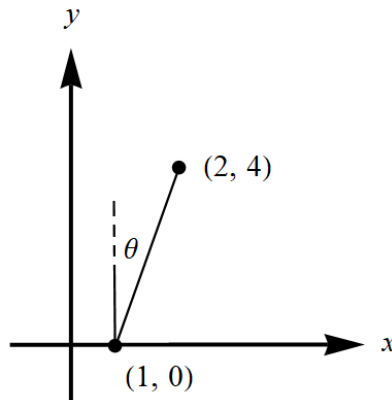


### Exercise 30

Suppose that the ship in Exercise 29 is pointing due north and traveling at a speed of 4 knots relative to the water. There is a current flowing due east at 1 knot. The units on the chart are nautical miles; 1 knot = 1 nautical mile per hour.

- If there were no current, what vector  $\mathbf{u}$  would represent the velocity of the ship relative to the sea bottom?
- If the ship were just drifting with the current, what vector  $\mathbf{v}$  would represent its velocity relative to the sea bottom?
- What vector  $\mathbf{w}$  represents the total velocity of the ship?
- Where would the ship be after 1 hour?
- Should the captain change course?
- What if the rock were an iceberg?

### Solution



The vector joining the ship to the rock is

$$(2, 4) - (1, 0) = (1, 4) \text{ nautical miles.}$$

The angle is

$$\tan \theta = \frac{1}{4} \quad \rightarrow \quad \theta = \tan^{-1} \frac{1}{4} \approx 14.04^\circ.$$

### Part (a)

If the ship is moving to the north at 4 knots relative to the water, and the water is still relative to the ground, then the ship's speed relative to the ground is

$$\mathbf{u} = (0, 4) + (0, 0) = (0, 4) \text{ knots.}$$

**Part (b)**

If the ship is still relative to the water, and the water is moving at 1 knot to the east relative to the ground, then the ship's speed relative to the ground is

$$\mathbf{v} = (0, 0) + (1, 0) = (1, 0) \text{ knots.}$$

**Part (c)**

If the ship is moving at 4 knots to the north relative to the water, and the water is moving at 1 knot to the east relative to the ground, then the ship's speed relative to the ground is

$$\mathbf{w} = (0, 4) + (1, 0) = (1, 4) \text{ knots.}$$

**Part (d)**

The ship's location after a time  $t$  (in hours) is

$$\begin{aligned} \mathbf{y}(t) &= \mathbf{w}t + \mathbf{y}_0 \text{ nautical miles} \\ &= (1, 4)t + (1, 0) \\ &= (t, 4t) + (1, 0) \\ &= (t + 1, 4t). \end{aligned}$$

The ship's location after one hour is

$$\mathbf{y}(1) = (2, 4) \text{ nautical miles,}$$

which is the rock's location.

**Part (e)**

The captain should change course if he doesn't want the ship to crash.

**Part (f)**

The captain should change course if he doesn't want the ship to crash.