*Drag coefficients*

How big is the force of air resistance on a moving car? This question is important to designers, because they need to try to make the air resistance as small as possible. However, it is not a simple question to answer, because the size of the force depends on the size and shape of the vehicle, the speed it is moving, and the density of the air it is moving through. The drag force at a particular speed can be calculated using this formula:

D = x ρ x V2 x CD x S (You do not need to remember this formula!)

D is the drag force on the vehicle.

ρ is the Greek letter ‘rho’, and represents the density of air (about 1.225 kg/m3 at sea level).

V is the speed of the vehicle in metres per second.

CD is called the coefficient of drag. It depends on the shape of the vehicle and it is usually found by measurements in a wind tunnel. For a car, the coefficient of drag is usually between 0.4 and 0.5. Cars with good streamlined shapes have low drag coefficients.

S is the front area of the car.

**1** Work out the drag force on a car at speeds from 10mph to 70mph, in 10mph intervals. Present your results in a table.

You will need to use the information above. Assume that the car has a CD of 0.45 and a front area of 2 m2. You can convert mph into m/s by dividing by 2.237.

**2** Plot a graph to show the drag on the car. Put speed on the horizontal axis.

**3** What causes the drag force? Use ideas about particles in your answer.

**4** Why do you think the drag force on a car depends on the density of the air? Explain as fully as you can. (*Hint:* you need to think about what density means in terms of how many air particles there are in a particular volume of air.)

**5** In some countries the land is thousands of feet above sea level, so the air density is less. Air density also decreases when the air is hot. What effect would these changes in density have on the drag force on a car? Explain your answer.

**6** Sometimes people put roof racks on their cars so they can carry more luggage.

**a** What effect will a roof rack have on the drag force?

**b** Would adding a roof rack increase or decrease the drag coefficient of a car?