Feb. 17, 2020

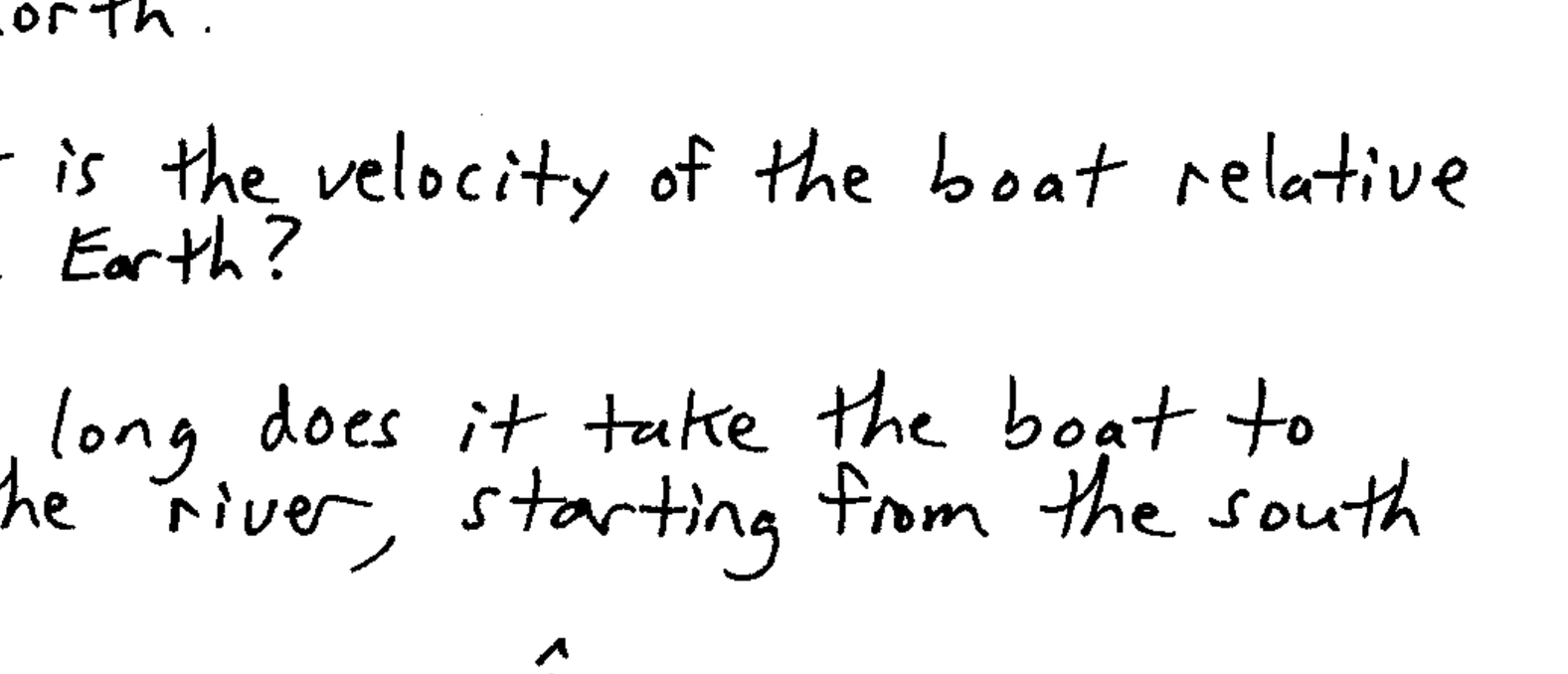
This is a 2-D problem involving relative motion.

A 350 m wide river flows in the east direction at 2.5 m/s. A boat with a speed of 9.5 m/s relative to the water sets a course that is pointed in a direction 25° west of north.

(a) What is the velocity of the boat relative to the Earth?

(b) How long does it take the boat to cross the river, starting from the south bank?

Solution:



(a) Use the vector equation: $\vec{v}_P = \vec{v}_B + \vec{v}_{PB}$

$\vec{v}_P$ = ? (velocity of the boat relative to the Earth)

$\vec{v}_B = 2.5\hat{i}$ (velocity of the river relative to the Earth)

$\vec{v}_{PB} = -9.5\sin 25°\,\hat{i} + 9.5\cos 25°\,\hat{j}$ (velocity of the boat relative to the water)

Substitute:

$$\vec{v}_p = 2.5\hat{i} - 9.5\sin 25°\,\hat{i} + 9.5\cos 25°\,\hat{j}$$

$$\vec{v}_p = -1.515\,\hat{i} + 8.61\,\hat{j} \text{ (units in m/s)}$$

(answer)

(b) The component of velocity in the width direction of the river is $8.61\,\hat{j}$ (m/s).

Since the width of the river is 350m, the time to cross it is:

$$t = \frac{350\,m}{8.61\,m/s} = 40.7\,s \text{ (answer)}$$