

W2.03**Relative Velocity**

- 1) A boat is traveling at 14 km/h with respect to the water of a river in the upstream direction. The water itself is flowing at 9 km/h with respect to the ground.
 - a) What is the velocity of the boat relative to the ground?
 - b) A child on the boat walks from bow to stern at 6 km/h. What is the child's velocity with respect to the ground?
- 2) A person walks up a stalled 15-m-long escalator in 90 s. When standing on the same escalator, now moving, the person is carried up in 60 s. How long would it take the person to walk up the moving escalator? Does the answer depend on the length of the escalator? (Explain why or why not!)
- 3) The airport in Geneva, Switzerland, has a "moving sidewalk" to speed passengers through a long corridor. Peter, who walks through the corridor but does not use the moving sidewalk, takes 150 s to do so. Paul, who simply stands on the moving sidewalk, covers the same distance in 75 s. Mary not only uses the sidewalk but walks along it. How long does Mary take? Assume that Peter and Mary walk at the same speed.
- 4) Two highways intersect at a right angle. A car is 600 m north of the intersection moving south at 60 km/h. A police car is 800 m east of the intersection moving west at 80 km/h. At this moment, what is the velocity of the motorist relative to the police car?
- 5) Snow is falling vertically at a constant speed of 8 m/s. At what angle from the vertical do the snowflakes appear to be falling as viewed by the driver of a car traveling on a straight road with a speed of 13.888 m/s (50 km/h).
- 6) A Cessna flies between two cities. City 2 is 500 km due East of city 1. The plane has an air speed of 250 km/h. There is a 125 km/h crosswind at cruising altitude. What direction must the plane fly in order to reach City 2? How long does the trip take?
- 7) A woman can row a boat 4.0 mph in still water. She decides to row her boat in a river where the current is 2.0 mph. Imagine she rows parallel to the bank of the river (does not cross the river).
 - a) How long would it take her to row 2.0 miles down river and then back to her starting point?
 - b) How long would it take her to row 2.0 miles up river and then back to her starting point?Now, imagine she wishes to reach a point across the river, directly oppose her starting point.
 - c) In what direction will her boat be headed if she wants to reach a point directly opposite from her starting point?
 - d) If the river is 4.0 miles wide, how long will it take her to cross the river?Imagine she wants to cross the river in the shortest amount of time.
 - e) In what direction should she head her boat?
 - f) What direction does the boat actually travel?

W2.03**Relative Velocity - KEY**

- 1) A boat is traveling at 14 km/h with respect to the water of a river in the upstream direction. The water itself is flowing at 9 km/h with respect to the ground.
 - a) What is the velocity of the boat relative to the ground?
 - b) A child on the boat walks from bow to stern at 6 km/h. What is the child's velocity with respect to the ground?
 - a) 5 km/h "upstream"
 - b) 1 km/h "downstream"
- 2) A person walks up a stalled 15-m-long escalator in 90 s. When standing on the same escalator, now moving, the person is carried up in 60 s. How long would it take the person to walk up the moving escalator? Does the answer depend on the length of the escalator? (Explain why or why not!)
 - t = 36 sec
 - No, it's all proportional.
- 3) The airport in Geneva, Switzerland, has a "moving sidewalk" to speed passengers through a long corridor. Peter, who walks through the corridor but does not use the moving sidewalk, takes 150 s to do so. Paul, who simply stands on the moving sidewalk, covers the same distance in 75 s. Mary not only uses the sidewalk but walks along it. How long does Mary take? Assume that Peter and Mary walk at the same speed.
 - t = 50 sec [note: speed side walk is 2x speed of walker, so both speeds is 3x walker or 1/3 time]
- 4) Two highways intersect at a right angle. A car is 600 m north of the intersection moving south at 60 km/h. A police car is 800 m east of the intersection moving west at 80 km/h. At this moment, what is the velocity of the motorist relative to the police car?
 - 100 km/h @ angle of 36.87° south of east
- 5) Snow is falling vertically at a constant speed of 8 m/s. At what angle from the vertical do the snowflakes appear to be falling as viewed by the driver of a car traveling on a straight road with a speed of 13.888 m/s (50 km/h).
 - 60°
- 6) A Cessna flies between two cities. City 2 is 500 km due East of city 1. The plane has an air speed of 250 km/h. There is a 125 km/h crosswind at cruising altitude. What direction must the plane fly in order to reach City 2? How long does the trip take?
 - 30°
 - 2.3 hours
- 7) A woman can row a boat 4.0 mph in still water. She decides to row her boat in a river where the current is 2.0 mph. Imagine she rows parallel to the bank of the river (does not cross the river).
 - a) How long would it take her to row 2.0 miles down river and then back to her starting point?
 - t_{down} = 20 min
 - t_{up} = 60 min
 - t_{total} = 80 min
 - b) How long would it take her to row 2.0 miles up river and then back to her starting point?
 - t_{up} = 60 min
 - t_{down} = 20 min
 - t_{total} = 80 min

Now, imagine she wishes to reach a point across the river, directly oppose her starting point.

 - c) In what direction will her boat be headed if she wants to reach a point directly opposite from her starting point?
 - 30°
 - d) If the river is 4.0 miles wide, how long will it take her to cross the river?
 - 1.15 hours

Imagine she wants to cross the river in the shortest amount of time.

 - e) In what direction should she head her boat? **Straight across**
 - f) What direction does the boat actually travel? **26.6° downstream of straight across**