Answer on Question 62347, Physics, Other

Question:

A $0.2\,kg$ hammer, moving horizontally at $8.5\,ms^{-1}$ driving nail $1.0\,cm$. What is duration of impact and what is the average force exerted on nail?

Solution:

a) Let's first find the deceleration of the hammer from the kinematic equation:

$$v_f^2 = v_i^2 + 2as,$$

here, $v_i = 8.5\,ms^{-1}$ is the initial velocity of the hammer, $v_f = 0\,ms^{-1}$ is the final velocity of the hammer (when it strikes the nail and comes to rest), a is the deceleration of the hammer and $s = 0.01\,m$ is the distance that nail passes through the board.

Then, from this formula we can find the deceleration of the hammer:

$$a = -\frac{v_i^2}{2s}.$$

We can find the duration of the impact from another kinematic equation:

$$v_f = v_i + at.$$

Substituting the formula for the deceleration of the hammer into the previous equation we get:

$$0 = v_i - \frac{v_i^2}{2s}t.$$

Finally, from this equation we can find t:

$$t = \frac{2s}{v_i} = \frac{2 \cdot 0.01\,m}{8.5\,ms^{-1}} = 2.35 \cdot 10^{-3}\,s.$$

b) From the definition of the impulse we have:

$$\bar{F}\Delta t = m\Delta v = m\left(v_f - v_i\right).$$

From this formula we can find the average force exerted on nail:

$$\bar{F} = \frac{m(v_f - v_i)}{\Delta t} = \frac{0.2\ kg \cdot (0\ ms^{-1} - 8.5\ ms^{-1})}{2.35 \cdot 10^{-3}\ s} = -723.4\ N.$$

The sign minus indicates that the average force exerted on the nail is directed downward.

Answer:

a) $t = 2.35 \cdot 10^{-3}\ s.$

b) $\bar{F} = 723.4\ N.$

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