Q 4. **A ball is dropped from a building of height 45 m. Simultaneously another ball is thrown up with a speed of 40 m/s. Calculate the relative speed of the balls as a function of time.**

Sol: In motion under gravity, if the ball is released or dropped that means its initial velocity is zero. In this problem as ball is dropped, so its initial velocity will be taken as zero. We will apply kinematic equations.

According to the problem, for the ball dropped from the building, $u_1 = 0$, $u_2 = 40$ m/s

Velocity of the ball after time t,

$v_1 = u_1 - gt$

$v_1 = -gt$

And for another ball which is thrown upward, $u_2 = 40$ m/s

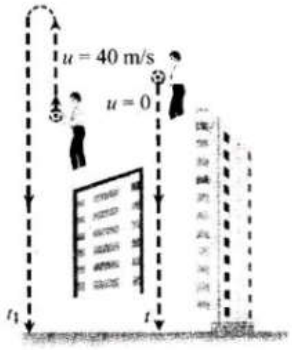
Velocity of the ball after time t,

$v_2 = u_2 - gt = (40 - gt)$

$\therefore$ Relative velocity of one ball w.r.t. another ball is

$v_{12} = v_1 - v_2 = -gt - [-40 - gt]$

$v_{12} = v_1 - v_2 = -gt + 40 + gt = 40$ m/s



Important point: Sign Convention:

Any vector quantity directed upward will be taken as positive and directed downward will be taken as negative. According to this sign convention:

(i) Displacement will be taken as positive if final position lies above initial position and negative if final position lies below initial position.

(ii) Velocity(initial or final) will be taken as positive if it is upward and negative if it is downward.

(iii) Acceleration a is always taken to be -g.

In equations of motions we replace a by -g (minus sign, because acceleration is always directed downward)

we get: $\begin{cases} v = u - gt \\ s = ut - \frac{1}{2}gt^2 \\ v^2 = u^2 - 2gs \end{cases}$