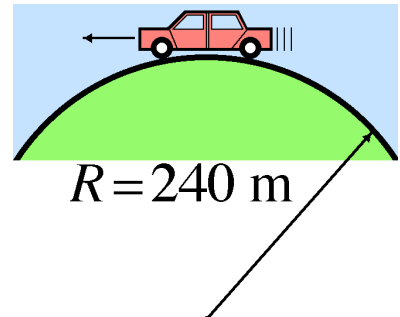


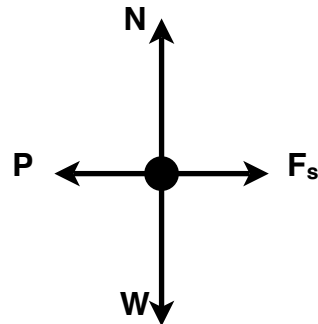
Car over a hill

A car is driving at constant speed over a hill, which is a circular dome of radius 240 m.

Above what speed will the car leave the road at the top of the hill?



Solution: Draw the free-body diagram for the car at the top of the hill:



The force pointing towards the centre of the circle (i.e. down) is

$$F_{\text{net}} = W - N = mg - N$$

The **maximum** value this can have occurs when $N = 0$, in which case for circular motion we have

$$F_{\text{net}} = mg - 0 = mg$$

so since the car is moving in a circle,

$$F_{\text{net}} = mg = mv^2/r$$

Hence the **maximum** speed is given when the force is this maximum:

$$v^2 = gr$$

so

$$v = \sqrt{gr} = \sqrt{9.8 \times 240} = 48.5 \text{ ms}^{-1} = 175 \text{ kmh}^{-1}$$

If the car moves faster than this, the normal force will go to zero (the car will feel weightless) but the weight alone will not be enough to keep the car moving in a circle, so it will leave the road at the top of the hill.