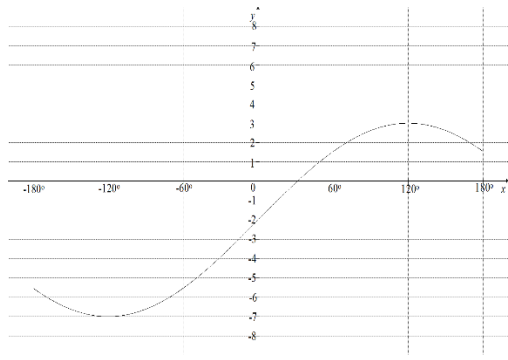
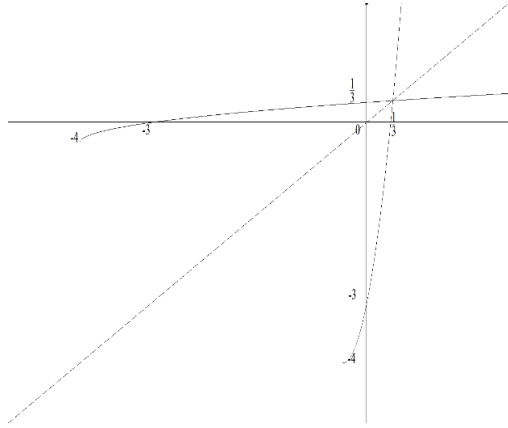


Question	Answer	Marks	Guidance
1(a)	$(f(x) \text{ or } y =) -3(3x+1)(x-1)(2x-5)$	3	B1 for $k\left(x+\frac{1}{3}\right)(x-1)\left(x-\frac{5}{2}\right)$ and no other work that would gain marks. B2 for $m(3x+1)(x-1)(2x-5)$ and no other work that would gain marks.
1(b)	$-\frac{1}{3} < x < 1$	B1	Must be in terms of x
	$x > \frac{5}{2}$	B1	Must be in terms of x
2(a)	5	B1	
2(b)	480°	B1	
2(c)		3	To obtain any marks the graph must be a curve with one min in the third quadrant and one max in the first quadrant. B1 for the shape, starting in the 3 rd quadrant and ending in the 1 st quadrant. Must cross the x -axis only once, between 0° and 60° . Must extend for the complete domain starting with $-6 < y < -5$ and ending with $1 < y < 2$ B1 for passing through $(0, -2)$ B1 for passing through $(120^\circ, 3)$ and $(-120^\circ, -7)$ soi
3	$\ln(y+2) = mx^2 + c$ soi	B1	
	Either of: $9.37 = 2.25m + c$ $3.92 = 4.75m + c$	M1	For at least one correct equation involving m and c
	$m = -2.18, -\frac{109}{50}$ oe $c = 14.3, 14.28, 14.275, \frac{571}{40}$	2	Dep M1 for attempt to solve for at least one unknown. A1 for both.
	$y = e^{(14.3-2.18x^2)} - 2$ oe	A1	FT on the first M1 for <i>their</i> m and c

Question	Answer	Marks	Guidance
3	Alternative		
	$\ln(y+2) = mx^2 + c$ soi	(B1)	
	Gradient = -2.18 , $-\frac{109}{50}$ oe	(B1)	
	$9.37 = 2.25m + c$ $3.92 = 4.75m + c$	(M1)	Use of a correct equation with <i>their</i> gradient and c
	$c = 14.3, 14.28, 14.275, \frac{571}{40}$	(A1)	
	$y = e^{(14.3-2.18x^2)} - 2$ oe	(A1)	FT on <i>their</i> m and c
4(a)	$n = 16$	B1	
	$+\frac{n(n-1)}{2!}\left(-\frac{x}{2}\right)^2, {}^nC_2\left(-\frac{x}{2}\right)^2$ oe $\frac{n(n-1)}{8} = p, p = 30$	2	M1 for attempt at third term allow unsimplified in terms of n or <i>their</i> n , but not just as part of an expansion unless used to find p A1 for p .
	$+\frac{n(n-1)(n-2)}{3!}\left(-\frac{x}{2}\right)^3, {}^nC_3\left(-\frac{x}{2}\right)^3$ $\frac{n(n-1)(n-2)}{48} = q, q = -70$	2	M1 for attempt at fourth term, allow unsimplified in terms of n or <i>their</i> n , but not just as part of an expansion unless used to find q A1 for q .
4(b)	${}^6C_4\left(\frac{2}{x^2}\right)^2\left(\frac{x}{3}\right)^4$	B1	For identifying the correct term and attempting to evaluate.
	$\frac{20}{27}$	B1	
5	$\cos\left(2\theta + \frac{\pi}{6}\right) = (\pm)\frac{\sqrt{3}}{2}$ oe or $\tan\left(2\theta + \frac{\pi}{6}\right) = (\pm)\frac{1}{\sqrt{3}}$ oe	B1	
	$\theta = -\frac{\pi}{6}, 0, \frac{\pi}{3}$ oe	4	M1 for a correct order of operations, may be implied by one correct solution. A1 for 1 correct solution. A1 for a 2nd correct solution A1 for a 3rd correct solution with no extra solutions in the range. All solutions must be from correct working.

Question	Answer	Marks	Guidance
6(a)	$c = 12$	B1	
	$p\left(\frac{1}{3}\right): \frac{a}{27} + \frac{b}{9} + \frac{c}{3} - 5 = 0$ soi	M1	Allow one arithmetic or sign error, may substitute in their c .
	$p(2): 8a + 4b + 2c - 5 = 95$	M1	Allow one arithmetic or sign error, may substitute in their c .
	$a + 3b = 27$ or $\frac{a}{27} + \frac{b}{9} = 1$ oe	A1	Allow multiples but c needs to have been eliminated and terms with powers evaluated.
	$2a + b = 19$ oe	A1	Allow multiples but c needs to have been eliminated
	$a = 6, b = 7$	2	M1, dep on at least one previous M1 , for attempt to solve <i>their</i> equations in a and b only, to find a or b . A1 for both a and b .
6(b)	$(3x - 1)(2x^2 + 3x + 5)$ cao	2	M1 for attempt at 2 terms in <i>their</i> quadratic factor. A1 for both factors.
	For $2x^2 + 3x + 5 = 0$, discriminant is less than zero, so no solutions. [Only solution is $x = \frac{1}{3}$.]	B1	Allow other valid arguments, but must be using a correct quadratic factor and an attempt to evaluate the discriminant
7(a)(i)	136080	B1	
7(a)(ii)	(End in 0) $15\,120$ or 9P_5 or $9 \times 8 \times 7 \times 6 \times 5$	B1	
	(End in 5) $13\,440$ or $8 \times {}^8P_4$ or $8 \times 8 \times 7 \times 6 \times 5$	B1	
	Total: 28560	B1	
	Alternative 1		
	(Does not start with 5:) $26\,880$ or $16 \times {}^8P_4$	(B1)	
	(Starts with 5:) $1\,680$ or 8P_4	(B1)	
	Total: 28560	(B1)	

Question	Answer	Marks	Guidance
7(a)(ii)	Alternative 2		
	(Number not divisible by 5: $107\,520$ or $8 \times 8 \times {}^8P_4$)	(B1)	
	$136\,080 - 107\,520$	(B1)	FT on <i>their</i> 136080
	Total: 28560	(B1)	
7(b)(i)	346104	B1	
7(b)(ii)	18	B1	Do not isw subsequent work
7(b)(iii)	the number of committees with no dentists: 11 440	M1	Allow attempts at 7 options, but must have all of them: 8, 448, 6720, 39 200, 101 920, 122 304 and 64 064
	334664	A1	May come from ${}^{24}C_7 - {}^{16}C_7$
8(a)(i)	$a = -\frac{1}{3}$ or $x \geq -\frac{1}{3}$	B1	Allow -0.333 or better Allow a correct recurring decimal
8(a)(ii)	$f \geq -4$	B1	
8(a)(iii)		4	B1 for $y = f(x)$, must have a correct shape (right hand side from the vertex of a quadratic curve), must be a 1:1 function, intersecting each of the x and y axes once, in quadrants 1, 3 and 4. B1, dependent on previous B for passing through $(0, -3)$ and $(\frac{1}{3}, 0)$. B1 dependent on first B1 for $y = f^{-1}(x)$, being a correct reflection of <i>their</i> $y = f(x)$, intersecting each of the x and y axes and $y = f(x)$ once. B1 dependent on previous B for passing through $(-3, 0)$ and $(0, \frac{1}{3})$.
8(b)	$3(\ln(2x^2 + 5)) - 2 (= 4)$	M1	For correct order
	$x = \sqrt{\frac{e^2 - 5}{2}}$ or exact equivalent	2	M1 dep for a correct attempt to deal with logarithms and obtain $x = \dots$ Allow one arithmetic or sign slip.

Question	Answer	Marks	Guidance
9	$12\left(x^{\frac{2}{3}}\right)^2 - 11\left(x^{\frac{2}{3}}\right) - 5 = 0$	B1	For recognition of a 3-term quadratic equation in terms of $x^{\frac{2}{3}}$ or a suitable substitution
	$\left(3x^{\frac{2}{3}} + 1\right)\left(4x^{\frac{2}{3}} - 5\right) = 0$ $x^{\frac{2}{3}} = -\frac{1}{3}, x^{\frac{2}{3}} = \frac{5}{4}$	2	M1 for attempt to solve a 3-term quadratic equation in the form $12u^2 \pm 11u \pm 5 = 0$ to obtain at least one solution in the form $x^{\frac{2}{3}} = \dots$ or 'u' = ... A1 for at least one correct solution.
	$x = 1.4$ only	A1	
10(a)	$27 = 12\theta$ $\theta = \frac{9}{4}$ oe	B1	$\angle AOB = \theta$
	Either $\tan(\pi - \theta) = \frac{CB}{12}$ soi Or $\frac{CB}{\sin(\pi - \theta)} = \frac{12}{\sin\left(\theta - \frac{\pi}{2}\right)}$	M1	Allow with <i>their</i> θ .
	Perimeter = $24 + 27 + 2(14.86\dots)$	M1	Allow with <i>their</i> CB .
	Perimeter = awrt 80.7	A1	From correct working only
10(b)	$\left(\frac{1}{2} \times 12^2 \times \text{their } \theta\right) + (12 \times \text{their } CB)$ 340 oe or 341 oe	3	M1 for each area A1 for awrt 340 or 341
11(a)	$\overrightarrow{AX} = \frac{\mathbf{b}}{2} - \mathbf{a}$	B1	Allow unsimplified
	$\overrightarrow{OZ} = \mathbf{a} + \lambda\left(\frac{\mathbf{b}}{2} - \mathbf{a}\right)$	2	M1 for $\overrightarrow{OZ} = \mathbf{a} + \lambda \times \text{their}\left(\frac{\mathbf{b}}{2} - \mathbf{a}\right)$ Allow unsimplified Mark final answer
11(b)	$\overrightarrow{OY} = \frac{1}{2}(\mathbf{a} + \mathbf{b})$ oe	B1	Allow unsimplified
	$\overrightarrow{OZ} = \frac{\mu}{2}(\mathbf{a} + \mathbf{b})$	B1	FT on <i>their</i> \overrightarrow{OY} , allow unsimplified Mark final answer

Question	Answer	Marks	Guidance
11(c)	$\mathbf{a} + \lambda \left(\frac{\mathbf{b}}{2} - \mathbf{a} \right) = \frac{\mu}{2} (\mathbf{a} + \mathbf{b})$	M1	For equating <i>their</i> final answer for (a) and <i>their</i> final answer for (b) and attempt to equate like vectors at least once to obtain a scalar equation
	$\lambda = \mu = \frac{2}{3}$	2	M1 dep for solving <i>their</i> simultaneous equations to obtain at least one unknown. Each equation must be in terms of λ and μ A1 for both.
11(d)	$\overrightarrow{OZ} = \frac{1}{3}(\mathbf{a} + \mathbf{b})$ oe	B1	Must be from correct work
12(a)	Cannot have the square root of a negative number. oe	B1	Must be a correct statement related to the question. Allow a numerical argument.
12(b)	$\frac{(x-3) \left(\frac{5}{2} \times (5x-2)^{-\frac{1}{2}} \right) - (5x-2)^{\frac{1}{2}}}{(x-3)^2}$ or $(x-3)^{-1} \frac{5}{2} (5x-2)^{-\frac{1}{2}}$ $+ \left(-(x-3)^{-2} \right) (5x-2)^{\frac{1}{2}}$	3	B1 for $\frac{5}{2} \times (5x-2)^{-\frac{1}{2}}$ seen M1 for an attempt to differentiate a quotient or correct product A1 for all other terms correct.
	$\frac{(5x-2)^{\frac{1}{2}}}{2(x-3)^2} (5(x-3) - 2(5x-2))$ oe	M1	Dep for an attempt to simplify to the given form, allow a sign error and an arithmetic error (e.g. Omission of a factor of 2 in the linear term).
	$\frac{-(5x+11)}{2(x-3)^2 \sqrt{5x-2}}$ cao	A1	