Question Number	Scheme	Marks
6(a)	$x^2 - xy + y^2 + 4x = 12$ $\Rightarrow 2x - x\frac{dy}{dx} - y + 2y\frac{dy}{dx} + 4 = 0$	M1A1
	$\frac{dy}{dx}(2y - x) = y - 2x - 4 \Rightarrow \frac{dy}{dx} = ...$	M1
	$\Rightarrow \left(\frac{dy}{dx}\right) = \frac{y - 2x - 4}{2y - x}$ oe	A1
		(4)
(b)	$(-4, -6) \rightarrow \frac{dy}{dx} = \frac{-6 + 8 - 4}{-12 + 4} = \frac{1}{4} \Rightarrow m_N = -4$	M1
	$y + 6 = -4(x + 4)$	M1
	$y = -4x - 22$	A1
		(3)
(c)	$y = -4x - 22 \Rightarrow 21x^2 + 202x + 472 = 0$ or $x = \frac{y + 22}{-4} \Rightarrow 21y^2 + 116y - 60 = 0$	M1
	$21x^2 + 202x + 472 = 0 \Rightarrow x = -\frac{118}{21}, \ (-4)$ or $21y^2 + 116y - 60 = 0 \Rightarrow y = \frac{10}{21}, (-6)$	dM1
	$x = -\frac{118}{21}$, o.e.e $\quad y = \frac{10}{21}$ o.e.e.	A1
		(3)
		Total 10

(a)

M1: For $xy \rightarrow \alpha y + \beta x\frac{dy}{dx}$ **or** $y^2 \rightarrow \alpha y\frac{dy}{dx}$

A1: Fully correct differentiation on the whole equation unsimplified or simplified.

M1: Makes $\frac{dy}{dx}$ the subject from **2** different terms in $\frac{dy}{dx}$ coming from the correct terms only

A1: Any correct expression

(b)

M1: Correct method for the gradient of the normal using their numerical value for $\frac{dy}{dx}$

M1 Correct method for finding the equation of the normal. Ft their normal gradient which must not be their tangent gradient.

A1: Correct equation in the required form

(c)

M1: Substitutes for x or y into the given equation to obtain a 3TQ in x or y.

dM1:	Solves 3TQ using any method [including using a calculator] to obtain either the x or y coordinate of Q This mark is dependent on the first M mark awarded.
A1:	Both correct **exact** coordinates. Accept values given separately. Ignore any reference to $(-4,-6)$

Question Number	Scheme	Marks
7(a)	$\pm\left(5\mathbf{i}-3\mathbf{j}+\mathbf{k}-\left(3\mathbf{i}-2\mathbf{j}+3\mathbf{k}\right)\right)$	M1
	e.g. $\mathbf{r}=5\mathbf{i}-3\mathbf{j}+\mathbf{k}+\lambda\left(2\mathbf{i}-\mathbf{j}-2\mathbf{k}\right)$ $\mathbf{r}=5\mathbf{i}-3\mathbf{j}+\mathbf{k}+\lambda\left(-2\mathbf{i}+\mathbf{j}+2\mathbf{k}\right)$ $\mathbf{r}=3\mathbf{i}-2\mathbf{j}+3\mathbf{k}+\lambda\left(2\mathbf{i}-\mathbf{j}-2\mathbf{k}\right)$ $\mathbf{r}=3\mathbf{i}-2\mathbf{j}+3\mathbf{k}+\lambda\left(-2\mathbf{i}+\mathbf{j}+2\mathbf{k}\right)$ or $\mathbf{r}=\begin{pmatrix}3\\-2\\3\end{pmatrix}+\lambda\begin{pmatrix}-2\\1\\2\end{pmatrix}$	A1
		(2)
(b)	e.g. $1-2\lambda=-5\Rightarrow\lambda=3$ $\lambda=3\Rightarrow\mathbf{r}=5\mathbf{i}-3\mathbf{j}+\mathbf{k}+3\left(2\mathbf{i}-\mathbf{j}-2\mathbf{k}\right)$	M1
	$\Rightarrow\alpha=11,\ \beta=-6$	A1
		(2)
(c)	$\overrightarrow{OC}\bullet\overrightarrow{AB}=\left(11\mathbf{i}-6\mathbf{j}-5\mathbf{k}\right)\bullet\left(-2\mathbf{i}+\mathbf{j}+2\mathbf{k}\right)=-22-6-10=\left(-38\right)$	M1
	$-38=\sqrt{11^2+6^2+5^2}\sqrt{2^2+1^2+2^2}\cos\theta\Rightarrow\theta=...$	dM1
	$\theta=20.1°$	A1
		(3)
(d)	e.g., $\overrightarrow{OD}\bullet\begin{pmatrix}2\\-1\\-2\end{pmatrix}=0\Rightarrow\begin{pmatrix}2\lambda+5\\-\lambda-3\\-2\lambda+1\end{pmatrix}\bullet\begin{pmatrix}2\\-1\\-2\end{pmatrix}\Rightarrow\lambda=...\left(-\frac{11}{9}\right)$ or e.g. $\overrightarrow{OD}\bullet\begin{pmatrix}-2\\1\\2\end{pmatrix}=0\Rightarrow\begin{pmatrix}3-2\lambda\\-2+\lambda\\3+2\lambda\end{pmatrix}\bullet\begin{pmatrix}-2\\1\\2\end{pmatrix}\Rightarrow\lambda=...\left(\frac{2}{9}\right)$	M1
	e.g. $\lambda=-\frac{11}{9}\Rightarrow\mathbf{r}=\begin{pmatrix}5\\-3\\1\end{pmatrix}-\frac{11}{9}\begin{pmatrix}2\\-1\\-2\end{pmatrix}$ or e.g. $\lambda=\frac{2}{9}\Rightarrow\mathbf{r}=\begin{pmatrix}3\\-2\\3\end{pmatrix}+\frac{2}{9}\begin{pmatrix}-2\\1\\2\end{pmatrix}$	M1

	$\left(\frac{23}{9}, -\frac{16}{9}, \frac{31}{9}\right)$	A1
		(3)
		Total 10

Notes

(a)

M1: Attempts the direction of l

Two out of three components correct in the direction implies the M mark.

A1: Any correct equation including '**r** =' Do not accept **l** = …..

Accept column vectors throughout, e.g., $\mathbf{r} = \begin{pmatrix} 3 \\ -2 \\ 3 \end{pmatrix} + \lambda \begin{pmatrix} -2 \\ 1 \\ 2 \end{pmatrix}$ but do **NOT** accept $\mathbf{r} = \begin{pmatrix} 3\mathbf{i} \\ -2\mathbf{j} \\ 3\mathbf{k} \end{pmatrix} + \lambda \begin{pmatrix} -2\mathbf{i} \\ 1\mathbf{j} \\ 2\mathbf{k} \end{pmatrix}$

(b)

M1: Uses the z component to find the value of the parameter for their equation and uses their parameter value to find the value of α and the value of β.

A1: Correct values or vector.

(c)

M1: Attempts the scalar product $\pm \overrightarrow{OC} \bullet \overrightarrow{AB}$ Ft their $\overrightarrow{OC}$ and $\overrightarrow{AB}$

Look for at least two correct products can be implied by the correct answer.

dM1: A complete method to find the angle (allow acute or obtuse, 20.13º or 159.87° respectively allow working in radians for the M marks)

A1: Awrt 20.1°

(d)

M1: Attempts the scalar product between their $\overrightarrow{OD}$ and the direction of l, sets = 0 and solves for λ for their equation.

M1: Uses their λ correctly to find D

A1: Correct exact coordinates (condone vector)

Do **NOT** accept the final answer in the form $\begin{pmatrix} \frac{23}{9}\mathbf{i} \\ -\frac{16}{9}\mathbf{j} \\ \frac{31}{9}\mathbf{k} \end{pmatrix}$