e.g. $\cos\theta = \dfrac{7^2 + (5\sqrt{2})^2 - 3^2}{2(7)(5\sqrt{2})}$

A1: $\cos\theta = \dfrac{9\sqrt{2}}{14}$ o.e such as $\cos\theta = \dfrac{9}{7\sqrt{2}}$

(b) Note that finding e.g. cos *BAC* $\left(= \dfrac{4}{21}\right)$ in (a) can still lead to full marks in (b)

M1: Attempts to find the **exact value** of $\sin\theta$ examples include:

- using $\sin\theta = \sqrt{1 - \left("\dfrac{9\sqrt{2}}{14}"\right)^2}$ oe May be implied by their $\dfrac{\sqrt{34}}{14}$ or exact equivalent or score for a correct expression for $\sin\theta$ with their $\cos\theta = \dfrac{9\sqrt{2}}{14}$ substituted. Condone invisible brackets.
- drawing a right-angled triangle to find the opposite side and then using $\sin\theta = \dfrac{\text{opp}}{\text{hyp}}$

If an exact expression is not seen somewhere in their solution then M0M0A0 but allow a candidate to write exact values but then use decimals in intermediate working provide exact values are recovered before the final answer.

Do not accept $\sin\theta = \sin\left(\cos^{-1}\left("\dfrac{9\sqrt{2}}{14}"\right)\right)$ for this mark.

M1: Attempts to apply $|\mathbf{a}||\mathbf{b}|\sin\theta$. The expression is sufficient. Look for e.g.

$"7"\times"\sqrt{50}"\times"\dfrac{\sqrt{34}}{14}"$

Condone $"7"\times"\sqrt{50}"\times\sin\left(\cos^{-1}\left("\dfrac{9\sqrt{2}}{14}"\right)\right)$ for this mark or

$"7"\times"\sqrt{50}"\times\sin(\text{awrt } 24.6)$

Note there are other methods to find the area. Send to review if you see something that you think is credit worthy.

A1: $5\sqrt{17}$ following an exact value for $\sin\theta$ **seen**, both previous method marks scored and $\cos\theta = \pm\dfrac{9\sqrt{2}}{14}$ o.e. (units not required)

Note: There are other valid methods which if seen then send to review:

Heron's formula

$$\left(s = \frac{7+5\sqrt{2}+3}{2} = 5+\frac{5\sqrt{2}}{2} \right) \Rightarrow A = 2\sqrt{s(s-7)(s-5\sqrt{2})(s-3)} = 5\sqrt{17}$$

Cross product e.g.

$$\left\| \begin{matrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ -6 & 2 & -3 \\ -4 & 3 & -5 \end{matrix} \right\| = \left| -\mathbf{i} - 18\mathbf{j} - 10\mathbf{k} \right| = \sqrt{(-1)^2 + (-18)^2 + (-10)^2} = 5\sqrt{17}$$

Question Number	Scheme	Marks
8 (a)	$\int te^{-t}\,dt = -te^{-t} + \int e^{-t}\,dt, = -te^{-t} - e^{-t}$	M1dM1
	$\frac{dV}{dt} = 12te^{-t} \Rightarrow V = -12te^{-t} - 12e^{-t} + c$	A1
	$t = 0, V = 6 \Rightarrow 6 = 0 - 12 + c \Rightarrow c = ...$	M1
	$V = 18 - 12te^{-t} - 12e^{-t}$	A1
		(5)
(b)	No, because e.g. upper limit of volume is 18 (litres)	B1 ft
		(1)

(a) **Note that differentiating using the product rule scores 0 marks**

M1: Uses integration by parts to achieve $\int te^{-t}\,dt = \alpha te^{-t} \pm \beta \int e^{-t}\,(dt)$ where $\alpha, \beta \neq 0$ but may be equal to each other (you do not need to be concerned about how they arrive at this) May be implied by further work.

dM1: Uses a correct method to integrate an expression of the form $\int te^{-t}\,(dt) = \alpha te^{-t} \pm \gamma e^{-t}$ where $\beta, \gamma \neq 0$. It is dependent on the previous method mark.

A1: Solves the differential equation with or without a constant of integration e.g. $\frac{dV}{dt} = 12te^{-t} \Rightarrow V = -12te^{-t} - 12e^{-t}(+c)$ o.e. May be written in an equivalent form e.g. $...V = ...\left(te^{-t} + e^{-t}\right)(+c)$

Watch out for the DI method

	D	I
+	$12t$	e^{-t}
−	12	$-e^{-t}$
+	0	e^{-t}

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.