PHYS 161	**QUIZ 2**
February 16, 2009	**10 POINTS**

An indestructible bullet 2.00 cm long is fired straight through a board 10.0 cm thick. The bullet strikes a board with a speed of 420 m/s and emerges with a speed of 280 m/sec.

(i) What is the average acceleration of the bullet as it passes through the board?

We are told the initial velocity, $v_i = 420$ m/s, the final velocity, $v_f = 280$ m/s, and the distance that is travelled during the deceleration, $\Delta x = 10.0$ cm. We can use the well-known kinematic equation

$$(v_f)^2 = (v_i)^2 + 2a\ \Delta x \tag{1.1}$$

and solve for the acceleration:

$$a = \frac{1}{2\ \Delta x}\left((v_f)^2 - (v_i)^2\right) \tag{1.2}$$

Plugging in the numbers, we find

$$\boxed{a = -490,000\frac{m}{s^2}} \tag{1.3}$$

Also accepted was $a = 408,333\frac{m}{s^2}$ if you stated $\Delta x = .12m$.

(ii) What is the total time the bullet is in contact with the board?

The acceleration we calculated in the first part is the *average* acceleration. Thus, we can use the simple linear relationship:

$$v_f = v_i + at \tag{1.4}$$

Notice that we still write $+at$ even though the bullet is slowing down—the deceleration is enforced by the value of a being negative. Solving for t, we find:

$$t = \frac{v_f - v_i}{a} \tag{1.5}$$

and plug in to find

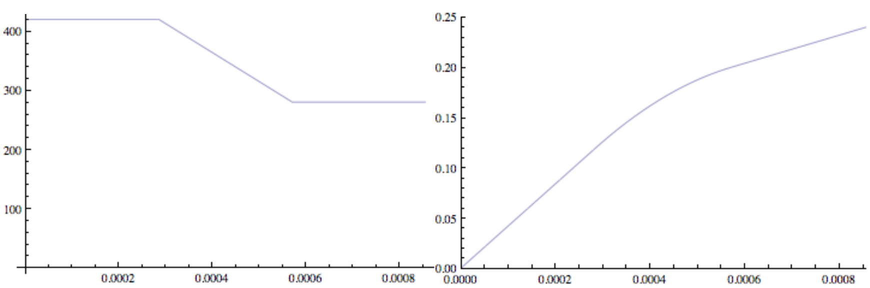
$$\boxed{t = 2.85 \times 10^{-4}s} \tag{1.6}$$

Also accepted was $t = 3.42 \times 10^{-4}s$ if you stated $\Delta x = .12m$.

(iii) Give a rough sketch of the $x - t$ and $v - t$ diagrams for the bullet starting before it hits the board till after it hits the board.

In these sketches, the bullet is passing through the wood from time t to time $2t$ on a scale that goes from 0 to $3t$ so that the deceleration appears in the middle of the graph. The velocity is graph is simple: The acceleration in the $x - t$ diagram is exaggerated, but the key features are clear: there is a straight line, a concave-down curve, and then a smooth transition into another line. There should be no kinks in the $x - t$ diagram.

□



(a) The $v - t$ diagram (b) The $x - t$ diagram