Question	Answer	Marks	Partial marks
1	−0.8, 0.55, 2.25	**B1**	
	$x < -0.8$ $0.55 < x < 2.25$	**B2**	**B1** for either inequality correct
2(a)	$5 - (x+2)^2$	**B2**	**B1** for $-(x+2)^2$ or $(x+2)^2$ or $a = 5$ and $b = 2$
2(b)	$f \leqslant 5$ or $f(x) \leqslant 5$	**B1**	**FT** *their* 5
2(c)	−2	**B1**	**FT** − *their* 2
2(d)	Complete method to find inverse function: Swaps the variables and rearranges or rearranges and swaps the variables at some point in their solution	**M1**	For **M1 FT** *their* part (a) provided it is in the form $a-(x+b)^2$
	$[g^{-1}(x) =] -2 + \sqrt{5-x}$ or $\left[g^{-1}(x)=\right]\dfrac{-4+\sqrt{4^2-4[1](x-1)}}{2}$ or $\left[g^{-1}(x)=\right]\dfrac{-(-4)-\sqrt{(-4)^2-4(-1)(1-x)}}{-2}$ oe, isw	**A2**	**A1** for $[g^{-1}(x) =] -2 \pm \sqrt{5-x}$ or $[g^{-1}(x) =] = \dfrac{-4\pm\sqrt{4^2-4[1](x-1)}}{2(1)}$ or $[g^{-1}(x) =] = \dfrac{-(-4)\pm\sqrt{4^2-4(-1)(1-x)}}{2(-1)}$
	[Domain:] $x \leqslant 5$	**B1**	**FT** *their* part (b) provided it is in form $f(x) \leqslant a$ where a is a constant
	[Range:] $g^{-1} \geqslant$ *their* −2	**B1**	**FT** *their* value of k in part (c)
3(a)	$4\tan^2\theta - \sec^2\theta$	**M1**	e.g. $4\dfrac{\sin^2\theta}{\cos^2\theta} - \dfrac{1}{\cos^2\theta}$
	Justified completion to given answer e.g. $4\tan^2\theta - (1+\tan^2\theta)$ $= 3\tan^2\theta - 1$ or $3\tan^2\theta - (\sec^2\theta - \tan^2\theta)$ $= 3\tan^2\theta - 1$	**A1**	e.g. $4\dfrac{\sin^2\theta}{\cos^2\theta} - \dfrac{\sin^2\theta+\cos^2\theta}{\cos^2\theta}$ $= 4\tan^2\theta - \tan^2\theta - 1$ $= 3\tan^2\theta - 1$
3(b)	$\tan\theta = [\pm]\sqrt{\dfrac{2}{3}}$ oe	**M2**	**M1** for $\tan^2\theta = \dfrac{2}{3}$ oe
	$[\theta =]$ 39.2 or 39.23 to 39.232 $[\theta =]$ 140.8 or 140.76 to 140.77 and no extras in range	**A2**	**A1** for either one correct, ignoring extras

Question	Answer	Marks	Partial marks
4(a)	Correct statement for area e.g. $\frac{1}{2}r^2\alpha = 9$ or $\frac{1}{2}rs = 9$	**B1**	
	Finds an equation that can be used to eliminate α or s e.g. $\alpha = \frac{18}{r^2}$ or $r\alpha = \frac{18}{r}$ or $s = \frac{18}{r}$	**M1**	
	Correct substitution and completion to given answer e.g. $P = 2r + r \times \frac{18}{r^2} = 2r + \frac{18}{r}$	**A1**	
4(b)	Correct derivative: $2 - \frac{18}{r^2}$ oe isw	**B1**	
	$2 - \frac{18}{r^2} = 0$ and solves for r	**M1**	**FT** *their* $\frac{\mathrm{d}P}{\mathrm{d}r} = 0$ providing of the form $2 + \frac{n}{r^k}$ where n and k are non-zero integers
	$r = 3$ only soi	**A1**	
	$P = 12$ only soi	**A1**	
	[2nd derivative =] $\frac{36}{r^3}$ oe **and** which is positive for $r = 3$ →minimum **or** as $r > 0$ [2nd derivative =] > 0 →minimum **or** [2nd derivative =] $\frac{36}{3^3}$ oe →minimum OR correctly finds the values of the first derivative at $3 \pm h$ where h is small → minimum	**A1**	**dep** on $r = 3$ and no other value

Question	Answer	Marks	Partial marks
5	[When $x = 3$] $y = \frac{2}{3}$ soi	**B1**	
	Correct derivative: $\dfrac{x \times \frac{1}{2}(x+1)^{-\frac{1}{2}} - \sqrt{x+1}}{x^2}$ or $-x^{-2}(x+1)^{\frac{1}{2}} + x^{-1} \times \frac{1}{2}(x+1)^{-\frac{1}{2}}$	**M2**	**M1** for an attempt to differentiate using the quotient rule oe
	Gradient of tangent: $\dfrac{3 \times \frac{1}{2}(4)^{-\frac{1}{2}} - \sqrt{4}}{3^2}$	**M1**	**dep** on attempt at a derivative which includes $(x+1)^{-\frac{1}{2}}$
	$-\frac{5}{36}$ isw	**A1**	**dep** on having a **correct derivative**
	$y = -\frac{5}{36}x + \frac{13}{12}$ oe or $y - \frac{2}{3} = \left(-\frac{5}{36}\right)(x-3)$ oe soi	**A1**	**FT** *their* non-zero $\frac{2}{3}$ and *their* non- zero $-\frac{5}{36}$
	$A(15, -1)$	**B2**	**B2 dep** on all previous marks awarded **B1 dep** for $x = 15$ or $y = -1$
6(a)	$\frac{2}{3}(3x+2)^{\frac{1}{2}}(+c)$ oe	2	**B1** for $k(3x+2)^{\frac{1}{2}}$ oe, soi where k is a constant and $k \neq 0$
6(b)	$-\frac{e^{1-2a}}{2} + \frac{1}{2}$ oe, isw	3	**B2** for $-\frac{1}{2}e^{(1-2x)}$ oe or **B1** for $ke^{(1-2x)}$ or $ke^{(1-2a)}$ where k is a constant, $k \neq 0$
7(a)	$x = \sqrt[3]{\frac{28}{56}}$ oe, nfww, isw	3	**B2** for $28x^{10}$ and $56x^{13}$ OR $[x^8](28x^2)$ and $[x^8](56x^5)$ or **B1** for $28x^{10}$ or $56x^{13}$ OR $[x^8](28x^2)$ or $[x^8](56x^5)$
7(b)(i)	$n = 10$	2	**B1** for the correct term in any form e.g. ${}^nC_5 x^{n-5}\left(\frac{2}{x}\right)^5$ or for $n - 5 = 5$ oe, soi
7(b)(ii)	8064	2	**B1** for ${}^{10}C_5 \times 2^5$ oe e.g. 252×32

Question	Answer	Marks	Partial marks
8(a)	$[x =]\ \frac{\pi}{24}, \frac{5\pi}{24}$ and no extras in range	2	**B1** for $[x =]\ \frac{\pi}{24}$ or $\frac{5\pi}{24}$ ignoring extras or for $4x = \frac{\pi}{6}$ **and** $\frac{5\pi}{6}$ soi
8(b)	Correct and complete plan soi e.g. $\int_{their\frac{\pi}{24}}^{their\frac{5\pi}{24}}\left(\sin(4x)-\frac{1}{2}\right)dx$ or $2\int_{their\frac{\pi}{24}}^{\frac{\pi}{8}}\left(\sin(4x)-\frac{1}{2}\right)dx$	M1	**FT** *their* limits in radians from part (a) or $\int_{their\frac{\pi}{24}}^{their\frac{5\pi}{24}}\sin 4x\,dx - \frac{1}{2}\left(their\frac{5\pi}{24} - their\frac{\pi}{24}\right)$
	Integrates sin 4x: $-\frac{1}{4}\cos 4x$	B2	**B1** for $k\cos 4x$ where $k < 0$ or $k = \frac{1}{4}$
	Substitutes exact limits in correct order: $-\frac{1}{4}\cos 4\left(\frac{5\pi}{24}\right)-\left[-\frac{1}{4}\cos 4\left(\frac{\pi}{24}\right)\right]$ oe soi	M1	**FT** *their* exact limits and *their* $-\frac{1}{4}\cos 4x$ providing at least **B1** awarded
	$\frac{\sqrt{3}}{4}-\frac{\pi}{12}$ or exact equivalent	A1	
9	$\frac{18+12\sqrt{10}}{2+\sqrt{10}}$	B1	
	$\frac{their18+(their12)\sqrt{10}}{2+\sqrt{10}}\times\frac{2-\sqrt{10}}{2-\sqrt{10}}$	M1	**FT** $\frac{a+b\sqrt{10}}{2+\sqrt{10}}$ where a and b are integers
	$\frac{36–18\sqrt{10}+24\sqrt{10}–120}{–6}$	A1	
	$14-\sqrt{10}$ nfww	A1	**dep** on all previous marks awarded
	Alternative		
	$\frac{16+11\sqrt{10}}{2+\sqrt{10}}\times\frac{2-\sqrt{10}}{2-\sqrt{10}}$ [+1]	(M1)	
	$\frac{32-16\sqrt{10}+22\sqrt{20}-110}{–6}$ [+1]	(A1)	
	$\frac{-78+6\sqrt{10}\ [-6]}{–6}$ oe	(A1)	e.g. $13-\sqrt{10}$ [+1]
	$14-\sqrt{10}$ nfww	(A1)	**dep** on all previous marks awarded

Question	Answer	Marks	Partial marks
10(a)	$1.1^n * 3$	B2	where * is any inequality sign or = **B1** for $\frac{10(1.1^n - 1)}{1.1 - 1} * 200$ or $\frac{10(1 - 1.1^n)}{1 - 1.1} * 200$ or for $r = 1.1$ soi
	$n\log1.1 * \log3$ oe or $\log_{1.1} 3$ [* n]	M1	**FT** $1.1^n * their3$ providing **B1** has been awarded for a correct sum to n terms **and** (*their* 3) > 0
	[n =]12	A1	**dep** on all previous marks awarded
10(b)	$r = 2$ only nfww	B4	**B3** for a correct equation or equations which can be solved directly for r e.g. $[d =]\frac{[a](r-1)}{2} = \frac{[a]r(r-1)}{4}$ or $[d =]\frac{[a](r-1)}{2} = \frac{[a](r^2-1)}{6}$ or $[a](r^2 - 3r + 2)$ [= 0] oe or $\frac{2(r+1)(r-1)}{(r-1)} = 6$ or $r = \frac{4d}{2d}$ or $[r =]\frac{a+2d}{a}$ or $[r =]\frac{a+6d}{a+2d}$ **and** $a = 2d$ or **B2** for a correct equation or equations which need to be rearranged to find r e.g. $[d =]\frac{ar-a}{2} = \frac{ar^2-ar}{4}$ or $[d =]\frac{ar-a}{2} = \frac{ar^2-a}{6}$ or $[a =]\frac{6[d]}{r^2-1} = \frac{2[d]}{r-1}$ or $a(r-1) = 2d$ and $ar(r-1) = 4d$ or **either** $[r =]\frac{a+2d}{a}$ or $[r =]\frac{a+6d}{a+2d}$ **and** $4d^2 - 2ad$ [= 0] or **B1** for $ar = a + 2d$ oe and **B1** for $ar^2 = a + 6d$ oe

Question	Answer	Marks	Partial marks
11(a)(i)	12	**2**	**B1** for 3! × 2! or ${}^2P_2 \times {}^3P_3$ oe
11(a)(ii)	72	**2**	**B1** for 5! − 4! × 2! oe or 6 × 2! × 3! oe
11(b)	4200	**2**	**B1** for ${}^{10}C_3 \times {}^7C_3 \left[\times {}^4C_4\right]$ oe or ${}^{10}C_4 \times {}^6C_3 \left[\times {}^3C_3\right]$ oe
12(a)	Correct derivative: $-\sin t - \cos t$	**M1**	
	$-\dfrac{1+\sqrt{3}}{2}$ oe or −1.37 or –1.366[02…] rot to 3 or more dp	**A1**	Mark **final answer**
12(b)	[$v = 0 \Rightarrow$] $\cos t - \sin t = 0$ $t = \dfrac{\pi}{4}$	**B2**	**B1** for $\cos t - \sin t = 0$
	Correct integral: $\sin t + \cos t$ (+ c)	**M1**	
	$0 = \sin 0 + \cos 0 + c$	**M1**	**FT** *their* attempt to integrate
	$s = \sin t + \cos t - 1$	**A1**	
	$\sqrt{2} - 1$ oe, isw or 0.414[21…]	**A1**	**dep** on all previous marks awarded
	Alternative		
	[$v = 0 \Rightarrow$] $\cos t - \sin t = 0$ $\rightarrow t = \dfrac{\pi}{4}$	**(B2)**	**B1** for $\cos t - \sin t = 0$
	Correct integral: $\sin t + \cos t$	**(M1)**	
	with limits $t = \dfrac{\pi}{4}$ and $t = 0$	**(A1)**	Must be in radians
	Substitutes limits into correct integral	**(M1)**	**FT** *their* $t = \dfrac{\pi}{4}$ from attempt at solving $v = 0$
	$\sqrt{2} - 1$ oe, isw or 0.414[21…]	**(A1)**	**dep** on all previous marks awarded
12(c)	$-s - 1$ oe isw	**B1**	