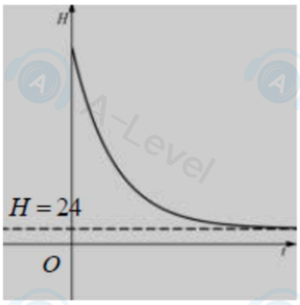
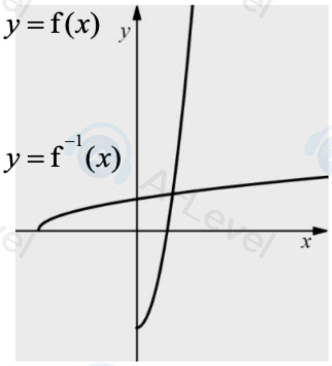
4 (a)	$\log_{10} N = 2 \Rightarrow N = 100$	B1	
			(1)
(b)	$\log_{10} N = 0.35t + 2 \Rightarrow N = 10^{0.35t+2}$	M1	
	$\Rightarrow N = 10^{0.35t} \times 10^{2}$	dM1	
	$\Rightarrow N = 100 \times 2.24^{t}$	A1	
			(3)
(c)	Rate of growth at 5 hours is $\frac{dN}{dt} = 100 \times \ln 2.24 \times 2.24^{5}$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

5 (a)	$304(°C)$	B1	
			(1)
(b)	 Shape or Asymptote	M1	
	Fully correct Shape and Asymptote	A1	
			(2)
(c)	$144 = 280\,e^{-0.05t} + 24 \quad \Rightarrow 280\,e^{-0.05t} = 120$	M1	
	Correct use of lns $\Rightarrow -0.05t = \ln\frac{120}{280} \Rightarrow t = 16.95$	dM1 A1	
			(3)
(d)	$\left(\frac{dH}{dt} =\right) -0.05 \times 280e^{-0.05t}$	M1	
	$\frac{dH}{dt} = -0.05 \times (H - 24) \Rightarrow \frac{dH}{dt} = 1.2 - 0.05H$	M1, A1cso	
			(3)
			(9 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)	$30e^{-0.2\times(T+8)} + 20e^{-0.2\times T} = 10$	M1	
	$\left(3e^{-1.6} + 2\right)e^{-0.2T} = 1$	A1	
	$e^{-0.2T} = \frac{1}{3e^{-1.6} + 2}$		
	$T = 5\ln\left(3e^{-1.6} + 2\right) = 4.79$	dM1, A1	
			(4)
		(7 marks)	

4.(a)	$f \geqslant -5$	B1	**(1)**
(b)	 Curve starting on negative x-axis and passing through positive y-axis, in quadrants 1 and 2 only. Shape and position correct.	M1 A1	**(2)**
(c)	$2x^2-5=x$ or $2x^2-5=\sqrt{\frac{x+5}{2}}$ or $x=\sqrt{\frac{x+5}{2}}$ or $2\left(2x^2-5\right)^2-5=x$	B1	
	Full attempt to solve $2x^2-x-5=0 \Rightarrow x=\ldots$ exact	M1	
	$x=\frac{1+\sqrt{41}}{4}$	A1	**(3)**
			6 marks

Question Number	Scheme	Marks
9(a)	$\frac{3\sin\theta\cos\theta}{\cos\theta+\sin\theta}=(2+\sec 2\theta)(\cos\theta-\sin\theta)$ $\Rightarrow \frac{3}{2}\sin 2\theta=(2+\sec 2\theta)(\cos\theta-\sin\theta)(\cos\theta+\sin\theta)$ **or** $\Rightarrow 3\sin\theta\cos\theta=(2+\sec 2\theta)\cos 2\theta$	M1
	$\Rightarrow \frac{3}{2}\sin 2\theta=(2+\sec 2\theta)\cos 2\theta$	**d**M1
	$\Rightarrow \frac{3}{2}\sin 2\theta=(2+\sec 2\theta)\cos 2\theta$ $\Rightarrow \frac{3}{2}\sin 2\theta=2\cos 2\theta+1 \Rightarrow 3\sin 2\theta-4\cos 2\theta=2$ *	A1*
		(3)

(b)	Way 1 using $R\sin(2x-\alpha)$ or $R\cos(2x+\alpha)$	
	$\Rightarrow R=\sqrt{3^2+4^2}=\ldots(5)$ **or** $(\alpha=)\ \tan^{-1}\left(\frac{4}{3} \text{ or } \frac{3}{4}\right)=\ldots$	M1
	$\Rightarrow R=\sqrt{3^2+4^2}=\ldots(5)$ **and** $(\alpha=)\ \tan^{-1}\left(\frac{4}{3} \text{ or } \frac{3}{4}\right)=\ldots$	**d**M1
	$3\sin 2x-4\cos 2x=2 \Rightarrow 5\sin(2x-0.927)=2$ **or** $3\sin 2x-4\cos 2x=2 \Rightarrow 5\cos(2x+0.644)=-2$	A1
	$5\sin(2x-0.927)=2 \Rightarrow x=\frac{\sin^{-1}\frac{2}{5}+0.927}{2}$ **or** $5\cos(2x+0.644)=-2 \Rightarrow x=\frac{\cos^{-1}\frac{-2}{5}-0.644}{2}$	**dd**M1
	$x=$ awrt 3.81	A1
		(5)
		(8 marks)

5 (a)	$f^{-1}(22) \Rightarrow 2+5\ln x = 22 \Rightarrow \ln x = 4 \Rightarrow (x=)\ e^4$	M1 A1
		(2)
(b)	$g(x) = \dfrac{6x-2}{2x+1} \Rightarrow g'(x) = \dfrac{6(2x+1)-2(6x-2)}{(2x+1)^2}$	M1 A1
	States $(g'(x)=)\ \dfrac{10}{(2x+1)^2} > 0$ hence increasing *	A1*
		(3)
(c)	$y = \dfrac{6x-2}{2x+1} \Rightarrow 2xy + y = 6x - 2 \Rightarrow 2xy - 6x = -y - 2$	M1
	$\Rightarrow x = \dfrac{-y-2}{2y-6}$ So $g^{-1}(x) = \dfrac{-x-2}{2x-6}$ o.e.	A1
	Domain $0 < x < 3$	B1
		(3)
(d)	Range fg is $fg < 2 + 5\ln 3$	M1, A1
		(2)
		(10 marks)

10(a)(i)	$(y=)10+k$	B1
(ii)	$x = \dfrac{10}{k}$ **or** $y = k$	B1
	$x = \dfrac{10}{k}$ **and** $y = k$	B1
		(3)

(b)	$kx - 10 + k = 2k \Rightarrow x = \ldots$ **or** $-kx + 10 + k = 2k \Rightarrow x = \ldots$	M1
	$kx - 10 + k = 2k \Rightarrow x = \ldots$ **and** $-kx + 10 + k = 2k \Rightarrow x = \ldots$	dM1
	$x \leqslant \dfrac{10-k}{k}$ or $x \geqslant \dfrac{10+k}{k}$ oe	A1
		(3)

(c)	$k > 3$	B1
	Maximum value of k occurs when $y = 3x + 1$ passes through vertex e.g. when $"k" = 3 \times "\dfrac{10}{k}" + 1 \Rightarrow k = \ldots$ **See below for alternative approaches.**	M1
	$k^2 - k - 30 = 0 \Rightarrow (k+5)(k-6) = 0 \Rightarrow k = 6$ So **maximum** k is 6	A1
	$3 < k < 6$	A1
		(4)
		Total 10