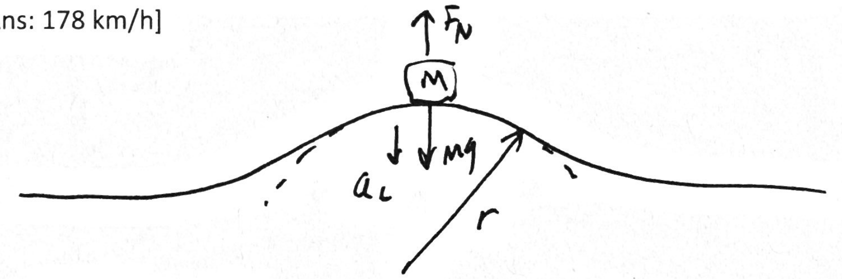
3. A stuntman drives a car over the top of a hill, the cross section of which can be approximated by a circle of radius 250 m, as in the figure. What is the greatest speed at which he can drive without the car leaving the road at the top of the hill?
[Ans: 178 km/h]



* opposite to a loop-the-loop problem where the car is "inside" a track.

$$\Sigma F = Ma_c$$

$$Mg - F_N = \frac{Mv^2}{r}$$

$$\boxed{v = \sqrt{\frac{r(Mg - F_N)}{M}}}$$

Note: if $v = \emptyset$, $F_N = Mg$ as it should.

@ max speed $F_N = \emptyset$ (loses contact).

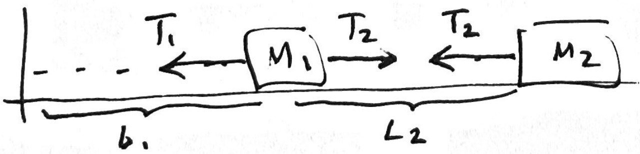
$$v = \sqrt{\frac{rMg}{M}}$$

$$\boxed{v = \sqrt{rg}}$$

≈ 49.4 m/s $= 178$ km/h

4. A mass of 6 kg is attached to a string and is rotating in a horizontal plane on a frictionless surface. The mass makes 72 revolutions in 12 seconds. Another mass is also attached to the same rope, but closer to the centre of rotation (6 cm from the centre to be exact). The mass that is further from the centre is moving at 2 times the tangential speed of the other mass. Calculate the separation of the two masses.

$f = \frac{72}{12} = 6$ Hz (same for both)



$\underline{\underline{M_1:}}$ $a_c = \frac{v^2}{r}$

$\cancel{T_1 - T_2 = \frac{M_1 v_1^2}{L_1}}$

$$\frac{v^2}{L_1} = 4\pi^2 L_1 f^2$$

$$v_1 = \sqrt{4\pi^2 L_1^2 f^2}$$

$$v_1 = 2\pi L_1 f = 2.2608 \text{ m/s}$$

$\underline{\underline{M_2:}}$ $\cancel{T_2 = \frac{M_2 v_2^2}{(L_1 + L_2)} = \frac{M_2 (2v_1)^2}{(L_1 + L_2)}}$

$$v_2 = 2\pi (L_1 + L_2) f$$

$$\cancel{2} v_1 = \cancel{2}\pi (L_1 + L_2) f$$

$L_1 + L_2 = 0.12$ m

$$\frac{v_1}{f\pi} = L_1 + L_2$$

$$\boxed{L_2 = \frac{v_1}{\pi f} - L_1} = 0.06 \text{ m}$$ ✓