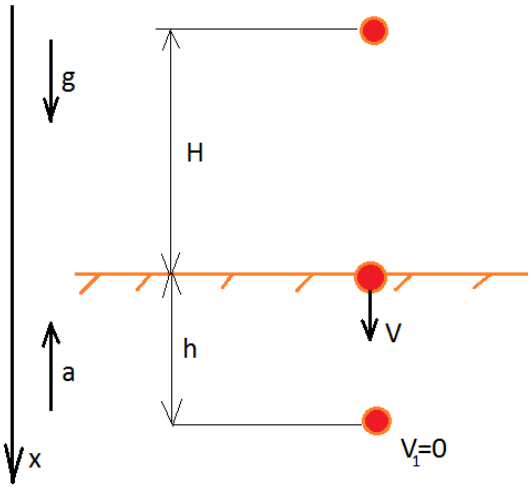
A ball is dropped from a height of 5 m onto a sandy floor and penetrates the sand up to 10 cm before coming to rest. Find the retardation of the ball in sand assuming it to be uniform.

Solution: In order to find retardation of ball in the sand, it is necessary to find the velocity that was before hit the sand. t1 – time that the ball flies before entering the sand, H (5m) – height from the sand surface, h (10 cm) – distance which ball covered in the sand before stop.

The equation of motion for the ball relative to the X-axis before entering the sand:



$$H = \frac{gt_1^2}{2};\ (V_{start} = 0\ )$$

$$t_1 = \sqrt{\frac{2H}{g}};$$

The rate equation for the ball before entering the sand:

$$V = gt_1 = \sqrt{2gH}\ (1)$$

The equation of speed after entering the sand:

$$0 = V - at_2, \quad t_2 - \ time\ after\ which\ the\ ball\ stops\ completely$$

$$t_2 = \frac{V}{a} = \frac{\sqrt{2gH}}{a}\ (2)$$

The equation of motion for the ball after entering the sand:

$$h = Vt_2 - \frac{at_2^2}{2}\ (3)$$

$$(1)\ and\ (2\ )to\ (3):\ \ 2h = 2\sqrt{2gH}\frac{\sqrt{2gH}}{a} - \frac{2gH}{a};$$

$$2h = \frac{2gH}{a};$$

$$a = \frac{gH}{h}.$$

Substitute the numerical values:

$$a = \frac{9.8\frac{m}{sec^2} * 5\ m}{0.1\ m} = 490\frac{m}{sec^2}.$$

Answer: $490\frac{m}{sec^2}$.