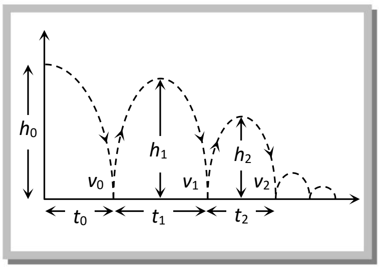
Rebounding of Ball after Collision with Ground.

If a ball is dropped from a height h on a horizontal floor, then it strikes with the floor with a speed.

$v_0 = \sqrt{2gh_0}$ [From $v^2 = u^2 + 2gh$]



and it rebounds from the floor with a speed

$v_1 = ev_0 = e\sqrt{2gh_0}$ $\left[\text{As } e = \frac{\text{velocity after collision}}{\text{velocity before collision}}\right]$

(1) **First height of rebound:** $h_1 = \frac{v_1^2}{2g} = e^2 h_0$

$\therefore$ $h_1 = e^2 h_0$

(2) **Height of the ball after nth rebound:** Obviously, the velocity of ball after nth rebound will be

$v_n = e^n v_0$

Therefore the height after nth rebound will be $h_n = \frac{v_n^2}{2g} = e^{2n} h_0$

$\therefore$ $h_n = e^{2n} h_0$

(3) **Total distance travelled by the ball before it stops bouncing**

$$H = h_0 + 2h_1 + 2h_2 + 2h_3 + ... = h_0 + 2e^2 h_0 + 2e^4 h_0 + 2e^6 h_0 + ...$$

$$H = h_0[1 + 2e^2(1 + e^2 + e^4 + e^6 ....)] = h_0\left[1 + 2e^2\left(\frac{1}{1-e^2}\right)\right]$$

$$\left[\text{As } 1 + e^2 + e^4 + ... = \frac{1}{1-e^2}\right]$$

$$\therefore \quad H = h_0\left[\frac{1+e^2}{1-e^2}\right]$$

(4) **Total time taken by the ball to stop bouncing**

$$T = t_0 + 2t_1 + 2t_2 + 2t_3 + ... = \sqrt{\frac{2h_0}{g}} + 2\sqrt{\frac{2h_1}{g}} + 2\sqrt{\frac{2h_2}{g}} + ...$$

$$= \sqrt{\frac{2h_0}{g}}\,[1 + 2e + 2e^2 + ...] \qquad [\text{As } h_1 = e^2 h_0;\ h_2 = e^4 h_0]$$

$$= \sqrt{\frac{2h_0}{g}}\,[1 + 2e(1 + e + e^2 + e^3 + ...)] = \sqrt{\frac{2h_0}{g}}\left[1 + 2e\left(\frac{1}{1-e}\right)\right] = \sqrt{\frac{2h_0}{g}}\left(\frac{1+e}{1-e}\right)$$

$$\therefore \qquad T = \left(\frac{1+e}{1-e}\right)\sqrt{\frac{2h_0}{g}}$$