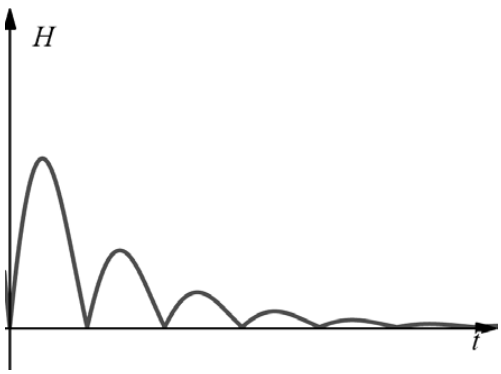
Question 12 (Total 10 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$f'(x) = 12e^{-\frac{x}{3}} \frac{d}{dx} \sin x + 12 \sin x \frac{d}{dx} e^{-\frac{x}{3}}$	M1	This mark is given for a method to differentiate to find an expression for $f'(x)$
	$= e^{-\frac{x}{3}}(12 \cos x - 4 \sin x)$	A1	This mark is given for correctly differentiating to find an expression for $f'(x)$
	$f'(x) = 0$ $\Rightarrow e^{-\frac{x}{3}}(-4 \sin x + 12 \cos x) = 0$ $\Rightarrow (-4 \sin x + 12 \cos x) = 0$	M1	This mark is given for setting $f'(x) = 0$ and finding as method to solve for $\tan x$
	$\frac{\sin x}{\cos x} = \frac{12}{4}$ $\tan x = 3$	A1	This mark is given for showing that $\tan x = 3$ as required.
(b)		M1	This mark is given for a graph with a correct shape
		A1	This mark is given for a graph with heights > 0
(c)	$\tan x = 3$, $x = 1.249$ from above, $t = \pi + 1.249 = 4.39$ for between first and second bounce	M1	This method is given for finding a value for t between the first and second bounce
	$H(4.39) = \lvert 12e^{-4\ 39/3} \sin(4.39) \rvert$	M1	This mark is given for substituting the value of $t = \pi + \arctan 3$ into $H(t)$
	$= \lvert 2.778 \times -0.94848 \rvert$ $= 2.63$ metres	A1	This mark is given for finding the maximum height of the ball
(d)	The time between each bounce should not stay the same when the heights of each bounce are getting smaller	B1	This mark is given for a valid explanation of why the model should not be used the predict the time of each bounce