(ii) $\tan\theta = \dfrac{1}{5\sqrt{3}}$

$\Rightarrow \sin\theta = \dfrac{1}{\sqrt{76}}$

But, $\sin\theta = \dfrac{d}{100}$

$\Rightarrow \dfrac{d}{100} = \dfrac{1}{\sqrt{76}}$

$\Rightarrow d = \dfrac{100}{\sqrt{76}}$

$= 11.47$ km

(iii) Two hours before:

relative distance = relative speed $\times$ time

$\Rightarrow x = 17.44 \times 2$

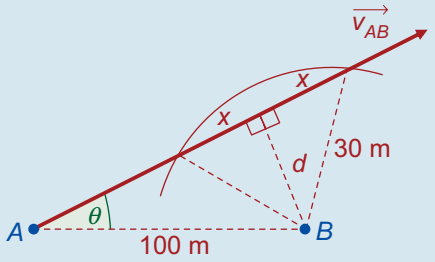
$= 34.88$ km

$y^2 = x^2 + d^2$

$\Rightarrow y = \sqrt{34.88^2 + 11.47^2}$

$= 36.72$ km

Q. 12.



(i) $\overrightarrow{v_A} = 10\cos 30°\vec{i} + 10\sin 30°\vec{j}$

$= 10\left(\dfrac{\sqrt{3}}{2}\right)\vec{i} + 10\left(\dfrac{1}{2}\right)\vec{j}$

$= 5\sqrt{3}\vec{i} + 5\vec{j}$

$\overrightarrow{v_B} = 3\vec{j}$

$\overrightarrow{v_{AB}} = \overrightarrow{v_A} - \overrightarrow{v_B} = 5\sqrt{3}\vec{i} + 2\vec{j}$

(ii) $|\overrightarrow{v_{AB}}| = \sqrt{(5\sqrt{3})^2 + 2^2} = \sqrt{79}$ m/s

$\tan\theta = \dfrac{2}{5\sqrt{3}}$

$\Rightarrow \theta = 13°$

$\Rightarrow 13°$ N of E

(iii) $\dfrac{d}{100} = \sin 13°$

$\Rightarrow d = 100\sin 13°$

$= 22.5$ m

(iv) Draw a circle of radius 30 m with centre B.

As long as the relative path, $\overrightarrow{v_{AB}}$, is inside this circle, Adam and Barbara will be within 30 m of each other. This will be for a relative distance of $2x$.

$x^2 + d^2 = 30^2$ … but $d = 22.5$

$\Rightarrow x = \sqrt{30^2 - 22.5^2}$

$= 19.843$ m

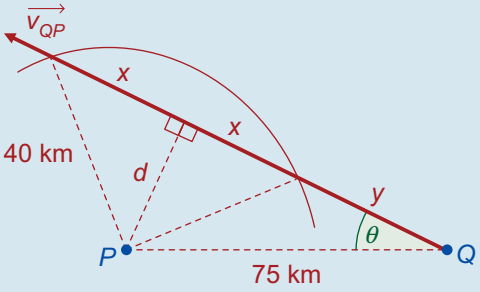
$\Rightarrow$ Adam and Barbara will be within 30 m of each other for a relative distance of $2(19.843) = 39.686$ m

Time $= \dfrac{\text{relative distance}}{\text{relative speed}}$

$= \dfrac{39.686}{\sqrt{79}}$

$= 4.47$ s

Q. 13.



(i) $\overrightarrow{v_P} = 50\cos 45°\vec{i} - 50\sin 45°\vec{j}$

$= 50\left(\dfrac{1}{\sqrt{2}}\right)\vec{i} - 50\left(\dfrac{1}{\sqrt{2}}\right)\vec{j}$

$= 25\sqrt{2}\vec{i} - 25\sqrt{2}\vec{j}$

$\overrightarrow{v_Q} = -30\vec{j}$

$\overrightarrow{v_{QP}} = \overrightarrow{v_Q} - \overrightarrow{v_P}$

$= -25\sqrt{2}\vec{i} + (25\sqrt{2} - 30)\vec{j}$

$= -35.36\vec{i} + 5.36\vec{j}$

$|\overrightarrow{v_{PQ}}| = \sqrt{(-35.36)^2 + (5.36)^2}$

$= 35.76$ m/s

$\tan\theta = \dfrac{5.36}{35.36}$

$\Rightarrow \theta = 8.62°$

$\Rightarrow 8.62°$ N of W

(ii) $\dfrac{d}{75} = \sin 8.62°$

$\Rightarrow d = 75\sin 8.62°$

$\Rightarrow d = 11.24$ km