1a	$-\frac{mgR^2}{2x^2} = mv\frac{\mathrm{d}v}{\mathrm{d}x}$	M1	Form differential equation in v and x only. Need to see $\frac{\mathrm{d}v}{\mathrm{d}x}$ or $v\frac{\mathrm{d}v}{\mathrm{d}x}$ Cannot get this mark using t. Allow with both m's cancelled. Condone sign error.
	$-\frac{gR^2}{2}\int\frac{1}{x^2}\mathrm{d}x = \int v\mathrm{d}v$	M1	Separate variables correctly and integrate at least one side. Cannot get this mark using t. Condone sign error.
	$v^2 = \frac{gR^2}{x} + C \quad *$	A1*	Obtain given answer from correct work. Must include at least one line of working between integral and final answer. Correct signs seen throughout working. Condone $\frac{v^2}{2} = \frac{gR^2}{2x} + C$ followed by $v^2 = \frac{gR^2}{x} + C$ Note: If the first line of working is $\frac{1}{2}v^2 = -\int\frac{gR^2}{2x^2}dx$ followed by integration of RHS, this scores M0M1A0*
ALT1 (a)	$\frac{1}{2}mu^2 - \frac{1}{2}mv^2 = \int\frac{gmR^2}{x^2}\mathrm{d}x$	M1	Form an energy equation with 2 KE terms and the integral of the variable force. Condone sign errors.
	$\frac{1}{2}mu^2 - \frac{1}{2}mv^2 = -\frac{gmR^2}{x} + A$	M1	Integrate the force wrt x. Condone sign errors.
	$v^2 = \frac{gR^2}{x} + C \quad *$	A1*	Obtain given answer from correct work. Must include at least one line of working and correct signs seen throughout working.
		[3]	
b	$x = 3R, v^2 = 3gR$	M1	Use initial conditions to evaluate C in the given answer.
	$\Rightarrow C = 3gR - \frac{gR^2}{3R}\left(= \frac{8gR}{3}\right)$	A1	Or equivalent
	$x = R \Rightarrow v = \sqrt{\frac{11gR}{3}}$	A1	Accept $\frac{\sqrt{33gR}}{3}$ Answer must be in terms of g and R
		[3]	
ALT1 (b)	Use of definite integral instead of finding + C		
	$\left[v^2\right]_{\sqrt{3gR}}^{v} = \left[\frac{gR^2}{x}\right]_{3R}^{R}$	M1	Use initial conditions in a definite integral.

	$v^2 - 3gR = \frac{gR^2}{R} - \frac{gR^2}{3R}$	A1	Or equivalent
	$v = \sqrt{\frac{11gR}{3}}$	A1	Accept $\frac{\sqrt{33gR}}{3}$ Answer must be in terms of g and R
		(6)	