Giving correct integration e.g. $\int te^{-t}\,dt = -12te^{-t} - 12e^{-t}$

M1: Ether states $t = 0, V = 6$ and states a value for c or uses the initial conditions for their integral to find the value of c. You do not need to be concerned by the mechanics of the rearrangement. Whilst not dependent on the earlier method marks, there must have been some attempt to solve the differential equation however poor (but not clearly differentiation)
May alternatively substitute in limits *V* and 6 and *t* and 0 onto each side of their integrated expression so the constant of integration is within the calculation.

A1: $V = 18 - 12te^{-t} - 12e^{-t}$ oe Condone if seen in (b)

(b)

B1ft: No, because upper limit of volume is 18 (litres) oe Ft on their $V = "18" - Ate^{-t} - Be^{-t}$
where *A*, *B* > 0

May set $V = 20$ and show that the equation cannot be solved.
e.g. $-2 = 12e^{-t}(t+1)$ and explains that $e^{-t} > 0$ and $t + 1 > 0$ so cannot be negative
If their $"18" > 20$ then they need to conclude yes with a reason.

Question Number	Scheme	Marks
9 (a)	$\frac{dy}{dt}=\frac{-1}{(t+1)^2}$, $\frac{dx}{dt}=\frac{2}{2t+5}$ $\Rightarrow\left(\frac{dy}{dx}=\right)-\frac{2t+5}{2(t+1)^2}$	M1A1
	Sets $-\frac{2t+5}{2(t+1)^2}=-4\Rightarrow 8t^2+14t+3=0$	M1A1
	$\Rightarrow(4t+1)(2t+3)=0\Rightarrow t=-\frac{1}{4}\Rightarrow(y=)\ \frac{4}{3}$	dM1A1
		(6)
(b) (i)	$a=2, b=5$	B1
	Area $=\int y\frac{dx}{dt}\,dt=\int_2^5\frac{1}{t+1}\times\frac{2}{2t+5}\,dt=\int_2^5\frac{2}{(t+1)(2t+5)}\,dt$	M1A1
(ii)	$\frac{2}{(t+1)(2t+5)}\equiv\frac{A}{(t+1)}+\frac{B}{(2t+5)}\Rightarrow A=...,\ B=...$	M1
	$=\frac{2/3}{(t+1)}-\frac{4/3}{(2t+5)}$	A1
	$\int\frac{2/3}{(t+1)}-\frac{4/3}{(2t+5)}\,dt=\frac{2}{3}\ln\lvert t+1\rvert-\frac{2}{3}\ln\lvert 2t+5\rvert$	M1A1ft
	$\int_2^5\frac{2}{(t+1)(2t+5)}\,dt=\left(\frac{2}{3}\ln 6-\frac{2}{3}\ln 15\right)-\left(\frac{2}{3}\ln 3-\frac{2}{3}\ln 9\right)$ $=\frac{2}{3}\ln\left(\frac{6}{5}\right)=\frac{1}{3}\ln\left(\frac{36}{25}\right)$	dM1A1
		(9) **(15 marks)**

(a)

M1: Attempts to find $\frac{dy}{dx}$ by dividing their $\frac{dy}{dt}$ by their $\frac{dx}{dt}$. Both must be attempts at differentiation, however poor. Do not allow e.g. $\frac{2}{2t+5}\rightarrow...\ln(2t+5)$ as this is clearly integration.

A1: $\left(\frac{dy}{dx}=\right)-\frac{2t+5}{2(t+1)^2}$ which may be unsimplified and may be implied by further work

M1: Sets their "$-\frac{2t+5}{2(t+1)^2}$" $=\pm 4$ and proceeds to a 3TQ in t. Do not be concerned by the mechanics of the rearrangement.