Question Number	Scheme	Marks
3 (a)	Coordinates of $P = (1, 2)$	B1
	Attempts $\frac{dx}{dt} = \frac{-4}{(t+2)^2}$ and $\frac{dy}{dt} = \frac{(t+4)\times 6 - 6t}{(t+4)^2}$	M1
	Attempts gradient of the tangent using $m = \frac{dy/dt}{dx/dt} = \left(\frac{-6(t+2)^2}{(t+4)^2}\right)$ at $t = 2$	M1
	Equation of tangent $y - 2 = -\frac{8}{3}(x-1) \Rightarrow y = -\frac{8}{3}x + \frac{14}{3}$	ddM1, A1
		(5)
(b)	Attempts to get t in terms of x or y. E.g. $x = \frac{4}{t+2} \Rightarrow t = \frac{4}{x} - 2$	M1
	Achieves a Cartesian Equation E.g. $y = \frac{6t}{t+4} \Rightarrow y = \frac{6\left(\frac{4}{x} - 2\right)}{\frac{4}{x} - 2 + 4}$	dM1
	$\Rightarrow y = \frac{-6x+12}{x+2}, \quad 0 < x < 4$	A1, B1
		(4)
(c)	Range $-2 < f < 6$	M1, A1
		(2)
		(11 marks)

(a)

B1: Coordinates of $P = (1, 2)$ but this may be implied within the tangent equation via use of $x = 1,\ y = 2$

M1: Attempts both $\frac{dx}{dt}$ and $\frac{dy}{dt}$ and reaching a correct form for each.

Look for $\frac{dx}{dt} = \pm\frac{\beta}{(t+2)^2}$ and $\frac{dy}{dt} = \frac{\lambda(t+4) - \delta t}{(t+4)^2}$ $\lambda, \delta > 0$ o.e. condoning missing brackets

For the differentiation of y with respect to t. You may see either chain rule or product rule used.

E.g. Chain rule; $y = \frac{6t}{t+4} = 6 - \frac{24}{t+4} \Rightarrow \frac{dy}{dt} = \frac{24}{(t+4)^2}$. Look for $\frac{dy}{dt} = \frac{\pm p}{(t+4)^2}$ following division.

E.g. Product rule $y = 6t(t+4)^{-1} \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}t} = 6(t+4)^{-1} - 6t(t+4)^{-2}$. Look for $e(t+4)^{-1} \pm ft(t+4)^{-2}$

M1: Attempts gradient of the tangent at $t = 2$ using $m = \frac{\mathrm{d}y/\mathrm{d}t}{\mathrm{d}x/\mathrm{d}t}$.

It is dependent upon getting one of $\frac{\mathrm{d}x}{\mathrm{d}t}$ or $\frac{\mathrm{d}y}{\mathrm{d}t}$ in the correct form

ddM1: For an attempt at the equation of the tangent at $t = 2$ using their gradient and their $(1, 2)$

If the form $y = mx + c$ is used they must proceed as far as $c =$…

The previous two M's must have been awarded.

A1: $y = -\frac{8}{3}x + \frac{14}{3}$ or exact equivalent in the form $y = mx + c$ following **fully correct work** including division if attempted. ISW after a correct answer.

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Note that the demand is to use parametric differentiation so candidates who use their answer to (b) cannot achieve all marks. If they have an equation of the form $y = \frac{ax+b}{cx+d}$ they can score a S.C. maximum of

B1 for $(1, 2)$, M0, M1 for correct attempt at quotient rule (see main scheme), ddM1, A0 for 3 out of 5.

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(b)

M1: Attempts to get t in terms of x or y.

E.g. $x = \frac{4}{t+2} \Rightarrow t = \frac{4}{x} - 2$ **or** $y = \frac{6t}{t+4} \Rightarrow t = \frac{4y}{6-y}$ condoning slips. The order of operations must be correct. Expect the form of the answer to be correct. E.g.

$t = \pm\frac{py}{q \pm ry}$, $t = \pm\frac{r}{x} \pm s$ or equivalents

dM1: And then fully substitutes this into the other equation to form an expression for f (x) or the Cartesian equation

E.g. $\left(\mathrm{f}(x)\right) = \frac{6\left(\frac{4}{x} - 2\right)}{\frac{4}{x} - 2 + 4}$ **or** $x = \frac{4}{t+2} \Rightarrow x = \frac{4}{\frac{4y}{6-y} + 2}$

It is dependent upon the previous M. Again, expect the form to be correct allowing for slips.

Condone the omission of the lhs

A1: Correct equation in required form. The left-hand side must be present (somewhere) linked to their final answer.

Either $y = \dfrac{-6x+12}{x+2}$ or $\mathrm{f}(x) = \dfrac{-6x+12}{x+2}$. The order doesn't matter so $y = \dfrac{12-6x}{2+x}$ is fine

B1: Either $k = 4$ or $0 < x < 4$

(c)

M1: Either limit seen condoning strict or non-strict inequalities.

E.g. $\mathrm{f} < 6$ or $y \leqslant 6$ allowable for the upper limit. Do not allow $\mathrm{f} > 6$

Condone the use of x for f or y for this mark only

A1: $-2 < \mathrm{f} < 6$ o.e. such as $-2 < \mathrm{f}(x) < 6$, $-2 < y < 6$, $y \in (-2, 6)$ or just $(-2, 6)$

The notation must be correct so $-2 < x < 6$ is A0

Question Number	Scheme	Marks
4. (a)	Attempts to find the time = $\left(\frac{1}{3}\times 21^2\sqrt{(21+4)}\right)\div 30$	M1
	Time = $\frac{735}{30}=24.5$ seconds	A1
		(2)
(b)	$V=\frac{1}{3}h^2\sqrt{(h+4)}\Rightarrow\frac{\mathrm{d}V}{\mathrm{d}h}=\frac{2h}{3}\times\sqrt{(h+4)}+\frac{1}{6}h^2(h+4)^{-\frac{1}{2}}$	M1, A1
	States or uses $\frac{\mathrm{d}V}{\mathrm{d}t}=30$	B1
	Uses $30=\frac{\mathrm{d}V}{\mathrm{d}h}\times\frac{\mathrm{d}h}{dt}$ with $h=5\Rightarrow\frac{\mathrm{d}h}{\mathrm{d}t}=\frac{108}{41}\,\mathrm{cms}^{-1}$	M1, A1
		(5)
		(7 marks)

(a)

M1: Attempts to find the time = $\left(\frac{1}{3}\times 21^2\sqrt{(21+4)}\right)\div 30$ condoning slips when substituting $h=21$ into the formula. E.g. condone slips where the 21^2 appears as 21

A1: Reaches a time of 24.5 seconds (including units). Allow variations like $\frac{49}{2}$ s or 24.5 sec.

(b)

M1: Attempts to differentiate using the product rule achieving a correct form.

Look for $\frac{\mathrm{d}V}{\mathrm{d}h}=Ah\sqrt{(h+4)}+Bh^2(h+4)^{-\frac{1}{2}}\quad A,B>0$

A1: Correct $\frac{\mathrm{d}V}{\mathrm{d}h}$ which may be left unsimplified

B1: States or uses $\frac{\mathrm{d}V}{\mathrm{d}t}=30$ which may be awarded from anywhere within the solution and even in the body of the question. Note that using 30 in part (a) does not score this unless you see the lhs

M1: Uses $\frac{\mathrm{d}V}{\mathrm{d}t}=\frac{\mathrm{d}V}{\mathrm{d}h}\times\frac{\mathrm{d}h}{dt}$ with $\frac{\mathrm{d}V}{\mathrm{d}t}=30$ and $\frac{\mathrm{d}V}{\mathrm{d}h}$ with $h=5$ to find $\frac{\mathrm{d}h}{\mathrm{d}t}$. A correct $\left.\frac{\mathrm{d}V}{\mathrm{d}h}\right|_{h=5}$ is $\frac{205}{18}$

There must have been some attempt at differentiation to find $\frac{\mathrm{d}V}{\mathrm{d}h}$ but the form is not important and the M1 does not need to have been scored. If the attempt to find $\frac{\mathrm{d}h}{\mathrm{d}t}$