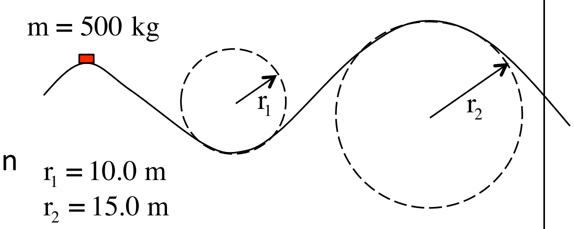
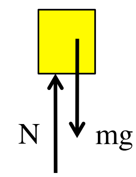
Problem 6.16



Interesting that they would allude to the motion of the car from the point of view of the car (that is, there is up and down motion but no apparent sideways motion). In any case:

a.) The force on the car at the bottom of first drop?

A f.b.d. on the car at that point is shown to the right. Below is N.S.L. on the car when at that point.



$\underline{\sum F_c :}$

$$N - mg = +ma_c$$

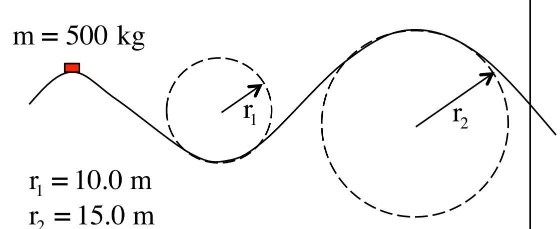
$$\Rightarrow \quad N = mg + m\left(\frac{v_{max}^2}{R}\right)$$

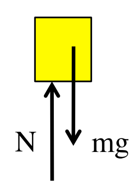
$$= (500\text{ kg})(9.80\text{ m/s}^2) + (500\text{ kg})\frac{(20.0\text{ m/s})^2}{(10.0\text{ m})}$$

$$= 2.49\text{x}10^4\text{ N}$$

1.)

b.) This is a classic problem. When the car passes over the top of the second hill with the largest velocity possible and still stays in contact with the track, it will be just barely touching the track. In other words, the normal force will go to zero at that point. Using that information with the f.b.d. for the car at that point, we can write:





$\sum F_c :$

$$\Rightarrow \quad \cancel{N}^{\,0} - mg = -ma_c$$

$$\Rightarrow \quad mg = m\left(\frac{v_{max}^2}{R}\right)$$

$$\Rightarrow \quad v_{max} = (gR)^{1/2}$$

$$= \left[(9.80\text{ m/s}^2)(15.00\text{ m})\right]^{1/2}$$

$$= 12.1\text{ m/s}$$

2.)