Question Number	Scheme	Notes	Marks
9.	$C: y^2 = 4ax;\ P(ap^2,\ 2ap)$ lies on C; circle: $(x-10a)^2 + y^2 = \frac{9}{4}a^2$		
(a)	$y = 2\sqrt{a}\,x^{\frac{1}{2}} \Rightarrow \frac{dy}{dx} = \sqrt{a}\,x^{-\frac{1}{2}} = \frac{\sqrt{a}}{\sqrt{x}}$	$\frac{dy}{dx} = \pm k\,x^{-\frac{1}{2}};\ k \neq 0$	M1
	$2y\frac{dy}{dx} = 4a$	$ky\frac{dy}{dx} = c;\ k, c \neq 0$	
	$\frac{dy}{dx} = \frac{dy}{dt}.\frac{dt}{dx} = 2a\left(\frac{1}{2ap}\right)$	their $\frac{dy}{dt} \times \frac{1}{\text{their}\frac{dx}{dt}}$; Condone $t \equiv p$	
	{At P, $x = ap^2$, $y = 2ap \Rightarrow$} $\frac{dy}{dx} = \frac{1}{p}$	Correct calculus work leading to $m_T = \frac{1}{p}$	A1
	So, at P, $m_N = -p$	Applies $m_N = \frac{-1}{m_T}$, to find m_N in terms of p, where m_T is found using calculus. Can be implied by later working.	M1
	either $y - 2ap = -p(x - ap^2)$ **or** $y - 0 = -p(x - 10a)$	Correct straight line method for an equation of a normal, where m_N $(\neq m_T)$ is found using calculus.	M1
	$0 - 2ap = -p(10a - ap^2)$ $2ap - 0 = -p(ap^2 - 10a)$ $\Rightarrow p = ... \Rightarrow x = ...$ or $y = ...$ **or** $2ap - 0 = -p(x - 10a) \Rightarrow x = ...$	**dependent on the previous M mark** Complete method to find either the x or y coordinate of P	dM1
	either $x = 8a$, $y = 4\sqrt{2}\,a$ **or** $P(8a,\ 4\sqrt{2}\,a)$	**Either** $x = 8a$ **or** $y = 4\sqrt{2}\,a$ **or** $y =$ awrt $5.66a$	A1
		$P(8a,\ 4\sqrt{2}\,a)$ or both $x = 8a$ and $y = 4\sqrt{2}\,a$	A1
	Note: $p = 2\sqrt{2}$ or $\sqrt{8}$. **Note:** Ignore the additional solution $P(8a,\ -4\sqrt{2}\,a)$		**(7)**
(b) **Way 1**	Area $SBP = \frac{1}{2}(10a - a)(4\sqrt{2}a)$	$\frac{1}{2}(10a - a)$(their y_P from (a))	M1
	$= 18\sqrt{2}\,a^2$	$18\sqrt{2}\,a^2$	A1
			(2)
(c) **Way 1**	$PB = \sqrt{(10a - "8a")^2 + ("4\sqrt{2}a")^2}$ $\{= 6a\}$	Complete Pythagoras method for finding length PB	M1
	$PR = 6a - 1.5a$	**dependent on the previous M mark** $PR =$ "their $6a$" $- 1.5a$	dM1
	$PR = 4.5a$	$PR = 4.5a$	A1
			(3)
(c) **Way 2**	$p = 2\sqrt{2} \Rightarrow l: y = -2\sqrt{2}x + 20\sqrt{2}a$ $(x - 10a)^2 + (-2\sqrt{2}x + 20\sqrt{2}a)^2 = \frac{9}{4}a^2$ $\Rightarrow 36x^2 - 720ax + 3591a^2 = 0$ $\Rightarrow 9(2x - 21a)(2x - 19a) = 0 \Rightarrow x = ...$	Substitutes their equation of l into the circle equation followed by a correct method for solving their 3TQ to give $x = ...$ or $y = ...$	M1
	$\Rightarrow R(9.5a,\ \sqrt{2}\,a)$		
	$PR = \sqrt{(9.5a - 8a)^2 + (\sqrt{2}a - 4\sqrt{2}\,a)^2}$	**dependent on the previous M mark** Complete applied Pythagoras method for finding the distance between their P and their R	dM1
	$PR = 4.5a$	$PR = 4.5a$	A1
			(3)

Question Number	Scheme	Notes	Marks
9. (b) **Way 2**	Area $SBP = \frac{1}{2}\begin{vmatrix} a & 10a & "8a" & a \\ 0 & 0 & "4\sqrt{2}a" & 0 \end{vmatrix}$ $= \frac{1}{2}\left\|0 - 0 + 40\sqrt{2}\,a^2 - 0 + 0 - 4\sqrt{2}\,a^2\right\|$	Complete applied method for finding area SBP using $S(a, 0)$, $B(10a, 0)$ and their P from (a)	M1
	$= 18\sqrt{2}\,a^2$	$18\sqrt{2}\,a^2$	A1
			(2)
9. (c) **Way 3**	$x_R = 10a - 1.5\cos\left(\tan^{-1}\left(\frac{"4\sqrt{2}\,a"}{10a - "8a"}\right)\right)$ $y_R = 1.5\sin\left(\tan^{-1}\left(\frac{"4\sqrt{2}\,a"}{10a - "8a"}\right)\right)$	Uses their P from (a) in a correct method for writing down either x_R or y_R	M1
	$\Rightarrow R(9.5a, \sqrt{2}\,a)$		
	$PR = \sqrt{(9.5a - 8a)^2 + (\sqrt{2}a - 4\sqrt{2}\,a)^2}$	**dependent on the previous M mark** Complete applied Pythagoras method for finding the distance between their P and their R	dM1
	$PR = 4.5a$	$PR = 4.5a$	A1
			(3)

Question 9 Notes

9. (a)	**Note**	Allow 1st M1 1st A1 (sufficient use of calculus) for $\{m_T =\}\ \frac{4a}{2y}$ which leads to $\{m_T =\}\frac{1}{p}$		
	Note	Allow 1st M1 1st A1 (sufficient use of calculus) for $\{m_T =\}\ \sqrt{\frac{a}{x}}$ which leads to $\{m_T =\}\frac{1}{p}$		
	Note	Give 3rd M1 for either • $2ap = "(-p)"(ap^2) + c \Rightarrow y = "(-p)"x +$ their c **or** • $0 = "(-p)"(10a) + c \Rightarrow y = "(-p)"x +$ their c		
	Note	Writing coordinates the wrong way around E.g. finding $x = 8a$, $y = 4\sqrt{2}\,a$ followed by $(4\sqrt{2}\,a, 8a)$ is final A0		
	Note	Give final A0 for $(8a, 5.65685...a)$ without reference to $y = 4\sqrt{2}\,a$ or $2\sqrt{8}\,a$		
	Note	Accept $y_P = 2\sqrt{8}\,a$ written in place of $y_P = 4\sqrt{2}\,a$ for the final A1 A1 marks		
	Note	**Special Case** If they write down either $\frac{dy}{dx} = \frac{1}{p}$, $m_T = \frac{1}{p}$ or $m_N = -p$ with no evidence of using calculus then they can gain any of or all the final 4 marks in part (a).		
	ALT	**Alternative Method for the 3rd M mark and 4th M mark**		
		$\{B(10a, 0), P(ap^2, 2ap) \Rightarrow\}$ $m_{BP} = \frac{2ap - 0}{ap^2 - 10a} = -p$	Finds gradient of BP and sets the result equal to the gradient of their normal	3rd M1
		$\Rightarrow p = ... \Rightarrow x = ...$ or $y = ...$	**dependent on the previous M mark** Complete method to find either the x or y coordinate of P	4th M1

	Question 9 Notes Continued	
9. (b)	**Note**	Give A0 $25.4558...a^2$ without reference to $18\sqrt{2}\,a^2$
	Note	Condone one slip of either writing 9 for $10a-a$ or writing $"4\sqrt{2}"$ instead of $"4\sqrt{2}\,a"$ for the M mark in (b)
(c)	**Note**	**Way 2:** For reference, $(x-10a)^2+(-2\sqrt{2}x+20\sqrt{2}a)^2=\frac{9}{4}a^2$ $x^2-20ax+100a^2+8x^2-160ax+800a^2=\frac{9}{4}a^2$ $9x^2-180ax+900a^2=\frac{9}{4}a^2$ $9x^2-180ax+\frac{3591}{4}a^2=0$ **or** $9x^2-180ax+897.75a^2=0$ **or** $x^2-20ax+99.75a^2=0$ **or** $4x^2-80ax+399a^2=0$ $x=\frac{180a\pm\sqrt{(180a)^2-4(9)(\frac{3591}{4})a^2}}{2(9)}=\frac{180a\pm 9a}{2(9)}$ $x=\frac{189a}{18},\frac{171a}{18}=10.5a,\,9.5a$
	Note	The method $PB=\sqrt{(10a-"8a")^2+("4\sqrt{2}a")^2}$ needs to be referred to in part (c) or the result of $PB=\sqrt{(10a-"8a")^2+("4\sqrt{2}a")^2}$ needs to be used in part (c) to gain the M mark in part (c)

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