$v = u + at;$ $\quad s = ut + \frac{1}{2}at^2$ $\quad$ and $\quad v^2 = u^2 + 2as$

reduces to $0 = u - gt$ $\quad h = ut - \frac{1}{2}gt^2$ $\quad$ and $\quad 0 = u^2 - 2gh$

[the velocty at the highest point is v = 0]

From the above equations we get

$$u = gt \quad ... \quad (4)$$

$$h = \frac{1}{2}gt^2 \quad ... \quad (5)$$

$$u^2 = 2gh \quad ... \quad (6)$$

These equations can be used to solve most of the problems of bodies projected vertically up. Let us summerise the above as: If the initial velocity of projection is given, we get three simple equations as:

$$h = \frac{u^2}{2g} \text{ ....[7]} \quad , \quad t = \frac{u}{g} \text{ ....[8]} \quad \text{or} \quad t = \sqrt{\frac{2h}{g}} \text{ ....[9]}$$

IMPORTANT POINTS

(1) In case of motion under gravity for a given body, mass, acceleration, and mechanical energy remain constant while speed, velocity, momentum, kinetic energy and potential energy change.

(2) The motion is independent of the mass of the body, as in any equation of motion, mass is not involved. This is why a heavy and lighter body when released from the same height, reach the ground simultaneously and with same velocity.

i.e $\quad t = \sqrt{(2h/g)}$ and $v = \sqrt{2gh}$

However, momentum, kinetic energy or potential energy depend on the mass of the body (all $\propto$ mass)

(3) As from equation (5) time taken to reach a height h,

$$t_u = \sqrt{(2h/g)}$$

Similarly, time taken to fall down through a distance h [from Eq(2)],