THIRD MIDTERM

A car on a frictionless roller-coaster is released from rest at a height $h$ as shown. At the top of the hump the radius of the curvature of the track is $R$. The height of the top of the hump is shown in the diagram.

(a) If the apparent weight of a person in the car is 1/3 of his normal weight at the top of the hump (point B), calculate $h$ in terms of $R$, $g$ and numbers. The person and car are assumed small compared to $R$.

(b) For the same starting conditions, calculate the apparent weight of a 100 kg person at point C, if the radius of the curvature at C is 2$R$.

**Part a)**

$$mgh = \frac{1}{2}m{v_B}^2 + mgR \quad (+5 \text{ if correct})$$

$$mg - N = \frac{m{v_B}^2}{R} \quad (+5 \text{ if correct})$$

$$N = \frac{1}{3}mg \quad \Rightarrow m{v_B} = \left( mg - \frac{1}{3}mg \right)R = \frac{2}{3}mgR$$

$$mgh = \frac{1}{2} \left( \frac{2}{3}mgR \right) + mg3R \quad \Rightarrow h = \frac{10}{3}R \quad (+5 \text{ if correct})$$

**Part b)**

$$mgh = \frac{1}{2}m{v_C}^2 \quad m{v_C}^2 = 2mgh = \frac{10}{3}mgR \quad (+3 \text{ if correct})$$

$$N - mg = \frac{m{v_C}^2}{2R} \quad (+3 \text{ if correct})$$

$$N = \left( \frac{10}{3} + 1 \right)mg = \frac{13}{3}mg = 433 \text{ kg or } 4.25 \text{ N} \quad (+4 \text{ if get } N)$$