

$$\begin{aligned}\vec{v}_Q &= -20 \cos 45^\circ \vec{i} + 20 \sin 45^\circ \vec{j} \\ &= -20 \left(\frac{1}{\sqrt{2}} \right) \vec{i} + 20 \left(\frac{1}{\sqrt{2}} \right) \vec{j}\end{aligned}$$

$$= -10\sqrt{2} \vec{i} + 10\sqrt{2} \vec{j}$$

$$\begin{aligned}\vec{v}_{TQ} &= \vec{v}_T - \vec{v}_Q \\ &= (5\sqrt{3} + 10\sqrt{2}) \vec{i} - (5 + 10\sqrt{2}) \vec{j} \\ &= 22.8 \vec{i} - 19.14 \vec{j} \text{ km/h}\end{aligned}$$

$$\begin{aligned}\text{(ii) } |\vec{v}_{TQ}| &= \sqrt{22.8^2 + 19.14^2} \\ &= 29.77 \text{ m/s}\end{aligned}$$

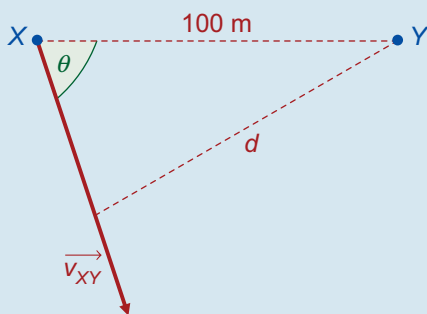
$$\tan \theta = \frac{19.14}{22.8}$$

$$\begin{aligned}\Rightarrow \theta &= \tan^{-1} \left(\frac{19.14}{22.8} \right) \\ &= 40^\circ\end{aligned}$$

$$\Rightarrow 40^\circ \text{ S of E}$$

$$\begin{aligned}\text{(iii) } \sin 40^\circ &= \frac{d}{100} \\ \Rightarrow d &= 100 \sin 40^\circ \\ \Rightarrow d &= 64.3 \text{ km}\end{aligned}$$

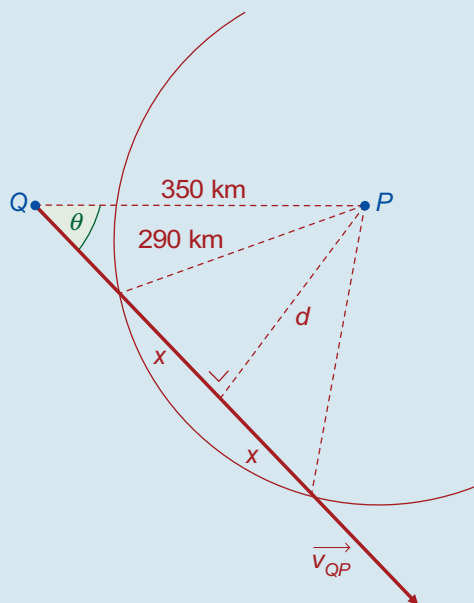
Q. 5.



$$\begin{aligned}\text{(i) } \vec{v}_X &= 7 \vec{i} \\ \vec{v}_Y &= 24 \vec{j} \\ \vec{v}_{XY} &= \vec{v}_X - \vec{v}_Y \\ &= 7 \vec{i} - 24 \vec{j} \text{ m/s}\end{aligned}$$

$$\begin{aligned}\text{(ii) } \tan \theta &= \frac{24}{7} \\ \Rightarrow \sin \theta &= \frac{24}{25} \\ \text{But, } \sin \theta &= \frac{d}{100} \\ \Rightarrow \frac{d}{100} &= \frac{24}{25} \\ \Rightarrow d &= 96 \text{ m}\end{aligned}$$

Q. 6.



$$\begin{aligned}\text{(i) } \vec{v}_P &= -\vec{i} + \vec{j} \\ \vec{v}_Q &= 3 \vec{i} - 2 \vec{j} \\ \vec{v}_{QP} &= \vec{v}_Q - \vec{v}_P \\ &= 4 \vec{i} - 3 \vec{j}\end{aligned}$$

$$\begin{aligned}\text{(ii) } |\vec{v}_{QP}| &= \sqrt{4^2 + 3^2} \\ &= 5 \text{ km/h}\end{aligned}$$

$$\begin{aligned}\tan \theta &= \frac{3}{4} \\ \Rightarrow \theta &= \tan^{-1} \frac{3}{4} \\ &= 36.87^\circ\end{aligned}$$

$$\Rightarrow 36^\circ 52' \text{ S of E}$$

$$\begin{aligned}\text{(iii) } \tan \theta &= \frac{3}{4} \\ \Rightarrow \sin \theta &= \frac{3}{5} \\ \text{But, } \sin \theta &= \frac{d}{350} \\ \Rightarrow \frac{d}{350} &= \frac{3}{5} \\ \Rightarrow d &= 210 \text{ km}\end{aligned}$$

- (iv) Insert circle with centre P and radius 290 km. As long as the relative path, \vec{v}_{QP} , is within this circle, P and Q will be able to exchange signals.

From the diagram, they will be within range for a relative distance of $2x$.

$$\begin{aligned}x^2 + d^2 &= 290^2 \quad \dots \text{ but } d = 210 \\ \Rightarrow x &= \sqrt{290^2 - 210^2} \\ &= 200 \text{ km}\end{aligned}$$