WALK THE DOG

Q1 The magnitude stays the same. (In other words Rex is always the same distance—the length of his leash—from the tree.)

Q2 Students should be able to get within about 1° of the answers below.

a. magnitude = 5; direction = 0°
b. magnitude = 5; direction = 143.13°
c. magnitude = 5; direction = 270°
d. magnitude = 5; direction = 233.13°

Q3 Students should be able to get within about 0.1 of the answers below.

a. (4.33, 2.50)
b. (−3.54, 3.54)
c. (−2.50, −4.33)
d. (3.00, −4.00)

Q4 To get away from the ladybug when it's at (5, 0), Rex should move to (−5, 0). In magnitude-direction form he should move 5 units in direction 180°. In general, vectors (x, y) and $(-x, -y)$ face in opposite directions.

Q5 To get away from the ladybug when it's at distance 5 units and direction 140°, he should move to distance 5 units and direction 320°. In component form he should move to (3.83, −3.21). Assuming positive magnitude, a vector in direction θ and a vector in direction $\theta + 180°$ face in opposite directions.

Q6 The components of **a** are (2, 4). To find these components without moving point *You* to the origin, you can subtract the coordinates of the tail from the coordinates of the head.

Q7 The only things that change when vector **a** is dragged are the locations of its head and tail. The first method for describing vectors uses magnitude and direction—neither of these changes as **a** is dragged. The second uses the components, and these don't change either. No matter where the head and tail actually are, the result of the subtraction never changes.

Q8 (82, 84). No matter where you're standing, Rex is 2 units to the right and 4 units up, because the components of the vector are (2, 4).

Q9 Page 3: (83, 81). Find the components by dragging the vector so its tail is at the origin. The components are (3, 1), so Rex is always 3 units to the right of you and 1 unit up from you.

Page 4: (74, 83). Find the components by dragging the vector so its tail is at the point marked (8, 6) and then subtracting. The components are (−6, 3), so if you are at (80, 80), Rex will be at (74, 83).

Q10 Page 3: (86, 82). If the leash is twice as long, the components must be (6, 2).

Page 4: (68, 86). If the leash is twice as long, the components must be (−12, 6).

Use this presentation to introduce vectors and two common ways to describe them. Vectors often represent physical quantities, and the scenario of walking a dog on a leash provides a hook students can use to understand the concepts better.

Q1 If you walk 2 miles north and then 2 miles south, how far did you go? (Encourage discussion of the alternative answers: 4 miles or no distance at all. Use the discussion to point out that distance alone isn't enough here, and that you also have to take into account the direction of the walk.)

Define a *vector* as a quantity that has both magnitude (size or length) and direction, and describe some areas in which vectors are important in everyday life.

WALK THE DOG

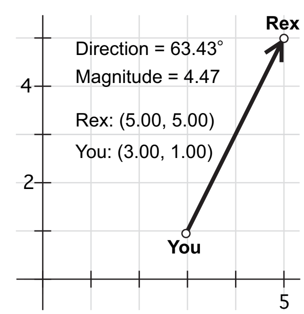
This activity is particularly effective with a student operating the computer and taking direction from you and from other students.

1. Open **Introduction to Vectors Present.gsp.** Describe the situation: Rex's leash is tied to a tree at the origin of an *xy*-coordinate system. Rex is pulling the leash tight as he excitedly waits for you to take him on a walk.

Q2 Get students to answer each of the questions on this page. Remind them periodically of the equivalence of the two different ways they are using to describe the same object: by components or by magnitude and direction.

Now it's time to untie the leash from the tree and take Rex for a walk.

2. On page 2 you've untied Rex from the tree, and he's pulling in a certain direction, no matter where you try to drag your end of the leash.



Q3 What are the components of vector **a**? How can you determine the components without moving point *You* to the origin?

Q4 Drag vector **a** around the screen and ask whether the vector changes as the coordinates of its head and tail change. Get students to explain why, no matter where you drag it, vector **a** is always the same vector. Encourage them to use both methods of describing the vector in their arguments.

Q5 On page 3, where will Rex be when you're at (80, 80)? How can you figure this out? Let the discussion develop until students find and understand a strategy.

Q6 On page 4 the objective is the same, but the available information is different. Encourage students to describe their strategy to each other.

Q7 What if your leash is twice as long, and Rex is still pulling in the same direction? Now where will Rex be when you're at (80, 80)? Answer for page 3 and page 4.