$\overrightarrow{v_Q} = -20\cos 45°\vec{i} + 20\sin 45°\vec{j}$

$= -20\left(\frac{1}{\sqrt{2}}\right)\vec{i} + 20\left(\frac{1}{\sqrt{2}}\right)\vec{j}$

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

$\overrightarrow{v_{TQ}} = \overrightarrow{v_T} - \overrightarrow{v_Q}$

$= (5\sqrt{3} + 10\sqrt{2})\vec{i} - (5 + 10\sqrt{2})\vec{j}$

$= 22.8\vec{i} - 19.14\vec{j}$ km/h

(ii) $\left|\overrightarrow{v_{TQ}}\right| = \sqrt{22.8^2 + 19.14^2}$

$= 29.77$ m/s

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

$\Rightarrow \theta = \tan^{-1}\left(\frac{19.14}{22.8}\right)$

$= 40°$

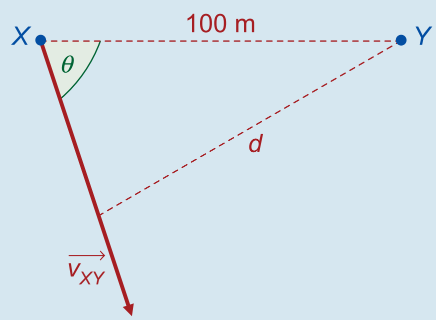
$\Rightarrow$ 40° S of E

(iii) $\sin 40° = \frac{d}{100}$

$\Rightarrow d = 100\sin 40°$

$\Rightarrow d = 64.3$ km

Q. 5.



(i) $\overrightarrow{v_X} = 7\vec{i}$

$\overrightarrow{v_Y} = 24\vec{j}$

$\overrightarrow{v_{XY}} = \overrightarrow{v_X} - \overrightarrow{v_Y}$

$= 7\vec{i} - 24\vec{j}$ m/s

(ii) $\tan\theta = \frac{24}{7}$

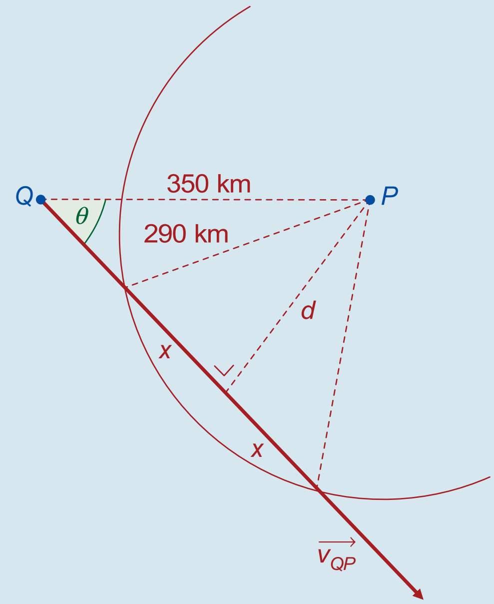
$\Rightarrow \sin\theta = \frac{24}{25}$

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

$\Rightarrow \frac{d}{100} = \frac{24}{25}$

$\Rightarrow d = 96$ m

Q. 6.



(i) $\overrightarrow{v_P} = -\vec{i} + \vec{j}$

$\overrightarrow{v_Q} = 3\vec{i} - 2\vec{j}$

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

$= 4\vec{i} - 3\vec{j}$

(ii) $\left|\overrightarrow{v_{QP}}\right| = \sqrt{4^2 + 3^2}$

$= 5$ km/h

$\tan\theta = \frac{3}{4}$

$\Rightarrow \theta = \tan^{-1}\frac{3}{4}$

$= 36.87°$

$\Rightarrow$ 36°52′ S of E

(iii) $\tan\theta = \frac{3}{4}$

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

But, $\sin\theta = \frac{d}{350}$

$\Rightarrow \frac{d}{350} = \frac{3}{5}$

$\Rightarrow d = 210$ km

(iv) Insert circle with centre P and radius 290 km. As long as the relative path, $\overrightarrow{v_{QP}}$, 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 $2x$.

$x^2 + d^2 = 290^2$ … but $d = 210$

$\Rightarrow x = \sqrt{290^2 - 210^2}$

$= 200$ km