

# Physics 50 Vectors and Relative Motion

For each question, choose only one letter A–E as your answer. Record your answers on a scantron sheet (882-E or compatible with that) and submit the scantron sheet on the due date.

This diagram is for questions 1–5.

In a river, a boat moves relative to the water and the water moves relative to the shore. The result is that the resultant velocity of the boat relative to the shore is different than the boat's speedometer reading, due to the movement of the water that the boat is in. In the diagram below, a top view of a river is shown. The river flows south (downward in the diagram). A boat starts on the west side (left side) of the river and heads a variety of directions to get to the other side. Match the boat headings and boat speeds to the indicated destinations. Use each letter once.

	Boat Heading	Boat Speed	Destination (A, B, C, D or E)
1.	→	14 mi/hr	
2.	→	7 mi/hr	
3.	↗	7 mi/hr	
4.	→	20 mi/hr	
5.	↗	12 mi/hr	

6. A pilot wishes to fly due north. The wind is blowing out of the southeast and towards the northwest. The small plane averages a velocity much greater than the wind speed. In what rough direction should the pilot set the plane's heading?

- (A) due north
- (B) northeast
- (C) northwest
- (D) southeast
- (E) southwest

Questions 7–9 refer to this situation. A riverboat heads east on a river that flows north. The riverboat is moving at 5.10 m/s with respect to the water. The water moves north with respect to the shore at a speed of 3.60 m/s.

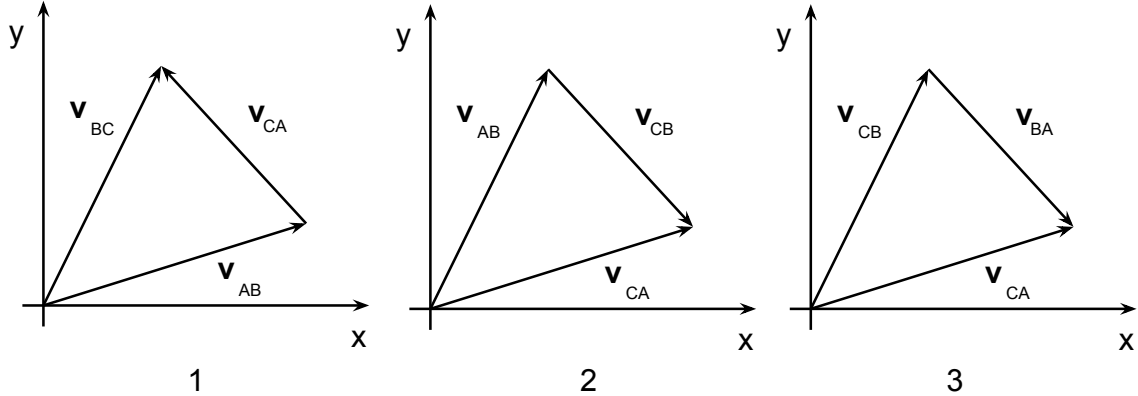
7. What is the resultant velocity of the riverboat (velocity with respect to the shore).
  - (A) 1.50 m/s
  - (B) 3.61 m/s
  - (C) 6.24 m/s
  - (D) 8.70 m/s
  - (E) 9.61 m/s
  
8. If the river is 71.0 m wide, what is the time required for the boat to cross the river?
  - (A) 8.16 s
  - (B) 11.4 s
  - (C) 13.9 s
  - (D) 19.7 s
  - (E) 47.3 s
  
9. What is the distance that the boat will travel downstream?
  - (A) 30.0 m
  - (B) 40.9 m
  - (C) 50.1 m
  - (D) 71.0 m
  - (E) 86.8 m

Questions 10-12 refer to this situation. Suppose that the boat attempts this same task of crossing the river (at 5.10 m/s with respect to the water) on a day in which the river current is greater, moving at 4.70 m/s with respect to the shore.

10. What is the resultant velocity of the riverboat (velocity with respect to the shore).
  - (A) 0.400 m/s
  - (B) 1.98 m/s
  - (C) 6.24 m/s
  - (D) 6.94 m/s
  - (E) 9.80 m/s

11. The river is still 71.0 m wide. What is the time required for the boat to cross the river?
- (A) 7.24 s
  - (B) 10.2 s
  - (C) 13.6 s
  - (D) 13.9 s
  - (E) 35.9 s
12. What is the distance that the boat will travel downstream?
- (A) 34.0 m
  - (B) 36.7 m
  - (C) 48.1 m
  - (D) 63.9 m
  - (E) 65.4 m
13. For a boat heading straight across a river, does the speed at which the river flows affect the time required for the boat to cross the river?
- (A) Yes, the boat's speed relative to the ground is greater when the river flows faster.
  - (B) Yes, the boat covers a larger distance if the river flows faster.
  - (C) No, the direction of the current flow is perpendicular to the direction across the river and perpendicular directions are independent.
  - (D) No, the speed at which the river flows has no affect on the boat's motion relative to the ground.

14. Particle C moves with a velocity  $\vec{v}_{CA}$  relative to observer A and with a velocity  $\vec{v}_{CB}$  relative to observer B. Which of these vector diagrams could possibly be valid in this situation?

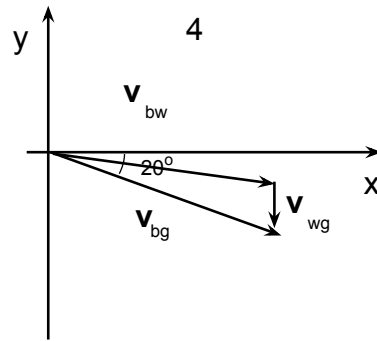
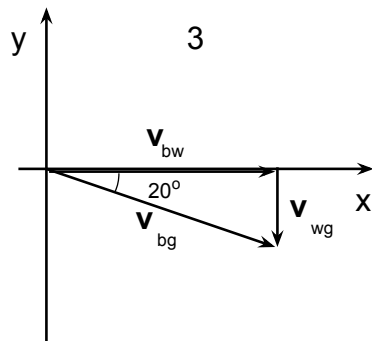
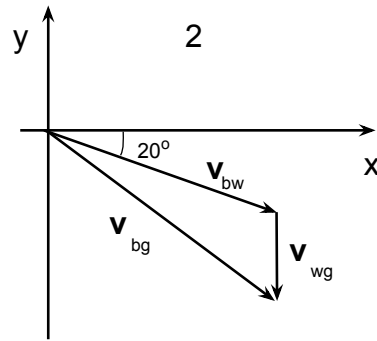
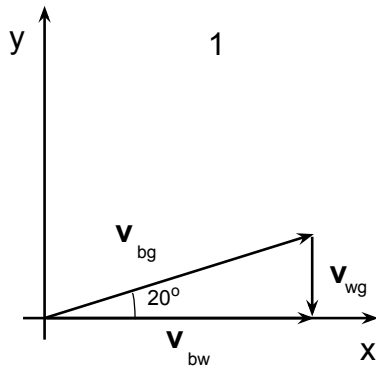


- (A) 1 only  
 (B) 2 only  
 (C) 3 only  
 (D) 1 and 3 only  
 (E) all

Questions 15-17 refer to this situation. You ride a boat across a river, and your velocity relative to the ground is 10.0 m/s at an angle of  $20.0^\circ$  *downstream* (this angle is measured relative to an  $x$  axis that points directly across the river). The current in the river has a speed of 2.00 m/s.

15. What is the speed of the boat speed relative to water?
- (A) 9.50 m/s  
 (B) 9.80 m/s  
 (C) 10 m/s  
 (D) 10.2 m/s  
 (E) 10.8 m/s
16. What is the direction of the boat's heading? All angles are relative to the  $x$ -axis:
- (A)  $0^\circ$   
 (B)  $8.59^\circ$  downstream  
 (C)  $20.0^\circ$  downstream  
 (D)  $20.0^\circ$  upstream  
 (E)  $30.0^\circ$  downstream

17. Let the subscript g refer to the ground, b to the boat, and w to the water. Which vector diagram accurately represents the situation in this problem?



- (A) 1
- (B) 2
- (C) 3
- (D) 4
- (E) none