3.4 Vector Applications

Practice Tasks

I. Concepts and Procedures

1. Suppose Madison is traveling due west for 0.5 miles and then due south for 1.2 miles.
   a. Draw a picture of this scenario with her starting point labeled A, ending point B, and include the vector $\overrightarrow{AB}$.
   b. State the value of $\overrightarrow{AB}$.
   c. What is the magnitude and direction of $\overrightarrow{AB}$?

II. Problem Solving

1. A ship leaves port and travels 49 miles at a standard position angle of 30°. The ship then travels for 89 miles in a standard position angle of 70°. At that point, the ship drops anchor. A helicopter, beginning from the same port, needs to join the ship as quickly as possible. Tell the helicopter's pilot how to get to the ship.

2. You jump into a river intending to swim straight across to the other side. But when you start swimming, you realize the current is traveling 4 miles per hour due south. You are trying to swim due East at 1 mile per hour, but the current is pulling on you. If you don't make any adjustment for the current, how far from your starting point will you be in 15 minutes?

3. A plane is traveling at 400 mph along a path 40° North of East. A strong wind begins to blow at 50 mph from North to South. If no adjustment is made for the wind, what are the resulting bearing and groundspeed of the plane?

4. A motorboat traveling from one shore to the other at a rate of 5 m/s east encounters a current flowing at a rate of 3.5 m/s north.

   a. What is the resultant velocity?

   b. If the width of the river is 60 meters wide, then how much time does it take the boat to travel to the opposite shore?

   c. What distance downstream does the boat reach the opposite shore?

5. A ship sails 12 hours at a speed of 8 knots (nautical miles per hour) at a heading of 68° south of east. It then turns to a heading of 75° north of east and travels for 5 hours at 15 knots.

   a. Find the resultant displacement vector. Give your answer in component form.

   b. Convert your answer to magnitude-direction form.

6. In three-person tug-of-war, three ropes are tied at a point. Adam is pulling due East with a force of 600 Newtons, Barry is pulling due North with a force of 400 Newtons, and Cal is pulling the third rope. The knot in the middle is not moving. What are the direction and magnitude of Cal's effort?

7. A rocket is launched at an angle of 33° from the ground at a rate of 50 m/s.
   a. How fast is the rocket traveling up to the nearest m/s?

   b. How fast is the rocket traveling to the right to the nearest m/s?

   c. What is the rocket's velocity vector?

   d. Does the magnitude of the velocity vector agree with the set-up of the problem? Why or why not?

   e. If a laser is in the path of the rocket and would like to strike the rocket, in what direction does the laser need to be aimed? Express your answer as a vector.

III. Reasoning

1. Is it possible for the sum of two vectors to equal one of the vectors? Explain your reasoning.

2. Consider any two vectors in space, u and v with θ the angle between them.
   a. Use the law of cosines to find the value of $\|u - v\|$.
   b. Use the law of sines to find the value of ψ, the angle between $u - v$ and u. State any restrictions on the variables.