7a	Conservation of mechanical energy:	M1	All terms required. Dimensionally correct $\cos\theta = \frac{5}{13}, \sin\theta = \frac{12}{13}$
	$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg\left(r + r\cos\theta\right)$	A1	Correct unsimplified equation
	$v^2 = u^2 - \frac{36}{13}gr$ *	A1*	Obtain given answer from correct working
		[3]	
7b	Equation of motion	M1	All terms required. Dimensionally correct. Condone sign errors and sin/cos confusion. Condone use of $R = 0$
	$R + mg\cos\theta = \frac{mv^2}{r}$	A1	Correct unsimplified equation. Condone (strict) inequality the right way round.
	Use $R \ldots 0$ and solve for u^2	M1	Complete method to obtain u^2 Condone use of $R = 0$ or $R > 0$
	$\frac{mv^2}{r} - mg\cos\theta \ldots 0$ $\Rightarrow u^2 - \frac{36}{13}gr \ldots \frac{5}{13}gr, \quad u^2 \ldots \frac{41}{13}gr$ *	A1*	Obtain given answer from correct working. Must have stated the inequality $R \geq 0$ If there is no reference to R, the max mark in (b) is M1A1M1A0*
		[4]	
7c	$BC = 2r\sin\theta = \frac{24}{13}r$	B1	Or equivalent $BC = 1.846\ldots r$
	Relevant vertical motion Eg time to return to the level of BC	M1	Complete method vertically using *suvat*
	$t = \frac{2v\sin\theta}{g} = \frac{24v}{13g}$	A1	Correct unsimplified expression for time Accept $\frac{24}{13g} \times 4\sqrt{\frac{gr}{13}}$, $\frac{24}{13}\sqrt{\frac{16r}{13g}}$ $\frac{96}{13}\sqrt{\frac{r}{13g}}$, $0.65\sqrt{r}$
	Relevant horizontal motion Eg distance travelled by P	M1	Complete method horizontally
	$= \left(v\cos\theta\right)t = v^2 \times \frac{120}{169g}$	A1	Correct unsimplified expression for distance $0.87r$, $\frac{1920}{2197}r$, $0.0892gr$
	$= \frac{16gr}{13} \times \frac{120}{169g} = \frac{160r}{169} \times \frac{12}{13} < 2r \times \frac{12}{13}$	A1*	Obtain given conclusion from correct working

	hence falls into the bowl *		
ALT 1 for last 3 marks	Horizontal: time, *T*, required to travel the length *BC*	M1	Complete method horizontally
	$2r\sin\theta = v\cos\theta \times T$ $T = \dfrac{2r\dfrac{12}{13}}{4\sqrt{\dfrac{gr}{13}}\times\dfrac{5}{13}} = 1.38\sqrt{r}$	A1	Correct unsimplified expression for *T*
	$t < T$ since $0.654\sqrt{r} < 1.38\sqrt{r}$ hence falls into the bowl *	A1*	Obtain given conclusion from correct working
ALT 2 for last 3 marks	Horizontal: speed, *V*, required to reach *C*	M1	Complete method horizontally
	$-V\sin\theta = V\sin\theta - g\dfrac{2r\sin\theta}{V\cos\theta}$ $\Rightarrow V = \sqrt{\dfrac{gr}{\cos\theta}} = \sqrt{\dfrac{13gr}{5}}$	A1	Correct unsimplified expression for *V*
	$v < V$ since $\sqrt{\dfrac{13gr}{5}} < \sqrt{\dfrac{16gr}{13}}$ hence falls into the bowl *	A1*	Obtain given conclusion from correct working
	SC: If range formula is quoted correctly award M1A1M1A1. Range = $\dfrac{2v^2\sin\theta\cos\theta}{g}$		
		[6]	
		(13)	

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