

## Paper 1: Pure Mathematics Mark Scheme

Question	Scheme	Marks	AOs
<b>1</b> <b>Way 1</b>	Uses $y = mx + c$ with both (3, 1) and (4, -2) and attempt to find $m$ or $c$	M1	1.1b
	$m = -3$	A1	1.1b
	$c = 10$ so $y = -3x + 10$ o.e.	A1	1.1b
		<b>(3)</b>	
<b>Or</b> <b>Way 2</b>	Uses $\frac{y - y_1}{x - x_1} = \frac{y_2 - y_1}{x_2 - x_1}$ with both (3, 1) and (4, -2)	M1	1.1b
	Gradient simplified to -3 (may be implied)	A1	1.1b
	$y = -3x + 10$ o.e.	A1	1.1b
		<b>(3)</b>	
<b>Or</b> <b>Way 3</b>	Uses $ax + by + k = 0$ and substitutes both $x = 3$ when $y = 1$ and $x = 4$ when $y = -2$ with attempt to solve to find $a, b$ or $k$ in terms of one of them	M1	1.1b
	Obtains $a = 3b, k = -10b$ or $3k = -10a$	A1	1.1b
	Obtains $a = 3, b = 1, k = -10$ Or writes $3x + y - 10 = 0$ o.e.	A1	1.1b
		<b>(3)</b>	
			<b>(7 marks)</b>
<b>Notes:</b>			
<p><b>M1:</b> Need correct use of the given coordinates</p> <p><b>A1:</b> Need fractions simplified to -3 (in ways 1 and 2)</p> <p><b>A1:</b> Need constants combined accurately</p> <p><b>N.B.</b> Answer left in the form <math>(y - 1) = -3(x - 3)</math> or <math>(y - (-2)) = -3(x - 4)</math> is awarded <b>M1A1A0</b> as answers should be simplified by constants being collected</p> <p><i>Note that a correct answer implies all three marks in this question</i></p>			

Question	Scheme	Marks	AOs
2	Attempt to differentiate	M1	1.1a
	$\frac{dy}{dx} = 4x - 12$	A1	1.1b
	Substitutes $x = 5 \Rightarrow \frac{dy}{dx} = \dots$	M1	1.1b
	$\Rightarrow \frac{dy}{dx} = 8$	A1ft	1.1b
<b>(4 marks)</b>			
<b>Notes:</b>			
<p><b>M1:</b> Differentiation implied by one correct term</p> <p><b>A1:</b> Correct differentiation</p> <p><b>M1:</b> Attempts to substitute <math>x = 5</math> into their derived function</p> <p><b>A1ft:</b> Substitutes <math>x = 5</math> into <b>their</b> derived function <b>correctly</b> i.e. Correct calculation of their <math>f'(5)</math> so follow through slips in differentiation</p>			

Question	Scheme	Marks	AOs
3(a)	Attempts $\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA}$ or similar	M1	1.1b
	$\overrightarrow{AB} = 5\mathbf{i} + 10\mathbf{j}$	A1	1.1b
		(2)	
(b)	Finds length using 'Pythagoras' $ AB  = \sqrt{(5)^2 + (10)^2}$	M1	1.1b
	$ AB  = 5\sqrt{5}$	A1ft	1.1b
		(2)	
<b>(4 marks)</b>			
<b>Notes:</b>			
<p><b>(a)</b></p> <p><b>M1:</b> Attempts subtraction but may omit brackets</p> <p><b>A1:</b> cao (allow column vector notation)</p>			
<p><b>(b)</b></p> <p><b>M1:</b> Correct use of Pythagoras theorem or modulus formula using their answer to (a)</p> <p><b>A1ft:</b> <math> AB  = 5\sqrt{5}</math> ft from their answer to (a)</p> <p><i>Note that the correct answer implies M1A1 in each part of this question</i></p>			

Question	Scheme	Marks	AOs
<b>4(a)</b>	States or uses $f(+3) = 0$	M1	1.1b
	$4(3)^3 - 12(3)^2 + 2(3) - 6 = 108 - 108 + 6 - 6 = 0$ and so $(x - 3)$ is a factor	A1	1.1b
		<b>(2)</b>	
<b>(b)</b>	Begins division or factorisation so $x$ $4x^3 - 12x^2 + 2x - 6 = (x - 3)(4x^2 + \dots)$	M1	2.1
	$4x^3 - 12x^2 + 2x - 6 = (x - 3)(4x^2 + 2)$	A1	1.1b
	Considers the roots of their quadratic function using completion of square or discriminant	M1	2.1
	$(4x^2 + 2) = 0$ has no real roots with a reason (e.g. negative number does not have a real square root, or $4x^2 + 2 > 0$ for all $x$ So $x = 3$ is the only real root of $f(x) = 0$ *	A1*	2.4
		<b>(4)</b>	
<b>(6 marks)</b>			
<b>Notes:</b>			
<b>(a)</b>			
<b>M1:</b> States or uses $f(+3) = 0$			
<b>A1:</b> See correct work evaluating and achieving zero, together with correct conclusion			
<b>(b)</b>			
<b>M1:</b> Needs to have $(x - 3)$ and first term of quadratic correct			
<b>A1:</b> Must be correct – may further factorise to $2(x - 3)(2x^2 + 1)$			
<b>M1:</b> Considers their quadratic for no real roots by use of completion of the square or consideration of discriminant then			
<b>A1*:</b> A correct explanation			

Question	Scheme	Marks	AOs
<b>5</b>	$f(x) = 2x + 3 + 12x^{-2}$	B1	1.1b
	Attempts to integrate	M1	1.1a
	$\int \left( +2x + 3 + \frac{12}{x^2} \right) dx = x^2 + 3x - \frac{12}{x}$	A1	1.1b
	$\left( (2\sqrt{2})^2 + 3(2\sqrt{2}) - \frac{12(\sqrt{2})}{2 \times 2} \right) - (-8)$	M1	1.1b
	$= 16 + 3\sqrt{2}^*$	A1*	1.1b
<b>(5 marks)</b>			
<b>Notes:</b>			
<p><b>B1:</b> Correct function with numerical powers</p> <p><b>M1:</b> Allow for raising power by one. <math>x^n \rightarrow x^{n+1}</math></p> <p><b>A1:</b> Correct three terms</p> <p><b>M1:</b> Substitutes limits and rationalises denominator</p> <p><b>A1*:</b> Completely correct, no errors seen</p>			

Question	Scheme	Marks	AOs
<b>6</b>	Considers $\frac{3(x+h)^2 - 3x^2}{h}$	B1	2.1
	Expands $3(x+h)^2 = 3x^2 + 6xh + 3h^2$	M1	1.1b
	So gradient = $\frac{6xh + 3h^2}{h} = 6x + 3h$ or $\frac{6x\delta x + 3(\delta x)^2}{\delta x} = 6x + 3\delta x$	A1	1.1b
	States as $h \rightarrow 0$ , gradient $\rightarrow 6x$ so in the limit derivative = $6x^*$	A1*	2.5
<b>(4 marks)</b>			
<b>Notes:</b>			
<p><b>B1:</b> Gives correct fraction as in the scheme above or <math>\frac{3(x+\delta x)^2 - 3x^2}{\delta x}</math></p> <p><b>M1:</b> Expands the bracket as above or <math>3(x+\delta x)^2 = 3x^2 + 6x\delta x + 3(\delta x)^2</math></p> <p><b>A1:</b> Substitutes correctly into earlier fraction and simplifies</p> <p><b>A1*:</b> Uses Completes the proof, as above ( may use <math>\delta x \rightarrow 0</math>), considers the limit and states a conclusion with no errors</p>			

Question	Scheme	Marks	AOs
<b>7(a)</b>	$\left(2 - \frac{x}{2}\right)^7 = 2^7 + \binom{7}{1}2^6 \cdot \left(-\frac{x}{2}\right) + \binom{7}{2}2^5 \cdot \left(-\frac{x}{2}\right)^2 + \dots$	M1	1.1b
	$\left(2 - \frac{x}{2}\right)^7 = 128 + \dots$	B1	1.1b
	$\left(2 - \frac{x}{2}\right)^7 = \dots - 224x + \dots$	A1	1.1b
	$\left(2 - \frac{x}{2}\right)^7 = \dots + \dots + 168x^2 (+ \dots)$	A1	1.1b
		<b>(4)</b>	
<b>(b)</b>	Solve $\left(2 - \frac{x}{2}\right) = 1.995$ so $x = 0.01$ and state that 0.01 would be substituted for $x$ into the expansion	B1	2.4
		<b>(1)</b>	
<b>(5 marks)</b>			
<b>Notes:</b>			
<p><b>(a)</b></p> <p><b>M1:</b> Need correct binomial coefficient with correct power of 2 and correct power of <math>x</math>. Coefficients may be given in any correct form; e.g. 1, 7, 21 or <math>{}^7C_0</math>, <math>{}^7C_1</math>, <math>{}^7C_2</math> or equivalent</p> <p><b>B1:</b> Correct answer, simplified as given in the scheme</p> <p><b>A1:</b> Correct answer, simplified as given in the scheme</p> <p><b>A1:</b> Correct answer, simplified as given in the scheme</p>			
<p><b>(b)</b></p> <p><b>B1:</b> Needs a full explanation i.e. to state <math>x = 0.01</math> and that this would be substituted and that it is a solution of <math>\left(2 - \frac{x}{2}\right) = 1.995</math></p>			

Question	Scheme		Marks	AOs
<b>8(a)</b>	<b>Way 1</b>	<b>Way 2</b>	M1	2.1
	Finds third angle of triangle and uses or states $\frac{x}{\sin 60^\circ} = \frac{30}{\sin 50^\circ}$	Finds third angle of triangle and uses or states $\frac{y}{\sin 70^\circ} = \frac{30}{\sin 50^\circ}$		
	So $x = \frac{30 \sin 60^\circ}{\sin 50^\circ}$ (= 33.9)	So $y = \frac{30 \sin 70^\circ}{\sin 50^\circ}$ (= 36.8)	A1	1.1b
	Area = $\frac{1}{2} \times 30 \times x \times \sin 70^\circ$ or $\frac{1}{2} \times 30 \times y \times \sin 60^\circ$		M1	3.1a
	= 478 m <sup>2</sup>		A1ft	1.1b
			<b>(4)</b>	
<b>(b)</b>	Plausible reason e.g. Because the angles and the side length are not given to four significant figures Or e.g. The lawn may not be flat		B1	3.2b
			<b>(1)</b>	
<b>(5 marks)</b>				
<b>Notes:</b>				
<b>(a)</b>				
<b>M1:</b> Uses sine rule with their third angle to find one of the unknown side lengths				
<b>A1:</b> Finds expression for, or value of either side length				
<b>M1:</b> Completes method to find area of triangle				
<b>A1ft:</b> Obtains a correct answer for their value of x or their value of y				
<b>(b)</b>				
<b>B1:</b> As information given in the question may not be accurate to 4sf or the lawn may not be flat so modelling by a plane figure may not be accurate				

Question	Scheme	Marks	AOs
9	Uses $\sin^2 x = 1 - \cos^2 x \Rightarrow 12(1 - \cos^2 x) + 7 \cos x - 13 = 0$	M1	3.1a
	$\Rightarrow 12 \cos^2 x - 7 \cos x + 1 = 0$	A1	1.1b
	Uses solution of quadratic to give $\cos x =$	M1	1.1b
	Uses inverse cosine on their values, giving two correct follow through values (see note)	M1	1.1b
	$\Rightarrow x = 430.5^\circ, 435.5^\circ$	A1	1.1b

**(5 marks)**

**Notes:**

**M1:** Uses correct identity

**A1:** Correct three term quadratic

**M1:** Solves their three term quadratic to give values for  $\cos x$ . (The correct answers are  $\cos x = \frac{1}{3}$  or  $\frac{1}{4}$  but this is not necessary for this method mark)

**M1:** Uses inverse cosine on their values, giving two correct follow through values - may be outside the given domain

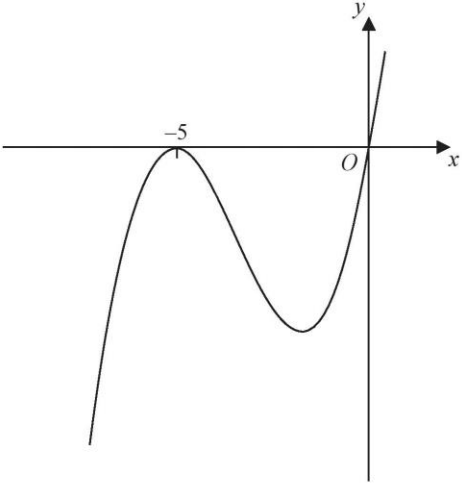
**A1:** Two correct answers in the given domain



Question	Scheme	Marks	AOs
<b>10</b>	Realises that $k = 0$ will give no real roots as equation becomes $3 = 0$ (proof by contradiction)	B1	3.1a
	(For $k \neq 0$ ) quadratic has no real roots provided $b^2 < 4ac$ so $16k^2 < 12k$	M1	2.4
	$4k(4k - 3) < 0$ with attempt at solution	M1	1.1b
	So $0 < k < \frac{3}{4}$ , which together with $k = 0$ gives $0 \leq k < \frac{3}{4}$ *	A1*	2.1
<b>(4 marks)</b>			
<b>Notes:</b>			
<b>B1:</b>	Explains why $k = 0$ gives no real roots		
<b>M1:</b>	Considers discriminant to give quadratic inequality – does not need the $k \neq 0$ for this mark		
<b>M1:</b>	Attempts solution of quadratic inequality		
<b>A1*:</b>	Draws conclusion, which is a printed answer, with no errors (dependent on all three previous marks)		

Question	Scheme	Marks	AOs
<b>11 (a)</b> <b>Way 1</b>	Since $x$ and $y$ are positive, their square roots are real and so $(\sqrt{x} - \sqrt{y})^2 \geq 0$ giving $x - 2\sqrt{x}\sqrt{y} + y \geq 0$	M1	2.1
	$\therefore 2\sqrt{xy} \leq x + y$ provided $x$ and $y$ are positive and so $\sqrt{xy} \leq \frac{x+y}{2} *$	A1*	2.2a
		<b>(2)</b>	
<b>Way 2</b> <b>Longer method</b>	Since $(x - y)^2 \geq 0$ for real values of $x$ and $y$ , $x^2 - 2xy + y^2 \geq 0$ and so $4xy \leq x^2 + 2xy + y^2$ i.e. $4xy \leq (x + y)^2$	M1	2.1
	$\therefore 2\sqrt{xy} \leq x + y$ provided $x$ and $y$ are positive and so $\sqrt{xy} \leq \frac{x+y}{2} *$	A1*	2.2a
		<b>(2)</b>	
<b>(b)</b>	Let $x = -3$ and $y = -5$ then LHS = $\sqrt{15}$ and RHS = $-4$ so as $\sqrt{15} > -4$ result does not apply	B1	2.4
		<b>(1)</b>	
<b>(3 marks)</b>			
<b>Notes:</b>			
<b>(a)</b>			
<b>M1:</b> Need two stages of the three stage argument involving the three stages, squaring, square rooting terms and rearranging			
<b>A1*:</b> Need all three stages making the correct deduction to achieve the printed result			
<b>(b)</b>			
<b>B1:</b> Chooses two negative values and substitutes, then states conclusion			

Question	Scheme		Marks	AOs
<b>12(a)</b>	$2^{2x} + 2^4$ is wrong in line 2 - it should be $2^{2x} \times 2^4$		B1	2.3
	In line 4, $2^4$ has been replaced by 8 instead of by 16		B1	2.3
			<b>(2)</b>	
<b>(b)</b>	<b><u>Way 1:</u></b>	<b><u>Way 2:</u></b>	M1	2.1
	$2^{2x+4} - 9(2^x) = 0$ $2^{2x} \times 2^4 - 9(2^x) = 0$ Let $2^x = y$ $16y^2 - 9y = 0$	$(2x + 4)\log 2 - \log 9 - x\log 2 = 0$		
	$y = \frac{9}{16}$ or $y = 0$ So $x = \log_2\left(\frac{9}{16}\right)$ or $\frac{\log\left(\frac{9}{16}\right)}{\log 2}$ o.e. with no second answer	$x = \frac{\log 9}{\log 2} - 4$ o.e.	A1	1.1b
			<b>(2)</b>	
<b>(4 marks)</b>				
<b>Notes:</b>				
<b>(a)</b>				
<b>B1:</b> Lists error in line 2 (as above)				
<b>B1:</b> Lists error in line 4 (as above)				
<b>(b)</b>				
<b>M1:</b> Correct work with powers reaching this equation				
<b>A1:</b> Correct answer here – there are many exact equivalents				

Question	Scheme	Marks	AOs
<b>13(a)</b>	$x^3 + 10x^2 + 25x = x(x^2 + 10x + 25)$	M1	1.1b
	$= x(x + 5)^2$	A1	1.1b
		<b>(2)</b>	
<b>(b)</b>		M1	1.1b
		A1ft	1.1b
		<b>(2)</b>	
<b>(c)</b>	Curve has been translated $a$ to the left	M1	3.1a
	$a = -2$	A1ft	3.2a
	$a = 3$	A1ft	1.1b
		<b>(3)</b>	
<b>(7 marks)</b>			
<b>Notes:</b>			
<b>(a)</b>			
<b>M1:</b> Takes out factor $x$			
<b>A1:</b> Correct factorisation – allow $x(x + 5)(x + 5)$			
<b>(b)</b>			
<b>M1:</b> Correct shape			
<b>A1ft:</b> Curve passes through the origin $(0, 0)$ and touches at $(-5, 0)$ – allow follow through from incorrect factorisation			
<b>(c)</b>			
<b>M1:</b> May be implied by one of the correct answers for $a$ or by a statement			
<b>A1ft:</b> ft from their cubic as long as it meets the $x$ -axis only twice			
<b>A1ft:</b> ft from their cubic as long as it meets the $x$ -axis only twice			

Question	Scheme	Marks	AOs	
<b>14(a)</b>	$\log_{10} P = mt + c$	M1	1.1b	
	$\log_{10} P = \frac{1}{200}t + 5$	A1	1.1b	
		<b>(2)</b>		
<b>(b)</b>	<p><b>Way 1:</b> As <math>P = ab^t</math> then <math>\log_{10} P = t \log_{10} b + \log_{10} a</math></p>	<p><b>Way 2:</b> As <math>\log_{10} P = \frac{t}{200} + 5</math> then <math>P = 10^{\left(\frac{t}{200} + 5\right)} = 10^5 10^{\left(\frac{t}{200}\right)}</math></p>	M1	2.1
	$\log_{10} b = \frac{1}{200}$ or $\log_{10} a = 5$	$a = 10^5$ or $b = 10^{\left(\frac{1}{200}\right)}$	M1	1.1b
	So $a = 100\,000$ or $b = 1.0116$		A1	1.1b
	Both $a = 100\,000$ and $b = 1.0116$ (awrt 1.01)		A1	1.1b
			<b>(4)</b>	
<b>(c)(i)</b>	The initial population	B1	3.4	
<b>(c)(ii)</b>	The proportional increase of population each year	B1	3.4	
		<b>(2)</b>		
<b>(d)(i)</b>	300000 to nearest hundred thousand	B1	3.4	
<b>(d)(ii)</b>	Uses $200000 = ab^t$ with their values of $a$ and $b$ or $\log_{10} 200000 = \frac{1}{200}t + 5$ and rearranges to give $t =$	M1	3.4	
	60.2 years to 3sf	A1ft	1.1b	
		<b>(3)</b>		
<b>(e)</b>	Any two valid reasons- e.g. <ul style="list-style-type: none"> <li>• 100 years is a long time and population may be affected by wars and disease</li> <li>• Inaccuracies in measuring gradient may result in widely different estimates</li> <li>• Population growth may not be proportional to population size</li> <li>• The model predicts unlimited growth</li> </ul>	B2	3.5b	
		<b>(2)</b>		

**Question 14 continued****Notes:****(a)****M1:** Uses a linear equation to relate  $\log P$  and  $t$ **A1:** Correct use of gradient and intercept to give a correct line equation**(b)****M1:** **Way 1:** Uses logs correctly to give log equation; **Way 2:** Uses powers correctly to “undo” log equation and expresses as product of two powers**M1:** **Way 1:** Identifies  $\log b$  or  $\log a$  or both; **Way 2:** Identifies  $a$  or  $b$  as powers of 10**A1:** Correct value for  $a$  or  $b$ **A1:** Correct values for both**(c)(i)****B1:** Accept equivalent answers e.g. The population at  $t = 0$ **(c)(ii)****B1:** So accept rate at which the population is increasing each year or scale factor 1.01 or increase of 1% per year**(d)(i)****B1:** cao**(d)(ii)****M1:** As in the scheme**A1ft:** On their values of  $a$  and  $b$  with correct log work**(e)****B2:** As given in the scheme – any two valid reasons

Question	Scheme	Marks	AOs
15	Finds $\frac{dy}{dx} = 8x - 6$	M1	3.1a
	Gradient of curve at $P$ is $-2$	M1	1.1b
	Normal gradient is $-\frac{1}{m} = \frac{1}{2}$	M1	1.1b
	So equation of normal is $(y - 2) = \frac{1}{2}\left(x - \frac{1}{2}\right)$ or $4y = 2x + 7$	A1	1.1b
	Eliminates $y$ between $y = \frac{1}{2}x + \ln(2x)$ and their normal equation to give an equation in $x$	M1	3.1a
	Solves their $\ln 2x = \frac{7}{4}$ so $x = \frac{1}{2}e^{\frac{7}{4}}$	M1	1.1b
	Substitutes to give value for $y$	M1	1.1b
	Point $Q$ is $\left(\frac{1}{2}e^{\frac{7}{4}}, \frac{1}{4}e^{\frac{7}{4}} + \frac{7}{4}\right)$	A1	1.1b

**(8 marks)**

**Notes:**

**M1:** Differentiates correctly

**M1:** Substitutes  $x = \frac{1}{2}$  to find gradient (may make a slip)

**M1:** Uses negative reciprocal gradient

**A1:** Correct equation for normal

**M1:** Attempts to eliminate  $y$  to find an equation in  $x$

**M1:** Attempts to solve their equation using exp

**M1:** Uses their  $x$  value to find  $y$

**A1:** Any correct exact form

Question	Scheme	Marks	AOs
<b>16(a)</b>	Sets $2xy + \frac{\pi x^2}{2} = 250$	B1	2.1
	Obtain $y = \frac{250 - \frac{\pi x^2}{2}}{2x}$ and substitute into $P$	M1	1.1b
	Use $P = 2x + 2y + \pi x$ with their $y$ substituted	M1	2.1
	$P = 2x + \frac{250}{x} - \frac{\pi x^2}{2x} + \pi x = 2x + \frac{250}{x} + \frac{\pi x}{2}$ *	A1*	1.1b
		<b>(4)</b>	
<b>(b)</b>	$x > 0$ and $y > 0$ (distance) $\Rightarrow \frac{250 - \frac{\pi x^2}{2}}{2x} > 0$ or $250 - \frac{\pi x^2}{2} > 0$ o.e.	M1	2.4
	As $x$ and $y$ are distances they are positive so $0 < x < \sqrt{\frac{500}{\pi}}$ *	A1*	3.2a
		<b>(2)</b>	
<b>(c)</b>	Differentiates $P$ with negative index correct in $\frac{dP}{dx}; x^{-1} \rightarrow x^{-2}$	M1	3.4
	$\frac{dP}{dx} = 2 - \frac{250}{x^2} + \frac{\pi}{2}$	A1	1.1b
	Sets $\frac{dP}{dx} = 0$ and proceeds to $x =$	M1	1.1b
	Substitutes their $x$ into $P = 2x + \frac{250}{x} + \frac{\pi x}{2}$ to give perimeter = 59.8 M	A1	1.1b
		<b>(4)</b>	
<b>(10 marks)</b>			



**Question 16 continued****Notes:****(a)****B1:** Correct area equation**M1:** Rearranges **their** area equation to make  $y$  the subject of the formula and attempt to use with an expression for  $P$ **M1:** Use correct equation for perimeter with their  $y$  substituted**A1\*:** Completely correct solution to obtain and state printed answer**(b)****M1:** States  $x > 0$  and  $y > 0$  and uses their expression from (a) to form inequality**A1\*:** Explains that  $x$  and  $y$  are positive because they are distances, and uses correct expression for  $y$  to give the printed answer correctly**(c)****M1:** Attempt to differentiate  $P$  (deals with negative power of  $x$  correctly)**A1:** Correct differentiation**M1:** Sets derived function equal to zero and obtains  $x =$ **A1:** The value of  $x$  may not be seen (it is 8.37 to 3sf or  $\sqrt{\left(\frac{500}{4 + \pi}\right)}$ )

Need to see awrt 59.8 M with units included for the perimeter

Question	Scheme		Marks	AOs
<b>17 (a)</b>	<b>Way 1:</b> Finds circle equation $(x \pm 2)^2 + (y \mp 6)^2 =$ $(10 \pm (-2))^2 + (11 \mp 6)^2$	<b>Way 2:</b> Finds distance between $(-2, 6)$ and $(10, 11)$	M1	3.1a
	Checks whether $(10, 1)$ satisfies their circle equation	Finds distance between $(-2, 6)$ and $(10, 1)$	M1	1.1b
	Obtains $(x + 2)^2 + (y - 6)^2 = 13^2$ and checks that $(10 + 2)^2 + (1 - 6)^2 = 13^2$ so states that $(10, 1)$ lies on $C^*$	Concludes that as distance is the same $(10, 1)$ lies on the circle $C^*$	A1*	2.1
			<b>(3)</b>	
<b>(b)</b>	Finds radius gradient $\frac{11-6}{10-(-2)}$ or $\frac{1-6}{10-(-2)}$ ( $m$ )		M1	3.1a
	Finds gradient perpendicular to their radius using $-\frac{1}{m}$		M1	1.1b
	Finds (equation and ) $y$ intercept of tangent (see note below)		M1	1.1b
	Obtains a correct value for $y$ intercept of their tangent i.e. 35 or -23		A1	1.1b
	<b>Way 1:</b> Deduces gradient of second tangent	<b>Way 2:</b> Deduces midpoint of $PQ$ from symmetry $(0, 6)$	M1	1.1b
	Finds (equation and ) $y$ intercept of second tangent	Uses this to find other intercept	M1	1.1b
	So obtains distance $PQ = 35 + 23 = 58^*$		A1*	1.1b
			<b>(7)</b>	
<b>(10 marks)</b>				

**Question 17 continued****Notes:****(a) Way 1 and Way 2:**

**M1:** Starts to use information in question to find equation of circle or radius of circle

**M1:** Completes method for checking that (10, 1) lies on circle

**A1\*:** Completely correct explanation with no errors concluding with statement that circle passes through (10, 1)

**(b)**

**M1:** Calculates  $\frac{11-6}{10-(-2)}$  or  $\frac{1-6}{10-(-2)}$  ( $m$ )

**M1:** Finds  $-\frac{1}{m}$  (correct answer is  $-\frac{12}{5}$  or  $\frac{12}{5}$ ). This is referred to as  $m'$  in the next note

**M1:** Attempts  $y-11 = \textit{their}\left(-\frac{12}{5}\right)(x-10)$  or  $y-1 = \textit{their}\left(\frac{12}{5}\right)(x-10)$  and puts  $x=0$ , or uses vectors to find intercept e.g.  $\frac{y-11}{10} = -m'$

**A1:** One correct intercept 35 or  $-23$

**Way 1:**

**M1:** Uses the negative of their previous tangent gradient or uses a correct  $-\frac{12}{5}$  or  $\frac{12}{5}$

**M1:** Attempts the second tangent equation and puts  $x=0$  or uses vectors to find intercept e.g.  $\frac{11-y}{10} = m'$

**Way 2:**

**M1:** Finds midpoint of  $PQ$  from symmetry. (This is at (0, 6))

**M1:** Uses this midpoint to find second intercept or to find difference between midpoint and first intercept. e.g.  $35 - 6 = 29$  then  $6 - 29 = -23$  so second intercept is at  $(-23, 0)$

**Ways 1 and 2:**

**A1\*:** Obtain 58 correctly from a valid method