

# Uniform Circular Motion: Worksheet 1

Assumes that the car shown below is going at a constant speed.



Fig. 1

1. Construct a qualitative motion map of the car in Figure 1.



2. In what direction is the car experiencing acceleration? Explain how you know.

towards the center of the circle  
we know it is accelerating bc it is changing direction

3. Construct a force diagram for the car when it's at the top of the hill.



$F_g$  is longer bc that is in

the direction of the acceleration at the top of

4. Suppose the speed of the car is 11.1 m/s ( $\approx 25$  mph) and the radius of curvature ( $r$ ) is 25 m; determine the magnitude of the centripetal acceleration of the car.

$$a_c = \frac{v^2}{r} = \frac{(11.1 \text{ m/s})^2}{25} = \boxed{4.93 \text{ m/s}^2}$$

5. If the mass of the car is 1200 kg, what  $F_{\text{net}}$  would be required to cause this centripetal acceleration?

$$F_{\text{net}} = ma_c = (1200 \text{ kg})(4.93 \text{ m/s}^2) = \boxed{5916 \text{ N}}$$

6. Now, determine values for the forces in your force diagram of number 3.

$$\text{In-car} = ma_c \Rightarrow F_g - F_N = ma_c \Rightarrow (1200 \text{ kg})(4.93 \text{ m/s}^2) - F_N = (1200 \text{ kg})(4.93 \text{ m/s}^2)$$

$$F_g = (1200 \text{ kg})(9.8 \text{ m/s}^2)$$

$$11760 \text{ N} - F_N = 5916 \text{ N}$$

$$\Rightarrow \begin{cases} F_N = 5844 \text{ N} \\ F_g = 11760 \text{ N} \end{cases}$$

7. At what speed would the centripetal force equal the force of gravity?

$$\text{Set } F_{\text{net}} = F_g \Rightarrow \frac{mv^2}{r} = mg \Rightarrow \frac{v^2}{25} = 9.8 \Rightarrow v^2 = 245 \text{ m/s}^2$$

$$\Rightarrow \boxed{v = 15.65 \text{ m/s}}$$

8. Suppose the car were going faster than the speed that you calculated for question 7; describe what would happen to the car.

It would come off the hill, bc when  $mg = \frac{mv^2}{r}$  it means there is no more normal force

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**Tao Wei**



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