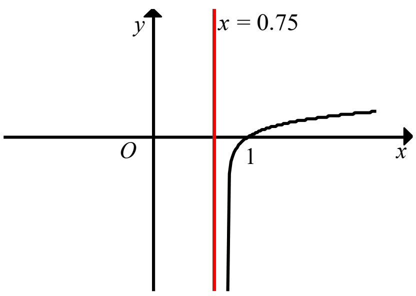
Question	Answer	Marks	Partial Marks
1	$\dfrac{4-\sqrt{5}}{7-3\sqrt{5}}\times\dfrac{7+3\sqrt{5}}{7+3\sqrt{5}}$ attempted	**M1**	
	Correct expansion $\dfrac{28+12\sqrt{5}-7\sqrt{5}-15}{49-45}$	**M1**	**DEP** condone one arithmetic or sign slip
	$\dfrac{13+5\sqrt{5}}{4}$ or simplified equivalent	**A1**	
2	Attempts to solve $2(7^{2x})-21(7^{x})-11=0$ or uses $u=7^x$ and attempts to solve $2u^2-21u-11=0$	**B1**	
	$(2(7^x)+1)(7^x-11)$ or $(2u+1)(u-11)$	**M1**	**FT** *their* $2(7^{2x})+b(7^{x})+c=0$ or $2u^2+bu+c=0$ with b and c both non-zero
	[$7^x=-\dfrac{1}{2}$ or] $7^x=11$	**A1**	
	$x=\log_7 11$ or $\dfrac{\ln 11}{\ln 7}$ or $\dfrac{\lg 11}{\lg 7}$ isw or 1.23[227...] only	**A1**	
3(a)	$3^4\times x^{\frac{8}{3}}\times y^{\frac{15}{4}}$	**B3**	**B1** for each correct power or **M1** for $\dfrac{x\left(243x^{\frac{5}{3}}y^5\right)}{3y^{\frac{5}{4}}}$ or better
3(b)(i)	$a^{\frac{3}{2}}=64$ or $a^{\frac{3}{4}}=8$ oe	**M1**	
	$a=16$	**A1**	If 0 scored, **SC1** for correctly finding a from $\log_a 8=k$, where $k\neq 0.75$
3(b)(ii)	Correct change of base to a: $\dfrac{\log_a 3a}{\log_a a^2}$ oe	**M1**	
	Simplifies denominator: $\log_a (3a)^{\frac{1}{2}}$ oe	**A1**	

Question	Answer	Marks	Partial Marks
4	$y = \tan x$	**B1**	
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \sec^2 x$	**B1**	**Alternative method for first 2 marks:** **B1** for $\frac{\mathrm{d}u}{\mathrm{d}x} = \cos x$ and $\frac{\mathrm{d}v}{\mathrm{d}x} = -\sin x$ **B1** for $\frac{\cos^2 x - (-\sin^2 x)}{\cos^2 x}$; allow unsimplified
	$\frac{\delta y}{h} = \mathit{their} \left.\frac{\mathrm{d}y}{\mathrm{d}x}\right\|_{x=-\frac{\pi}{4}}$	**M1**	
	$2h$	**A1**	
5(a)	$(2x - 3)(x - 7)$	**M1**	
	CV 1.5, 7	**A1**	
	$1.5 \leqslant x \leqslant 7$ nfww	**A1**	**FT** *their* CVs
5(b)	$\int_{\mathit{their}1.5}^{\mathit{their}7} (2x^2 - 17x + 21)\,\mathrm{d}x$ $= \left[\frac{2x^3}{3} - \frac{17x^2}{2} + 21x\right]_{\mathit{their}1.5}^{\mathit{their}7}$	**B1**	
	F(*their* 7) – F(*their* 1.5)	**M1**	**FT** *their* 7 and *their* 1.5 from (a); must have at least two terms correct
	[$-\frac{1331}{24}$, therefore area =] $\frac{1331}{24}$ isw or 55.5 or 55.4583333... rot to 4 or more sig figs; nfww	**A1**	
6(a)	p(–0.25) = $36(-0.25)^3 - 15(-0.25)^2 - 2(-0.25) + 1$ = 0 oe	**B1**	

Question	Answer	Marks	Partial Marks
6(b)	$(4x + 1)(9x^2 – 6x + 1)$ oe	**B2**	**B1** for any two correct terms in the quadratic factor
	$(4x + 1)(3x – 1)(3x – 1)$ nfww	**B1**	dep on **B2**
	States e.g. Repeated factor, so repeated root or finds the remaining roots as $x=\frac{1}{3}, x=\frac{1}{3}$ or finds $x=\frac{1}{3}$ and indicates e.g. twice	**B1**	dependent on all previous marks
	Alternative method $p'(x)=108x^2-30x-2$	**(B1)**	
	solving *their* $p'(x)=0$ or factorising *their* $p'(x)$	**(B1)**	
	$x=\frac{1}{3}, x=-\frac{1}{18}$	**(B1)**	
	$p\left(\frac{1}{3}\right)=36\left(\frac{1}{3}\right)^3-15\left(\frac{1}{3}\right)^2-2\left(\frac{1}{3}\right)+1=0$ [x-axis tangential to turning point, therefore root is repeated oe]	**(B1)**	
7(a)	Correct sketch 	**B2**	**B1** for correct shape passing through (1, 0) **B1** for attempt at correct shape with asymptote at $x = 0.75$ soi
7(b)	$\frac{dy}{dx}=\frac{4}{4x-3}$	**B2**	**B1** for $\frac{dy}{dx}=\frac{k}{4x-3}$ where $k \neq 4$ or 0
	$\left.\frac{dy}{dx}\right\|_{x=2}=\frac{4}{4(2)-3}$ or $\frac{4}{5}$	**M1**	**FT** *their* k; dep on at least **B1** awarded for differentiation
	When $x = 2$, $y = \ln 5$	**B1**	
	$y-\ln 5=\frac{4}{5}(x-2)$ oe, isw	**A1**	**FT** *their* ln5 and *their* 0.8

Question	Answer	Marks	Partial Marks
8(a)(i)	$-3\cos\left(\frac{\phi+\pi}{3}\right)(+c)$ oe	**B2**	**B1 for** $k\cos\left(\frac{\phi+\pi}{3}\right)(+c)$ where $k<0$ or $k=3$
8(a)(ii)	$\left[\int 5\mathrm{d}\theta=\right]$ $5\theta+c$	**B2**	**B1** for $5\sin^2\theta+5\cos^2\theta=5$ soi prior to integrating
8(b)	$\int\left(\frac{2}{x}+\frac{1}{x^2}\right)\mathrm{d}x$ soi	**B1**	
	$\left[2\ln x+\frac{x^{-1}}{-1}\right]_1^{\mathrm{e}}$	**M1**	**FT** $\int\left(\frac{k}{x}+\frac{1}{x^2}\right)\mathrm{d}x$
	$\left[2\ln \mathrm{e}-\frac{1}{\mathrm{e}}\right]-[2\ln 1-1]$	**DM1**	
	$2-\frac{1}{\mathrm{e}}+1=\frac{3\mathrm{e}-1}{\mathrm{e}}$	**A1**	
9(a)(i)	$15-2(x+1)^2$ isw	**B3**	**B1** for $(x+1)^2$ **B1** for $a=15$
9(a)(ii)	$\mathrm{f}\leqslant 15$	**B1**	**STRICT FT** *their a*
9(b)(i)	Domain: $x\geqslant\sqrt{2}$	**B1**	
	Range: $\mathrm{g}^{-1}\geqslant 1$	**B1**	
9(b)(ii)	$x^2+2x+(-1-y^2)=0$ or $y^2+2y+(-1-x^2)=0$	**B1**	
	Correctly applies quadratic formula: $[x=]\frac{-2\pm\sqrt{2^2-4(1)(-1-y^2)}}{2}$ or $[y=]\frac{-2\pm\sqrt{2^2-4(1)(-1-x^2)}}{2}$	**M1**	**FT** *their* $x^2+2x+(-1-y^2)=0$ or $y^2+2y+(-1-x^2)=0$ with at most one sign error in the equation
	Justifies the positive square root at some point	**B1**	
	Correct completion to $\mathrm{g}^{-1}(x)=-1+\sqrt{x^2+2}$	**A1**	

Question	Answer	Marks	Partial Marks
10(a)	$y = \dfrac{30}{x^2}$ oe	**B1**	
	$S = \pi x\sqrt{x^2 + \left(their\dfrac{30}{x^2}\right)^2}$	**M1**	**FT** *their* $y = \dfrac{30}{x^2}$ providing $10\pi = \dfrac{1}{3}\pi x^2 y$ was attempted
	Correct completion to given answer $S = \dfrac{\pi\sqrt{x^6 + 900}}{x}$	**A1**	
10(b)	$\dfrac{\mathrm{d}([\pi]\sqrt{x^6+900})}{\mathrm{d}x} = [\pi\times]\dfrac{1}{2}(x^6+900)^{-\frac{1}{2}} \times 6x^5$	**B2**	**B1** for $[\pi\times]\,kx^5(x^6+900)^{-\frac{1}{2}}$, $k \neq 3$ or 0
	Applies correct form of quotient or product rule e.g.: $\dfrac{\pi x\left(3x^5(x^6+900)^{-\frac{1}{2}}\right) - \pi(x^6+900)^{\frac{1}{2}}}{x^2}$ or $-\pi x^{-2}(x^6+900)^{\frac{1}{2}} + \dfrac{\pi}{x}\left(3x^5(x^6+900)^{-\frac{1}{2}}\right)$	**M1**	**FT** *their* $\dfrac{\mathrm{d}([\pi]\sqrt{x^6+900})}{\mathrm{d}x}$
	their $\dfrac{\mathrm{d}S}{\mathrm{d}x} = 0$ and attempt to solve	**M1**	**DEP**
	$x = \sqrt[6]{450}$ isw	**A1**	

Question	Answer	Marks	Partial Marks
11(a)(i)	$\frac{1}{q}-\frac{1}{p}=-\frac{1}{q}-\frac{1}{q}$ oe or $-\frac{1}{p}-(3-1)d=\frac{1}{p}+(2-1)d$ or $\frac{1}{p}=\frac{3}{2}\left\{\frac{2}{p}+(3-1)d\right\}$	**M2**	**M1** for $[d=]\frac{1}{q}-\frac{1}{p}$ or $[d=]-\frac{1}{q}-\frac{1}{q}$ or $[2d=]-\frac{1}{q}-\frac{1}{p}$ or $-\frac{1}{q}=\frac{1}{p}+(3-1)d$ or $\frac{1}{q}=\frac{1}{p}+(2-1)d$ or $\frac{1}{p}+\frac{1}{q}-\frac{1}{q}=\frac{3}{2}\left\{\frac{2}{p}+(3-1)d\right\}$
	correct completion to given answer $-\frac{2}{3p}$ e.g. $-\frac{1}{3p}-\frac{1}{3p}=-\frac{2}{3p}$ or $\frac{1}{3p}-\frac{1}{p}=\frac{1}{3p}-\frac{3}{3p}=-\frac{2}{3p}$ or makes d the subject of $-\frac{1}{p}-(3-1)d=\frac{1}{p}+(2-1)d$ or $\frac{1}{p}=\frac{3}{2}\left\{\frac{2}{p}+(3-1)d\right\}$	**A1**	
11(a)(ii)	$\left[u_{10}\text{oe or }\frac{k}{p}=\right]\frac{1}{p}+9\left(\frac{-2}{3p}\right)$	**M1**	
	$k=-5$	**A1**	

Question	Answer	Marks	Partial Marks
11(b)	$ar = 1.5$ and $\frac{a}{1-r} = 8$ oe, soi	**B1**	
	Correctly eliminates *a*: $\frac{3}{2r} = 8(1-r)$ oe	**M1**	
	$16r^2 - 16r + 3 = 0$ oe	**A1**	
	Attempts to solve *their* 3-term quadratic in *r*	**M1**	
	Correct solutions $r = \frac{3}{4}$ $r = \frac{1}{4}$	**A1**	
	Alternative method $ar = 1.5$ and $\frac{a}{1-r} = 8$ oe, soi	**(B1)**	
	Correctly eliminating *r*: $a\left(1 - \frac{a}{8}\right) = \frac{3}{2}$ oe	**(M1)**	
	$a^2 - 8a + 12 = 0$	**(A1)**	
	Attempting to solve *their* 3-term quadratic in *a* **and** use the values of *a* to find *r*	**(M1)**	
	Correct solutions $r = \frac{3}{4}$ $r = \frac{1}{4}$	**(A1)**	
12(a)	$\left[v = \frac{ds}{dt} = \right] 1 + 2\sin t$ soi	**B1**	
	Puts *their* $1 + 2\sin t = 0$ and solves for *t*	**M1**	**FT** $a + b\sin t$ where *a* and *b* are non-zero
	$t = \frac{7\pi}{6}$	**A1**	
	$s = \frac{7\pi}{6} + 2 - 2\cos\frac{7\pi}{6}$	**M1**	**FT** *their* $t \neq 0$; dep on previous **M1**
	7.4[0] or 7.397[24...] (metres) rot to 4 or more sig figs	**A1**	
12(b)	$t = \frac{11\pi}{6}$	**B1**	
12(c)	7.3972... + (7.3972... – 6.7123...)	**M1**	
	8.08[20...] (metres)	**A1**	