I. Wondering About...
...hand and foot reaction times.

II. Investigation To Undertake
Build a spreadsheet in which you can collect data about reaction times for various uses of your hands and feet: catching a dropped object with your hand, moving your hand away so that a small dropped object does not hit it, moving your foot away so that your hand does not hit it. This data should be collected on a number of people so that averages can be generated.

III. Background
Many factors affect your reaction time in using your hands and feet: the inertia of the limb being used, the speed of nerve signals from the brain to the involved muscles, the complexity of the action, the precision of the action, general muscle tone, etc. Some of these reaction times are quite important in everyday life, say, in driving a car, for instance. The distance that you travel at various speeds while you are reacting to a situation can be greater than the distance you travel while you are applying the breaks or steering to avoid an unpleasant situation.

   Typical reaction times are 0.10 seconds or greater. How far does one travel at 60 mph in 0.20 seconds, a more typical reaction time? In another setting, it is useful to realize that a golf ball is nine meters away by the time you can react to feeling it hit the club! While typical impact times in golf are 0.0005 seconds, in other sports impact times can be as long as 0.005 seconds. You can use this and an estimate of the speed of the object being hit to estimate how far away it is by the time that you can react.

IV. Related Science Concepts
Use the time for an object to fall a short distance as your measure of reaction time. A meter stick or ruler will be required to measure the distance fallen.

1. For a simple hand reaction, place the subject’s palm down on a table with the ruler standing straight up just beyond the fingertips. Drop a small object (a ball, paper clip, etc.)
from increasing heights starting at about 5 cm (2 inches) until the subject can just get his/her fingers out of the way before the object hits the table. Does the thickness of the fingers matter?

2. For a more complex hand reaction, have the subject place his/her forearm on the table with the hand extending out beyond the edge. The hand should be poised to grasp a vertically falling ruler. Hold the edge of the ruler just above the hand. Drop the ruler. How much of the ruler falls through the hand is a measure of the time for the ruler to fall while the hand is reacting. Just where on the hand do you measure the amount of fall of the ruler? Which reaction time is shorter on the average, this one or the previous one?

3. For a foot reaction, use an arrangement on the floor much like number 1 above. Place the ruler just beyond the toes with the foot flat on the floor. Drop a small object from various heights until the foot can just clear before the object can hit it. Does the thickness of the toes/shoe matter?

**EQUATIONS**
When falling from rest the distance fallen is
\[ d = \frac{at^2}{2} \]
where \( d \) is the distance fallen, \( t \) is the time of fall, and \( a \) is the acceleration of the fall. The time to fall is therefore
\[ t = \sqrt{\frac{2d}{a}} \]
The acceleration of a falling object is 9.8 m/s\(^2\) or 32 ft/s\(^2\).

**V. Mathematical Methods**
Set up your spreadsheet with
1. the first column to list the subject’s last name,
2. the second column to list the subject’s first name,
3. the third column to indicate the distance fallen for the simple hand reaction,
4. the fourth column to calculate the time of fall for the simple hand reaction,
5. the fifth column to indicate the distance fallen for the complex hand reaction,
6. the sixth column to calculate the time of fall for the complex hand reaction,
7. the seventh column to indicate the distance fallen for the foot reaction, and
8. the eighth column to calculate the time of fall for the foot reaction.

Put a label at the heading of each column and for measured and calculated values indicate the units used. At the bottom of each measured and calculated column have the spreadsheet calculate the average, maximum, and minimum values in the column.