Problem 5.37

A .0120 gram bullet moving at 260 m/s stops in a sand bag in .23 meters. What is the magnitude and direction of the frictional force that did the stopping.

Although you will find in the next chapter that this problem could be done more easily using energy considerations, we'll use N.S.L. to do it here.

We'll start with kinematics to determine the acceleration. That is:

$$\cancel{(v_2)^2}^{\,0} = (v_1)^2 + 2a(\Delta x)$$

$$\Rightarrow \quad a = -\frac{(v_2)^2}{2\Delta x}$$

$$= -\frac{(260\ \text{m/s})^2}{2(.230\ \text{m})}$$

$$= -1.47\text{x}10^5\ \text{m/s}^2$$

The direction of the acceleration will be opposite the direction of motion.

The only force acting on the bullet will be friction, so N.S.L. give us:

$$\underline{\textstyle\sum F_v:}$$

$$F_{\text{friction}} = ma$$

$$= (.0120\ \text{kg})(1.47\text{x}10^5\ \text{m/s}^2)$$

$$= 1.76\text{x}10^5\ \text{N}$$

I've use the magnitude of "a" in the N.S.L. expression, yielding a force magnitude as shown. Again, if the bullet was traveling in the $+\hat{i}$ direction, the frictional force would have to be in the $-\hat{i}$ direction.