

$$\begin{aligned} \Rightarrow \sqrt{x^2 + (y - 6)^2} &= 10 \quad \dots \text{ but } x = 4 - y \\ \Rightarrow (4 - y)^2 + (y - 6)^2 &= 100 \\ \Rightarrow 16 - 8y + y^2 + y^2 - 12y + 36 - 100 &= 0 \\ \Rightarrow 2y^2 - 20y - 48 &= 0 \\ \Rightarrow y^2 - 10y - 24 &= 0 \\ \Rightarrow (y - 12)(y + 2) &= 0 \\ \Rightarrow y = 12, y = -2 \\ \Rightarrow x = -8, x = 6 \end{aligned}$$

Let  $x = -8$  and  $y = 12$       Let  $x = 6$  and  $y = -2$

$$\begin{aligned} \Rightarrow \vec{v}_W &= -8\vec{i} + 12\vec{j} & \Rightarrow \vec{v}_W &= 6\vec{i} - 2\vec{j} \\ \vec{v}_{WG} &= -12\vec{i} + 12\vec{j} & \vec{v}_{WG} &= 2\vec{i} - 2\vec{j} \end{aligned}$$

$\vec{v}_{WG} = -12\vec{i} + 12\vec{j}$  is not from the North-West. It is, in fact, towards the North-West. We therefore exclude  $x = -8$  and  $y = 12$

$$\begin{aligned} \vec{v}_{WG} &= 2\vec{i} - 2\vec{j} \text{ is from the North-West as required.} \\ \Rightarrow \vec{v}_W &= 6\vec{i} - 2\vec{j} \text{ is the actual velocity of the wind.} \end{aligned}$$

(ii)  $\vec{v}_G = -p\vec{i}, \quad p > 0$

$$\begin{aligned} \vec{v}_W &= 6\vec{i} - 2\vec{j} \\ \vec{v}_{WG} &= \vec{v}_W - \vec{v}_G = (6 + p)\vec{i} - 2\vec{j} \\ |\vec{v}_{WG}| &= 8 \\ \Rightarrow \sqrt{(6 + p)^2 + (-2)^2} &= 8 \\ \Rightarrow 36 + 12p + p^2 + 4 &= 64 \\ \Rightarrow p^2 + 12p - 24 &= 0 \\ \Rightarrow p &= \frac{-12 \pm \sqrt{(12)^2 - 4(1)(-24)}}{2} \\ &= \frac{-12 \pm \sqrt{240}}{2} \\ p > 0 \\ \Rightarrow p &= \frac{-12 + \sqrt{240}}{2} = 1.75 \\ \Rightarrow \text{Girl should cycle at } &1.75 \text{ m/s due west.} \end{aligned}$$

**Q. 10.**  $\vec{v}_T = 4\vec{i}$   
 $\vec{v}_S = x\vec{i} + y\vec{j}$   
 $\vec{v}_{ST} = \vec{v}_S - \vec{v}_T = (x - 4)\vec{i} + y\vec{j}$   
 $\vec{v}_{ST}$  towards south-east  
 $\Rightarrow x - 4 = -y \Rightarrow x = 4 - y$   
 Also,  $|\vec{v}_S| = 20$   
 $\Rightarrow \sqrt{x^2 + y^2} = 20 \quad \dots \text{ but } x = 4 - y$   
 $\Rightarrow (4 - y)^2 + y^2 = 400$   
 $\Rightarrow 16 - 8y + y^2 + y^2 = 400$

$$\begin{aligned} \Rightarrow 2y^2 - 8y - 384 &= 0 \\ \Rightarrow y^2 - 4y - 192 &= 0 \\ \Rightarrow (y - 16)(y + 12) &= 0 \\ \Rightarrow y = 16, y = -12 \\ \Rightarrow x = -12, x = 16 \end{aligned}$$

Taking  $x = -12$  and  $y = 16$  gives  $\vec{v}_{ST} = -16\vec{i} + 16\vec{j}$ . This is not towards the south-east. It is, in fact, from the south-east. These values are therefore excluded.