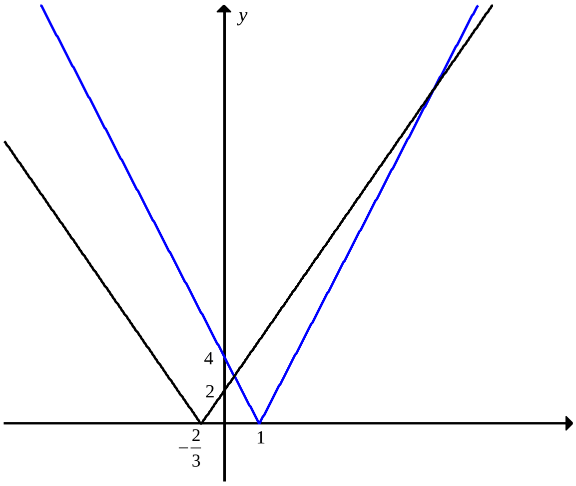
Question	Answer	Marks	Partial Marks
1(a)	Fully correct, ruled graphs with all intercepts indicated 	3	**M2** for a graph of correct shape with vertex on the x-axis and 1 and 4 oe appropriately indicated or a graph of correct shape with vertex on the x-axis and $-\frac{2}{3}$ and 2 oe appropriately indicated or **M1** for a graph of correct shape with vertex on the x-axis and 1 or 4 oe appropriately indicated or a graph of correct shape with vertex on the x-axis and $-\frac{2}{3}$ or 2 oe appropriately indicated
1(b)	$4(x - 1) * 3x + 2$ oe and $4(x - 1) * -3x - 2$ oe OR $7x^2 - 44x + 12 \quad [*0]$ where * is = or any inequality sign	**M2**	**M1** for $4(x - 1) * -3x - 2$ oe OR **M1** for $(4(x - 1))^2 = (3x + 2)^2$ oe
	Critical values $\frac{2}{7}$ and 6	**A1**	
	$\frac{2}{7} \leqslant x \leqslant 6$ mark final answer	**A1**	
2	$a = 5$	**B1**	
	$b = 3$	**B1**	
	$c = -2$	**B1**	

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3	$(x-2)^2+(y+1)^2=74$ oe nfww or $x^2+y^2-4x+2y-69=0$ oe nfww	**4**	**M1** for centre: $\left(\frac{-3+7}{2},\frac{6-8}{2}\right)$ or $(2,-1)$ soi **M2** for [r =] $\sqrt{74}$ or [r^2 =] 74 or [diameter =] $2\sqrt{74}$ or c = –69 or **M1** for $\left[AB^2=\right](-3-7)^2+(6--8)^2$ oe or $\left[r^2=\right](-3-their\,2)^2+(6-their(-1))^2$ oe or $\left[r^2=\right](7-their\,2)^2+(-8-their(-1))^2$ oe **Alternative method** **M2** for $\frac{y-6}{x-(-3)}\times\frac{y-(-8)}{x-7}=-1$ or **M1** for e.g. $P(x, y)$ on the circumference means $AP\perp BP\to m_{AP}\times m_{BP}=-1$ **M1** for $\frac{y^2+2y-48}{x^2-4x-21}=-1$ oe **FT** *their* $\left(\frac{y-6}{x-(-3)}\times\frac{y-(-8)}{x-7}\right)$ with at most one sign error
4(a)	$a^2\left(-\frac{1}{2}\right)^3+2a\left(-\frac{1}{2}\right)^2+a\left(-\frac{1}{2}\right)+2=0$ oe, soi	**M1**	
	Simplifies and solves for a	**M1**	**FT** *their* quadratic in a providing $\text{p}\left(-\frac{1}{2}\right)=0$ oe attempted
	$a=4$	**A1**	
4(b)	$2(2x+1)(4x^2+1)$ mark final answer	**2**	**M1** for $(2x+1)\left(\frac{their\ a^2}{2}x^2\ldots+2\right)$ or $(8x^2+2)$ found as quadratic factor
4(c)	Discriminant of $4x^2+1$ is $0-16<0$ oe and no real roots oe or $4x^2+1=0\to4x^2=-1$ oe and therefore no solution oe [statement that only solution is $x=-\frac{1}{2}$]	**1**	

Question	Answer	Marks	Partial Marks
5(a)	$2\left(x-\frac{1}{2}\right)^2+\frac{5}{2}$	**3**	**B2** for $2\left(x-\frac{1}{2}\right)^2$ or **B1** for $\left(x-\frac{1}{2}\right)^2$ or a = 2 and b = –0.5 oe **B1** for $\frac{5}{2}$ or c = 2.5 oe
5(b)	$\frac{1}{2}$	**B1**	**FT** –*their b*
5(c)	$f \geqslant \frac{5}{2}$	**B1**	**FT** *their c*
5(d)	$\left[f^{-1}(x)=\right]\frac{1}{2}-\sqrt{\frac{1}{2}\left(x-\frac{5}{2}\right)}$ oe or $\left[f^{-1}(x)=\right]\frac{2-\sqrt{8x-20}}{4}$ oe	**3**	**M1 FT** for a complete method to find the inverse with a correct order of operations **FT** an expression of the form $f(x) = a(x+b)^2+c$ **A1 FT** for $\left[f^{-1}(x)=\right]\frac{1}{2}\pm\sqrt{\frac{1}{2}\left(x-\frac{5}{2}\right)}$ oe **FT** *their* $\frac{1}{2}$ and *their* $\frac{5}{2}$
6(a)	$\cos\theta=-\sqrt{\frac{5}{6}}$ oe, isw	**B2**	**B1** for $\cos\theta=\sqrt{\frac{5}{6}}$ oe or $\cos\theta=\pm\sqrt{\frac{5}{6}}$ oe
6(b)	$\sin\theta=-\sqrt{\frac{1}{6}}$ oe, isw	**B1**	
6(c)	$\frac{5-[1]\sqrt{6}}{\sqrt{5}}$	**2**	**M1** for $[\sec\theta+\cot\theta=]\ \frac{1}{\cos\theta}+\frac{1}{\tan\theta}$ or $\frac{1}{\cos\theta}+\frac{\cos\theta}{\sin\theta}$ soi or for $\frac{1}{their\cos\theta}+\frac{5}{\sqrt{5}}$ oe or $\frac{1}{their\cos\theta}+\frac{their\cos\theta}{their\sin\theta}$

Question	Answer	Marks	Partial Marks
7(a)	$(2x+1)(x+1)=5+2(x+1)$ or $(2x-1)(x+1)=5$ oe	**M1**	
	$2x^2+x-6[=0]$	**A1**	
	Factorises or solves *their* 3-term quadratic e.g. $(x+2)(2x-3)$	**M1**	
	$\left(\frac{3}{2}, 4\right)$	**A1**	
7(b)	Correct plan, difference of integrals oe: $\int_0^k\left(\frac{5}{x+1}+2\right)\mathrm{d}x$ – area correct trapezium soi where $k > 0$	**M1**	or $\int_0^k\left(\frac{5}{x+1}+2\right)\mathrm{d}x - \int_0^k(2x+1)\mathrm{d}x$ soi
	Area of trapezium: $\frac{1}{2}(\textit{their}\,4+1)\left(\textit{their}\,\frac{3}{2}\right)$ oe	**B1**	or $\left(\textit{their}\,\frac{3}{2}\right)^2+\textit{their}\,\frac{3}{2}\,[-0]$ or $\frac{15}{4}$ oe
	Integral: $\left[5\ln(x+1)+2x\right]_0^{\textit{their}\,1.5}$	**B2**	**B1** for $5\ln x+1$ or for $n\ln(x+1)$ where n is a constant and $n > 0$
	Correct substitution of upper and lower limits into $5\ln(x+1)+2x$	**M1**	**FT** *their* integral providing at least **B1** awarded and *their* 1.5
	Area of shaded region: $5\ln\left(\frac{5}{2}\right)-\frac{3}{4}$ isw	**A1**	
	Alternative method		
	Correct plan, integral of difference of functions: $\int_0^k\left(\frac{5}{x+1}-2x+1\right)\mathrm{d}x$ soi where $k > 0$	**(M1)**	
	Integral: $\left[5\ln(x+1)+x-x^2\right]_0^{\textit{their}\,1.5}$	**(B3)**	**B2** for $5\ln(x+1)$ and one other correct term or $n\ln(x+1)+x-x^2$ where n is a constant and $n > 0$ or **B1** for $5\ln x+1$ or for $n\ln(x+1)$ where n is a constant and $n > 0$
	Area of shaded region: $5\ln\left(\frac{5}{2}\right)-\frac{3}{4}$ isw	**(2)**	**M1FT** for correct substitution of upper and lower limits; **FT** *their* integral providing at least **B1** awarded and *their* 1.5

Question	Answer	Marks	Partial Marks
8(a)	$10r = 10 + 3d$ soi	**B1**	
	$10r^2 = 10 + 5d$ soi	**B1**	
	$10\left(\frac{10+3d}{10}\right)^2 = 10 + 5d$ oe or $10r^2 = 10 + \frac{5(10r-10)}{3}$ oe	**M1**	
	$9d^2 + 10d = 0$ or $3r^2 - 5r + 2 = 0$ oe	**A1**	
	Correct method to find *d* or *r*	**A1**	**FT** *their* quadratic in *d* or *r*
	$d = -\frac{10}{9}$ and $r = \frac{2}{3}$	**A1**	
8(b)	Appropriate determination for *their r* e.g. $\lvert r\rvert < 1$ so the geometric progression has a sum to infinity oe	**B1**	**STRICT FT** *their r*
9	Correct change of base e.g. $\log_2(x+1) - \frac{4\log_2 2}{\log_2(x+1)} = 3$ or $\frac{\log_{(x+1)}(x+1)}{\log_{(x+1)} 2} - 4\log_{(x+1)} 2 = 3$	**B1**	
	$(\log_2(x+1))^2 - 3\log_2(x+1) - 4 \quad [=0]$ oe or $4(\log_{(x+1)} 2)^2 + 3\log_{(x+1)} 2 - 1 \quad [=0]$ oe	**B1**	
	Factorises or solves e.g. $(\log_2(x+1) - 4)(\log_2(x+1) + 1) = 0$ or $(4\log_{(x+1)} 2 - 1)(\log_{(x+1)} 2 + 1) = 0$	**M1**	**FT** *their* 3-term quadratic in a suitable logarithm providing correct change of base seen
	$\log_2(x+1) = \textit{their}\, 4$ and $\log_2(x+1) = \textit{their}\,(-1)$ or $\log_{(x+1)} 2 = \textit{their}\, \frac{1}{4}$ and $\log_{(x+1)} 2 = \textit{their}\,(-1)$ **and** correctly solves as far as *x* = … at least once	**M1**	**dep** on previous **M1** **FT** $\log_2(x+1) = a$ or $\log_{(x+1)} 2 = b$ where *a* and *b* are constants
	$x = 15$, $x = -\frac{1}{2}$ nfww mark final answer	**A1**	

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10	[When $x = 5$] $y = 9$	B1	
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{2}{3}(5x+2)^{-\frac{1}{3}} \times 5$ oe	B2	**B1** for $\frac{\mathrm{d}y}{\mathrm{d}x} = k(5x+2)^{-\frac{1}{3}}$, $k \neq \frac{10}{3}$
	$\left.\frac{\mathrm{d}y}{\mathrm{d}x}\right\|_{x=5} = \frac{10}{9}$	B1	**FT** *their* $\left.\frac{\mathrm{d}y}{\mathrm{d}x}\right\|_{x=5}$ providing previous **B1** awarded
	Equation of normal e.g. $y - \mathit{their}9 = -\frac{1}{\mathit{their}\frac{10}{9}}(x-5)$ oe, soi	M1	**FT** $\frac{-1}{\mathit{their}\left.\frac{\mathrm{d}y}{\mathrm{d}x}\right\|_{x=5}}$ and *their* y-coordinate
	Eliminates one variable e.g. $11 - x - \mathit{their}9 = -\frac{1}{\mathit{their}\frac{10}{9}}(x-5)$	M1	**dep** on previous **M** mark
	For Q: $x = -25$, $y = 36$	A2	**A1** for each
	Coordinates of R: (35, –18) or $\left((10 - \mathit{their}(-25)),\ (18 - \mathit{their}36)\right)$	B1	**FT** *their* coordinates of Q
11(a)	$[\overrightarrow{OX} =]$ $\mathbf{b} + \lambda\left(\frac{3}{4}\mathbf{a} - \mathbf{b}\right)$ oe or $[\overrightarrow{OX} =]$ $\frac{3}{4}\mathbf{a} + (1-\lambda)\left(\mathbf{b} - \frac{3}{4}\mathbf{a}\right)$ oe	3	**B2** for $\overrightarrow{BN} = \frac{3}{4}\mathbf{a} - \mathbf{b}$ oe, soi or **B1** for $\overrightarrow{ON} = \frac{3}{4}\mathbf{a}$ oe, soi
11(b)	$[\overrightarrow{OX} =]$ $\frac{1}{2}\mathbf{b} + \mu\left(\mathbf{a} - \frac{1}{2}\mathbf{b}\right)$ oe or $[\overrightarrow{OX} =]$ $\mathbf{a} + (1-\mu)\left(\frac{1}{2}\mathbf{b} - \mathbf{a}\right)$ oe	2	**B1** for $\overrightarrow{MA} = \mathbf{a} - \frac{1}{2}\mathbf{b}$
11(c)	$\mathbf{b} + \lambda\left(\frac{3}{4}\mathbf{a} - \mathbf{b}\right) = \frac{1}{2}\mathbf{b} + \mu\left(\mathbf{a} - \frac{1}{2}\mathbf{b}\right)$ soi	M1	**FT** *their* answer to **(a)** in terms of **a**, **b** and λ and **(b)** in terms of **a**, **b** and μ
	$\frac{3}{4}\lambda = \mu$ or $1 - \lambda = \frac{1}{2} - \frac{1}{2}\mu$	M1	**FT** *their* answer to **(a)** in terms of **a**, **b** and λ and **(b)** in terms of **a**, **b** and μ
	$\frac{3}{4}\lambda = \mu$ and $1 - \lambda = \frac{1}{2} - \frac{1}{2}\mu$	A1	
	$\lambda = \frac{4}{5}$, $\mu = \frac{3}{5}$	A1	

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12(a)	$\frac{\mathrm{d}}{\mathrm{d}x}\left(\mathrm{e}^{3x+2}\right)=3\mathrm{e}^{3x+2}$ soi	**B1**	
	$\frac{\mathrm{d}y}{\mathrm{d}x}=x\times \mathit{their}\left(3\mathrm{e}^{3x+2}\right)+[1]\mathrm{e}^{3x+2}$ oe, isw	**2**	**FT** *their* $3\mathrm{e}^{3x+2}$ **M1** for correct structure of product rule
12(b)	$\frac{1}{3}x\mathrm{e}^{3x+2}-\frac{1}{9}\mathrm{e}^{3x+2}+c$ oe, nfww	**4**	**B3** for $\int 3x\mathrm{e}^{3x+2}\mathrm{d}x=x\mathrm{e}^{3x+2}-\frac{1}{3}\mathrm{e}^{3x+2}\quad(+A)$ or better or **B2** for $\int 3x\mathrm{e}^{3x+2}\mathrm{d}x=x\mathrm{e}^{3x+2}-\int \mathrm{e}^{3x+2}\mathrm{d}x$ or better or $\frac{1}{3}\mathrm{e}^{3x+2}+\int 3x\mathrm{e}^{3x+2}\mathrm{d}x=x\mathrm{e}^{3x+2}$ or $\int x\mathrm{e}^{3x+2}\mathrm{d}x=\frac{x}{3}\mathrm{e}^{3x+2}+k\mathrm{e}^{3x+2}$ where $k=\frac{1}{9}$ or $-\frac{1}{3}$ or **B1** for $\int 3x\mathrm{e}^{3x+2}\mathrm{d}x=\int\left(3x\mathrm{e}^{3x+2}+\mathrm{e}^{3x+2}\right)\mathrm{d}x-\int \mathrm{e}^{3x+2}\mathrm{d}x$ or $\int\frac{\mathrm{d}y}{\mathrm{d}x}\mathrm{d}x=\int 3x\mathrm{e}^{3x+2}\mathrm{d}x+\int \mathrm{e}^{3x+2}\mathrm{d}x$ or better