A ball of mass 50 g dropped from height of 20 m. a boy on the ground hits the ball vertically upwards with a bat with an average force of 200N so that it attains a vertical height of 45 m .the time for which the ball remains in contact with the bat g=10 m/s square

Solution

According to the conservation of energy law potential energy of the ball on height $h_1 = 20$ m is equal to kinetic energy of the ball on the ground:

$$mgh_1 = \frac{mv_1^2}{2} \to v_1 = \sqrt{2gh_1}.$$

When a boy on the ground hits the ball vertically upwards it have kinetic energy which equal potential energy of the ball on height $h_1 = 45$ m:

$$\frac{mv_2^2}{2} = mgh_2 \to v_2 = \sqrt{2gh_2}.$$

Impulse transmitted to the ball by bat:

$$I = F\Delta t = P_2 - P_1 = mv_2 - (-mv_1) = m(v_1 + v_2) = m\left(\sqrt{2gh_1} + \sqrt{2gh_2}\right),$$

P_1 is negative because it is opposite to direction f force F.

A time for which the ball remains in contact with the bat:

$$\Delta t = \frac{m\left(\sqrt{2gh_1} + \sqrt{2gh_2}\right)}{F} = \frac{50 * 10^{-3}\ \text{kg}\left(\sqrt{2 * 10\frac{\text{m}}{\text{s}^2} * 45m} + \sqrt{2 * 10\frac{\text{m}}{\text{s}^2} * 20m}\right)}{200N}$$
$$= 0.0125s.$$

Answer: $\mathbf{0.0125}\boldsymbol{s}$.