Question	Scheme	Marks	AOs
7	Any 2 of $x=\pm(4-3)$ or $y=\pm(-3-5)$ or $z=\pm(-1-2)$ for $\pm\overrightarrow{BC}$	M1	3.1a
	$\left(\left\|\overrightarrow{AB}\right\|=\right)\sqrt{4^2+3^2+1^2}$ or $\left(\left\|\overrightarrow{AC}\right\|=\right)\sqrt{3^2+5^2+2^2}$ or $\left(\left\|\overrightarrow{BC}\right\|=\right)\sqrt{1^2+8^2+3^2}$ NB $\left(\left\|\overrightarrow{AB}\right\|=\sqrt{26},\ \left\|\overrightarrow{AC}\right\|=\sqrt{38},\ \left\|\overrightarrow{BC}\right\|=\sqrt{74}\right)$	M1	1.1b
	$74=26+38-2\sqrt{26}\sqrt{38}\cos\theta$ or e.g. $\cos BAC=\dfrac{38+26-74}{2\sqrt{38}\sqrt{26}}$ or e.g. $\cos^{-1}\left(\dfrac{74-38-26}{-2\sqrt{38}\sqrt{26}}\right)$	ddM1	2.1
	$=99.2°$	A1	2.2a
		(4)	
			(4 marks)

Note that they are not asked for $\overrightarrow{BC}$ or $\overrightarrow{CB}$ in this question. As such, for the main scheme, all they need are the magnitudes of the components of $\overrightarrow{BC}$ or $\overrightarrow{CB}$ to find $\left|\overrightarrow{BC}\right|$ or $\left|\overrightarrow{CB}\right|$ so you can ignore if $\overrightarrow{BC}$ or $\overrightarrow{CB}$ is correct or not and full marks can be awarded even if there are sign errors in their $\overrightarrow{BC}$ or $\overrightarrow{CB}$ if they write it as a vector.

So allow full marks for use of $\pm\overrightarrow{BC}=\pm\mathbf{i}\pm8\mathbf{j}\pm3\mathbf{k}$ oe as a column vector.

Remember to check Figure 1 for lengths/vectors which may imply the method marks.

M1: Attempts to find at least 2 of the components of $\overrightarrow{BC}$ or $\overrightarrow{CB}$ correctly.
It is for any 2 of $x=\pm(4-3)$ or $y=\pm(-3-5)$ or $z=\pm(-1-2)$.
May be implied by correct values which may be seen as a vector.
$\pm(4-3)\mathbf{i}\pm(-3-5)\mathbf{j}\pm(-1-2)\mathbf{k}$ or as a column vector.

Note that e.g. $\mathbf{i}+8\mathbf{j}+3\mathbf{k}$ would score this mark and also gives access to the rest of the marks.

M1: Attempts to find the length or the square of the length **of at least one** side of the triangle using Pythagoras correctly e.g. $\left(\left|\overrightarrow{AB}\right|=\right)\sqrt{4^2+3^2+1^2}$ or $\left(\left|\overrightarrow{AB}\right|^2=\right)4^2+3^2+1^2$

Or $\left(\left|\overrightarrow{AC}\right|=\right)\sqrt{3^2+5^2+2^2}$ or $\left(\left|\overrightarrow{AC}\right|^2=\right)3^2+5^2+2^2$ or $\left(\left|\overrightarrow{BC}\right|=\right)\sqrt{"1"^2+"8"^2+"3"^2}$ or $\left(\left|\overrightarrow{BC}\right|^2=\right)"1"^2+"8"^2+"3"^2$

Condone incorrect or no labelling of sides/vectors and just look for a correct calculation or value.

Follow through their components of $\overrightarrow{BC}$ or $\overrightarrow{CB}$ however obtained.

ddM1: Attempts to use the cosine rule with their values correctly placed for angle *BAC*.
Allow use of e.g. θ (or any other letter) for angle *BAC*.
Condone slips in substitution or rearrangement if a correct cosine rule formula is seen but the values should be correctly placed e.g. condone the omission of the "2" if a correct formula is quoted. **Depends on both previous method marks.**
May be implied by the correct value of $\cos BAC$ which is –0.159… **but not** +0.159… unless the correct cosine rule is seen first and **not** just the correct value of angle *BAC*

A1: Awrt 99.2° only with or without a degrees symbol. Do not isw if e.g. they subsequently find e.g. 360° – 99.2°.
Give BOD for cases where use of the cosine rule leads to an angle of 80.8… which subsequently becomes 99.2 unless it clearly follows an incorrect cosine rule formula.

Alternative using the scalar product (not on this spec):

	$\pm\overrightarrow{AB}\cdot\overrightarrow{AC} = \pm(12-15-2) = \pm 5$	M1	3.1a
	$\left\|\overrightarrow{AB}\right\| = \sqrt{4^2+3^2+1^2}$ or $\left\|\overrightarrow{AC}\right\| = \sqrt{3^2+5^2+2^2}$ $\left\|\overrightarrow{AB}\right\| = \sqrt{26}$, $\left\|\overrightarrow{AC}\right\| = \sqrt{38}$	M1	1.1b
	$\sqrt{38}\sqrt{26}\cos\theta = \pm 5$ or e.g. $\cos\theta = \dfrac{\pm 5}{\sqrt{38}\sqrt{26}}$ or e.g. $BAC = \cos^{-1}\left(\dfrac{\pm 5}{\sqrt{38}\sqrt{26}}\right)$	ddM1	2.1
	99.2°	A1	2.2a
		(4)	

Notes

M1: Attempts $\pm\overrightarrow{AB}\cdot\overrightarrow{AC}$
May be implied by sight of ±5 if it is clear they are attempting the scalar product or by a correct calculation e.g. $\pm\left(4\times 3+5\times(-3)+2\times(-1)\right)$

M1: Attempts to find the length or the square of the length **for at least one** of *AB* or *AC* using Pythagoras correctly e.g. $\left(\left|\overrightarrow{AB}\right| =\right)\sqrt{4^2+3^2+1^2}$ or $\left(\left|\overrightarrow{AB}\right|^2 =\right)4^2+3^2+1^2$
or $\left(\left|\overrightarrow{AC}\right| =\right)\sqrt{3^2+5^2+2^2}$ or $\left(\left|\overrightarrow{AC}\right|^2 =\right)3^2+5^2+2^2$
Condone incorrect or no labelling of sides/vectors and just look for a correct calculation.

ddM1: Attempts to use the scalar product with the values correctly placed.
Allow use of e.g. θ (or any other letter) for angle *BAC*.
May be implied by $\cos BAC$ = ± 0.15907… but **not** just the correct value of angle *BAC*
Depends on both previous method marks.

A1: Awrt 99.2° only with or without a degrees symbol.
Do not isw if e.g. they subsequently find 360° – 99.2°

Alternative using the vector product (not on this spec):

	$\overrightarrow{AB}\times\overrightarrow{AC} = -\mathbf{i}-11\mathbf{j}+29\mathbf{k}$	M1	3.1a
	$\left\|\overrightarrow{AB}\right\| = \sqrt{4^2+3^2+1^2}$ or $\left\|\overrightarrow{AC}\right\| = \sqrt{3^2+5^2+2^2}$ $\left\|\overrightarrow{AB}\right\| = \sqrt{26}$, $\left\|\overrightarrow{AC}\right\| = \sqrt{38}$	M1	1.1b
	$\sin\alpha = \dfrac{\sqrt{1^2+11^2+29^2}}{\sqrt{38}\sqrt{26}}$	ddM1	2.1
	$\left(BAC =\right)180-\sin^{-1}\left(\dfrac{\sqrt{963}}{\sqrt{38}\sqrt{26}}\right) = 99.2°$	A1	2.2a
		(4)	

Notes

M1: Attempts to find at least 2 components of $\overrightarrow{AB}\times\overrightarrow{AC}$

It is for any 2 of $x=\pm(-6+5)$ or $y=\pm(8+3)$ or $z=\pm(20+9)$.

May be implied by correct values which may be seen as a vector e.g.

$\pm(-6+5)\mathbf{i}\pm(8+3)\mathbf{j}\pm(20+9)\mathbf{k}$ or as a column vector e.g. $\begin{pmatrix}\pm(-6+5)\\ \pm(8+3)\\ \pm(20+9)\end{pmatrix}$

M1: Attempts to find the length or the square of the length *AB* or *AC* using Pythagoras correctly e.g. $\left(\left|\overrightarrow{AB}\right|=\right)\sqrt{4^2+3^2+1^2}$ or $\left(\left|\overrightarrow{AB}\right|^2=\right)4^2+3^2+1^2$

or $\left(\left|\overrightarrow{AC}\right|=\right)\sqrt{3^2+5^2+2^2}$ or $\left(\left|\overrightarrow{AC}\right|^2=\right)3^2+5^2+2^2$

Condone incorrect or no labelling of sides/vectors and just look for a correct calculation.

ddM1: Attempts to use the vector product with the values correctly placed.

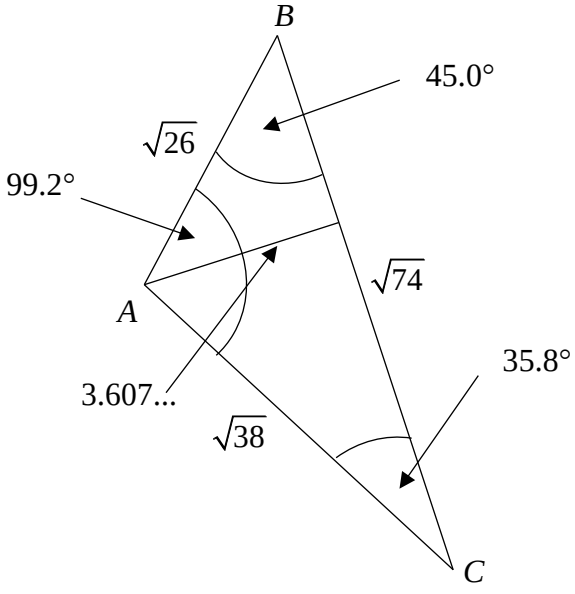
May be implied by the correct value of $\sin BAC$ which is 0.98727… but **not** just the correct value of angle *BAC*

Depends on both previous method marks.

A1: Awrt 99.2° only with or without a degrees symbol.

Note that they need to subtract their value from 180° to reach the correct answer with this method.

Q7 Diagram/values for reference:



Note that there may be more convoluted methods **e.g.**

$$\pm\overrightarrow{BC}=\pm\mathbf{i}\pm8\mathbf{j}\pm3\mathbf{k} \text{ or e.g. } \begin{pmatrix}\pm1\\ \pm8\\ \pm3\end{pmatrix}\Rightarrow\left|\overrightarrow{BC}\right|=\sqrt{74}$$

$$38 = 26 + 74 - 2\sqrt{26}\sqrt{74}\cos B \Rightarrow B = 45.02977...°$$

Perpendicular distance A to BC is $\sqrt{26}\sin 45.02977...° = 3.60742...$

So $\frac{1}{2}\sqrt{74} \times 3.607424... = \frac{1}{2}\sqrt{26}\sqrt{38}\sin\alpha \Rightarrow \alpha = 80.8470...°$

But A is obtuse so $A = 180° - 80.8470...° = 99.2°$

In such cases the main MS can be applied for the first 2 method marks and then the ddM1 mark would require a complete and correct method to find e.g. angle B and then the perpendicular height followed by an equation using the areas involving angle B to at least find an acute value for angle A and then A1 for awrt 99.2

They may also unnecessarily find angle *B* and angle *C* then subtract from 180°

The first 2 method marks can be applied as in the main scheme but then the 3rd method would need to be for a complete method for angle *A*.