Question number	Scheme	Marks
5(a)	$v\dfrac{\mathrm{d}v}{\mathrm{d}x}=-\dfrac{gR^2}{x^2}$	M1 A1
	$\int v\,\mathrm{d}v=-\int\dfrac{gR^2}{x^2}\,\mathrm{d}x$ or $\dfrac{1}{2}V^2=-\int\dfrac{gR^2}{x^2}\,\mathrm{d}x$ Or the Energy alternative below	M1
	$\dfrac{1}{2}v^2=\dfrac{gR^2}{x}+C$	A1
	Use of $x = R$, $v = U$ to find C $\quad (C=\dfrac{1}{2}u^2-gR)$	M1
	$v^2=\dfrac{2gR^2}{x}+U^2-2gR$ *	A1*
		(6)
5(b)	$\dfrac{1}{4}gR=\dfrac{2gR^2}{x}+gR-2gR$	M1
	$x=\dfrac{8R}{5}$	A1
	$AB=\dfrac{3R}{5}$ oe	A1
		(3)
5(c)	Correct statement regarding $\dfrac{2gR^2}{x}$ for example • $\dfrac{2gR^2}{x}>0$ for $x\geq R$ • $x\to\infty,\ \dfrac{2gR^2}{x}\to 0$	M1
	Correct reasoning. • $U^2-2gR=0$ • $U^2\to 2gR$ • $U^2\geq 2gR$	dM1
	$U_{\text{MIN}}=\sqrt{2gR}$	A1
		(3)
		(12)
	Notes	
5(a)		
M1	Equation with or without -ve sign and any derivative form for the acceleration	
A1	Correct equation with -ve sign	
M1	Separate variables and clear attempt to integrate acceleration in terms of v and x.	
A1	Correct equation; allow without C	
M1	Use of initial conditions or limits	
A1*	Given answer correctly obtained	

5(b)	
M1	Substitution of v^2 and U^2 into (a) to produce a correct equation
A1	Correct value of x
A1	cao
5(c)	
M1	Correct reasoning for the term $\frac{2gR^2}{x}$ Accept $x=\infty$, $x\to\infty$, $\frac{2gR^2}{x}=0$
dM1	Dependent on previous M. Correct reasoning leading to correct equation or inequality.
A1	cso
ALT 5a	**Energy approach must use integration**
M1 A1	Energy equation with variable force. The sign may be missing for the M mark. $\frac{1}{2}mv^2-\frac{1}{2}mU^2=\int F\ \mathrm{dx}=\int-\frac{mgR^2}{x^2}\ \mathrm{dx}$
M1 A1	Clear attempt to integrate. Limits may be missing or incorrect. $\frac{1}{2}mv^2-\frac{1}{2}mU^2=\left[\frac{mgR^2}{x}\right]_R^x$
M1	Correct limits substituted the right way round. $\frac{1}{2}mv^2-\frac{1}{2}mU^2=\frac{mgR^2}{x}-\frac{mgR^2}{R}$
	$v^2-U^2=\frac{2gR^2}{x}-2gR$
A1*	$v^2=\frac{2gR^2}{x}+U^2-2gR$