

A boat is headed at  $115^\circ$  and is traveling downstream at 28 mph. The stream is flowing S38°E at 11 mph. In what direction is the boat traveling? At what rate can it travel in still water?

**Solution**

The direction is the boat traveling is at  $115^\circ$  to the direction of the stream (S38°E). We have

$$S38^\circ E + 115^\circ = W13^\circ S.$$

The velocity of a boat ( $\vec{V}_1$ ) is a vector sum of vectors of velocity in still water ( $\vec{V}_0$ ) and the stream ( $\vec{V}$ ):

$$\vec{V}_1 = \vec{V}_0 + \vec{V}.$$

According to the cosine theorem

$$V_0^2 = V_1^2 + V^2 - 2VV_1 \cos 115 = V_1^2 + V^2 + 2VV_1 \cos 65.$$

So

$$V_0 = \sqrt{28^2 + 11^2 + 2 * 11 * 28 * \cos 65} = 34.14 \text{ mph.}$$

**Answer: W13°S; 34.14 mph.**