small plane from Boston to Buffalo, which is located 660 km due west of Boston. Immediately after taking off you point your plane due west, set the autopilot to cruise at a speed of 220 km/h relative to the air, and then you take a nap. You wake up later and, after checking your watch, you expect to be directly over your destination. Instead, you find yourself 240 km south and 480 km west of Boston, close to Harrisburg, Pennsylvania instead.

[5 points] (a) Assuming the autopilot did exactly what you told it to do, what was the average velocity of the wind acting on your airplane during the flight? You can express this in terms of its components.

[5 points] (b) Sketch a vector diagram to support your calculations above.