

Adding Velocity Vectors (aka Relative Motion)

Make a sketch of the problem to help you visualize it. Draw arrowheads to indicate the direction of each vector. Tip: The Resultant is always the motion of the object relative to the ground. The other vectors must add up to give the resultant.

One Dimension

1. i) You are riding on a train that is traveling at 50 km/hour. You kick a can and give it speed of 5 km/hr in the same direction that the train is moving. A.) What is the speed of the can relative to the ground? B.) What if you kick the can in the opposite direction of the train's motion?
2. i) A railroad flatcar is traveling to the right at a speed of 12m/s relative to a person standing on the ground. A motor scooter is being ridden on the flatcar. What is the velocity of the motor scooter relative to the flatcar if its velocity relative to the person on the ground is a.) 18m/s to the right? B.) 1.5m/s to the left? C.) zero?
3. i) Riding on your bicycle you see a car. You are riding at 10 km/hour. You determine that the car is traveling at a speed of 50 km/hour relative to you. What is the speed of the car relative to the ground if a) you are traveling in the same direction and b) you are traveling in opposite directions?
4. i) You are traveling at 10m/s North relative to the ground. Another car is traveling 20m/s relative to the ground. What is the speed of the other car relative to you if the other car is A.) also traveling North? B.) traveling South?
5. ii) Two piers, A and B, are located on a river; B is 1400m downstream from A. Two men must make round trips from pier A to pier B and return. One man is to row a boat at a constant speed of 5.8km/h relative to the water and the other man is to walk on the shore at constant speed of 5.8km/h. The velocity of the river is 3.2km/h in the direction from A to B. How much time does it take each man to make the round trip?

Two-Dimensions

6. i) Driving your car, you are moving at a speed of 15 m/s forward. You throw an apple core sideways out the window at 5 m/s relative to you. What is the velocity of the apple relative to the ground?
7. i) Hitting golf balls, you measure the magnitude and direction of 2 shots. Shot 1: 150m, 125°. Shot 2: 45m, 35°. What is the location of the ball, from your starting point?
8. ii) Mr. A and Tim are driving Tim's AMC Eagle, and decide to throw apples at road signs. Tim drives 30m/s at 45° N of E, while Mr. A throws an apple at an angle of 45° from forward out the passenger window at 14 m/s. How fast and at what angle will the apple hit the road sign?
9. ii) Running hurriedly toward the trash can with a sick stomach at a rate of 3m/s, you begin to hurl. Directing the projectile downward at an angle of 15° from the horizontal, it exits your mouth at .5m/s. With what velocity will it hit Fred, in the front row of the classroom? (Assume no gravitational acceleration).
10. ii) You are running along a bridge, moving 5m/s. If you drop a rock off the bridge as you run, what is the net acceleration of the rock?
11. ii) A pet-store supply truck moves at 25m/s north along a highway. Inside, a dog moves at 5.75m/s at an angle of 35 degrees East of North. What is the velocity of the dog relative to the road?
12. ii) Humanoid robots designed to replace us are being produced in a faraway factory. The robots are moved along a conveyor belt which moves at 3m/s at 65 ° relative to a wall. One robot decides to walk on the conveyor at 45°, at 5m/s. What is its resultant velocity?
13. iii) A plane is flying from Boston to New York, 200 miles away, departs at 1:00 and is scheduled to arrive at 1:45. (Pretend NYC is directly south of Boston.) A crosswind blowing to the west with a speed of 20 miles/hour would push the plane off course. The pilot, who had of course taken physics, knows that if he aims at an angle towards the wind, he will still make it to New York. At what velocity and angle should the pilot direct the plane?
14. iii) The current of a 200m wide straight river has a flow rate of 2.5km/h. A motorboat with a speed of 30km/h in still water crosses the river. Aim the boat 45 degrees up river. Where does it land?
15. If a boat's speed in water is just equal to the current of the river, it is guaranteed to lose ground when crossing from one side to the other. Explain why.

1. a) 55km/hr b) 45km/hr
2. a) 6m/s b) -13.5m/s c) -12m/s
3. a) 60km/hr b) -40km/hr
4. a) 10km/hr b) -30km/hr
5. Time for boat: .693 hr. Time for walker: .483hr
- 6.
- 7.
- 8.
9. 3.48 m/s, -2.14°
10. 9.8 m/s^2 , -90°
11. 29.9m/s, 83.7°
- 12.
13. 266.8 mi/hr, -87.8°
14. 176m upstream