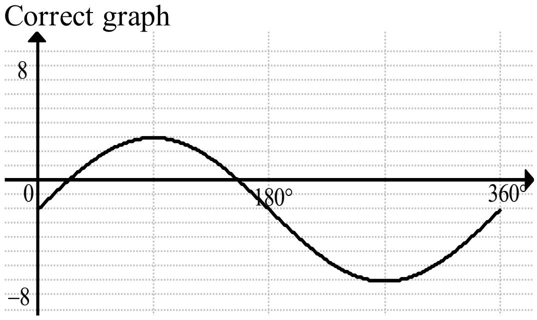
Question	Answer	Marks	Partial Marks
1(a)	$\begin{pmatrix}-2.5\\5\end{pmatrix}$ oe	**B2**	**B1** for $-\frac{1}{4}\begin{pmatrix}-2\\8\end{pmatrix}\left[+\begin{pmatrix}-3\\7\end{pmatrix}\right]$ oe, soi
1(b)	$3\alpha - 8 = 2\alpha + 5\beta$ or $18 - 2\beta = 20$	**M1**	Equates like vectors at least once
	$\alpha = 3$ $\beta = -1$	**A2**	**A1** for either value correct
2	$5x^2 - 10x - 15 * 0$ oe	**M1**	where * is any inequality sign or =
	Factorises *their* 3-term quadratic expression or solves *their* 3-term quadratic equation	**M1**	
	Critical values –1 and 3	**A1**	
	$-1 \leqslant x \leqslant 3$	**A1**	Do not accept separate inequalities unless connected with 'and'
3(a)	$(3-4)^2 + (-1+3)^2 = 5$ or showing that distance between point A and centre of circle = radius e.g. $\sqrt{(3-4)^2 + (-1+3)^2} = \sqrt{5}$	**B1**	Accept if x-coordinate substituted to find y- coordinate
3(b)	$\begin{pmatrix}4\\-3\end{pmatrix} + \begin{pmatrix}1\\-2\end{pmatrix}$ oe, soi or using centre and point A e.g. $\frac{3+x}{2} = 4$ and $\frac{-1+y}{2} = -3$ or solve simultaneously the line $y = -2x + 5$ with the circle leading to 3 term quadratic $x^2 - 8x + 15[=0]$ with an attempt to solve	**M1**	Award **M1** for the 2 equations Award the **M1** for the quadratic
	(5, –5)	**A1**	

Question	Answer	Marks	Partial Marks
3(c)	gradient of radius $= \dfrac{-3+1}{4-3} = -2$ soi by gradient of tangent	M1	
	gradient of tangent = $\dfrac{-1}{their(-2)}$	M1	**FT** *their* –2 Allow if differentiation is used e.g.:
	$y + 1 = \dfrac{1}{2}(x-3)$ oe	A1	**FT** $\dfrac{-1}{their -2}$ ISW from a correct unsimplified answer
	Alternative		
	use of differentiation e.g.: $(y+3)^2 = 5-(x-4)^2$ $y = \sqrt{-x^2+8x-11} - 3$ $\dfrac{dy}{dx} = \dfrac{-2x+8}{2\sqrt{-x^2+8x-11}}$	(M1)	allow one error or use of implicit differentiation (not on syllabus) e.g.: $2x+2y\dfrac{dy}{dx}-8+6\dfrac{dy}{dx}=0$ leading to $\dfrac{dy}{dx}=\dfrac{8-2x}{2y+6}$
	Substitute $(3,-1)$ in *their* $\dfrac{dy}{dx}$ to get gradient $=\dfrac{1}{2}$	(M1)	**Dep** on first **M1**
	$y + 1 = \dfrac{1}{2}(x-3)$ oe	(A1)	ISW from a correct unsimplified answer
4(a)	Solves or factorises $x^{\frac{1}{3}} - x^{\frac{1}{6}} - 2 = 0$ oe: $\left(x^{\frac{1}{6}}+1\right)\left(x^{\frac{1}{6}}-2\right)$ or when substituting $y = x^{\frac{1}{3}}$ factorises to $\left(y^{\frac{1}{2}}+1\right)\left(y^{\frac{1}{2}}-2\right)$	M1	A substitution may be used $\left(x^{\frac{1}{3}}\right)^6 - \left(x^{\frac{1}{6}}\right)^6 = 2^6$ scores 0 marks $\left(x^{\frac{1}{3}}\right) - \left(x^{\frac{1}{6}}\right) = x^{\log_x 2}$ then $\dfrac{1}{3}-\dfrac{1}{6}=\log_x 2$ scores 0 marks
	$\left[x^{\frac{1}{6}}=-1\right]$, $x^{\frac{1}{6}}=2$	A1	
	$x = 64$ [$x = 1$]	A1	
	Rejects $x^{\frac{1}{6}}=-1$ or $x = 1$ ignored at some stage, soi	B1	

Question	Answer	Marks	Partial Marks
4(b)	$x+2y=1$	B1	
	Correctly eliminates one unknown	M1	**Dep** on **B1** allow unsimplified e.g. $x=1-2y$ or $y=\frac{1-x^2}{4x+1}$
	Correct quadratic in solvable form: $y-4y^2[=0]$ oe or $2x^2-3x+1[=0]$ oe	A1	
	Factorises or solves *their* quadratic to get two solutions	M1	**Dep** on previous **M1**
	$y = 0$, $x = 1$ and $y = \frac{1}{4}$, $x = \frac{1}{2}$	A1	
5(a)	$2x - 1 = -3$ and $2x - 1 = 3$	M1	
	$x = 2$, $x = -1$	A2	**A1** for either correct
	Alternative		
	$4x^2-4x-8=0$ oe	**(B1)**	
	Solves or factorises *their* 3-term quadratic	**(M1)**	
	$x = -1, 2$	**(A1)**	
5(b)	Correct graph 	2	**B1** for a correct sine curve one cycle **and** with correct amplitude at 3 and –7 **B1** for a correct sine curve one cycle **and** with correct midline $y = -2$

Question	Answer	Marks	Partial Marks
6(a)	Correct derivative $\frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{x^2-1}{x^2+1}\right)=\frac{(x^2+1)(2x)-(x^2-1)(2x)}{(x^2+1)^2}$ or $2x\left(x^2+1\right)^{-1}-2x\left(x^2-1\right)\left(x^2+1\right)^{-2}$	2	**M1** for an attempt at the quotient or product rule **A1** fully correct
	Correct derivative $\frac{\mathrm{d}y}{\mathrm{d}x}=4\left(\frac{x^2-1}{x^2+1}\right)^3\left(\frac{(x^2+1)(2x)-(x^2-1)(2x)}{(x^2+1)^2}\right)$ or $4\left(\frac{x^2-1}{x^2+1}\right)^3\left(2x\left(x^2+1\right)^{-1}-2x\left(x^2-1\right)\left(x^2+1\right)^{-2}\right)$	2	**Dep M1** for $\frac{\mathrm{d}y}{\mathrm{d}x}=k\left(\frac{x^2-1}{x^2+1}\right)^3\times \mathrm{f}(x)$ where $\mathrm{f}(x)$ is *their* attempt to differentiate **A1** fully correct
	Correct completion to $\frac{16x(x^2-1)^3}{(x^2+1)^5}$	A1	
	Alternative		
	Correct derivatives $u=(x^2-1)^4$ $\mathrm{d}u=4(x^2-1)^3\times(2x)$ oe and $v=(x^2+1)^4$ $\mathrm{d}v=4(x^2+1)^3\times(2x)$ oe	(2)	**M1** for either correct OR for $\mathrm{d}u=4(x^2-1)^3\times \mathrm{g}(x)$ where $\mathrm{g}(x)$ is an attempt to differentiate x^2-1 and $\mathrm{d}v=4(x^2+1)^3\times \mathrm{h}(x)$ where $\mathrm{h}(x)$ is an attempt to differentiate x^2+1
	Correct derivative $\frac{\mathrm{d}y}{\mathrm{d}x}=$ $\frac{(x^2+1)^4\times 4(x^2-1)^3(2x)-(x^2-1)^4\times 4(x^2+1)^3(2x)}{\left((x^2+1)^4\right)^2}$ or $4(2x)\left(x^2-1\right)^3\left(x^2+1\right)^{-4}-$ $4(2x)\left(x^2-1\right)^4\left(x^2+1\right)^{-5}$	(2)	**M1** for an attempt at the product or quotient rule
	Correct completion to $\frac{16x(x^2-1)^3}{(x^2+1)^5}$	(A1)	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Partial Marks</th></tr>
<tr><td>6(b)(i)</td><td>their $16x(x^2-1)^3=0$
therefore x = 0, $x^2-1=0$ → x = ±1 oe</td><td>B1</td><td>FT their 16
Allow for their $16x(x^2-1)=0$</td></tr>
<tr><td rowspan="2">6(b)(ii)</td><td>Any two of
<table>
<tr><td>x</td><td>$-1 < x < 0$</td><td>0</td><td>$0 < x < 1$</td></tr>
<tr><td>$\frac{dy}{dx}$</td><td>positive</td><td>0</td><td>negative</td></tr>
</table>
<table>
<tr><td>x</td><td>$0 < x < 1$</td><td>1</td><td>$x > 1$</td></tr>
<tr><td>$\frac{dy}{dx}$</td><td>negative</td><td>0</td><td>positive</td></tr>
</table>
<table>
<tr><td>x</td><td>$x < -1$</td><td>–1</td><td>$-1 < x < 0$</td></tr>
<tr><td>$\frac{dy}{dx}$</td><td>negative</td><td>0</td><td>positive</td></tr>
</table>
</td><td>M1</td><td>or equivalent. Must show change in the sign of first derivative around the stationary points

M0 only if second derivative is used</td></tr>
<tr><td>x = 1 and x = –1 are minimum points</td><td>A1</td><td></td></tr>
</table>

Question	Answer	Marks	Partial Marks
7	$2x^3 - 9x^2 + 10x - 3[=0]$	**B1**	
	Finds a correct linear factor $x - 1$ or $x - 3$ or $2x - 1$	**M1**	
	Finds the correct corresponding quadratic factor For $(x - 1)$ gives $2x^2 - 7x + 3$ or For $(x - 3)$ gives $2x^2 - 3x + 1$ or For $(2x - 1)$ gives $x^2 - 4x + 3$	**2**	**M1** for a corresponding quadratic factor with 2 terms correct
	Factorises *their* 3-term quadratic factor or solves *their* 3-term quadratic equation	**M1**	
	$x = \frac{1}{2}$, 1, 3	**A1**	
	Alternative		
	$2x^3 - 9x^2 + 10x - 3 = 0$	**(B1)**	
	Finds a correct linear factor $x - 1$ or $x - 3$ or $2x - 1$	**(M1)**	
	Finds a second correct linear factor $x - 1$ or $x - 3$ or $2x - 1$	**(M1)**	
	Finds a third correct linear factor $x - 1$ or $x - 3$ or $2x - 1$	**(M1)**	
	$x - 1$, $x - 3$ and $2x - 1$	**(A1)**	
	$x = \frac{1}{2}$, 1, 3	**(A1)**	
8(a)	$x > \frac{4}{12}$ oe	**B1**	allow $0.\dot{3}$ for $\frac{4}{12}$

Question	Answer	Marks	Partial Marks
8(b)	$\log_x 125 = \frac{\log_5 125}{\log_5 x} = \frac{3}{\log_5 x}$ $\frac{1}{\log_x 125} = \log_{125} x$ or $\log_5(12x-4) = \frac{\log_x(12x-4)}{\log_x 5}$	**B1**	for a correct and relevant change of base seen
	$\log_5(12x-4) = 2\log_5 x + 1$ or $\log_x(12x-4) = 2 + \log_x 5$	**B1**	**Dep** on correct change of base
	$\log_5 \frac{12x-4}{x^2} = 1$ oe or $\log_x \frac{12x-4}{5} = 2$ oe or $\log_5(12x-4) = \log_5(5x^2)$	**B1**	**Dep** on correct change of base
	$5x^2 - 12x + 4 = 0$	**B1**	**Dep** on correct change of base
	$(5x-2)(x-2) = 0$ oe	**M1**	**dep** on at least one previous **B1** awarded
	$x = 0.4,\ 2$	**A1**	

Question	Answer	Marks	Partial Marks
9	[When x = 2] y = 3	**B1**	
	$\frac{dy}{dx} = \frac{1}{2}(4x+1)^{-\frac{1}{2}} \times 4$	**M1**	for $\left[\frac{dy}{dx} =\right]\frac{1}{2}(4x+1)^{-\frac{1}{2}} \times k$, $k \neq 0$
	[gradient of tangent =] $\frac{1}{2}(4(2)+1)^{-\frac{1}{2}} \times 4$ soi	**M1**	**FT** *their* $\frac{dy}{dx}$ must be in the form $k(4x+1)^{-\frac{1}{2}}$, $k \neq 0$
	$y - their\ 3 = their \frac{2}{3}(x-2)$	**M1**	**Dep** on first **M1**
	[x-intercept for tangent =] $-\frac{5}{2}$ soi	**A1**	Must be from correct straight line equation
	$\frac{1}{2} \times \left(\frac{5}{2}+2\right) \times 3$ soi	**B1**	For area of triangle – allow unsimplified
	[x-intercept for curve =] $-\frac{1}{4}$ soi	**B1**	
	Area below curve: $\left[\frac{(4x+1)^{\frac{3}{2}}}{\frac{3}{2} \times 4}\right]_{-0.25}^{2}$ oe	**M1**	**M1** for integration in the form of $k(4x+1)^{\frac{3}{2}}$, $k \neq 0$ or 4
	correct use of upper and lower limits: $\left(\frac{(4(2)+1)^{\frac{3}{2}}}{6} - \frac{(4(-0.25)+1)^{\frac{3}{2}}}{6}\right)$ oe	**M1**	**Dep** on previous M1 for area under the curve Allow if using wrong limits but must see correct substitution
	Shaded area = $\frac{27}{4} - \frac{9}{2} = \frac{9}{4}$ oe	**A1**	

Question	Answer	Marks	Partial Marks
10(a)	$\dfrac{\sin\theta}{\sqrt{\cot^2\theta}}+\dfrac{1}{\sqrt{\sec^2\theta}}$	**B1**	for correct use of the trigonometry identity $\text{cosec}^2\theta-1=\cot^2\theta$
	$\sin\theta\tan\theta+\cos\theta$ oe	**B1**	
	$\sin\theta\times\dfrac{\sin\theta}{\cos\theta}+\cos\theta$	**B1**	
	$\dfrac{\sin^2\theta+\cos^2\theta}{\cos\theta}=\dfrac{1}{\cos\theta}=\sec\theta$	**B1**	**Dep** on all 3 previous marks Last mark is not available if persistent missing of θ
	Alternative		
	$\dfrac{\sin\theta}{\sqrt{\cot^2\theta}}+\dfrac{1}{\sqrt{\sec^2\theta}}$	**(B1)**	for correct use of the trigonometry identity $\text{cosec}^2\theta-1=\cot^2\theta$
	$\dfrac{\sec\theta\sin\theta+\cot\theta}{\cot\theta\sec\theta}$	**(B1)**	
	$\dfrac{\dfrac{\sin\theta}{\cos\theta}+\dfrac{\cos\theta}{\sin\theta}}{\dfrac{\cos\theta}{\sin\theta}\times\dfrac{1}{\cos\theta}}$	**(B1)**	
	$\dfrac{\dfrac{\sin^2\theta+\cos^2\theta}{\cos\theta\sin\theta}}{\dfrac{1}{\sin\theta}}$ leading to $\dfrac{1}{\cos\theta}$	**(B1)**	**Dep** on all 3 previous marks Last mark is not available if persistent missing θ

Question	Answer	Marks	Partial Marks
10(b)	$\cos x = \frac{1}{\alpha}$	B1	could be implied by $\frac{1}{\alpha^2} = 1 - \sin^2 x$
	$\sin^2 x + \left(\frac{1}{\alpha}\right)^2 = 1$ oe OR [opposite ²=] $\alpha^2 - 1$ soi and use of $\sin x = \frac{\text{opposite}}{\text{hypotenuse}}$ at some stage leading to $\sin x = [\pm]\sqrt{1 - \frac{1}{\alpha^2}}$ oe	M1	
	$\sin x = -\sqrt{1 - \frac{1}{\alpha^2}}$ oe	A1	
11(a)	10 – 2*d* and 10 – *d*	B2	**B1** for either ignore labels
11(b)	Squares each term and forms a sum e.g. $100 - 40d + 4d^2 + 100 - 20d + d^2 + 100$ $[=140]$ or $100 - 40d + 4d^2 + 100 - 20d + d^2 [= 40]$ $a^2 + \frac{a^2 + 20a + 100}{4} = 40$ oe	M1	**FT** from *their* two terms in **(a),** must be both 2 terms expression in terms of *d* only or Correct expressions in terms of *a* only, must see substitution and expansion
	Correct equation in solvable form $5d^2 - 60d + 160 = 0$ $5a^2 + 20a - 60 = 0$ oe	A1	
	Factorises *their* 3-term quadratic expression or solves *their* 3-term quadratic equation	M1	
	$d = 8$ $d = 4$	A1	
	Finds the first term when *d* = 4: *a* = 2	M1	**FT** 10 – 2(*their d*)
	$[S_{200} =] \frac{200}{2}\{4 + 199 \times 4\}$ oe	M1	**FT** *their a* and *their d*
	80 000	A1	

Question	Answer	Marks	Partial Marks
12	$\dfrac{n!}{(n-5)!5!}-\dfrac{(n-1)!}{(n-6)!5!}$ $\dfrac{(n-1)!\ \times[n-(n-5)]}{(n-5)!5!}$	M1	For substituting ${}^{n}C_5$ and ${}^{n-1}C_5$
	$\dfrac{(n-1)!}{(n-6)!5!}\left(\dfrac{n}{n-5}-1\right)$ oe	M1	**dep** on previous **M1** awarded For Factorising $\dfrac{(n-1)!}{(n-6)!5!}$ or $\dfrac{(n-1)!}{(n-5)!5!}$ Do not allow if using ${}^{n-1}C_4$ to simplify the left-hand side
	$\dfrac{(n-1)!}{(n-6)!5!}\left(\dfrac{5}{n-5}\right)$ oe	M1	**dep** on at least one previous **M1** awarded Simplifying fraction
	Completes argument: $\dfrac{(n-1)!}{(n-6)!5!}\left(\dfrac{5}{n-5}\right)=\dfrac{(n-1)!}{(n-1-4)!4!}={}^{n-1}C_4$	A1	
	Alternative 1		
	$\dfrac{n!}{(n-5)!5!}-\dfrac{(n-1)!}{(n-6)!5!}$	(M1)	For substituting ${}^{n}C_5$ and ${}^{n-1}C_5$
	$\dfrac{1}{(n-6)!}=\dfrac{n-5}{(n-5)!}$ or $n!=n\times(n-1)!$	(B1)	**dep** on previous **M1** awarded
	$\dfrac{(n-1)!\ \times[n-(n-5)]}{(n-5)!5!}$	(M1)	**dep** on previous **M1** awarded factorising $(n-1)!$ in the fraction
	$\dfrac{(n-1)!\ \times 5}{(n-5)!5!}=\dfrac{(n-1)!}{(n-5)!4!}={}^{n-1}C_4$	(A1)	
	Alternative 2		
	$\dfrac{n!}{(n-5)!5!}-\dfrac{(n-1)!}{(n-6)!5!}$	(M1)	For substituting ${}^{n}C_5$ and ${}^{n-1}C_5$ could be implied by expansions of the factorial
	$\dfrac{n(n-1)(n-2)(n-3)(n-4)}{5!}-\dfrac{(n-1)(n-2)(n-3)(n-4)(n-5)}{5!}$	(B1)	**dep** on previous **M1** awarded
	$\dfrac{(n-1)(n-2)(n-3)(n-4)[n-(n-5)]}{5!}$	(M1)	**dep** on previous **M1** awarded factorising $(n-1)(n-2)(n-3)(n-4)$ in the fraction
12	Completes argument: $\dfrac{(n-1)(n-2)(n-3)(n-4)}{4!}=\dfrac{(n-1)!}{4!(n-5)!}={}^{n-1}C_4$	(A1)	