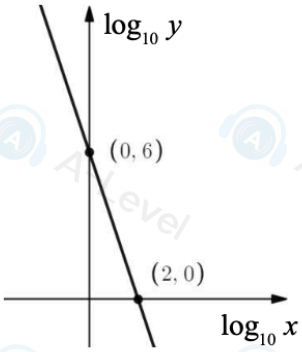
Question Number	Scheme	Marks
6(a)	$\left(\frac{3\pi}{2}, 0\right)$	B1
		(1)
(b)	$f'(x) = \left(6\cos^2 x\right)e^{3\sin x} - \left(2\sin x\right)e^{3\sin x}$	M1A1
	$f'(x) = \left(6\cos^2 x\right)e^{3\sin x} - \left(2\sin x\right)e^{3\sin x}$ $\Rightarrow \left(6\left(1-\sin^2 x\right)-2\sin x\right)(=0)$	**d**M1
	$\Rightarrow 3\sin^2 x + \sin x - 3 = 0$ oe	A1
		(4)
(c)	$\sin x = \frac{-1+\sqrt{37}}{6} \Rightarrow x = ...$	M1
	$x = 2.131$	A1
		(2)
		(7 marks)

9(a)	$x = 0 \Rightarrow \frac{2}{3}\sin\left(3y + \frac{\pi}{4}\right) = 0 \Rightarrow 3y + \frac{\pi}{4} = \pi, 2\pi, ... \Rightarrow y = ...$	M1
	$y = \frac{\pi}{4}$ or $y = \frac{7\pi}{12}$	A1
	$y = \frac{\pi}{4}$ and $y = \frac{7\pi}{12}$	A1
		(3)

(b)	$x = \frac{2}{3}\sin\left(3y + \frac{\pi}{4}\right) \Rightarrow \frac{dx}{dy} = \frac{2}{3} \times 3\cos\left(3y + \frac{\pi}{4}\right)\left(= 2\cos\left(3y + \frac{\pi}{4}\right)\right)$	B1
	$\Rightarrow \frac{dy}{dx} = \frac{1}{2\cos\left(3y + \frac{\pi}{4}\right)} \Rightarrow \left(\frac{dy}{dx}\right)^2 = \frac{1}{4\cos^2\left(3y + \frac{\pi}{4}\right)} = \frac{1}{4\left(1-\sin^2\left(3y + \frac{\pi}{4}\right)\right)}$	M1
	$= \frac{1}{4\left(1-\left(\frac{3x}{2}\right)^2\right)}$	**d**M1
	$= \frac{1}{4-9x^2}$	A1
		(4)

(c)	Identifies that one of the gradients is $\sqrt{"4"}$ or that one of the gradients is $\frac{1}{\sqrt{"4"}}$ **or** Identifies that one of the gradients is 2 or that one of the gradients is $\frac{1}{2}$	B1ft
	At A: $y - "\frac{\pi}{4}" = "2"x$ **and** At B: $y - "\frac{7\pi}{12}" = "\frac{1}{2}"x$	M1
	$"2"x + "\frac{\pi}{4}" = "\frac{1}{2}"x + "\frac{7\pi}{12}" \Rightarrow x = ...$	**d**M1
	$x = \frac{2\pi}{9}$	A1
		(4)
		Total 11

3 (i)	$y = \dfrac{10^6}{x^3} \Rightarrow \log_{10} y = \log_{10} 10^6 - \log_{10} x^3 \Rightarrow \log_{10} y = 6 - 3\log_{10} x$	
		B1 B1 B1 **(3)**
(ii)	States $\log_3 N = 2t + 4$ **or** $\log_3 N = \log_3 a + t\log_3 b$	B1
	$N = 3^{2t+4} = 3^{2t} \times 3^4$ **or** $\log_3 a = 4 \Rightarrow a = \ldots$ **or** $\log_3 b = 2 \Rightarrow b = \ldots$	M1
	$N = 81 \times 9^t$	A1cso **(3)** **(6 marks)**

9.(a)	$x = 30e^{-0.2\times 8} = 6.06\,(\text{mg})$	M1, A1 **(2)**
(b)	$x = 30e^{-0.2\times 10} + 20e^{-0.2\times 2} = 17.5\,(\text{mg})$ *	B1* **(1)**
(c)	$30e^{-0.2\times(T+8)} + 20e^{-0.2T} = 10$	M1
	$\left(3e^{-1.6} + 2\right)e^{-0.2T} = 1$	A1
	$e^{-0.2T} = \dfrac{1}{3e^{-1.6} + 2}$	
	$T = 5\ln\left(3e^{-1.6} + 2\right) = 4.79$	dM1, A1 **(4)**
		(7 marks)

7 (a)	$f(x)=x^3\sqrt{4x+7} \Rightarrow f'(x)=3x^2\sqrt{4x+7}+2x^3(4x+7)^{-\frac{1}{2}}$	M1, A1
	$\Rightarrow f'(x)=3x^2\sqrt{4x+7}+\frac{2x^3}{\sqrt{4x+7}}=\frac{3x^2(4x+7)+2x^3}{\sqrt{4x+7}}$	dM1
	$\Rightarrow f'(x)=\frac{7x^2(2x+3)}{\sqrt{4x+7}}$	A1
		(4)
(b)	Substitutes $x=-\frac{3}{2}$ into $x^3\sqrt{4x+7} \Rightarrow y=...$	M1
	$\left(-\frac{3}{2},-\frac{27}{8}\right)$	A1
		(2)
(c)	Attempts $-4\times"-\frac{27}{8}"$	M1
	y „ $\frac{27}{2}$	A1
		(2)
(d)	$(2,7)$	M1, A1
		(2)
		Total 10

4 (a)	$\log_{10} N=2 \Rightarrow N=100$	B1
		(1)
(b)	$\log_{10} N=0.35t+2 \Rightarrow N=10^{0.35t+2}$	M1
	$\Rightarrow N=10^{0.35t}\times10^2$	dM1
	$\Rightarrow N=100\times2.24^t$	A1
		(3)
(c)	Rate of growth at 5 hours is $\frac{dN}{dt}=100\times\ln 2.24\times2.24^5$	M1
	Allow an answer in the range 4530 to 4550 (bacteria per hour)	A1
		(2)
		Total 6

Question Number	Scheme	Marks
3(a)	$m=\dfrac{2.25-2}{5}$ $\log_{10}V=0.05t+2$	M1 A1
		(2)
(b)	$\log_{10}V=0.05t+2\Rightarrow V=10^{0.05t+2}$ $a=100$ or $b=1.12$ $V=100\times(1.12)^t$	M1 A1 A1
		(3)
(c)	$\dfrac{\mathrm{d}V}{\mathrm{d}t}=100\times\ln1.12\times(1.12)^t\quad\left(=11.33(1.12)^t\right)$ $100\times\ln1.12\times(1.12)^T=50\Rightarrow(1.12)^T=\dfrac{50}{100\ln1.12}$ $(T=)\ \log_{1.12}\left(\dfrac{50}{100\ln1.12}\right)=\ldots$ $(T=)13$	B1ft M1 dM1 A1
		(4)
		(9 marks)

Question Number	Scheme	Marks
7(a)	$y=\dfrac{16}{9(3x-k)}=\dfrac{16}{27x-9k}\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=-\dfrac{432}{(27x-9k)^2}$	M1A0
(b)	$-\dfrac{432}{(27x-9k)^2}=-12\Rightarrow12(27x-9k)^2=432$	M1
	$12(27x-9k)^2=432\Rightarrow(27x-9k)^2=36\Rightarrow27-9k=\pm6\Rightarrow k=\ldots$	**d**M1
	$k=\dfrac{7}{3},\dfrac{11}{3}$	A1
(c)	$y=\dfrac{16}{27-21}$	M1 (B1 on ePEN)
	$y-"\dfrac{8}{3}"=\dfrac{1}{12}(x-1)$	**d**M1
	$12y-x-31=0$	A1
(d)	$\displaystyle\int\frac{16}{27x-9k}\mathrm{d}x=\frac{16}{27}[\ln(27x-9k)]$	M1
	$=\dfrac{16}{27}\left[\ln(27x-21)\right]$	A1ft
	$\dfrac{16}{27}\left[\ln(27x-21)\right]_1^3=\dfrac{16}{27}\left(\ln(27(3)-21)-\ln(27-21)\right)$	**d**M1
	$=\dfrac{16}{27}\ln(10)$	A1