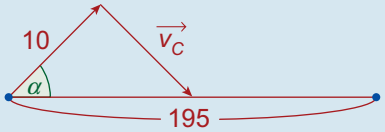
Q. 21.



$\overrightarrow{v_{SC}} = 10\cos\alpha\vec{i} + 10\sin\alpha\vec{j}$

$\overrightarrow{v_C} = 5\vec{i} - 6\vec{j}$

$\overrightarrow{v_S} = \overrightarrow{v_{SC}} + \overrightarrow{v_C}$

$= (10\cos\alpha + 5)\vec{i} + (10\sin\alpha - 6)\vec{j}$

j-component $= 0$

$10\sin\alpha - 6 = 0$

$\Rightarrow \sin\alpha = \frac{3}{5}$

$\Rightarrow \cos\alpha = \frac{4}{5}$

$\therefore \overrightarrow{v_S} = \left(10\left(\frac{4}{5}\right) + 5\right)\vec{i} + 0\vec{j} = 13\vec{i}$

Time $= \frac{195}{13}$

$= 15$ s

Returning is similar, giving the result

$\overrightarrow{v_S} = (-10\cos\alpha + 5)\vec{i} + (10\sin\alpha - 6)\vec{j}$

$10\sin\alpha - 6 = 0$

$\Rightarrow \sin\alpha = \frac{3}{5}$

$\Rightarrow \cos\alpha = \frac{4}{5}$

$\therefore \overrightarrow{v_S} = \left(-10\left(\frac{4}{5}\right) + 5\right)\vec{i}$

$= -3\vec{i}$

Time $= \frac{195}{3}$

$= 65$ s

$\therefore$ Total time $= 15 + 65$

$= 80$ s

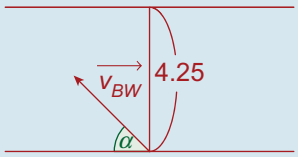
The difference between the outward and return speeds must be $2 \times 5 = 10$ m/s

(Since outward speed gains 5 m/s from the current, but return speed loses 5 m/s)

The outward speed $= \frac{195}{13} = 15$ m/s, the return speed will be $15 - 10 = 5$ m/s.

The time will be $\frac{195}{5} = 39$ s

Q. 22.



$\overrightarrow{v_{BW}} = -18\cos\alpha\vec{i} + 18\sin\alpha\vec{j}$

$\overrightarrow{v_W} = 8\sqrt{2}\vec{i} - 8\sqrt{2}\vec{j}$

$\therefore \overrightarrow{v_B} = (-18\cos\alpha + 8\sqrt{2})\vec{i} + (18\sin\alpha - 8\sqrt{2})\vec{j}$

The i-component is zero $\Rightarrow -18\cos\alpha + 8\sqrt{2} = 0$

$\Rightarrow \cos\alpha = \frac{8\sqrt{2}}{18} = \frac{4\sqrt{2}}{9}$

$\Rightarrow \sin\alpha = \frac{7}{9}$

$\therefore \overrightarrow{v_B} = 0\vec{i} + \left(18\left(\frac{7}{9}\right) - 8\sqrt{2}\right)\vec{j} = (14 - 8\sqrt{2})\vec{j}$

Time $= \frac{4.25}{14 - 8\sqrt{2}}$

Similarly, returning time $= \frac{4.25}{14 + 8\sqrt{2}}$

Total time $= \frac{4.25}{14 - 8\sqrt{2}} + \frac{4.25}{14 + 8\sqrt{2}}$

$= \frac{4.25(14 + 8\sqrt{2}) + 4.25(14 - 8\sqrt{2})}{(14 - 8\sqrt{2})(14 + 8\sqrt{2})} = \frac{7}{4}$ hours