1 | **boatman problem**

Target displacement: $\langle 3\text{km}, 2\text{km}\rangle$

We are working with the velocities of the boat and the river. The velocity of the river is defined as $r = \langle 0, -3.5\rangle$. We want to find vector $v = \langle v_x, v_y\rangle$ s.t.

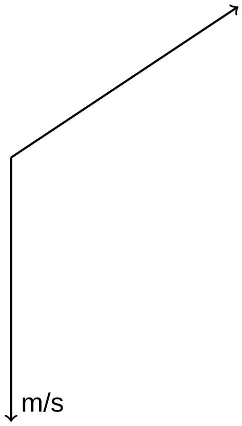
$$|v| = 13 \text{ km/h}$$
$$\lambda(v + r) = \langle 3, 2\rangle$$

Where the trip will take λ hours

$$v_x^2 + v_y^2 = 13^2$$
$$\lambda(v_x + 0) = 3$$
$$\lambda(v_y + -3.5) = 2$$

$$v_x = \frac{3}{\lambda}$$
$$v_y = \frac{2}{\lambda} + 3.5$$
$$\frac{3^2}{\lambda^2} + \left(\frac{2}{\lambda} + 3.5\right)^2 = 13^2$$
$$\frac{3^2}{\lambda^2} + \frac{2^2}{\lambda^2} + 3.5^2 + \frac{4(3.5)}{\lambda} = 13^2$$
$$\frac{3^2 + 2^2}{\lambda^2} + \frac{4(3.5)}{\lambda} = 13^2 - 3.5^2$$
$$3^2 + 2^2 + 4(3.5)\lambda = \lambda^2\left(13^2 - 3.5^2\right)$$
$$13 + 4(3.5)\lambda = \lambda^2\,(156.75)$$
$$-156.75\lambda^2 + 14^2 + 13 = 0$$
$$\frac{-14 \pm \sqrt{14^2 + 4(13)156.75}}{-2(156.75)}$$
$$\frac{-14 + \sqrt{14^2 + 4(13)156.75}}{-2(156.75)} = -0.24676847741$$
$$\frac{-14 - \sqrt{14^2 + 4(13)156.75}}{-2(156.75)} = 0.336082671987$$

Maybe it's time to do it geometrically



Let θ be the angle difference that you paddle at, and ϕ be the angle that you are aiming for.

$$\begin{aligned}
3.5^2\lambda^2 &= 13 + 13\lambda - 2(13)13\lambda\cos\theta \\
\tan\phi &= \frac{3}{2} \\
\sin(\theta+\phi) &= \frac{3.5\lambda+2}{13\lambda}
\end{aligned}$$

attempt 3: after getting help from leonard

$$\begin{aligned}
\beta = \alpha + \frac{\pi}{2} &= \tan^{-}\frac{2}{3} = 2.158 \\
\frac{\sin\beta}{|v|} &= \frac{\sin\gamma}{3.5} \\
\frac{\sin(2.158)}{13} &= \frac{\sin\gamma}{3.5} \\
3.5\frac{\sin(2.158)}{13} &= \sin\gamma \\
\gamma &= 3.5\frac{\sin(2.158)}{13} = 0.2241 \\
\alpha + \gamma &= 0.588 + 0.2241 = 0.8121 \text{ radians}
\end{aligned}$$

The speed

$$\frac{3}{13\cos 0.812} = 0.3353 \text{ hours}$$

dang it i was actually right the first time. apparently math isn't a democracy.