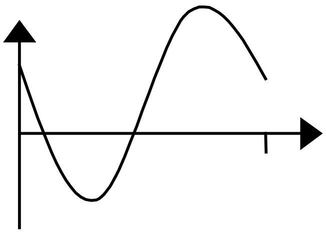
Question number		Scheme	Marks
1.	(*a*)	f (–2) = $(-2)^3 - (19 \times -2) - 30$ M: Evaluate f (–2) or f (2)	M1
		f (–2) = 0, so (*x* + 2) is a factor	A1 (2)
	(*b*)	$(x^3 - 19x - 30) = (x+2)(x^2 - 2x - 15)$	M1 A1
		$= (x + 2)(x + 3)(x - 5)$	M1 A1 (4)
			(6 marks)
2.	(*a*)	$(x^3)^{12}$; ... $+ \binom{12}{1}(x^3)^{11}\left((-)\frac{1}{2x}\right) + \binom{12}{2}(x^3)^{10}\left((-)\frac{1}{2x}\right)^2 + \ldots$	B1; M1
		[For M1, needs binomial coefficients, ^nC_r form OK, at least as far as shown]	
		Correct values for $^nC_r\,s$: 12, 66, 220 used (may be implied)	B1
		$(x^3)^{12} + 12(x^3)^{11}\left(-\frac{1}{2x}\right) + 66(x^3)^{10}\left(-\frac{1}{2x}\right)^2 + 220(x^3)^9\left(-\frac{1}{2x}\right)^3 \ldots$	
		$x^{36} - 6x^{32} + \frac{33}{2}x^{28} - \frac{55}{2}x^{24}$	A2(1,0) (5)
	(*b*)	Term involving $(x^3)^3\left((-)\frac{1}{2x}\right)^9$;	M1
		coeff = $\frac{12.11.10}{3.2.1}\left((-)\frac{1}{2}\right)^9$	A1
		$= -\frac{55}{128}$ (or –0.4296875)	A1 (3)
			(8 marks)

Question number	Scheme	Marks
3. (a)	 Shape	B1
	Position	B1 (2)
(b)	$\left(0, \frac{1}{\sqrt{2}}\right)$, $\left(\frac{\pi}{4}, 0\right)$, $\left(\frac{5\pi}{4}, 0\right)$	B1, B1, B1 (3)
(c)	$\left(x + \frac{\pi}{4} =\right)$ $\frac{\pi}{3}$	B1
	Other value $\left(2\pi - \frac{\pi}{3} =\right)$ $\frac{5\pi}{3}$	M1
	Subtract $\frac{\pi}{4}$ $x = \frac{\pi}{12}, x = \frac{17\pi}{12}$	M1 A1 (4)
		(9 marks)
4. (a)	$\log_2 (16x) = \log_2 16 + \log_2 x$	M1
	$= 4 + a$	A1 c.a.o (2)
(b)	$\log_2 \left(\frac{x^4}{2}\right) = \log_2 x^4 - \log_2 2$	M1
	$= 4 \log_2 x - \log_2 2$	M1
	$= 4a - 1$ (accept $4\log_2 x - 1$)	A1 (3)
(c)	$\frac{1}{2} = 4 + a - (4a - 1)$	M1
	$a = \frac{3}{2}$	A1
	$\log_2 x = \frac{3}{2} \Rightarrow x = 2^{\frac{3}{2}}$	M1
	$\underline{\underline{x = \sqrt{8} \text{ or } 2\sqrt{2}}}$ or $\sqrt{2^3}$ or $(\sqrt{2})^3$	A1 (4)
		(9 marks)

Question number		Scheme	Marks	
5.	(*a*)	$\tan x = \frac{8}{3}$ (or exact equivalent, or 3 s.f. or better)	B1	(1)
	(*b*)	$\tan x = \frac{8}{3}$ $x = 69.4°$ (α), $x = 249.4°$ ($180 + \alpha$)	M1 A1, A1ft	(3)
	(*c*)	$3(1-\cos^2 y) - 8\cos y = 0$ $3\cos^2 y + 8\cos y - 3 = 0$	M1 A1	
		$(3\cos y - 1)(\cos y + 3) = 0$ $\cos y = \ldots,$ $\frac{1}{3}$ (or–3)	M1 A1	
		$y = 70.5°$ (β), $x = 289.5°$ ($360 - \beta$)	A1 A1ft	(6)
				(10 marks)
6.	(*a*)	$(x^4 - 6x^2 + 9)$	M1	
		$(x^4 - 6x^2 + 9) \div x^3 = x - 6x^{-1} + 9x^{-3}$ (*)	A1	(2)
	(*b*)	$\mathrm{f}'(x) = 1 + 6x^{-2} - 27x^{-4}$ First A1: 2 terms correct (unsimplified)	M1 A1 A1	
		Second A1: all 3 correct (simplified)	A1	(3)
	(*c*)	When $x = \pm\sqrt{3}$, $\mathrm{f}'(x) = 1 + \frac{6}{(\sqrt{3})^2} - \frac{27}{(\sqrt{3})^4}$	M1	
		$\left(= 1 + \frac{6}{3} - \frac{27}{9}\right)$ $= 0$, $\therefore$ Stationary	A1	(2)
	(*d*)	$\mathrm{f}''(x) = -12x^{-3} + 108x^{-5}$ M: Attempt to diff. $\mathrm{f}'(x)$, <u>not</u> $\mathrm{g}(x)\,\mathrm{f}'(x)$	M1	
		$\mathrm{f}''(\sqrt{3}) = -\frac{12}{(\sqrt{3})^3} + \frac{108}{(\sqrt{3})^5}$ $(\approx -2.309 + 6.928 = 4.619)\left(= \frac{8}{\sqrt{3}}\right)$	A1	
		> 0, $\therefore$ Minimum (not dependent on a numerical version of $\mathrm{f}''(x)$)	A1ft	(3)
				(10 marks)

Question number		Scheme	Marks	
7.	(a)	Solve $\frac{3}{2}x^2 - \frac{1}{4}x^3 = 0$ to find p = 6, or verify: $\frac{3}{2}\times 6^2 - \frac{1}{4}\times 6^3 = 0$ (*)	B1	(1)
	(b)	$\frac{dy}{dx} = 3x - \frac{3x^2}{4}$	M1 A1	
		$m = -9$, $y - 0 = -9(x-6)$ (Any correct form)	M1 A1	(4)
	(c)	$3x - \frac{3x^2}{4} = 0$, $x = 4$	M1, A1ft	(2)
	(d)	$\int\left(\frac{3x^2}{2} - \frac{x^3}{4}\right)dx = \frac{x^3}{2} - \frac{x^4}{16}$ (Allow unsimplified versions)	M1 A1	
		$[.........]_0^6 = \frac{6^3}{2} - \frac{6^4}{16} = 27$ M: Need 6 and 0 as limits.	M1 A1	(4)
				(11 marks)
8.	(*a*)	$(S =)\ a + ar + ... + ar^{n-1}$ "S =" not required. Addition required.	B1	
		$(rS =)\ ar + ar^2 + ... + ar^n$ "rS =" not required (M: Multiply by r)	M1	
		$S(1-r) = a(1-r^n)$ $S = \frac{a(1-r^n)}{1-r}$ (M: Subtract and factorise each side) (*)	M1 A1	(4)
	(*b*)	$r = 0.9$	B1	
		$S_{20} = \frac{10(1-0.9^{20})}{1-0.9} = 87.8$	M1 A1	(3)
	(*c*)	Sum to infinity $= \frac{a}{1-r} = \frac{10}{1-0.9} = 100$ (ft only for $\|r\| < 1$)	M1 A1ft	(2)
	(*d*)	$\frac{a}{1-r} = \frac{r}{1-r} = 10$ (Put $a = r$ in the formula from (c), and equate to 10)	M1	
		$r = 10(1-r)$ $r = ...,$ $\frac{10}{11}$ (or exact equivalent)	M1, A1	(3)
				(12 marks)