Question	Answer	Marks	Guidance
8(a)	$\left(x-\left(-\frac{1}{2}p\right)\right)^2+\left(y-(-1)\right)^2$ OE	**B1***	Allow $a=-\frac{1}{2}p$ and $b=-1$, or centre is $\left(-\frac{1}{2}p,-1\right)$.
	$\left(x-\left(-\frac{1}{2}p\right)\right)^2+\left(y-(-1)\right)^2=-q+1+\left(-\frac{1}{2}P\right)^2$ OE	**DB1**	
		2	
8(b)(i)	[Gradient of tangent =] $-\frac{1}{2}$	**B1**	OE SOI
	[Gradient of normal =] 2	**M1**	Use of $m_1m_2=-1$with *their* numeric tangent gradient.
	$\frac{y-3}{x-4}=2$ $[y=2x-5]$	**A1**	OE ISW Allow $y=2x+c,\ 3=2\times4+c \Rightarrow c=-5$.
		3	

Question	Answer	Marks	Guidance
8(b)(ii)	**Method 1 for the first two marks:**		
	$-1-3=2\left(-\frac{1}{2}p-4\right)$ or $-1=-p-5$	**M1***	Using *their* stated centre or $\left(\frac{\pm p}{2},\ \pm 1\right)$ in *their* equation of the normal.
	$p=-4$	**A1**	
	Method 2 for the first two marks:		
	$-1=2x-5 \Rightarrow x=2 \ \Rightarrow \ -\frac{1}{2}p=2$	**M1***	Using their normal equation and *their* stated centre or $\left(\frac{\pm p}{2},\ \pm 1\right)$.
	$p=-4$	**A1**	
	Method 3 for the first two marks:		
	$2x+2y\frac{dy}{dx}+p+2\frac{dy}{dx}=0 \quad \left[\Rightarrow p=-8-8\frac{dy}{dx}\right]$	**M1***	
	$\left[\frac{dy}{dx}=-\frac{1}{2}\Rightarrow\right] \ p=-4$	**A1**	

Question	Answer	Marks	Guidance
8(b)(ii)	**Method 1 for the last 3 marks:**		
	$r^2 = (4-2)^2 + (3-(-1))^2$ $[= 20]$	**M1***	Using (4, 3) and *their* centre or $\left(\frac{\pm their\ p}{2}, \pm 1\right)$ to find r^2 or r.
	$-q + 1 + \frac{1}{4}p^2 = 20$	**DM1**	OE Using *their* expression for r^2 (from **(a)**) equated to *their* 20.
	$q = -15$	**A1**	
	Method 2 for the last 3 marks:		
	$r = \frac{\lvert 2-2-10\rvert}{\sqrt{5}}$ $\left[= \frac{10}{\sqrt{5}}\right]$	**M1***	Using $(2, -1)$ and $x + 2y - 10 = 0$ (distance from a point to a line).
	$-q + 1 + \frac{1}{4}p^2 = \left(\frac{10}{\sqrt{5}}\right)^2$	**DM1**	OE Using *their* expression for r^2 equated to *their* $\left(\frac{10}{\sqrt{5}}\right)^2$.
	$q = -15$	**A1**	
	Method 3 for the last 3 marks:		
	$4^2 + 3^2 + 4p + 6 + q = 0$ $[\Rightarrow\ 4p + q + 31 = 0]$ OR $\left(4 - \left(-\frac{1}{2}p\right)\right)^2 + (3-(-1))^2 = -q + 1 + \left(-\frac{1}{2}p\right)^2$	**M1***	Substituting $(4, 3)$ into their circle equation.
	$4(-4) + q + 31 = 0$	**DM1**	Substituting *their* $p = -4$.
	$q = -15$	**A1**	

Question	Answer	Marks	Guidance
8(b)(ii)	**Alternative Method for Question 8(b)(ii)**		
	$4^2+3^2+4p+6+q=0$ $x^2+(2x-5)^2+px+2(2x-5)+q=0$ with $x=4$ $x^2+\left(\frac{10-x}{2}\right)^2+px+2\left(\frac{10-x}{2}\right)+q=0$ with $x=4$ $\left(\frac{y+5}{2}\right)^2+y^2+p\left(\frac{y+5}{2}\right)+2y+q=0$ with $y=3$ $(10-2y)^2+y^2+p(10-2y)+2y+q=0$ with $y=3$ $\{\text{Each of these} \Rightarrow 4p+q+31=0\}$	**M1***	Substituting $(4,3)$ into *their* circle equation, or replacing y with $2x-5$ from the normal equation, or replacing y with $\frac{10-x}{2}$ from the tangent equation, or replacing x with $\frac{y+5}{2}$ from the normal equation, or replacing x with $10-2y$ from the tangent equation, and using either $x=4$ or $y=3$ to form an equation in p and q.
	$\frac{5}{4}x^2+(p-6)x+35+q=0 \Rightarrow (p-6)^2-4\times\frac{5}{4}\times(35+q)=0$ OR $5y^2-y(38+2p)+100+10p+q=0 \Rightarrow (38+2p)^2-4\times5\times(100+10p+q)=0$ $\{\text{Each of these} \Rightarrow p^2-12p-139-5q=0\}$	**M1***	Solving the tangent and circle equations simultaneously to form a quadratic equation in either x or y. Then using $b^2-4ac=0$ on their quadratic to form an equation in p and q.
	Solving the equations simultaneously to find p or q	**DM1**	
	$p=-4$	**A1**	
	$q=-15$	**A1**	
		5	