Question Number	Scheme	Marks
1	$y = 2 + 10x^{\frac{1}{2}} - 2x^{\frac{3}{2}}$	
(a)	$\frac{dy}{dx} = 5x^{-\frac{1}{2}} - 3x^{\frac{1}{2}}$	M1 A1 A1
		(3)
(b)	$x = 2 \Rightarrow \quad \frac{dy}{dx} = \frac{5}{\sqrt{2}} - 3\sqrt{2}$	M1
	$\frac{5}{\sqrt{2}} - 3\sqrt{2} = \frac{5}{2}\sqrt{2} - 3\sqrt{2} = -\frac{1}{2}\sqrt{2}$	A1
		(2)
		(5 marks)

(a) Mark (a) and (b) together.

M1: For ANY one of: $10x^{\frac{1}{2}} \to ...x^{-\frac{1}{2}}$ or $-2x^{\frac{3}{2}} \to ...x^{\frac{1}{2}}$ or $2 \to 0$

A1: For one simplified term e.g. either $10x^{\frac{1}{2}} \to 5x^{-\frac{1}{2}}$ or $-2x^{\frac{3}{2}} \to -3x^{\frac{1}{2}}$

A1: $\left(\frac{dy}{dx} =\right) 5x^{-\frac{1}{2}} - 3x^{\frac{1}{2}}$. Allow e.g. $\left(\frac{dy}{dx} =\right) \frac{5}{\sqrt{x}} - 3\sqrt{x}$. The "$\frac{dy}{dx} =$" is not required. Condone "+ 0" as part of their answer.

There must be no other terms e.g. "+ c" or e.g. $\left(\frac{dy}{dx} =\right) 2 + 5x^{-\frac{1}{2}} - 3x^{\frac{1}{2}}$ but apply isw if possible once a correct simplified derivative with no extra terms is seen.

(b)

M1: For an attempt to substitute $x = 2$ fully into their $\frac{dy}{dx}$ which is not y e.g. it must be a "changed" function which could even come from integration.

All that is required is the substitution so allow for e.g. $5(2)^{-\frac{1}{2}} - 3(2)^{\frac{1}{2}}$

This mark may be implied by their answer or e.g. a decimal answer of awrt –0.7 following a correct derivative.

Do **not** allow this mark if they have e.g. $\left(\frac{dy}{dx} =\right) 5x^{-\frac{1}{2}} - 3x^{\frac{1}{2}} + c$ in part (a) **AND** subsequently go on to try and establish a value for "c" using $x = 2$.

A1: $-\frac{1}{2}\sqrt{2}$ or exact simplified equivalent e.g. $-\frac{1}{\sqrt{2}}, -0.5\sqrt{2}, -2^{-\frac{1}{2}}, -2^{-0.5}$ **following at least one intermediate line of working**.

E.g. $\frac{5}{\sqrt{x}} - 3\sqrt{x} = \frac{5}{\sqrt{2}} - 3\sqrt{2} = -\frac{1}{\sqrt{2}}$ scores M1A0

but $\frac{5}{\sqrt{x}}-3\sqrt{x}=\frac{5}{\sqrt{2}}-3\sqrt{2}=\frac{5\sqrt{2}}{2}-3\sqrt{2}=-\frac{\sqrt{2}}{2}$ or $-\frac{1}{\sqrt{2}}$ scores M1A1

Other examples of sufficient working:

$\frac{5}{\sqrt{x}}-3\sqrt{x}=\frac{5}{\sqrt{2}}-3\sqrt{2}=\frac{5-6}{\sqrt{2}}=-\frac{1}{\sqrt{2}}$, $\frac{5}{\sqrt{x}}-3\sqrt{x}=\frac{5}{\sqrt{2}}-3\sqrt{2}=\left(\frac{5}{2}-3\right)\sqrt{2}=-\frac{\sqrt{2}}{2}$

Apply isw once a correct exact answer is seen.

Question Number	Scheme	Marks
2(a)	$P(-3,7), Q(9,11)$ and $R(12,2)$	
Way 1	grad $PQ=\frac{11-7}{9--3}=\frac{1}{3}$, grad $QR=\frac{11-2}{9-12}=-3$	M1 A1
	$\frac{1}{3}\times-3=-1$ so angle $PQR=$ 90°	A1
		(3)
Way 2	$PQ^2=(9--3)^2+(11-7)^2=160$ $QR^2=(12-9)^2+(2-11)^2=90$ $PR^2=(12--3)^2+(2-7)^2=250$	M1 A1
	$PQ^2+QR^2=PR^2$ (or e.g. 90 + 160 = 250) so angle $PQR=$ 90° or e.g. $\cos\theta=\frac{160+90-250}{2\sqrt{160}\sqrt{90}}=0\Rightarrow\theta=90°$	A1
		(3)
Way 3	$\overrightarrow{PQ}=\begin{pmatrix}9--3\\11-7\end{pmatrix}=\begin{pmatrix}12\\4\end{pmatrix}$, $\overrightarrow{QR}=\begin{pmatrix}12-9\\2-11\end{pmatrix}=\begin{pmatrix}3\\-9\end{pmatrix}$	M1A1
	$\overrightarrow{PQ}\bullet\overrightarrow{QR}=\begin{pmatrix}12\\4\end{pmatrix}\bullet\begin{pmatrix}3\\-9\end{pmatrix}=36-36=0$ so angle $PQR=$ 90°	A1
		(3)

General Guidance for part (a)

M1: Requires some correct work depending on the method
A1: Correct work for the chosen method
A1: Depends on both previous marks and requires an explanation and a conclusion.
The conclusion must refer to angle *PQR* being 90° or equivalent e.g. "*PQ* and *QR* are perpendicular",
"*Q* is 90", "*Q* is a right angle" etc. but condone e.g. "*A* = 90" or e.g. "θ = 90" if the solution is otherwise correct.
This may occur in a preamble e.g. If grad *PQ* x Grad *QR* = –1 then *PQR* = 90,

$\frac{11-7}{9--3}=\frac{1}{3}, \frac{11-2}{9-12}=-3, \ \frac{1}{3}\times -3=-1$ **hence proven.**

Scores full marks.

(a) **Way 1**

M1: Attempts both gradients with an attempt at $\frac{\text{difference in } y}{\text{difference in } x}$ seen at least once.

A1: Achieves both correct gradients which may be left unsimplified e.g. grad $PQ = \frac{4}{12}$ and

grad $QR = \frac{9}{-3}$

A1: e.g. $\frac{1}{3}\times -3=-1 \Rightarrow PQR=90°$ or e.g. $\frac{1}{3}$ is the negative reciprocal of – 3 so Q = 90.

Do not allow ambiguous statements e.g. $\frac{1}{3}$ is the opposite inverse of – 3 for the explanation.

NB: $\frac{11-7}{9--3}=\frac{1}{3}, \frac{11-2}{9-12}=-3, \ \frac{1}{3}\times -3=-1 \Rightarrow PQR=90°$ would be a minimum for M1A1A1

(a) **Way 2**

M1: Attempts all three lengths with an attempt at "the difference between the coordinates" and "squaring" seen at least twice. Note that the "differences" may be implied by their answers or their lengths.

A1: All three lengths or lengths^2 correct as single exact terms or as decimals – allow one d.p.

Lengths are $\sqrt{160}$, $\sqrt{90}$, $\sqrt{250}$ or $4\sqrt{10}$, $3\sqrt{10}$, $5\sqrt{10}$ or e.g. 12.6, 9.5 (or 9.4 truncated), 15.8

A1: via Pythagoras or cosine rule e.g.

$PQ^2+QR^2=PR^2$ so PQR = 90° or e.g. $\cos\theta=\frac{160+90-250}{2\sqrt{160}\sqrt{90}}=0\Rightarrow\theta=90°$

If via the cosine rule, all values must be in the correct positions with correct signs.

"160, 90, 250 is a Pythagorean triple so PQR = 90°" is acceptable for the final mark.

Values must appear as exact for this mark. E.g. $\cos\theta=\frac{12.6^2+9.5^2-15.8^2}{2\times12.6\times9.5}=0\Rightarrow\theta=90°$ scores M1A1A0

(a) **Way 3**

M1: Attempts $\pm\overrightarrow{PQ}$ and $\pm\overrightarrow{QR}$ with an attempt at "the difference between the coordinates" seen at least twice

A1: Correct vectors for $\pm\overrightarrow{PQ}$ and $\pm\overrightarrow{QR}$

A1: $\overrightarrow{PQ}\bullet\overrightarrow{QR}=0$ so angle PQR = 90°

Part (b)

(b)	E.g. $(-3,7)+(3,-9)=...$ or $(12,2)-(12,4)=...$	M1
	$(0,-2)$	A1
		(2)
ALT 1	grad $PQ = \frac{11-7}{9--3}=\frac{1}{3}\Rightarrow$ eqn RS is $y-2=\frac{1}{3}(x-12)$ grad $QR = \frac{11-2}{9-12}=-3\Rightarrow$ eqn PS is $y-7=-3(x+3)$ $\Rightarrow x=..., y=...$	M1
	$(0,-2)$	A1
ALT 2	Midpoint PR is $\left(\frac{9}{2},\frac{9}{2}\right)\Rightarrow \frac{9+x}{2}=\frac{9}{2}, \frac{11+y}{2}=\frac{9}{2}\Rightarrow x=.., y=...$	M1
	$(0,-2)$	A1
		(5 marks)

(b)

M1: Any suitable method of finding at least x or y for S. It can be implied by one correct coordinate which may be seen on a diagram.
e.g. Via vectors $(-3,7)+(3,-9)=(0,-2)$ or $(12,2)-(12,4)=(0,-2)$

A1: Correct coordinates $(0,-2)$ which may be written separately e.g. $x = 0$, $y = -2$ or as $\begin{pmatrix}0\\-2\end{pmatrix}$

Alt 1(b)

M1: Attempts the equation of line PS, the equation of line RS and solves simultaneously to find x or y

A1: Correct coordinates $(0,-2)$ which may be written separately e.g. $x = 0$, $y = -2$ or as $\begin{pmatrix}0\\-2\end{pmatrix}$

Alt 2(b)

M1: Attempts the midpoint of PR and uses Q to find S for at least one of x or y

A1: Correct coordinates $(0,-2)$ which may be written separately e.g. $x = 0$, $y = -2$ or as $\begin{pmatrix}0\\-2\end{pmatrix}$