Question	Scheme	Marks
1	**Angle**	
	$(4x)^2 = (2x)^2 + (3x)^2 - 2\times 2x\times 3x\times \cos ABC$ **or**	M1A1
	$\left(\cos ABC =\right)\dfrac{(2x)^2+(3x)^2-(4x)^2}{2\times 2x\times 3x} \Rightarrow \angle ABC = 104.47751...^{\circ}(1.823476...^{c})$	
	OR	
	$(3x)^2 = (2x)^2 + (4x)^2 - 2\times 2x\times 4x\times \cos BAC$ **or**	[M1A1]
	$\left(\cos BAC =\right)\dfrac{(2x)^2+(4x)^2-(3x)^2}{2\times 2x\times 4x} \Rightarrow \angle BAC = 46.56746...^{\circ}(0.812755...^{c})$	
	OR	
	$(2x)^2 = (3x)^2 + (4x)^2 - 2\times 3x\times 4x\times \cos ACB$ **or**	[M1A1]
	$\left(\cos ACB =\right)\dfrac{(3x)^2+(4x)^2-(2x)^2}{2\times 3x\times 4x} \Rightarrow \angle ACB = 28.95502...^{\circ}(0.505360....^{c})$	
	Area	
	$50 = \dfrac{1}{2}\times 2x\times 3x\times \sin"104.47751"^{\circ} \Rightarrow x^2\left(=17.213259...\right)$	dM1
	$\Rightarrow x = 4.15$	A1
	OR	
	$50 = \dfrac{1}{2}\times 2x\times 4x\times \sin"46.56746"^{\circ} \Rightarrow x^2\left(=17.213259...\right)$	[dM1
	$\Rightarrow x = 4.15$	A1]
	OR	
	$50 = \dfrac{1}{2}\times 3x\times 4x\times \sin"28.95502"^{\circ} \Rightarrow x^2\left(=17.213259...\right)$	[dM1
	$\Rightarrow x = 4.15$	A1] [4]
ALT1	Uses Heron's formula	
	$s = \dfrac{2x+3x+4x}{2} = \dfrac{9x}{2}$ oe	M1A1
	$50 = \sqrt{"\dfrac{9x}{2}"\left("\dfrac{9x}{2}"-2x\right)\left("\dfrac{9x}{2}"-3x\right)\left("\dfrac{9x}{2}-4x"\right)} = \sqrt{\dfrac{135x^4}{16}}$	dM1
	$\Rightarrow x^2 = 17.213259... \Rightarrow x = 4.15$	A1 [4]

ALT 2	$(4x)^2 = (2x)^2 + (3x)^2 - 2\times 2x\times 3x\times \cos ABC$ **or** $\left(\cos ABC =\right)\dfrac{(2x)^2+(3x)^2-(4x)^2}{2\times 2x\times 3x}\left(=-\dfrac{1}{4}\right)$ $\Rightarrow \left(\sin ABC =\right)\sqrt{\dfrac{15}{16}}\left(=\dfrac{\sqrt{15}}{4}=0.9682458...\right)$ oe OR $(3x)^2 = (2x)^2 + (4x)^2 - 2\times 2x\times 4x\times \cos BAC$ **or** $\left(\cos BAC =\right)\dfrac{(2x)^2+(4x)^2-(3x)^2}{2\times 2x\times 4x}\left(=\dfrac{11}{16}\right)$ $\Rightarrow \left(\sin ABC =\right)\sqrt{\dfrac{135}{256}}\left(=3\dfrac{\sqrt{15}}{16}=0.7261843...\right)$ oe OR $(2x)^2 = (3x)^2 + (4x)^2 - 2\times 3x\times 4x\times \cos ACB$ **or** $\left(\cos ACB =\right)\dfrac{(3x)^2+(4x)^2-(2x)^2}{2\times 3x\times 4x}\left(=\dfrac{7}{8}\right)$ $\Rightarrow \left(\sin ABC =\right)\sqrt{\dfrac{15}{64}}\left(=\dfrac{\sqrt{15}}{8}=0.4841229...\right)$ oe	M1 A1 {M1 A1} {M1 A1}
	$50=\dfrac{1}{2}\times 2x\times 3x\times "\sqrt{\dfrac{15}{16}}" \Rightarrow x^2\left(=17.213259...\right)$ or $x=$ $\Rightarrow x = 4.15$ OR $50=\dfrac{1}{2}\times 2x\times 4x\times "\sqrt{\dfrac{135}{256}}" \Rightarrow x^2\left(=17.213259...\right)$ or $x=$ $\Rightarrow x = 4.15$ OR $50=\dfrac{1}{2}\times 3x\times 4x\times "\sqrt{\dfrac{15}{64}}" \Rightarrow x^2\left(=17.213259...\right)$ or $x=$ $\Rightarrow x = 4.15$	dM1 A1 {dM1 A1} {dM1 A1} [4]
		Total 4 marks

Mark	Notes
M1	For a fully correct substitution into the cosine **formula** as shown. ie including an equals sign. OR for a fully correct **expression** for cos*ABC* or cos*BAC* or cos*ACB* Allow students to use just *B, A* and *C* for angles or any labelling.
A1	For one of the correct angles in the triangle.

Note for M1 A1
In this question, we will override the general principle of marking for multiple attempts, if the attempts are finding other angles. Mark the attempt that is correct.
The x can be consistently omitted **or**
the x can be recovered (also indicated by a correct angle) **or**
values in the correct proportions can be used as an alternative (also indicated by a correct angle).
M1 may also be awarded if the values in the expression or equation lead to the correct angle for those values, regardless of the labelling of the angle. This may also lead to A1

$$(2x)^2 = (3x)^2 + (4x)^2 - 2\times 3x \times 4x \times \cos A \quad \textbf{or}$$

e.g.

$$\left(\cos A =\right)\frac{(3x)^2+(4x)^2-(2x)^2}{2\times 3x\times 4x} \Rightarrow \angle A = 28.95502...^\circ$$

All the values here are correct to give 28.95502, but the labelling of angle A is incorrect.
Allow angles in degrees to be rounded to the nearest whole number here and angles in radians to be rounded to 1 dp.
Where candidates do not actually work the angle out, if and only if the fully correct expression for cos(angle) or angle = $\cos^{-1}$ is seen in the 1st M1, look for any of the following used in the 2nd M1, then this A mark can be awarded.
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$$\sin\left(\cos^{-1}(\text{ANS})\right) \text{ or } \sin\left(\cos^{-1}\left(\left((angle)\ A\right)\right)\right) \text{ or } \sin\left(\cos^{-1}\left(\left((angle)\ B\right)\right)\right)$$

$$\text{or } \sin\left(\cos^{-1}\left(\left((angle)\ C\right)\right)\right)$$

$$\text{or for } \sin\left(\cos^{-1}\left(-\frac{1}{4}\right)\right) \text{ or } \sin\left(\cos^{-1}\left(\frac{11}{16}\right)\right) \text{ or } \sin\left(\cos^{-1}\left(\frac{7}{8}\right)\right) \text{ seen}$$

Mark	Notes
dM1	For using the correct formula for the area of a triangle using 50 and their angle (or use of $\sin\cos^{-1}$ correctly and the correct 2 sides for their angle and a fully correct rearrangement to find x^2 or x If 1st M1 has been gained and a poor rearrangement occurs to give an incorrect angle ft their angle. This is a general principle of marking. Sight of 17.2(1……….) following M1 A1 and the correct formula written will imply this mark. The same condition applies, if the angle is not actually worked out as for the A mark. Dependent on previous method mark.
A1	For the correct value of x. Accept awrt 4.15 [cm]
ALT1	
M1	For fully correct substitution, as shown into Heron's formula.
A1	For the correct expression for s
x must be present, but may be recovered (indicated by A1)	
dM1	Applies Heron's formula correctly with their value of s and 50 and a fully correct rearrangement to find x^2 or x
A1	For the correct value of x. Allow all awrt 4.15.

<table>
<tr><th>ALT2</th><th></th></tr>
<tr><td>M1</td><td>For a fully correct substitution into the cosine formula as shown. ie including an equals sign.
OR for a fully correct expression for cosABC or cosBAC or cosACB
Allow students to use just B, A and C for angles or any labelling.</td></tr>
<tr><td>A1</td><td>For one of the correct values for sin(relevant angle)</td></tr>
<tr><td colspan="2">Note for M1 A1
The x can be consistently omitted or
the x can be recovered (also indicated by a correct value for sin) or
values in the correct proportions can be used as an alternative (also indicated by a correct value for sin).
M1 may also be awarded if the values in the expression or equation lead to the correct sin value for those values, regardless of the labelling of the angle. This may also lead to A1
$(2x)^2 = (3x)^2 + (4x)^2 - 2\times 3x \times 4x \times \cos A$ or
e.g. $(\cos A =)\dfrac{(3x)^2+(4x)^2-(2x)^2}{2\times 3x\times 4x} \Rightarrow \sin A = \sqrt{\dfrac{15}{64}}$
All the values here are correct to give $\Rightarrow (\sin ABC =)\sqrt{\dfrac{15}{64}}$, but the labelling of angle A is incorrect.
Allow values to be rounded to 1 dp.</td></tr>
<tr><td>dM1</td><td>For using the correct formula for the area of a triangle using 50 and their sin value correctly and the correct 2 sides for their angle and a fully correct rearrangement to find x^2 or x
If M1 has been gained but their sin value is incorrect, students must be seen to have substituted into $\cos^2(\text{angle})+\sin^2(\text{angle})=1$. Though a poor rearrangement to give an incorrect sin value, will potentially allow this mark to be awarded.
Sight of 17.2(1……….) following M1 A1 will imply this mark.
Dependent on previous method mark.</td></tr>
<tr><td>A1</td><td>For the correct value of x. Accept awrt 4.15 [cm]</td></tr>
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