Form B

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

$\| \overrightarrow{QP} \| = \sqrt{(-2)^2 + 1^2 + (-4)^2} = \sqrt{21}$

$\Rightarrow \vec{u} = \dfrac{\overrightarrow{QP}}{\| \overrightarrow{QP} \|} = -\dfrac{2}{\sqrt{21}} \hat{\imath} + \dfrac{1}{\sqrt{21}} \hat{\jmath} - \dfrac{4}{\sqrt{21}} \hat{k}.$

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

$\vec{w} = \overrightarrow{QR} = \langle 1-4, 3+2, -2-1 \rangle = \langle -3, 5, -3 \rangle.$

Then

$$\cos\theta = \frac{\vec{w} \circ \vec{v}}{\|\vec{w}\| \, \|\vec{v}\|} = \frac{6+5+12}{\sqrt{43} \cdot \sqrt{21}} = \frac{23}{\sqrt{903}}$$

2. (a)

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

$= \hat{\imath} - 9\hat{\jmath} - 14\hat{k}.$

(b) $\text{Volume} = \left| \vec{u} \circ (\vec{v} \times \vec{w}) \right| = \left| \langle 2, -1, -3 \rangle \circ \langle -1, -9, 14 \rangle \right| = 49.$