Q- A skydiver of mass 80.0 kg jumps from a slow-moving aircraft and reaches a terminal speed of 50.0 m/s. If the air drag is proportional to the square of velocity of the body-
a) What is the acceleration of the skydiver when her speed is 30.0 m/s^2?
b) What is the drag force on the skydiver when her speed is 50.0 m/s
c) What is the drag force on the skydiver when her speed is 30.0 m/s?

The air drag is proportional to the square of the velocity of the falling body and increases with speed in magnitude. When the diver is falling, the forces acting on it are (1) its weight mg vertically downward and (2) the air drag F on it in vertically upward direction. It is moving under these two forces and hence the equation of its motion is given by

      mg - F = m*a

Here downward direction is taken positive and a is the acceleration of the diver.
Let the air drag is given by

      $F = Kv^2$

Here K is a constant and v is the velocity of the diver. Hence substituting this in the equation above we have

      $mg - Kv^2 = m*a$ -------------------- (1)

Now the terminal speed of the diver v = 50.0 m/s. this means that this is the maximum speed and after this the speed is not increasing or the acceleration a of the diver is zero hence from equation 1 we have

      $80.0*9.8 - K*(50.0)^2 = 80.0*0$
      Gives K = 784.0/2500 = 0.3136 N.s^2/m^2 --------------------- (2)

(a) When the velocity of the diver is 30.0 m/s from equation (1) and (2) we have
      $80.0*9.8 - 0.3136*(30.0)^2 = 80.0*a$
      Gives a = 9.8 - 3.528 = 6.272 m/s^2

(b) When the speed is 50.0 m/s, the terminal speed, the drag force is equal to the weight of the diver and hence equal to
      F = mg = 80.0*9.8 = 784.0 N clearly upward

(c) When the speed is 30.0 m/s the drag force is given by

      $F = Kv^2 = 0.3136*(30.0)^2 = 282.24$ N upward.