Warm up 03.29.2018

A golf ball with mass 0.048 kg rests on a tee.

It is struck by a golf club with an effective mass of 0.220 kg and a speed of 43 m/s. Assuming that the collision is elastic, find the speed of the ball when it leaves the tee.

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$m_1 = 0.048$ Kg
$v_1 = 0$ m/s
$m_2 = 0.220$ Kg
$v_2 = 43$ m/s

$v_3 = ?$

For all elastic collisions, the kinetic energy and momentum are conserved.

CONSERVATION OF MOMENTUM

$$m_1 v_1 + m_2 v_2 = m_1 \underline{v_3} + m_2 \underline{v_4}$$
$$\overset{0}{\cancel{m_1 v_1}} + m_2 v_2 - m_1 v_3 = m_2 v_4$$

Extract (*) $v_4 = \dfrac{m_1 v_1 + m_2 v_2 - m_1 v_3}{m_2} = \dfrac{m_2 v_2 - m_1 v_3}{m_2}$

CONSERVATION OF KINETIC ENERGY

$$\frac{m_1 \cdot v_1^2}{2} + \frac{m_2 v_2^2}{2} = \frac{m_1 v_3^2}{2} + \frac{m_2 v_4^2}{2}$$

Replace v_4 with (*) and $v_1 = 0$ m/s

$$\frac{m_2 v_2^2}{2} = \frac{m_1 v_3^2}{2} + \frac{m_2}{2}\left(\frac{m_2 v_2 - m_1 v_3}{m_2}\right)^2 \quad \Big| \times 2$$

$$m_2 v_2^2 = m_1 v_3^2 + m_2 \left(\frac{m_2^2 v_2^2 + m_1^2 v_3^2 - 2 m_1 m_2 v_2 v_3}{m_2^2}\right)$$

$$m_2 v_2^2 = m_1 \cdot v_3^2 + \frac{m_2^2 v_2^2 + m_1^2 v_3^2 - 2 m_1 m_2 v_2 v_3}{m_2} \quad \Big| \times m_2$$

$$\underline{m_2^2 v_2^2} = m_1 m_2 v_3^2 + \underline{m_2^2 v_2^2} + m_1^2 v_3^2 - 2 m_1 m_2 v_2 v_3$$

$$m_1 m_2 v_3^2 + m_1^2 v_3^2 - 2 m_1 m_2 v_2 v_3 = 0$$

$$v_3 (m_1 m_2 \cdot v_3 + m_1^2 v_3 - 2 m_1 m_2 v_2) = 0$$

$$m_1 m_2 v_3 + m_1^2 v_3 - 2 m_1 m_2 v_2 = 0$$

$$v_3 = \frac{2 m_1 m_2 \cdot v_2}{m_1 m_2 + m_1^2} = \frac{2 m_2 v_2}{m_2 + m_1}$$

$$v_3 = \frac{2 m_2 v_2}{m_2 + m_1}$$

$$v_3 = 2 \cdot \frac{0.220\,kg \cdot 43\,m/s}{(0.220\,kg + 0.048\,kg)} = \frac{18.92}{0.268}\,m/s = 70.597\,m/s$$

$$v_3 = 70.597\,m/s$$