SPH4U **RELATIVE MOTION PROBLEM SET**

**DAY #1** Date:

1. The current in a river moves at 2.0m/s [S]. How fast and in what direction must a swimmer move through the water in order to have a resultant velocity relative to the river band of

a) 3.6 m/s [S]?

b) 3.6 m/s [N]?

c) 3.6 m/s [E]?

1. A boat sails 8.0km [S10oE] through still water. What are the components of its displacement in each of the following directions?

a) [S]

b) [E]

* 1. [S10OE]
  2. [E10ON]

1. A helicopter rises with a uniform speed of 30 m/s at an angle of 50o degrees to the horizontal
2. What are the vertical and horizontal components of its velocity?
3. How long will it take to reach an altitude of 1.00km?
4. What horizontal distance will it have covered by that time?
5. A ball is thrown from the top of a building with a speed of 20m/s and at a downward angle of 300 to the horizontal. What are the horizontal and vertical components of the ball’s initial velocity?

300

1. A dog walks at 1.6 m/s on the deck of a boat that is traveling north at 7.6 m/s with respect to the water.
2. What is the velocity of the dog with respect to the water if it walks toward the bow?
3. What is the velocity of the dog with respect to the water if it walks towards the stern?
4. What is the velocity of the dog with respect to the water if it walks towards the east rail, at right angles to the boat’s keel?
5. An airplane maintains a heading due west at an air speed of 900km/h. It is flying through a hurricane with winds of 300 km/h, from the northeast
6. In which direction is the plane moving relative to the ground?
7. What is the plane’s ground speed?
8. How long would it take the plane to fly from one city to another 500km away, along the path in a).
9. A newspaper boy throws papers sideways onto the porches of his customers while riding his bicycle along the sidewalk. The sidewalk is 15m in front of the porches. The boy throws the papers at a horizontal speed of 6.0 m/s relative to himself, and rides the bicycle at a speed of 4.0 m/s relative to the sidewalk.
10. With what horizontal speed do the papers actually travel relative to the ground?
11. How far in advance of a porch should the boy through a paper so that it lands on target?
12. If he waits until he is directly opposite a porch, at what horizontal angle with respect to the sidewalk will he have to throw the paper, to hit the porch?
13. A train has a speed of 20km/h. Raindrops falling against its side windows make traces inclined at 30o to the vertical. We ignore air turbulence and there is no wind.
14. What is the horizontal component of a raindrop’s velocity with respect to the earth? With respect to the train?
15. What is the velocity of a raindrop with respect to the Earth? With respect to the train?
16. A batter strikes a baseball moving horizontally towards him at 15m/s. The ball leaves the bat horizontally at 24m/s, 40o to the left of a line from the plate to the pitcher. The ball is in contact with the bat for 0.01s. Determine
17. The change in velocity of the ball.
18. Its average acceleration while being hit by the bat.

*SPH4U: Physics (Grade 12 University Prep) Relative Motion Problem Set*

**DAY #2** Date:

1. A jet has a maximum airspeed of 800km/h and is flying through a wind that is moving at a rate of 90*km* / *h* in the direction of *W* 300 *S* . Determine
   1. the correct heading of the jet if the pilot wishes to maintain a bearing of due north.
   2. the ground speed of the plane in part a)
2. A fighter jet flying at rate of 1400 km/h needs to hit a target that is directly **north** of the plane’s current position. The missile has a maximum speed of 2500 km/h [w.r.t the jet]. The plane currently has a heading that is due **east**. If the

wind is coming ***from*** a direction of *E*300 *S*  at a rate of 175 km/h. Determine:

* 1. The missile’s ground speed
  2. The angle from which the missile should be fired from the plane
  3. The time it takes to hit the target if it is located 10 km away directly north of the plane.

1. You’re on a Greenpeace mission protesting the illegal activity of some evil doer. Your mission is to strike the evil doer’s boat with stink bombs. Your stink bomb cannon can fire its projectiles at a velocity of 70 km/h. Your Zodiac is ripping through the water at a rate of 50*km* / *h* [*W* ] through a current that is moving at a rate of

10*km* / *h*  *S* 200 *W* The evil doer’s boat is anchored at a position that is exactly south of you when you launch your attack.

* 1. Sketch a detailed vector diagram
  2. Find angle the stink bomb cannon should be fired from the Zodiac in order to hit the evil doer’s boat
  3. Determine the stink bomb’s ground speed.
  4. The time it takes to “annoy the threat” if the jerk is located 20*m* away directly south when you fired the bomb.