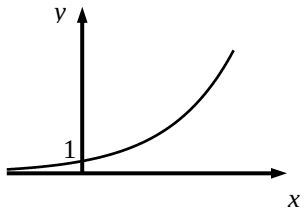
Question			Answer	Marks	Guidance	
1			$kx^{\frac{5}{2}}$ $k = 12$ $+ c$	M1 A1 A1 **[3]**		
2	(i)		converging + valid reason	1 **[1]**		eg converges to 0, $r = ½$, difference between terms decreasing, sum of terms converges to 6, G.P. with $\|r\| < 1$
2	(ii)		neither + valid reason	1 **[1]**		eg divergent oe, A.P., $d = 4$ oe, convergent and periodic ruled out with correct reasons
2	(iii)		periodic + valid reason	1 **[1]**		eg repeating cycle of terms
3	(i)		(0.8, −2) oe	2 **[2]**	**B1** each coordinate	**SC0** for (4, −2)
3	(ii)		Translation $\begin{pmatrix} 90 \\ 0 \end{pmatrix}$ oe	B1 B1 **[2]**	or eg 270 to left	allow **B2** for rotation through 180° about (45, 0) oe

Question			Answer	Marks	Guidance	
4	(i)		$1.2r = 4.2$ 3.5 cao	M1 A1 **[2]**	or $\frac{68.7549...}{360} \times 2\pi r = 4.2$ with θ to 3 sf or better	**B2** if correct answer unsupported
4	(ii)		$\cos 0.6 = \frac{d}{\text{their}3.5}$ 2.888.. to 2.9	M1 A1 **[2]**	or $\cos 34.377.. = \frac{d}{\text{their}3.5}$ with θ to 3 sf or better	or correct use of Sine Rule with 0.9708 (55.623°) or area = 5.709 = 0.5 × h × 3.952, or $3.5^2 - 1.976^2 = d^2$
5			gradient = $\frac{4\sqrt{9.5} - 12}{9.5 - 9}$ 0.6577 to 0.66 $9 < x_C < 9.5$	M1 A1 B1 **[3]**	or 0.657656...isw	$4\sqrt{38} - 24$ $4\sqrt{38} - 24$ allow $8.53 \leq x_C < 9$
6			$6x^2 + 18x - 24$ their $6x^2 + 18x - 24 = 0$ or > 0 or ≥ 0 −4 and + 1 identified oe $x < -4$ and $x > 1$ cao	B1 M1 A1 A1 **[4]**	or $x \leq -4$ and $x \geq 1$	or sketch of $y = 6x^2 + 18x - 24$ with attempt to find x-intercepts if **B0M0** then **SC2** for fully correct answer

Question			Answer	Marks	Guidance	
7			$\cos A = \frac{105^2 + 92^2 - 75^2}{2 \times 105 \times 92}$ oe	M1	or $\cos B = \frac{75^2 + 92^2 - 105^2}{2 \times 75 \times 92}$ oe	or $\cos C = \frac{105^2 + 75^2 - 92^2}{2 \times 105 \times 75}$ oe
			0.717598…soi	A1	0.2220289…soi	0.519746…soi
			A = 44.14345…° soi [0.770448553…]	A1	B = 77.1717719……° soi [1.346901422]	C = 58.6847827…° soi [1.024242678…] ignore minor errors due to premature rounding for second **A1** condone *A*, *B* or *C* wrongly attributed
			½ × 92 × 105 × sin (*their* A)	M1	or ½ × 75 × 92 × sin (*their* B)	or ½ × 75 × 105 × sin (*their* C)
			3360 or 3361 to 3365	A1		**or** **M3** for $\sqrt{136(136-75)(136-105)(136-92)}$ **A2** for correct answer 3360 or 3363 - 3364
				[5]		
8	**(i)**			M1	for curve of correct shape in both quadrants	**SC1** for curve correct in 1st quadrant and touching (0,1) or identified in commentary
				A1	through (0, 1) shown on graph or in commentary	
				[2]		

Question			Answer	Marks	Guidance	
8	(ii)		$5x - 1 = \dfrac{\log_{10} 500\,000}{\log_{10} 3}$	M1	or $5x - 1 = \log_3 500\,000$	condone omission of base 10 use of logs in other bases may earn full marks
			$x = (\dfrac{\log_{10} 500\,000}{\log_{10} 3} + 1) \div 5$	M1	$x = (\log_3 500000 + 1) \div 5$	
			[x =] 2.588 to 2.59	A1	oe; or **B3** www	if unsupported, **B3** for correct answer to 3 sf or more www
				[3]		
9	(i)		$(\dfrac{\sin\theta}{\cos\theta}) = 1$ oe	M1		
			$\sin\theta = \cos^2\theta$ and completion to given result	A1	www	
				[2]		
9	(ii)		$\sin^2\theta + \sin\theta - 1$[= 0]	M1	allow 1 on RHS if attempt to complete square	condone $y^2 + y - 1 = 0$
			[$\sin\theta$ =] $\dfrac{-1 \pm \sqrt{5}}{2}$ oe may be implied by correct answers	A1	may be implied by correct answers	mark to benefit of candidate
			[θ =] 38.17... ,or 38.2 and 141.83..., 141.8 or 142	A1	ignore extra values outside range, **A0** if extra values in range or in radians **NB** 0.6662 and 2.4754 if working in radian mode earns **M1A1A0**	ignore any work with negative root & condone omission of negative root with no comment eg **M1** for 0.618… if unsupported, **B1** for one of these, **B2** for both. If both values correct with extra values in range, then **B1**. **NB** 0.6662 and 2.4754 to 3sf or more
				[3]		

Question			Answer	Marks	Guidance	
10	(i)		at A $y = 3$	B1		
			$\frac{dy}{dx} = 2x - 4$	B1		
			their $\frac{dy}{dx} = 2 \times 4 - 4$	M1*	must follow from attempt at differentiation	
			grad of normal = $^{-1}/_{\text{their 4}}$	M1dep*		
			$y - 3 = (^{-1}/_{4}) \times (x - 4)$ oe isw	A1		
			substitution of $y = 0$ and completion to given result with at least 1 correct interim step www	A1	or substitution of $x = 16$ to obtain $y = 0$	correct interim step may occur before substitution
				[6]		
10	(ii)		at B, $x = 3$	B1	may be embedded	
			$F[x] = \frac{x^3}{3} - \frac{4x^2}{2} + 3x$	M1*	condone one error, must be three terms, ignore + c	
			F[4] – F[their 3]	M1* dep	dependent on integration attempted	
			area of triangle = 18 soi	B1		may be embedded in final answer
			area of region = $19\frac{1}{3}$ oe isw	A1	19.3 or better	
				[5]		

Question			Answer	Marks	Guidance	
11	(i)	(*A*)	$2A + D = 25$ oe $4A + 6D = 250$ oe $D = 50$, $A = -12.5$ oe	B1 B1 B1 B1 **[4]**		condone lower-case *a* and *d*
11	(i)	(*B*)	$\frac{50}{2}(2 \times their A + 49 \times their D)$ [= 60 625] or $\frac{20}{2}(2 \times their A + 19 \times their D)$ [= 9250] their "$S_{50} - S_{20}$" 51 375 cao	M1 M1 A1 **[3]**	or a = their $A + 20D$ $S_{30} = \frac{30}{2}(a + l)$ oe with l = their $A + 49D$	$S_{30} = \frac{30}{2}(2 \times their 987.5 + 29 \times their 50)$

Question			Answer	Marks	Guidance	
11	(ii)		$\frac{a\left(r^2-1\right)}{r-1}=25$ or $\frac{a\left(r^4-1\right)}{r-1}=250$	B1		
			$\frac{a\frac{(r^4-1)}{r-1}}{a\frac{(r^2-1)}{(r-1)}}=\frac{250}{25}$ oe	M1		allow $a(1 + r)$ as the denominator in the quadruple- decker fraction
			and completion to given result www		at least one correct interim step required	
			use of $r^4 - 1 = (r^2 - 1)(r^2 + 1)$ to obtain $r^2 + 1 = 10$ www	M1	or multiplication and rearrangement of quadratic to obtain $r^4 - 10r^2 + 9 = 0$ oe with all three terms on one side	$r^2 = x$ oe may be used or **M1** for valid alternative algebraic approaches eg using $a(1 + r) = 25$ <u>and</u> $ar^2 + ar^3 = ar^2 (1 + r) = 225$
			$r = \pm 3$	A1		or **B2** for all four values correct, **B1** for both r values or both a values or one pair of correct values if second **M** mark not earned
			$a = 6.25$ or -12.5 oe	A1	or **A1** for one correct pair of values of r and a	
				[5]		
12	(i)		$\log_{10}p = \log_{10}a + \log_{10}10^{kt}$	M1	condone omission of base;	if unsupported, **B2** for correct equation
			$\log_{10}p = \log_{10}a + kt$ www	A1		
				[2]		
12	(ii)		2.02, 2.13, 2.23	B1	allow given to more sig figs	2.022304623…, 2.129657673, 2.229707433
			plots correct	B1f.t.	to nearest half square	
			ruled line of best fit	B1	y-intercept between 1.65 and 1.7 and at least one point on or above the line and at least one point on or below the line	ft their plots must cover range from $x = 9$ to 49
				[3]		

Question			Answer	Marks	Guidance	
12	(iii)		0.0105 to 0.0125 for k 1.66 to 1.69 for $\log_{10}a$ or 45.7 to 49.0 for a	B1 B1		must be connected to k must be connected to a
			$\log_{10}p$ = their kt + their $\log_{10}a$ p = their "$47.9 \times 10^{0.0115t}$" or "$10^{1.6785+0.0115t}$"	B1 B1 **[4]**	must be a correct form for equation of line and with their y-intercept and their gradient (may be found from graph or from table, must be correct method) as above, "47.9" and "0.0115" must follow from correct method	
12	(iv)		45.7 to 49.0 million	1 **[1]**	'million' needed, not just the value of p	
12	(v)		reading from graph at 2.301.. their 54 2014 cao	M1* M1dep* A1 **[3]**	or $\log_{10}200$ = "$\log_{10}a + kt$" eg for their $t = \dfrac{\log 200 - 1.68}{0.0115}$ if unsupported, allow **B3** only if consistent with graph	or 200 = "$10^{\log a + kt}$" oe or **M1** for their $t = \dfrac{\log \dfrac{200}{47.9}}{0.0115}$