Question Number	Scheme	Marks
5(a)	$y^3 - x^2 + 4x^2y = k$	
	$y^3 \to 3y^2\dfrac{dy}{dx}$	M1
	$4x^2y \to 8xy + 4x^2\dfrac{dy}{dx}$	M1
	$y^3 - x^2 + 4x^2y = k \Rightarrow 3y^2\dfrac{dy}{dx} - 2x + 8xy + 4x^2\dfrac{dy}{dx} = 0$	A1
	$\Rightarrow \left(3y^2 + 4x^2\right)\dfrac{dy}{dx} = 2x - 8xy$	M1
	$\Rightarrow \dfrac{dy}{dx} = \dfrac{2x - 8xy}{3y^2 + 4x^2}$	A1
		(5)
(b)	$\dfrac{dy}{dx} = -1$ at P	M1
	Uses $\dfrac{dy}{dx} = \pm 1$ and $y = x$ to set up and solve equation in x, y or 'p' $\Rightarrow -1 = \dfrac{2p - 8p^2}{3p^2 + 4p^2} \Rightarrow p = 2$	M1 A1
	e.g. $k = "2"^3 - "2"^2 + 4 \times "2"^3$	**dd**M1
	$k = 36$	A1
		(5)
		(10 marks)

(a) Allow equivalent notation for the $\dfrac{dy}{dx}$ e.g. y'

M1: Differentiates $y^3 \to Py^2\dfrac{dy}{dx}$

M1: Uses the product rule to differentiate $4x^2y$ and obtains $Qxy + Rx^2\dfrac{dy}{dx}$

A1: Correct differentiation including the " = 0" which may be implied by subsequent work.

Note that some candidates have a spurious $\dfrac{dy}{dx} = ...$ at the start (as their intention to differentiate) and this can be ignored for the first 3 marks so condone $\dfrac{dy}{dx} = 3y^2\dfrac{dy}{dx} - 2x + 8xy + 4x^2\dfrac{dy}{dx} = 0$

Allow versions such as $3y^2dy - 2xdx + 8xydx + 4x^2dy = 0$

M1: Dependent upon having achieved two <u>different</u> terms in $\dfrac{dy}{dx}$, one from each of the terms y^3 and $4x^2y$.

Look for $(... \pm ...)\dfrac{dy}{dx} = ... \Rightarrow \dfrac{dy}{dx} = ...$ which may be implied by their working.

For those candidates who had a spurious $\dfrac{dy}{dx} = ...$ at the start, they may incorporate this in their rearrangement in which case they will have 3 terms in $\dfrac{dy}{dx}$ and so score M0.

If they ignore it, then this mark is available for the condition as described above.

A1: $\dfrac{dy}{dx} = \dfrac{2x - 8xy}{3y^2 + 4x^2}$ or exact equivalent e.g. $\dfrac{dy}{dx} = \dfrac{8xy - 2x}{-3y^2 - 4x^2}$

(b)

M1: States or uses $\frac{\mathrm{d}y}{\mathrm{d}x} = -1$ which may be implied by their working e.g.

$$\frac{2x-8xy}{3y^2+4x^2} = -1,\ \frac{8xy-2x}{3y^2+4x^2} = 1,\ \frac{3y^2+4x^2}{8xy-2x} = 1 \text{ etc.}$$

Do not award for e.g. "Gradient = –1"

M1: Uses $y = x$ or $x = y$ or $y = x =$ "p" in their $\frac{\mathrm{d}y}{\mathrm{d}x}$ sets $= \pm 1$ and attempts to solve to obtain a value for their variable.

e.g. $\frac{2x-8x^2}{3x^2+4x^2} = \pm 1 \Rightarrow x = ...,\ \frac{2y-8y^2}{3y^2+4y^2} = \pm 1 \Rightarrow y = ...,\ \frac{2p-8p^2}{3p^2+4p^2} = \pm 1 \Rightarrow p = ...,$

A1: For x, y or "p" = 2 at P

ddM1: Uses their non-zero value for x, y or "p" to obtain a value for k using the given equation of the curve.

Depends on both previous method marks.

A1: $k = 36$

Correct answer only with no working scores no marks.

Question Number	Scheme	Marks
6(a)	$\left(2,3,-7\right)$	B1
		(1)
(b)	Attempts $\begin{pmatrix}1\\2\\2\end{pmatrix}\bullet\begin{pmatrix}4\\-1\\8\end{pmatrix}=1\times4+2\times-1+2\times8=\left(18\right)$	M1
	Attempts $\mathbf{a}.\mathbf{b}=\left\|\mathbf{a}\right\|\left\|\mathbf{b}\right\|\cos\theta$: $18=\sqrt{1^2+2^2+2^2}\times\sqrt{4^2+\left(-1\right)^2+8^2}\cos\theta$	**d**M1
	$\cos\theta=\frac{2}{3}$	A1
		(3)
(b) Alt	e.g. $\pm\left(\begin{pmatrix}4\\-1\\8\end{pmatrix}-\begin{pmatrix}1\\2\\2\end{pmatrix}\right)=\pm\begin{pmatrix}3\\-3\\6\end{pmatrix}$	M1
	$3^2+3^2+6^2=1^2+2^2+2^2+4^2+\left(-1\right)^2+8^2-2\sqrt{1^2+2^2+2^2}\times\sqrt{4^2+\left(-1\right)^2+8^2}\cos\theta$	dM1
	$\cos\theta=\frac{2}{3}$	A1
(c)	Uses $\lambda=6$ to find length PQ E.g. $\overrightarrow{PQ}=6\mathbf{i}+12\mathbf{j}+12\mathbf{k}\Rightarrow PQ=\sqrt{6^2+12^2+12^2}=\left(18\right)$ Or $PQ=6\times\sqrt{1^2+2^2+2^2}=\left(18\right)$	M1
	Area $QPR=\frac{1}{2}ab\sin C=\frac{1}{2}\times18^2\times\sqrt{1-\left(\frac{2}{3}\right)^2}=54\sqrt{5}$	M1 A1
		(3)
(d)	Attempts a correct method of finding at least one value for μ e.g. $\left(4\mu\right)^2+\mu^2+\left(8\mu\right)^2=6^2+12^2+12^2$ $\Rightarrow\mu=\frac{\text{"18"}}{\sqrt{4^2+\left(-1\right)^2+8^2}}=\left(\pm\right)2$	M1
	Attempts one correct position $\mathbf{r}=\begin{pmatrix}2\\3\\-7\end{pmatrix}\pm2\begin{pmatrix}4\\-1\\8\end{pmatrix}$	**d**M1
	Possible coordinates $\left(10,1,9\right)$ and $\left(-6,5,-23\right)$	A1
		(3)
		(10 marks)