Question	Scheme	Marks	AOs
10	$V = 4\pi h(h+6) = 4\pi h^2 + 24\pi h \quad 0 \leqslant h \leqslant 25\,;\ \dfrac{dV}{dt} = 80\pi$		
(a)	Time $= \dfrac{4\pi(24)(24+6)}{80\pi} = \dfrac{2880\pi}{80\pi} = 36$ (s) *	B1 *	3.4
		(1)	
(b)	When $t = 8,\ V = 80\pi(8) = 640\pi \Rightarrow 640\pi = 4\pi h(h+6)$	M1	3.1a
	$160 = h(h+6) \Rightarrow h^2 + 6h - 160 = 0 \Rightarrow (h+16)(h-10) = 0 \Rightarrow h = ...$	M1	1.1b
	$\{h = -16, \text{reject}\},\ h = 10$	A1	1.1b
	$\dfrac{dV}{dh} = 8\pi h + 24\pi$	M1	1.1b
		A1	1.1b
	$\left\{\dfrac{dV}{dh} \times \dfrac{dh}{dt} = \dfrac{dV}{dt} \Rightarrow\right\}\ (8\pi h + 24\pi)\dfrac{dh}{dt} = 80\pi$	M1	3.1a
	When $h = 10,\ \left\{\dfrac{dh}{dt} = \dfrac{dV}{dt} \div \dfrac{dh}{dt} =\right\} \dfrac{80\pi}{(8\pi(10) + 24\pi)} \left\{= \dfrac{80\pi}{124\pi}\right\}$	M1	3.4
	When $h = 10,\ \dfrac{dh}{dt} = \dfrac{10}{13}$ (cm s^{-1}) or awrt 0.769 (cm s^{-1})	A1	1.1b
		(8)	
		(9 marks)	

Question 10 Notes:

(a)	
B1*:	Uses the model to show that it takes 36 seconds to fill the bowl from empty to a height of 24 cm
(b)	
M1:	Complete strategy to find the value of h when $t = 8$
M1:	Uses $\dfrac{dV}{dt} = 80\pi$ to deduce the volume of water in the bowl, V, after 8 seconds and sets this result to $4\pi h(h+6)$
A1:	Finds $h = 10$
M1:	Differentiates V with respect to h to give $\pm\alpha h \pm \beta;\ \alpha, \beta \neq 0$
A1:	$8\pi h + 24\pi$
M1:	A complete strategy of forming an equation relating $\dfrac{dh}{dt}$ to 80π E.g. applies $\left(\text{their } \dfrac{dV}{dh}\right) \times \dfrac{dh}{dt} = 80\pi$
M1:	Substitutes their $h = "10"$ into their model for $\dfrac{dh}{dt}$ which is in the form $\dfrac{80\pi}{\left(\text{their } \dfrac{dV}{dh}\right)}$, where their h has been found from solving a quadratic equation in h
A1:	$\dfrac{10}{13}$ or awrt 0.769