

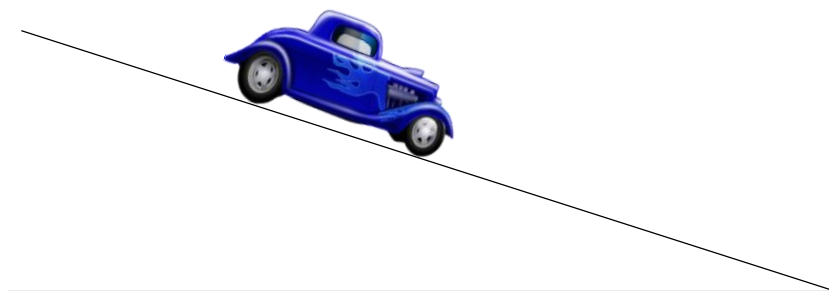
## Measuring the friction force on a car

On my way to work one day, I noticed that if I starting going down a particular hill at 57mph my speed stayed absolutely steady all the way down. By knowing some measurements of the hill (taken from a map) and the mass of the car (from the car's manual), you can use this to work out the total friction force acting on the car at this speed.

### Information:

- Mass of car: 2100 kg
- Length of the relevant downhill section of road, from map: 725 metres
- The relevant downhill section of road starts at a height of 105 metres above sea level, and ends 70m above.

- 1) Calculate the steepness of the hill as an angle above the horizontal.
- 2) If the car's velocity is constant whilst going down the hill, what must be true about the forces on the car?
- 3) Add all the numerical information you know at this stage to the diagram below and add arrows to show all the forces acting on the car.



- 4) By taking components, calculate the total frictional force acting on the car.

- 5) List all the contributory causes to this total friction force.
- 6) Would you expect the total friction force on the car at a lower speed to be higher, lower or the same value as that calculated in 4)?
- 7) a) If I start going down the same hill at a lower speed than 57 mph, would you expect the car to speed up, slow down or stay the same speed?
- b) Explain why.
- 8) On a different day, I started going down the hill at 45mph. By the time I was at the bottom of the hill, I was going 49mph. Calculate the average frictional force on the car in this situation.

$$(1 \text{ ms}^{-1} = 2.24 \text{ mph})$$