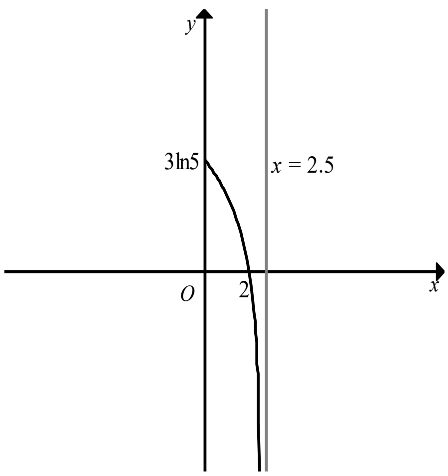
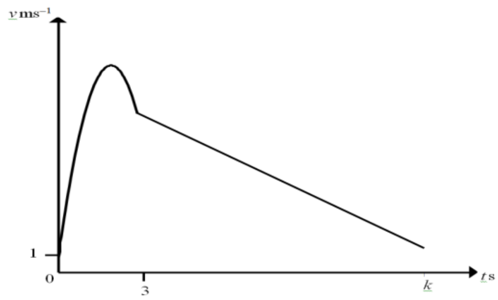
Question	Answer	Marks	Partial Marks
1(a)	$a = 1$	**B1**	
	$b = 2,\ c = -1$ or $c = 2,\ b = -1$	**B1**	
1(b)	Critical values: awrt –1.7, –1, awrt 1.2	**B1**	
	$-1.7 \leqslant x \leqslant -1$	**B1**	**FT** *their* reasonable attempts at –1.7
	$x \geqslant 1.2$	**B1**	**FT** *their* reasonable attempts at 1.2
2	$(4k)^2 - 4(k+3)$ soi	**M1**	For correct use of discriminant
	$16k^2 - 4k - 12$ oe	**A1**	
	$(4k+3)(k-1) = 0$ oe	**M1**	**Dep** on previous **M** mark for solving a 3 term quadratic equated to zero to obtain 2 values for k
	$k = -\dfrac{3}{4}, 1$	**A1**	Mark final answer
3	$A = -31$	**B1**	
	$x - 1$ or $x - 5$ or $x + 6$	**B1**	For finding a factor
	$[x-1](x^2 + x - 30)$ $[x-5](x^2 + 5x - 6)$ $[x+6](x^2 - 6x + 5)$	**2**	**M1** for a quadratic factor with 2 correct terms or for one further linear factor
	$(x - 1)(x - 5)(x + 6)$	**A1**	
4	$\dfrac{2}{\log_x 10} = 2\lg x$	**B1**	
	$\lg\left(\dfrac{x^2}{x+4}\right) = \lg 2$ soi	**M1**	For use of power and subtraction rules
	$x^2 - 2x - 8 = 0$	**A1**	
	$(x-4)(x+2) = 0$	**M1**	**Dep** on previous **M** mark
	$x = 4$ only	**A1**	

Question	Answer	Marks	Partial Marks
5(a)	Centre $(5,\ 12)$ soi	**B1**	
	Gradient of radius = $\dfrac{12-4}{5-11}$ $\left(=-\dfrac{4}{3}\right)$	**M1**	
	Equation of normal: $y-4=\dfrac{3}{4}(x-11)$	**M1**	Must be using *their* perpendicular gradient and the correct point
	$3x-4y=17$	**A1**	
5(b)	Distance between centres = 13 Sum of radii = 12	**M1**	For both
	$13>12$ so no intersection	**A1**	
6	$8(\ln x)^2-10\ln x+3\ \ (=0)$	**2**	**M1** for elimination of y and re-arrangement to a 3 term quadratic in terms of $\ln x$
	$\ln x=0.75,\quad \ln x=0.5$	**2**	**Dep** on previous **M** mark for correct method of solution
	$x=\mathrm{e}^{0.75},\quad x=\mathrm{e}^{0.5}$	**A1**	For both
7(a)	$\dfrac{1}{2}\times 6\times 6\times \sin\theta=9$ oe	**M1**	
	$\sin\theta=\dfrac{1}{2}$	**A1**	
7(b)	$\dfrac{1}{2}(36)(\theta-\textit{their}\sin\theta)=15\pi-9$ oe	**M1**	
	$\theta=\dfrac{5\pi}{6}$	**A1**	
	5π	**2**	**M1** for $6\times \textit{their}\dfrac{5\pi}{6}$, but not $\dfrac{\pi}{6}$
8(a)	$\dfrac{5}{2}$, 1	**B1**	

Question	Answer	Marks	Partial Marks
8(b)	Area of trapezium = $\frac{7}{4}$	**B1**	**FT** on *their y* coordinates
	Area under curve = $\int_1^2 \left(\frac{3}{x+1} - 1 + \frac{2}{x}\right) dx$	**B1**	Condone omission of limits here
	$3\ln(x+1) - x + 2\ln x$	**2**	**M1** for at least one correct log term
	$(3\ln 3 - 2 - 2\ln 2) - (3\ln 2 - 1)$	**M1**	**Dep** on previous **M** mark
	$\ln\frac{27}{2} - 1$	**M1**	**Dep** on previous **M** mark for simplification using log rules correctly
	$\frac{11}{4} - \ln\left(\frac{27}{2}\right)$	**A1**	
9(a)(i)	$\frac{1}{8} - 2\left(x - \frac{9}{4}\right)^2$	**3**	**B2** for $a - 2\left(x - \frac{9}{4}\right)^2$ or **B1** for $a + b\left(x - \frac{9}{4}\right)^2$ **B1** for $a = \frac{1}{8}$ oe
9(a)(ii)	Turning point $\left(\frac{9}{4}, \frac{1}{8}\right)$	**B1**	FT on *their a* and *c*
	f^{-1} does not exist as given domain includes the turning point. oe	**B1**	**Dep** on previous **B** mark, turning point must be correct
9(b)(i)	 	**3**	**B1** for correct shape ; may not be over correct domain but must have positive *y*-intercept and appear to tend to a vertical asymptote in the 4th quadrant **B1** for (0, 3 ln 5) and (2, 0) stated or marked on graph; must have attempted correct shape **B1** for asymptote at $x = 2.5$

Question	Answer	Marks	Partial Marks
9(b)(ii)	$g^{-1}(x)=\frac{1}{2}\left(5-e^{\frac{x}{3}}\right)$	2	**M1** for an attempt at the full method to find the inverse function with at most one sign or arithmetic slip
9(b)(iii)	Domain: $x \leqslant 3\ln 5$	**B1**	
	Range: $0 \leqslant g^{-1} < 2.5$	**B1**	
10(a)	$\overrightarrow{AB}=\mathbf{b}-\mathbf{a}$	**B1**	
	$\overrightarrow{OC}=\mathbf{a}+3(\mathbf{b}-\mathbf{a})$ or $\mathbf{b}+2(\mathbf{b}-\mathbf{a})$	**B1**	**FT** on *their* $\mathbf{b}-\mathbf{a}$
	$\overrightarrow{OC}=3\mathbf{b}-2\mathbf{a}$	**B1**	
10(b)	$\overrightarrow{OD}=4.5\mathbf{a}$ or $\overrightarrow{AD}=3.5\mathbf{a}$	**B1**	Allow unsimplified
	$\overrightarrow{DC}=\textit{their}(3\mathbf{b}-2\mathbf{a})-\textit{their}\,4.5\mathbf{a}$ or $\overrightarrow{CD}=\textit{their}\,4.5\mathbf{a}-\textit{their}(3\mathbf{b}-2\mathbf{a})$	**B1**	**FT** Allow unsimplified
	$\overrightarrow{OE}=\textit{their}\,4.5\mathbf{a}+\mu\times\textit{their}(3\mathbf{b}-6.5\mathbf{a})$ oe or $\overrightarrow{OE}=\textit{their}(3\mathbf{b}-2\mathbf{a})+v\times\textit{their}(6.5\mathbf{a}-3\mathbf{b})$	**M1**	
	$\mu=\frac{9}{13}$ oe or $v=\frac{4}{13}$ oe	**A1**	
	$\lambda=\frac{27}{13}$	**A1**	
11(a)	$v=1+12t-3t^2$	**B1**	
	$v=12-\frac{2}{3}t$	**B1**	
		2	**B1** for correct shape for $0 \leqslant t \leqslant 3$, with v-intercept of 1 and end point (3, 10) soi and maximum point **B1** for a line with negative gradient for $3 \leqslant t \leqslant k$, start point (3, 10) soi and end point above the t-axis

Question	Answer	Marks	Partial Marks
11(b)	When $t = 3$, $s = 30$	**B1**	
	$\frac{1}{2}(10+12-\frac{2}{3}k)(k-3)=57-30$ oe or $12k-\frac{k^2}{3}-3\ [-30]=57\ [-30]$ oe	2	**M1** for attempt at area using $t=k$
	$k = 6$ or $k = 30$	2	**A1** for $-\frac{1}{3}k^2+12k-60[=0]$ or $k^2-36k+180[=0]$ oe
	$k = 6$	**A1**	as v is negative when $k = 30$
12	$\frac{dy}{dx}=-\frac{8}{x^3}+a$ oe	**B1**	
	When $x=2$, $\frac{dy}{dx}=a-1$ soi	**B1**	**FT** on *their* $\frac{dy}{dx}$
	$\frac{-1}{their(a-1)}=-\frac{1}{4}$ or *their* $(a-1) = 4$	**M1**	**FT** on *their* $(a-1)$
	$a=5$	**A1**	
	When $x = 2$, $b=2+4(their\ 18)$ oe	**M1**	**Dep**
	$b = 74$	**A1**	