60. Here, the subscript W refers to the water. Our coordinates are chosen with $+x$ being *east* and $+y$ being *north.* In these terms, the angle specifying *east* would be 0° and the angle specifying *south* would be −90° or 270°. Where the length unit is not displayed, km is to be understood.

(a) We have $\vec{v}_{A\,W} = \vec{v}_{A\,B} + \vec{v}_{B\,W}$, so that $\vec{v}_{A\,B} = (22 \angle -90°) - (40 \angle 37°) = (56 \angle -125°)$ in the magnitude-angle notation (conveniently done with a vector capable calculator in polar mode). Converting to rectangular components, we obtain

$$\vec{v}_{A\,B} = -32\,\hat{\imath} - 46\,\hat{\jmath} \;\; \text{km/h} \; .$$

Of course, this could have been done in unit-vector notation from the outset.

(b) Since the velocity-components are constant, integrating them to obtain the position is straightforward ($\vec{r} - \vec{r}_0 = \int \vec{v}\, dt$)

$$\vec{r} = (2.5 - 32t)\,\hat{\imath} + (4.0 - 46t)\,\hat{\jmath}$$

with lengths in kilometers and time in hours.

(c) The magnitude of this $\vec{r}$ is

$$r = \sqrt{(2.5 - 32t)^2 + (4.0 - 46t)^2}$$

We minimize this by taking a derivative and requiring it to equal zero – which leaves us with an equation for t

$$\frac{dr}{dt} = \frac{1}{2}\frac{6286t - 528}{\sqrt{(2.5 - 32t)^2 + (4.0 - 46t)^2}} = 0$$

which yields $t = 0.084$ h.

(d) Plugging this value of t back into the expression for the distance between the ships (r), we obtain $r = 0.2$ km. Of course, the calculator offers more digits ($r = 0.225...$), but they are not significant; in fact, the uncertainties implicit in the given data, here, should make the ship captains worry.