If they use e.g. $BC=\sqrt{10^2+15^2+2\times10\times15\mathbf{cos53.1°}}$ this is correct for the obtuse angle.

But do not allow if this follows e.g. $BC=\sqrt{a^2+b^2+2ab\cos C}$

Note that incorrectly using $\theta=\frac{4}{5}$ e.g. $\left(BC^2\right)=10^2+15^2-2\times10\times15\cos\left(\frac{4}{5}\right)$ scores M0

A1: Length BC is awrt 22.5 (m) but allow exact value of $\sqrt{505}$ (m)

Units are **not** required but if any are given they must be correct.

Allow the use of radians to score for equivalent work in (b) e.g.

$$\theta=\pi-0.927...=\text{awrt } 2.21\Rightarrow\left(BC^2\right)=10^2+15^2-2\times10\times15\cos2.21\Rightarrow BC=22.5$$

(c)	$\frac{\sin ABC}{10}=\frac{\sin'126.9°'}{'22.5'}\Rightarrow\sin ABC=...$ or e.g. $60=\frac{1}{2}\times15\times'22.5'\times\sin ABC\Rightarrow\sin ABC=...$ or e.g. $10^2=15^2+'505'-2\times15\sqrt{'505'}\cos ABC\Rightarrow\cos ABC=...$	M1
	Smallest angle (ABC) = awrt $20.9°$ (or awrt $20.8°$)	A1
		(2)

Notes:

Allow equivalent work in radians but the final answer must be in degrees.

M1: Full attempt to find sin ABC or cos ABC using angle $BAC=\sin^{-1}\frac{4}{5}$ which may be acute or obtuse and follow through their answer to part (b).

Score for $\frac{\sin ABC}{10}=\frac{\sin'126.9°'\left(\text{or }'53.1°'\right)}{'22.5'}\left(\text{or e.g. }\frac{4/5}{'22.5'}\right)\Rightarrow\sin ABC=...$

or $60=\frac{1}{2}\times15\times'22.5'\times\sin ABC\Rightarrow\sin ABC=...$

or $10^2=15^2+'505'-2\times15'\sqrt{505}'\cos ABC\Rightarrow\cos ABC=...$

Note that incorrectly using $\theta=\frac{4}{5}$ e.g. $\frac{\sin ABC}{10}=\frac{\sin\left(\frac{4}{5}\right)}{'22.5'}\Rightarrow\sin ABC=...$ scores M0

Allow alternative methods that correctly find angle ACB first and then $ABC=180-\sin^{-1}\frac{4}{5}-ACB$

e.g. $60=\frac{1}{2}\times10\times'22.5'\times\sin ACB\Rightarrow ACB=...(32.2...)\Rightarrow ABC=180-\sin^{-1}\frac{4}{5}-'32.2'$

or e.g. $\frac{\sin ACB}{15}=\frac{\sin'126.9°'\left(\text{or }'53.1°'\right)}{'22.5'}\Rightarrow ACB=...\left(32.2...\right)\Rightarrow ABC=180-\sin^{-1}\frac{4}{5}-'32.2'$

A1: Awrt $20.9°$ or awrt $20.8°$ following correct work in (b) e.g. do not allow this mark if the 22.5 was obtained fortuitously in part (b). (Unless they start again).

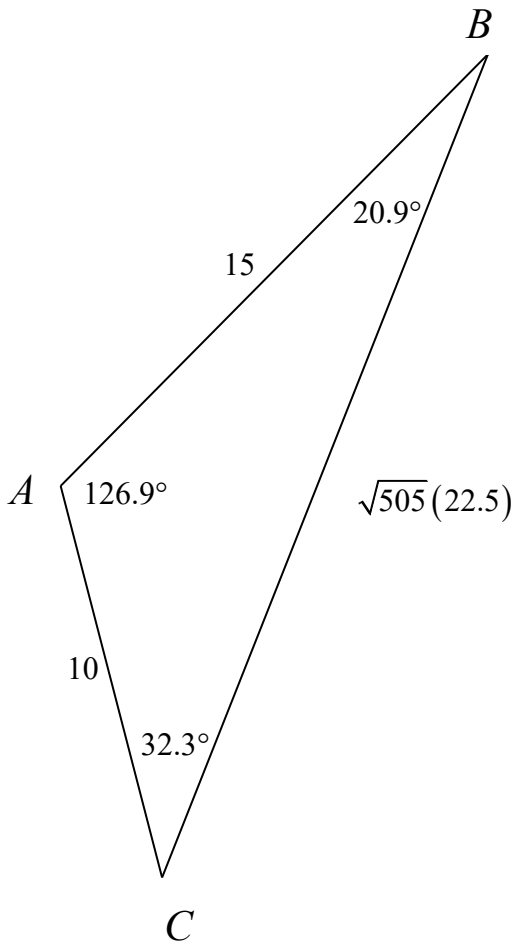
The degrees symbol is **not** required.

If both other angles have been found then the awrt $20.9°$ or awrt $20.8°$ must clearly be selected.

For reference use of the acute angle in (a) leading to $BC=\sqrt{145}$ in (b) gives an answer of $41.6...°$ in (c)

		(6 marks)

Diagram for Q3:



Question Number	Scheme	Marks
4(a)	$\frac{\mathrm{d}\left(x^3\right)}{\mathrm{d}x}=3x^2$	B1
	$\frac{\mathrm{d}\left(2x^2\sqrt{x}\right)}{\mathrm{d}x}=\frac{\mathrm{d}\left(2x^{\frac{5}{2}}\right)}{\mathrm{d}x}=...x^{\frac{3}{2}}$	M1
	$\left(\mathrm{f}'(x)=\right)3x^2-5x^{\frac{3}{2}}$	A1
	$3x^2-5x^{\frac{3}{2}}=0\Rightarrow x^{\frac{3}{2}}\left(3x^{\frac{1}{2}}-5\right)=0\Rightarrow 3x^{\frac{1}{2}}-5=0$ or e.g. $3x^2-5x^{\frac{3}{2}}=0\Rightarrow 3x^{\frac{1}{2}}-5=0$ or e.g. $3x^2-5x^{\frac{3}{2}}=0\Rightarrow 3x^2=5x^{\frac{3}{2}}\Rightarrow 9x^4=25x^3\Rightarrow 9x=25\left(\text{ or } x=\frac{25}{9}\right)$	**d**M1
	$x=\frac{25}{9}$	A1 cso
		(5)

Notes

Mark (a) and (b) together e.g. ignore labelling in this question.

B1: Correct differentiation of x^3. Allow the index to be unprocessed e.g. $3x^{3-1}$.

M1: Differentiates $2x^2\sqrt{x}$ to obtain $...x^{\frac{3}{2}}$. Allow the index to be unprocessed e.g. $...x^{\frac{5}{2}-1}$

May be implied by an attempt to use the product rule e.g.

$\left(2x^2\sqrt{x}\right)'=\frac{1}{2}\times 2x^2\times x^{-\frac{1}{2}}+4x\times x^{\frac{1}{2}}=\frac{1}{2}\times 2x^{\frac{3}{2}}+4x^{\frac{3}{2}}$

Allow for $\left(2x^2\sqrt{x}\right)'=\alpha x^{\frac{3}{2}}+\beta x^{\frac{3}{2}}$ and allow the indices to be unprocessed e.g. $\alpha x^{2-\frac{1}{2}}+\beta x^{1+\frac{1}{2}}$

A1: $\left(\mathrm{f}'(x)=\right)3x^2-5x^{\frac{3}{2}}$ oe. May be unsimplified but indices must now be processed and terms combined if necessary. Condone poor notation e.g. spurious integral signs.

e.g. allow $\left(\mathrm{f}'(x)=\right)3x^2-\frac{5}{2}\times 2x^{\frac{3}{2}}$ and allow $\left(\mathrm{f}'(x)=\right)3x^2-5x^{\frac{3}{2}}+0$ but do not allow

$\left(\mathrm{f}'(x)=\right)3x^2-5x^{\frac{3}{2}}+c$. "$\mathrm{f}'(x)=$" is not required.

dM1: Sets $\mathrm{f}'(x)=0$ where $\mathrm{f}'(x)$ is of the form $px^2-qx^{\frac{3}{2}}$, $p,q>0$ and **uses correct index work** to obtain $ax^b=c$, $ac>0$ or equivalent e.g. $ax^b-c=0$, $ac>0$ where a and/or b could be 1

but they cannot go from just $3x^2-5x^{\frac{3}{2}}=0\Rightarrow x=\frac{25}{9}$ as the question asks for all stages of working to be shown and a calculator not to be used.

See main scheme for some examples and the next page for further examples of acceptable work.

Depends on the first method mark.

A1: $x=\frac{25}{9}$ following the award of all previous marks.

There must be no other solutions so if e.g. $x = 0$ is given and not rejected, score A0

Further examples of acceptable work for the dM1 in part (a):

$$3x^2 - 5x^{\frac{3}{2}} = 0 \Rightarrow 3 - 5x^{-\frac{1}{2}} = 0$$

$$y = \sqrt{x} \Rightarrow 3y^4 - 5y^3 = 0 \Rightarrow y = \frac{5}{3}\left(\text{or } 3y - 5 = 0\right)$$

Condone: $3x^2 - 5x^{\frac{3}{2}} = 0 \Rightarrow 9x^4 - 25x^3 = 0 \Rightarrow x = \frac{25}{9}$

(b)(i)	$\left(\mathrm{f}''(x)=\right)6x-\frac{15}{2}x^{\frac{1}{2}}$	M1 A1
	$6x-\frac{15}{2}x^{\frac{1}{2}}=66\Rightarrow\quad 4x-5x^{\frac{1}{2}}-44=0$ *	A1*

Notes

M1: Differentiates an expression of the form px^2+qx^r to obtain $...x-...x^{r-1}$ where r is a non-integer fraction. Condone poor notation e.g. spurious integral signs.

A1: Correct differentiation $\left(\mathrm{f}''(x)=\right)6x-\frac{15}{2}x^{\frac{1}{2}}$. May be unsimplified but indices must be processed.

e.g. allow $\left(\mathrm{f}'(x)=\right)6x-\frac{3}{2}\times 5x^{\frac{1}{2}}$. Condone poor notation and just look for the correct expression.

"$\mathrm{f}''(x)=$" is not required.

A1*: Sets $6x-\frac{15}{2}x^{\frac{1}{2}}=66$ and reaches $4x-5x^{\frac{1}{2}}-44=0$ from fully correct work.

An intermediate step is **not** required.

(b)(ii)	$4x-5x^{\frac{1}{2}}-44=\left(x^{\frac{1}{2}}-4\right)\left(4x^{\frac{1}{2}}+11\right)$ or e.g. $4x-5x^{\frac{1}{2}}-44=0\Rightarrow\left(\sqrt{x}=\right)\frac{5\pm\sqrt{5^2-4(4)(-44)}}{8}\left(=4,-\frac{11}{4}\right)$	M1
	e.g. $x^{\frac{1}{2}}-4=0$ only as $x^{\frac{1}{2}}$ cannot be < 0 so $x = 16$ or e.g. If $x^{\frac{1}{2}}=-\frac{11}{4}$, $x=\frac{121}{16}\Rightarrow 4x-5x^{\frac{1}{2}}-44=-\frac{55}{2}\neq 0$ If $x^{\frac{1}{2}}=4, x=16\Rightarrow 4x-5x^{\frac{1}{2}}-44=0$ $x = 16$	A1*
		(5)

Notes

M1: For an attempt to **factorise** $4x-5x^{\frac{1}{2}}-44$ **or** a non-calculator attempt to **solve** $4x-5x^{\frac{1}{2}}-44=0$
Attempts to factorise or solve must follow the usual rules (see general guidance)
Do **not** condone attempts to solve/factorise a different equation.
Do not be concerned at this stage if it is unclear whether their values represent e.g. x rather than $\sqrt{x}$. If the quadratic formula is used look for a minimum of $\left(\sqrt{x}=\right)\frac{5\pm\sqrt{5^2-4(4)(-44)}}{8}$ or $\left(\sqrt{x}=\right)\frac{5\pm\sqrt{729}}{8}$ or $\left(\sqrt{x}=\right)\frac{5\pm 27}{8}$

May be implied by substitution e.g. $y=\sqrt{x}\Rightarrow 4x-5x^{\frac{1}{2}}-44=4y^2-5y-44=(y-4)(4y+11)$

or even $x=\sqrt{x}\Rightarrow 4x-5x^{\frac{1}{2}}-44=4x^2-5x-44=(x-4)(4x+11)$

If answers are **just written down**, this scores M0 e.g. $\left(\sqrt{x}=\right)\frac{-b\pm\sqrt{b^2-4ac}}{2a}=4,\ -\frac{11}{4}$

A1*: Must follow M1 and requires:

- Correct factorisation or correct values of $\sqrt{x}$
- **Either** a valid reason to reject $4x^{\frac{1}{2}}+11=0$ e.g. because $x^{\frac{1}{2}}<0$
  or a valid reason that $x^{\frac{1}{2}}-4=0$ gives the only solution e.g. because $x^{\frac{1}{2}}>0$

- A conclusion that $x = 16$

Allow as a minimum e.g. $\sqrt{x} = -\frac{11}{4}$ (which is) **< 0** (so reject) so $x = 16$

Do not allow incorrect arguments such as "$\sqrt{x} \neq -\frac{11}{4}$ as you can't square root a negative number"

or insufficient reasoning e.g. $\sqrt{x} = -\frac{11}{4}$ (reject)

An alternative for the A1* would be to check which values of *x* are valid e.g.

$x = \frac{121}{16} \Rightarrow 4\left(\frac{121}{16}\right) - 5\left(\frac{11}{4}\right) - 44 = -\frac{55}{2}$

$x = 16 \Rightarrow 4(16) - 5(4) - 44 = 0$

$x = 16$ is the only solution

This must follow M1 and requires:

- Correct values of x
- Correct evaluation of $4x - 5x^{\frac{1}{2}} - 44$ for $x = \frac{121}{16}$ and $x = 16$
- A (minimal) conclusion e.g. $x = 16$, QED, tick etc.

(10 marks)