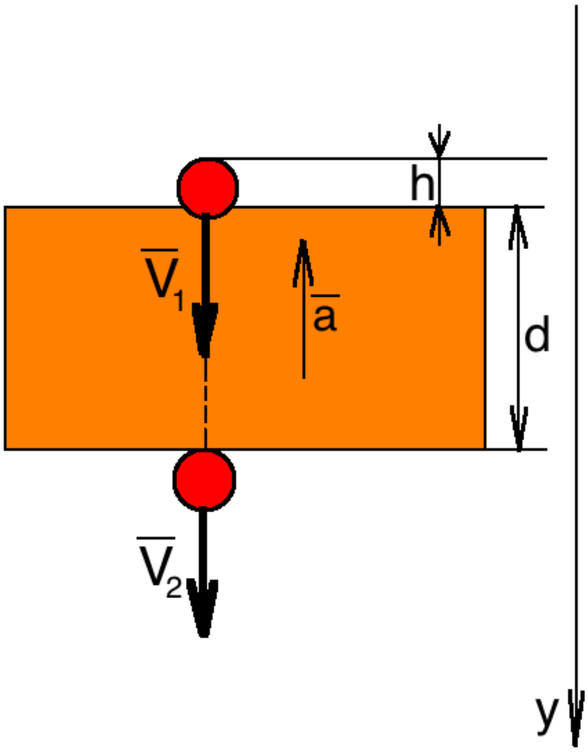
Answer on Question#40193 – Physics – Mechanics | Kinematics | Dynamics

A bullet is fired through a board 10.0 cm thick in such a way that the bullet's line of motion is perpendicular to face of the board. If the initial speed of the bullet is 400 m/s and it emerges from the other side of the board with a speed of 300 m/s, find (a) the acceleration of the bullet as it passes through the board and (b) the total time the bullet is in contact with the board.

Solution:



$V_1 = 400\frac{m}{s} -$ the initial velocity of the bullet;

$V_2 = 300\frac{m}{s} -$ final velocity of the bullet;

$d = 10cm = 0.1m -$ thickness of the board;

$a -$ acceleration inside the board.

$t -$ total time that the bullet is in contact with the board

Assuming constant acceleration we can use the rate equation and motion equation the to find the acceleration inside the board. Rate equation alond the Y axis:

$$V_2 = V_1 - at$$

$$t = \frac{V_1 - V_2}{a} \qquad (1)$$

Motion equation alond the Y axis:

$$d = V_1 t - \frac{at^2}{2} \qquad (2)$$

$(1)\text{in}(2)$:

$$d = V_1\left(\frac{V_1 - V_2}{a}\right) - \frac{a\left(\frac{V_1 - V_2}{a}\right)^2}{2}$$

$$2a\,d = -2V_1V_2 + 2V_1^2 - V_1^2 + 2V_1V_2 + V_2^2$$

$$2a\,d = V_1^2 + V_2^2$$

$$a = \frac{V_1^2 + V_2^2}{2\,d} = \frac{\left(400\,\frac{m}{s}\right)^2 + \left(300\,\frac{m}{s}\right)^2}{2 \cdot 0.1m} = 1.25 \times 10^6\,\frac{m}{s^2}$$

To find the total time that the bullet is in contact with the board we can use formula (1):

$$t = \frac{V_1 - V_2}{a} = \frac{400\,\frac{m}{s} - 300\,\frac{m}{s}}{1.25 \times 10^6\,\frac{m}{s^2}} = 8 \times 10^{-5}s$$

Answer: a) $1.25 \times 10^6\,\frac{m}{s^2}$

b) $8 \times 10^{-5}s$