

Q- A stone weighing 3kg falls from the top of a tower 100m high and buries itself 2m deep in the sand. What is the time of penetration.

The velocity with which it reaches ground is given by the first equation of motion as

$$[v^2 = u^2 + 2as]$$

Or $v^2 = 0 + 2gh$

Or $v = \sqrt{2gh} = \sqrt{2 * 9.8 * 100} = 44.3 \text{ m/s}$

Now the time taken by the stone to travel 2m in sand is given by using average velocity time relation as

$$\left[d = \left(\frac{u+v}{2} \right) t \right] \text{ (if the acceleration is uniform average velocity is } (u+v)/2$$

Or $d = \left(\frac{v+0}{2} \right) t$ (initial velocity is v and final velocity is zero)

Or $t = \frac{2d}{v}$

Thus, the time taken by stone to penetrate 2m in sand is given by

$$t = \frac{2*2}{44.3} = 0.09 \text{ s}$$