# Practice Problem #2

## Newton's Laws of Motion

**Question**: *An advertisement claims that a particular automobile can "stop on a dime". What net force would actually be necessary to stop a 850 kg automobile traveling initially at 45.0 km/hour in a distance equal to the diameter of a dime, which is 1.8 cm?*

**Solution**: First convert the speed of the automobile and the diameter of the dime to SI units:

$$45.0\,\frac{\cancel{km}}{\cancel{h}}\cdot\frac{1,000\,m}{1\,\cancel{km}}\cdot\frac{1\,\cancel{h}}{3,600\,s}=12.5\,\frac{m}{s}$$

$$1.8\,\cancel{cm}\cdot\frac{1\,m}{100\,\cancel{cm}}=0.018\,m$$

To solve for the net force, the net acceleration is needed first. This can be found using the following kinematic equation:

$$v_f^2=v_i^2+2a\Delta x$$

Note that when the automobile comes to a stop, $v_f=0$. Solving for $a$:

$$0=v_i^2+2a\Delta x$$

$$-2a\Delta x=v_i^2$$

$$a=-\frac{v_i^2}{2\Delta x}$$

Applying Newton's 2nd Law:

$$\sum F=ma_{net}$$

$$=m\Big(-\frac{v_i^2}{2\Delta x}\Big)$$

$$=(850\,kg)\Big(-\frac{(12.5\,\frac{m}{s})^2}{2(0.018\,m)}\Big)$$

$$\approx\boxed{-3.7\cdot10^6\,N}$$

The magnitude of this force is $\approx 1/3$ the thrust of a Space Shuttle rocket booster at liftoff. It is *incredibly* unlikely that an automobile would have this capability.