1. Let $\vec{A}$ and $\vec{B}$ be defined as in the picture.

(a) Draw $\vec{A} + \vec{B}$
(b) Draw $\vec{A} - 2\vec{B}$
(c) What kind of vector is $\vec{A} + \vec{B}$ if $\vec{A}$ and $\vec{B}$ are acceleration vectors?
(d) What kind of vector is $\vec{A} + \vec{B}$ if $\vec{A}$ is a velocity vector and $\vec{B}$ is a position vector?

2. It is game day, and Rutgers is playing against Cincinnati. (Sorry, this problem is from 2009.) At the start of a play, Tom Savage runs directly backwards (perpendicular to the line of scrimmage) for two meters, then to the right (parallel to the line of scrimmage) for three meters, and then two meters backwards to the left at an angle of 45°. At this point, he is sacked.

(a) Draw his path and his resulting displacement vector.
(b) Find his total forward displacement and his total sideways displacement.
(c) Give a numerical version of his total displacement vector (magnitude and direction).
(d) If the play took five seconds, what was his average velocity (magnitude and direction)?
(e) How would you draw his velocity vector?

3. A force acts on an object in the $x$ direction. In which direction does the object’s acceleration point?

4. An object’s velocity vector is spinning in a circle, but its magnitude remains constant. Is the object accelerating?

5. A rope is pulling an 180,000 kg blue whale upward with a force of 1,000,000 N. Assume the rope is massless and cannot be stretched.

(a) Draw a free-body diagram for the whale.
(b) Find the net force on the whale.
(c) Find the whale’s acceleration (magnitude and direction).
(d) The rope can withstand a maximum tension of 2,000,000 N without breaking. What is the largest upward acceleration that the whale can experience without the rope breaking?
6. A swimmer needs to cross the Raritan as soon as possible to avoid an untimely death in its poisonous waters. He can swim at a maximum speed of 1.5 m/s. The current of the river is 1 m/s and the river is 15 m wide. When the swimmer enters the river, his velocity will add to the water’s velocity.

(a) If he swims so that his motion is perpendicular to the “Banks of the Old Raritan,” how long will it take him to reach the other side?

(b) If he instead lets his body be carried downstream by the current while aiming himself at the other bank, how long will it take him to reach the other side?

(c) In this situation, how far downriver will he travel?