Form A

1. (a) $\overrightarrow{QP} = \langle -2-4, -1-2, 3+1 \rangle = \langle -6, -3, 4 \rangle.$

$$\|\overrightarrow{QP}\| = \sqrt{(-6)^2 + (-3)^2 + 4^2} = \sqrt{61}$$

$$\Rightarrow \vec{u} = \frac{\overrightarrow{QP}}{\|\overrightarrow{QP}\|} = -\frac{6}{\sqrt{61}}\,\hat{i} - \frac{3}{\sqrt{61}}\,\hat{j} + \frac{4}{\sqrt{61}}\,\hat{k}.$$

(b) Take $\vec{v} = \overrightarrow{QP}$, found in (a). Take $\vec{w}$ to be the vector

$$\vec{w} = \overrightarrow{QR} = \langle 1-4, 3-2, -2+1 \rangle = \langle -3, 1, -1 \rangle.$$

Then

$$\cos\theta = \frac{\vec{w} \circ \vec{v}}{\|\vec{w}\|\,\|\vec{v}\|} = \frac{18-3-4}{\sqrt{11}\,\sqrt{61}} = \frac{11}{\sqrt{671}}.$$

2. (a)

$$\vec{w} \times \vec{v} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 3 & -2 \\ 4 & 2 & -1 \end{vmatrix} = \begin{vmatrix} 3 & -2 \\ 2 & -1 \end{vmatrix}\hat{i} - \begin{vmatrix} 1 & -2 \\ 4 & -1 \end{vmatrix}\hat{j} + \begin{vmatrix} 1 & 3 \\ 4 & 2 \end{vmatrix}\hat{k}$$

$$= \hat{i} - 7\hat{j} - 10\hat{k}.$$

(b)

$$\text{Volume} = \left| \vec{u} \circ (\vec{v} \times \vec{w}) \right| = \left| \langle -2, -1, 3 \rangle \circ \langle -1, 7, 10 \rangle \right| = 25.$$