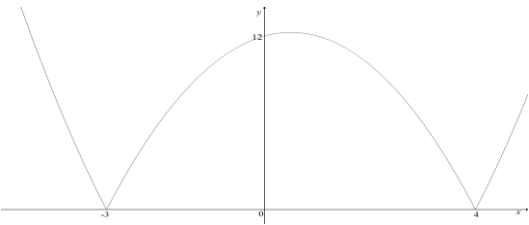
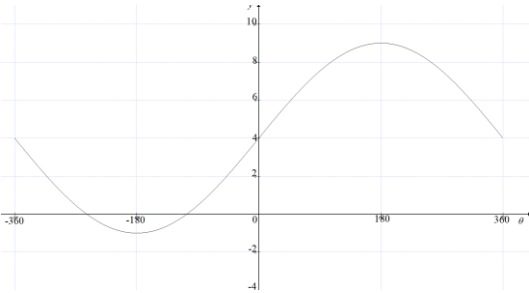
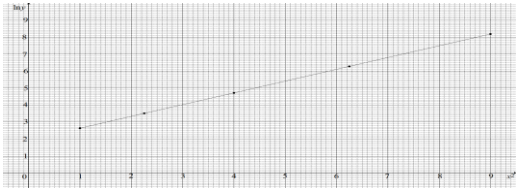


Question	Answer	Marks	Guidance
1(a)	$y = x^2 - x - 12$ $\frac{dy}{dx} = 2x - 1$ or $(x + 3) + (x - 4)$ or $y = \left(x - \frac{1}{2}\right)^2 - \frac{49}{4}$ or using symmetry $x = \frac{4 - 3}{2}$	<b>M1</b>	For expanding the brackets and differentiate with at least one correct term or for using the product rule or for completing the square or for using symmetry
	$x = \frac{1}{2}$	<b>A1</b>	
	$y = -\frac{49}{4}$ oe	<b>A1</b>	
1(b)		<b>2</b>	<b>B1</b> for the correct shape. Must have the parabola part of the curve with maximum in the first quadrant and cusps on the $x$ -axis. Ignore labelling of their maximum point if incorrect coordinates  <b>B1</b> for correct intercepts. Must be correct shape
1(c)	$k > \frac{49}{4}$ oe	<b>B1</b>	<b>FT</b> on $\left  \text{their } -\frac{49}{4} \right $ excluding $k > 12$
2		<b>4</b>	<b>B1</b> for correct shape must be a curve with one min in 3 <sup>rd</sup> quadrant and one max in first quadrant and correct endpoints $(-360, 4)$ and $(360, 4)$ Ignore labelling of their maximum point if incorrect coordinates. <b>depB1</b> for intercept of 4 on $y$ -axis. Must have the correct shape <b>depB1</b> for max in correct position of $(180^\circ, 9)$ . Must have the correct shape <b>depB1</b> for min in correct position of $(-180^\circ, -1)$ . Must have the correct shape
3	$4x^2 - 4kx - k + 2 [= 0]$	<b>B1</b>	soi
	$k^2 + k - 2$ Critical values $-2, 1$	<b>2</b>	<b>M1</b> for use of discriminant on <i>their</i> three-term quadratic equation to obtain two critical values
	$-2 < k < 1$	<b>A1</b>	Strict inequality

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4(a)	$3 = \log_2 8$	<b>B1</b>													
	$\log_2 \frac{8a^4}{b}$	<b>2</b>	<b>M1</b> for correct use of two operations from multiplication, division or power rule for logs to the base of 2. <b>A1</b> for log to the base of 2 only												
4(b)	$\lg x = \frac{4}{\lg x}$ or $\frac{1}{\log_x 10} = 4 \log_x 10$	<b>B1</b>	Change of base												
	$(\lg x)^2 = 4$ or $(\log_x 10)^2 = \frac{1}{4}$	<b>B1</b>	Dep on correct change of base Must work with $(\lg x)^2$ or $(\log_x 10)^2$ not $\log x^2$ or $(\log_x 100)$												
	$x = 100$	<b>B1</b>	Dep on correct change of base												
	$x = \frac{1}{100}$ or 0.01	<b>B1</b>	Dep on correct change of base												
5(a)	$p(-2): -8a + 4b + 38 + c = 0$	<b>M1</b>	For substitution of $-2$ in $p(x)$ and equating to zero. Allow one sign error in evaluating												
	$p(-1): -a + b + 19 + c = 20$	<b>M1</b>	For substitution of $-1$ in $p(x)$ and equating to 20. Allow one sign error in evaluating												
	$7a - 3b = 39$	<b>A1</b>	AG – must be from correct work												
5(b)	$p'(1): 3a + 2b - 19 = 1$	<b>M1</b>	For substitution of 1 in $p'(x)$ and equating to 1 Allow one sign error in evaluating. Can be unsimplified												
	$a = 6, b = 1, c = 6$	<b>2</b>	<b>M1 dep</b> for solution of <i>their</i> equation with that from (a) to find at least one unknown.												
6(a)	<table border="1" style="margin-bottom: 10px;"> <tr> <td><math>x^2</math></td> <td>1</td> <td>2.25</td> <td>4</td> <td>6.25</td> <td>9</td> </tr> <tr> <td><math>\ln y</math></td> <td>2.64</td> <td>3.51</td> <td>4.72</td> <td>6.28</td> <td>8.18</td> </tr> </table> 	$x^2$	1	2.25	4	6.25	9	$\ln y$	2.64	3.51	4.72	6.28	8.18	<b>2</b>	<b>M1</b> for plotting points with one error
$x^2$	1	2.25	4	6.25	9										
$\ln y$	2.64	3.51	4.72	6.28	8.18										

Question	Answer	Marks	Guidance
6(b)	$\ln y = x^2 \ln b + \ln A$	<b>B1</b>	May be seen in part (a)
	Gradient = $\ln b$ ( $\ln b = 0.7$ ) $b = 2$	<b>2</b>	<b>M1</b> for attempt to find the gradient and equate to $\ln b$ Gradient must be from linear graph of $\ln y$ vs $x^2$
	Intercept = $\ln A$ ( $\ln A = 1.95$ ) $A = 7$	<b>2</b>	<b>M1</b> for attempt to use intercept
6(c)	When $y = 200$ , $\ln y = 5.3$ $x^2 = 4.85$ $x = 2.2$ (allow 2.1 or 2.3)	<b>2</b>	<b>M1</b> for using <i>their</i> linear graph with $\ln y = 5.3$ to obtain a value for $x^2$ <b>A0</b> for $x = \pm 2.2$ if $-2.2$ is not rejected
7(a)	$x^2 + 3x^2 \ln x$	<b>2</b>	<b>M1</b> for attempt to differentiate a product Allow unsimplified for 2 marks
7(b)	$\int 3x^2 \ln x \, dx = x^3 \ln x - \int x^2 \, dx$	<b>B1</b>	
	$\left[ x^3 \ln x - \frac{x^3}{3} \right]_1^2$ $8 \ln 2 - \frac{8}{3} + \frac{1}{3}$	<b>M1</b>	Dep on <b>B1 M1</b> for correct use of limits
	$\ln 256 - \frac{7}{3}$	<b>2</b>	<b>A1</b> for one correct term
8(a)	$5x^2 + 3x - 14 = 0$ or $5y^2 - 4y - 57 = 0$	<b>M1</b>	soi
	$x = \frac{7}{5}$ , $y = \frac{19}{5}$ $x = -2$ , $y = -3$	<b>3</b>	<b>M1</b> for attempt to solve <i>their</i> quadratic to obtain either $x = \dots$ or $y = \dots$ <b>A1</b> for one correct pair both $x$ or both $y$ or one correct $(x, y)$ point
	Midpoint $\left(-\frac{3}{10}, \frac{2}{5}\right)$	<b>B1</b>	Must be correct midpoint
	Gradient of perpendicular $-\frac{1}{2}$	<b>B1</b>	Must be correct
	Perp bisector: $y - \frac{2}{5} = -\frac{1}{2}\left(x + \frac{3}{10}\right)$	<b>M1</b>	Must be using <i>their</i> midpoint and a gradient $= -\frac{1}{2}$
	$k = -\frac{4}{5}$	<b>A1</b>	

Question	Answer	Marks	Guidance
8(b)	$\left(\frac{9}{2}, -2\right)$	2	<b>B1</b> for one correct <b>FT</b> on $2 \times (\text{their } k) - \text{their } \frac{2}{5}$
	$\left(-\frac{51}{10}, \frac{14}{5}\right)$	2	<b>B1</b> for one correct <b>FT</b> on $\left[\left(3 \times \text{their } \frac{2}{5}\right) - (2 \times \text{their } k)\right]$
9(a)	$\mathbf{c} - 2\mathbf{a}$	<b>B1</b>	
9(b)	$4\mathbf{a} + \frac{2}{3}(\text{their } (\mathbf{c} - 2\mathbf{a}))$ oe	<b>M1</b>	Alternative route: $OC + CB + BD = \mathbf{c} + 2\mathbf{a} - \frac{1}{3} \text{their } AB$
	$\frac{8}{3}\mathbf{a} + \frac{2}{3}\mathbf{c}$	<b>A1</b>	Allow unsimplified
9(c)	$\mu \left( \text{their } \left( \frac{8}{3}\mathbf{a} + \frac{2}{3}\mathbf{c} \right) \right)$	<b>B1</b>	Must be in terms of $\mathbf{a}$ and $\mathbf{c}$ in a valid vector form. Allow unsimplified
9(d)	$\overline{AC} = \mathbf{c} - 4\mathbf{a}$	<b>B1</b>	
	$\lambda(\text{their } (\mathbf{c} - 4\mathbf{a}))$	<b>B1</b>	Must be in terms of $\mathbf{a}$ and $\mathbf{c}$ in a valid vector form
9(e)	$4\mathbf{a} = \text{their } (\mathbf{c}) - \text{their } (\mathbf{d})$ oe	<b>M1</b>	Must be in terms of $\mathbf{a}$ and $\mathbf{c}$ in a valid vector form
	$\lambda = \frac{1}{2}, \mu = \frac{3}{4}$	3	<b>M1 dep</b> on first M1 for equating like vectors once <b>M1 dep</b> on first M1 for attempt to solve 2 simultaneous equations in $\lambda$ and $\mu$ . leading to $\lambda = \dots$ or $\mu = \dots$ <b>A1</b> for both
10(a)	$\tan \theta = \frac{2}{7}, \tan \theta = -1$	2	<b>M1</b> for attempt to factorise or use formula to obtain $\tan \theta = \dots$
	$15.9^\circ, -164.1^\circ, -45^\circ, 135^\circ$	2	<b>A1</b> for two correct solutions <b>A1</b> for a further 2 correct solutions and no extras in the range

Question	Answer	Marks	Guidance
10(b)	$\sin(3\phi - 1.5) = \frac{2}{3}$ $3\phi - 1.5 = 0.7297$	<b>M1</b>	Correct order of the operation Do not accept in degrees
	$3\phi - 1.5 = 2.41[12], 7.01[3]$	<b>A1</b>	soi by correct answers with no extras within the range
	0.743, 1.30, 2.84	<b>3</b>	<b>M1 dep</b> on first M1 for correct order of operations or one correct solution <b>A1</b> for one solution <b>A1</b> for a further 2 correct solutions and no extras in the range Do not accept in degrees
11(a)	$d = 3\log_x 3$ or $\log_x 3^3$ nfw	<b>B1</b>	Must be exact Allow $d = \log_x 27$ nfw
	$\frac{n}{2}(2\log_x 3 + 3(n-1)\log_x 3)$ nfw	<b>M1</b>	For use of sum formula with <i>their</i> $d$ must be in the form of $\log_x 3$
	$\frac{n}{2}(3n-1)\log_x 3$ or $\left(\frac{3n^2}{2} - \frac{n}{2}\right)\log_x 3$	<b>A1</b>	Must be in the form of $k \log_x 3$
11(b)	$r = 3\tan^2 \theta$	<b>B1</b>	soi
	$ 3\tan^2 \theta  < 1$ or $[-1 <] 3\tan^2 \theta < 1$ or $\left[-\frac{1}{3} < \right] \tan^2 \theta < \frac{1}{3}$ or $[0 <] \tan^2 \theta < \frac{1}{3}$	<b>B1</b>	
	$\tan \theta < \frac{1}{\sqrt{3}}$ or $0 < \tan \theta < \frac{1}{\sqrt{3}}$	<b>B1</b>	
	$0 < \theta < \frac{\pi}{6}$	<b>B1</b>	