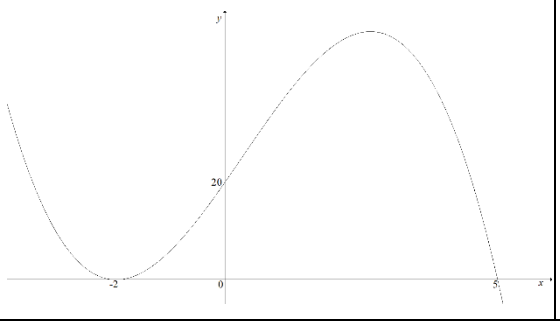
Question	Answer	Marks	Guidance
1	$kx^2+2x+3k-1\ \ [=0]$	**2**	**M1** for attempt to equate equations of the line and curve, re-arrange and equate to zero. Allow one sign error.
	$4=4k\times\ their(3k-1)$ oe	**M1**	**Dep** for attempt to use the discriminant of *their* quadratic equation and solve to obtain *k*.
	$k=\frac{1\pm\sqrt{13}}{6}$ isw	**A1**	
	Alternative method		
	$kx^2+2x+3k-1=0$	**2**	**M1** for attempt to equate equations of the line and curve, re-arrange and equate to zero. Allow one sign error.
	Grad of straight line = -1 Gradient function of curve = $2kx+1$ Substitution to obtain $3k^2-k-1=0$ oe with attempt to solve to obtain *k*	**M1**	**Dep**
	$k=\frac{1\pm\sqrt{13}}{6}$ isw	**A1**	
2(a)	$\frac{dy}{dx}=2(x+2)(5-x)+(-1)(x+2)^2$ or $y=-x^3+x^2+16x+20$ $\frac{dy}{dx}=-3x^2+2x+16$	**2**	**M1** for attempt at differentiation of a product, or expansion and then differentiation. **A1** for all correct
	$(x+2)(8-3x)=0$	**M1**	**Dep** for attempt to solve *their* quadratic $\frac{dy}{dx}=0$
	$x=-2,\ \frac{8}{3}$	**A1**	For both.
2(b)		**3**	**B1** for correctly shaped curve, with maximum point in the first quadrant **B1** for $(5,\ 0)$ and a stationary point at $(-2,\ 0)$, must have a cubic graph. **B1** for $(0,\ 20)$, must have a cubic graph

Question	Answer	Marks	Guidance
2(c)	When $x=\frac{8}{3}$, $y=\frac{1372}{27}$ or awrt 50.8	**M1**	For attempt to find the value of y using *their* $\frac{8}{3}$.
	$k>\frac{1372}{27}$ or awrt 50.8	**A1**	
	$k<0$	**B1**	
3	${}^{10}C_2(2x)^8\left(-\frac{1}{x}\right)^2$ or ${}^{10}C_1(2x)^9\left(-\frac{1}{x}\right)^1$	**M1**	For attempting to find terms which will give terms of x^8 or x^6, allow coefficients. Allow as part of an expansion
	45×256 $\left[x^6\right]$ oe	**A1**	
	$[-]$ 5120 $\left[x^8\right]$	**A1**	
	their(-11520) + *their*(-5120)	**M1**	**Dep**
	–16 640	**A1**	Condone inclusion of x^8
4(a)	$\lg\frac{x^3}{1000y^4}$ oe	**3**	**B1** for $3=\lg1000$ **M1** for correct use of power rule at least once and division rule at least once **A1** cao
4(b)	$\log_x 3=\frac{1}{\log_3 x}$ soi	**B1**	For change of base.
	$2(\log_3 x)^2-5(\log_3 x)+2=0$	**M1**	For attempt to obtain a 3-term quadratic equation, equated to zero. Allow one sign error. May be using a substitution.
	$2\log_3 x=1$ $\log_3 x=2$	**M1**	**Dep** for attempt to solve *their* quadratic equation and a correct attempt to obtain at least one value of x.
	$x=\sqrt{3}$ oe	**A1**	Allow 1.73(2…)
	$x=9$	**A1**	

Question	Answer	Marks	Guidance
4(b)	**Alternative method 1**		
	$\log_3 x = \frac{1}{\log_x 3}$ soi	**B1**	For change of base.
	$2(\log_x 3)^2 - 5(\log_x 3) + 2 = 0$	**M1**	For attempt to obtain a 3-term quadratic equation, equated to zero. Allow one sign error.
	$2\log_x 3 = 1 \quad \log_x 3 = 2$	**M1**	**Dep** for attempt to solve *their* quadratic equation and a correct attempt to obtain at least one value of x.
	$x = \sqrt{3}$ oe	**A1**	Allow 1.73(2…)
	$x = 9$	**A1**	
	Alternative method 2		
	$\log_3 x = \frac{\lg x}{\lg 3}$ and $\log_x 3 = \frac{\lg 3}{\lg x}$ oe	**B1**	For a consistent change of base.
	$2(\lg x)^2 - 5(\lg x) + 2(\lg 3)^2 = 0$ oe	**M1**	For attempt to obtain a 3-term quadratic equation, equated to zero. Allow one sign error.
	$2\lg x = \lg 3 \quad \lg x = 2\lg 3$ oe	**M1**	**Dep** for attempt to solve *their* quadratic equation and a correct attempt to obtain at least one value of x.
	$x = \sqrt{3}$ oe	**A1**	Allow 1.73(2…)
	$x = 9$ oe	**A1**	
5(a)		**2**	**B1** for 3 or 4 correctly plotted points

Question	Answer	Marks	Guidance
5(b)	$\ln y = mx^2 + c$ soi	**B1**	$m \neq \ln A,\ c \neq \ln b$
	Gradient = $\ln b$	**M1**	For attempt to find the numerical gradient of *their* straight line graph and equate to $\ln b$. May be implied by later work
	$b = 4$	**A1**	
	Intercept on vertical axis = $\ln A$	**M1**	For use of *their* intercept on the vertical axis of *their* straight line graph oe.
	$A = 0.5$	**A1**	
	Alternative method		
	$\ln y = mx^2 + c$ soi	**B1**	$m \neq \ln A,\ c \neq \ln b$
	Forming 2 equations correctly using points on *their* graph	**M1**	
	Solving the equations to obtain either A or b	**M1**	**Dep**
	$b = 4$	**A1**	
	$A = 0.5$	**A1**	
	Special case		
	$A = 0.5$ not using transformed data	**B1**	
	$b = 4$ not using transformed data	**B1**	
5(c)	35 nfww Allow answers between 33 and 37	**2**	**M1** for attempt at a complete method using *their* straight line graph or equation
5(d)	1.63 nfww Allow answers between 1.5 and 1.7	**2**	**M1** for attempt at a complete method using *their* straight line graph or equation

Question	Answer	Marks	Guidance
6	$k(5x+2)^{\frac{3}{5}}$	**M1**	
	$f'(x)=\frac{1}{3}(5x+2)^{\frac{3}{5}} \quad (+c)$	**A1**	Condone omission of c
	$\frac{17}{3}=\frac{1}{3}(32)^{\frac{3}{5}}+c$ oe	**M1**	**Dep** for use of $f'(6)$ and attempt to evaluate c
	$c=3$	**A1**	
	$k(5x+2)^{\frac{8}{5}}$	**M1**	
	$\frac{1}{24}(5x+2)^{\frac{8}{5}}+cx$	**A1**	**FT** on *their c*
	$\frac{26}{3}=\frac{1}{24}(32)^{\frac{8}{5}}+d+((3\times6))$ oe	**M1**	**Dep** for use of $f(6)$ and attempt to evaluate d.
	$[f(x)] =\frac{1}{24}(5x+2)^{\frac{8}{5}}+3x-20$	**A1**	
7(a)(i)	154 440	**B1**	
7(a)(ii)	124 200	**2**	**B1** for ${}^{10}P_5$
	Alternative method		
	124 200	**2**	**B1** for 1 symbol: 75 600 2 symbols: 43 200 3 symbols: 5400
7(b)	$16(n-11)=12(n+1)$ oe	**B2**	**B1** for correct numbers or correct factors must be using combinations
	$n=47$	**B1**	**Dep** on both previous **B** marks Must be the only solution

Question	Answer	Marks	Guidance
8	$A\ (2.5,\ 0)$ soi	**B1**	
	$C\ (4.5,\ 0)$ soi	**B1**	
	$2x^2 + x - 21 = 0$	**M1**	For a correct attempt to find the intersection of the straight line and the curve. Must have attempt to solve the resulting quadratic equation to obtain x = .
	$x = 3,\ \left[-\frac{7}{2}\right]$	**A1**	
	$B\left(3,\ \frac{1}{2}\right)$ soi	**A1**	
	$\int\left(2 - \frac{3}{x-1}\right) \mathrm{d}x = 2x - 3\ln(x-1)$	**B1**	
	e.g. $\left[2x - 3\ln(x-1)\right]_{\frac{5}{2}}^{3} =$ $(6 - 3\ln 2) - \left(5 - 3\ln\frac{3}{2}\right)$	**M1**	**Dep** for application of appropriate limits e.g. $x = their\ \frac{5}{2}$ and $x = their\ 3$ $x = their\ \frac{5}{2}$ and $x = their\ \frac{9}{2}$ $x = their 3$ and $x = their\ \frac{9}{2}$ Integral must be in the form $ax + b\ln(x-1)$
	$1 + 3\ln\frac{3}{4}$ oe	**A1**	
	Area of an appropriate triangle	**B1**	**FT** on $\frac{1}{2} \times their\ \frac{1}{2} \times their\ \frac{3}{2}$ oe $\frac{1}{2} \times their 2 \times their\ \frac{2}{3}$ oe Must be appropriate for *their* method
	Area = $\frac{11}{8} + \ln\frac{27}{64}$	**2**	**B1** for each correct term
9(a)(i)	$\begin{pmatrix}2\\5\end{pmatrix}$	**B1**	
9(a)(ii)	Velocity vector = $\begin{pmatrix}12\\-5\end{pmatrix}$ soi by correct speed	**B1**	
	Speed = 13	**B1**	

Question	Answer	Marks	Guidance
9(a)(iii)	$2+12t=158$ and $5-5t=-48$ $t=13$, $t=10.6$ soi	**M1**	Either for finding two values of t or for finding one value of t and substitute to obtain a position vector.
	Times are different so P does not pass through the given point or time calculated gives an inconsistent position vector	**A1**	For a valid conclusion
9(b)	$\overrightarrow{AB}=\mathbf{b}-\mathbf{a}$ and $\overrightarrow{AC}=\mathbf{c}-\mathbf{a}$	**B1**	
	$4(\mathbf{b}-\mathbf{a})=\mathbf{c}-\mathbf{a}$ oe	**M1**	For substitution into a valid equation from *their* ratio. **FT** on *their* $\overrightarrow{AB}$ and *their* $\overrightarrow{AC}$
	$\mathbf{c}=4\mathbf{b}-3\mathbf{a}$	**A1**	
	Alternative method		
	$\overrightarrow{AB}=\mathbf{b}-\mathbf{a}$ and $\overrightarrow{AC}=4\mathbf{b}-4\mathbf{a}$ oe	**B1**	
	$\left(\overrightarrow{OC}=\right)\ \mathbf{c}=\mathbf{a}+4\mathbf{b}-4\mathbf{a}$	**M1**	**FT** on *their* $\overrightarrow{AB}$ and *their* $\overrightarrow{AC}$
	$\mathbf{c}=4\mathbf{b}-3\mathbf{a}$	**A1**	
10(a)	$\cos\theta=x-2$ and $\sin\theta=\frac{2}{y}$ soi	**B1**	
	$(x-2)^2+\frac{4}{y^2}=1$	**M1**	For a correct attempt to use $\cos^2\theta+\sin^2\theta=1$ or other relevant identity
	$y^2=\frac{4}{1-(x-2)^2}$ oe	**M1**	**Dep** for attempt to rearrange to obtain y^2
	$y=\frac{2}{\sqrt{1-(x-2)^2}}$ or $\frac{2}{\sqrt{4x-x^2-3}}$ oe	**A1**	Must be positive
	Alternative method		
	$\theta=\cos^{-1}(x-2)$ and $\theta=\sin^{-1}\left(\frac{2}{y}\right)$	**B1**	
	$\cos^{-1}(x-2)=\sin^{-1}\left(\frac{2}{y}\right)$	**M1**	
	$y=\frac{2}{\sin\left(\cos^{-1}(x-2)\right)}$	**2**	**Dep M1** for correct attempt to rearrange to obtain y = ...

Question	Answer	Marks	Guidance
10(b)	$\tan\frac{\phi}{2}=\sqrt{3}$ or $\sin\frac{\phi}{2}=\frac{\sqrt{3}}{2}$ or $\cos\frac{\phi}{2}=\frac{1}{2}$	**B1**	
	$\frac{\phi}{2}=\frac{\pi}{3}$ or awrt 1.05	**M1**	**Dep** for a correct attempt to solve *their* equation, must be using $\frac{\phi}{2}$.
	$\phi=\frac{2\pi}{3}$ or awrt 2.09	**M1**	**Dep** for correct order of operations, may be implied by one correct solution.
	$\phi=-\frac{10\pi}{3},-\frac{4\pi}{3},\frac{2\pi}{3},\frac{8\pi}{3}$ or $-10.5,\ -4.19,\ 2.09,\ 8.38$	**A2**	**A1** for a correct pair of solutions. **A1** for a second correct pair of solutions and no extra solutions within the range. Allow greater accuracy if decimals used.