4.5.3 Terminal velocity

Terminal velocity occurs for objects falling in a fluid. In the case of objects falling in air, terminal velocity occurs when the upward forces of air resistance balance downward force of weight.

videos

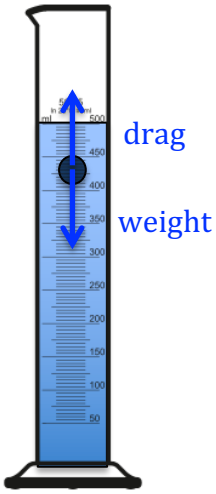
Things to note:

1) weight is a constant
2) air resistance increases as velocity increases

Because the forces are balanced, the object falls with a constant velocity – terminal velocity.

(1) Describe and explain how the forces acting on a skydiver change after jumping out of an aeroplane. How does this affect the skydiver's motion?

The same effect is observed for objects falling in a liquid.



For example, we can drop a ball bearing in a measuring cylinder filled with oil and record its descent with a video recorder. If we look at the displacement at equal time intervals, we find that it remains constant. Therefore, the ball bearing is falling with a constant speed – terminal velocity.

The upward force is called drag. It increases as the speed increases. Again, weight remains constant.

The drag force is given by the following expression (called the Stokes' drag):

$$F_d = 6\pi\eta r v$$

where η=dynamic viscosity, r=radius of sphere, v=velocity
(Note: Not required for this course.)

(2) Work out the terminal velocity for a steel ball bearing with a mass of 4.1×10^{-3}kg, and a radius of 5×10^{-3}m. The ball bearing is falling through cooking oil with a dynamic viscosity η =70Pa·s.

The top speed of cars

As a car speeds up the resistive forces increase. As a car has maximum driving force, eventually the resistive forces will balance the maximum driving force and the car can no longer accelerate. The car has reached its top speed.

(3) What can designers do to increase the top speed of a car?