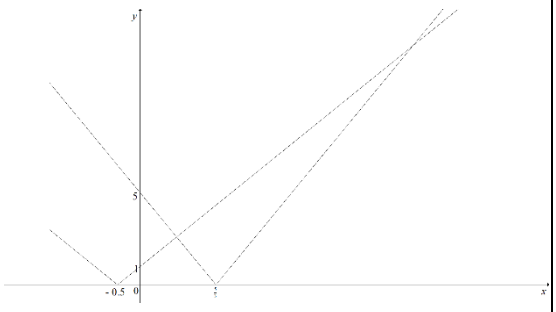
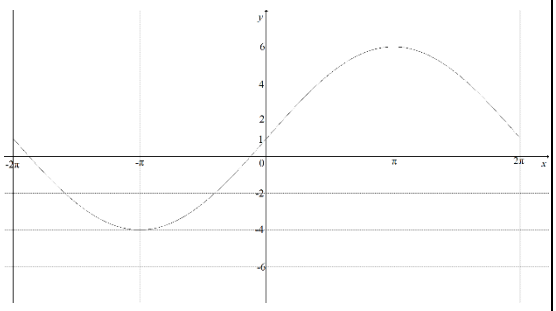
Question	Answer	Marks	Guidance
1(a)		**3**	**B1** for 2 V-shaped graphs with vertices in the 1st and 2nd quadrants, intersecting twice in the first quadrant. **Dep B1** for $(0,1)$ and $(0,5)$ **B1** for $\left(-\frac{1}{2},0\right)$ and $\left(\frac{5}{3},0\right)$
1(b)	$x=\frac{4}{5}$	**B1**	
	$2x+1=-5+3x$ oe	**M1**	For considering the negative for one of the functions
	$x=6$	**A1**	
	Alternative		
	$5x^2-34x+24=0$	**(2)**	**M1** for squaring each function and attempt to form a 3-term quadratic equation = 0. Allow one error. **A1** for a correct equation
	$x=\frac{4}{5}$, $x=6$	**(A1)**	For both
2(a)		**3**	**B1** for a complete cycle starting and finishing at $(-2\pi,\ 1)$ and $(2\pi,\ 1)$ **B1** for intercept at $y=1$ **B1** for a maximum when $y=6$ and a minimum when $y=-4$
2(b)	5	**B1**	
2(c)	4π or 720^{o}	**B1**	

Question	Answer	Marks	Guidance
3	$y^3 = m\ln x + c$	**B1**	May be implied by subsequent work
	$5 = m + c$ $15 = 6m + c$ $m = 2,\ \ c = 3$	**2**	**B1** for $m = 2$ **B1** for $c = 3$
	$y = \sqrt[3]{2\ln x + 3}$	**B1**	
	Alternative		
	$y^3 = m\ln x + c$	**(B1)**	May be implied by subsequent work
	Gradient = 2	**(B1)**	For finding the gradient and equating to m
	$5 = m + c$ $15 = 6m + c$ $c = 3$	**(B1)**	For at least one correct equation and finding c
	$y = \sqrt[3]{2\ln x + 3}$	**(B1)**	
4	$x = \dfrac{2 \pm \sqrt{4 + 4\left(\sqrt{5}-1\right)\left(\sqrt{5}+1\right)}}{2\left(\sqrt{5}-1\right)}$	**M1**	For a correct use of the quadratic formula with sufficient detail
	$x = \dfrac{2 \pm 2\sqrt{5}}{2\left(\sqrt{5}-1\right)}$ or $x = \dfrac{1 \pm \sqrt{5}}{\left(\sqrt{5}-1\right)}$	**2**	**Dep M1** for attempt to simplify to obtain 2 real roots **A1** for either
	$x = \dfrac{\left(\sqrt{5}+1\right)}{\left(\sqrt{5}-1\right)} \times \dfrac{\left(\sqrt{5}+1\right)}{\left(\sqrt{5}+1\right)}$	**M1**	For attempt at rationalisation
	$x = \dfrac{3}{2} + \dfrac{\sqrt{5}}{2}$	**A1**	
	$x = -1$	**B1**	
5(a)	$a + 3d = 25$ $a + 8d = 50$	**M1**	For at least one correct equation and attempt to solve to find at least one unknown
	$a = 10$	**A1**	
	$d = 5$	**A1**	

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5(b)	$\frac{n}{2}\left(20+\left(n-1\right)5\right)\ \ \left(=25\ 000\right)$	**M1**	For attempting the sum to *n* terms using *their a* and *d*
	$5n^2+15n-50\ 000=0$ $n=98.5...$	**A1**	
	$n=99$	**A1**	
6	$1-4x+\frac{68}{9}x^2$	**2**	**B1** for $1-4x$ **B1** for $\frac{68}{9}x^2$ or $7.56x^2$
	$1+9x+27x^2$	**B1**	
	Term in x: $-4x+9x=5x$ or coefficients of x: $-4+9$	**M1**	For $\left(their\ -4\left(x\right)\right)+\left(their\ 9\left(x\right)\right)$
	$a=5$	**A1**	
	Term in x^2: $\frac{68}{9}x^2+27x^2-36x^2$ or coefficients of x^2: $\frac{68}{9}+27-36$	**M1**	For $\left(their\frac{68}{9}\left(x\right)\right)+\left(their27\left(x\right)\right)+$ $\left(\left(their-4\left(x\right)\right)\times\left(their\ 9\left(x\right)\right)\right)$
	$b=-\frac{13}{9}$	**A1**	Must be exact
7(a)	$2\pi r+4x+2x\theta$	**3**	**B1** for $2\pi r$ **B1** for $+4x$ **B1** for $2x\theta$
7(b)	$\pi r^2-x^2\theta$	**B1**	
7(c)	Least value when $x=r$	**B1**	
	Least value = $r^2\left(\pi-\theta\right)$ oe	**B1**	
8	$2\ln\left(x+1\right)-\ln\left(x+2\right)$	**2**	**B1** for $2\ln\left(x+1\right)$ **B1** for $-\ln\left(x+2\right)$
	$\left(2\ln\left(a+1\right)-\ln\left(a+2\right)\right)+\ln2$	**M1**	For attempt to apply limits correctly, dependent on having 2 log terms.
	$\ln\frac{2\left(a+1\right)^2}{\left(a+2\right)}$	**2**	**M1** for use of either power rule or the division rule.

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9	$2\log_p y + \dfrac{10}{\log_p y} - 9 = 0$ or $\dfrac{2}{\log_y p} + 10\log_y p - 9 = 0$	**B1**	For a change of base
	$2\left(\log_p y\right)^2 - 9\log_p y + 10 = 0$ or $10\left(\log_y p\right)^2 - 9\log_y p + 2 = 0$	**M1**	For attempt to obtain a 3-term quadratic equation = 0, in either $\log_p y$ or $\log_y p$
	$\log_p y = \dfrac{5}{2}$, $\log_p y = 2$ or $\log_y p = \dfrac{2}{5}$, $\log_y p = \dfrac{1}{2}$	**M1**	**Dep M** mark for attempt to solve the quadratic to obtain 2 solutions
	$y = p^{\frac{5}{2}}$	**A1**	
	$y = p^2$	**A1**	
10	$\dfrac{65n!}{(n-5)!5!} = \dfrac{2(n-1)(n+1)!}{(n-5)!6!}$ $65 = \dfrac{n^2-1}{3}$	**2**	**B1** for simplifying numerical factorials to 3 **B1** for simplifying algebraic factorials to either $(n-1)(n+1)$ or n^2-1
	$n = 14$	**B1**	
11(a)	$\overrightarrow{AC} = \mathbf{c} - \mathbf{a}$	**B1**	
	$\overrightarrow{AB} = \dfrac{2}{5}(\mathbf{c} - \mathbf{a})$ or $\overrightarrow{BC} = \dfrac{3}{5}(\mathbf{c} - \mathbf{a})$	**B1**	
	$\dfrac{2}{5}(\mathbf{c} - \mathbf{a}) = \mathbf{b} - \mathbf{a}$ or $\dfrac{3}{5}(\mathbf{c} - \mathbf{a}) = \mathbf{c} - \mathbf{b}$	**M1**	For equating two different forms of $\overrightarrow{AB}$ or 2 different forms of $\overrightarrow{BC}$
	$5\mathbf{b} - 3\mathbf{a} = 2\mathbf{c}$	**A1**	Simplification to obtain the given answer
11(b)	$\overrightarrow{XC} = \mathbf{c} - \dfrac{3\mathbf{a}}{4}$	**B1**	
	$\overrightarrow{XC} = \dfrac{5\mathbf{b}}{2} - \dfrac{9\mathbf{a}}{4}$	**B1**	

Question	Answer	Marks	Guidance
11(c)	$m\mathbf{b} - \frac{3}{4}\mathbf{a} = \lambda\left(\frac{5\mathbf{b}}{2} - \frac{9\mathbf{a}}{4}\right)$	**B1**	
	$\lambda = \frac{1}{3}, \quad m = \frac{5}{6}$	**3**	**M1** for equating like vectors at least once **A1** for $\lambda = \frac{1}{3}$ **A1** for $m = \frac{5}{6}$
12(a)	$\frac{\text{cosec}\theta + 1 + \text{cosec}\theta - 1}{\text{cosec}^2\theta - 1}$	**B1**	Allow denominator unsimplified
	$\frac{2\text{cosec}\theta}{\cot^2\theta}$	**B1**	
	$\frac{2}{\sin\theta} \times \frac{\sin^2\theta}{\cos^2\theta}$ $2\sin\theta\sec^2\theta$	**B1**	Sufficient detail must be seen
12(b)	$2\sin 2\phi\sec^2 2\phi = 4\sin 2\phi$ Leading to $\sin 2\phi = 0$ $\phi = \pm 90^\circ,\ 0^\circ$	**2**	**M1** for attempt to solve $\sin 2\phi = 0$ obtaining at least one correct solution **A1** for all solutions
	$2\sin 2\phi\sec^2 2\phi = 4\sin 2\phi$ $\cos 2\phi = (\pm)\frac{1}{\sqrt{2}}$	**M1**	For dealing with $\sec^2 2\phi$ to obtain $\cos 2\phi = k$, where $0 \leq k \leq 1$
	$\phi = \pm 67.5^\circ,\ \pm 22.5^\circ$	**3**	**M1** for solution to obtain at least one correct solution **A1** for a correct pair of solutions **A1** for a second correct pair of solutions with no extra solutions within the range

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13	$f'(x) = 4(3x+4)^{\frac{1}{2}} \quad (+c)$	**2**	**M1** for $a(3x+4)^{\frac{1}{2}}$ **A1** for $4(3x+4)^{\frac{1}{2}}$
	$18 = 4(4) + c$	**M1**	**Dep M** mark for attempting correctly to find the value of the arbitrary constant
	$c = 2$	**A1**	
	$f(x) = \frac{8}{9}(3x+4)^{\frac{3}{2}} \quad (+2x+d)$	**M1**	For $b(3x+4)^{\frac{3}{2}}$
	$f(x) = \frac{8}{9}(3x+4)^{\frac{3}{2}} + 2x \quad (+d)$	**A1**	Allow unsimplified
	$\frac{64}{9} = \frac{64}{9} \ (+8) \ + d$	**M1**	**Dep M** mark for attempt to find a second arbitrary constant
	$f(x) = \frac{8}{9}(3x+4)^{\frac{3}{2}} + 2x - 8$	**A1**	