Measuring Motion

**Purpose:** To gain experience describing and identifying different types of motion; To calculate the average speed of an object from measurements of distance and time.

**Procedures:**

1. Set up a small length of Hotwheels track so that it is inclined with respect to the level floor. (You can prop one end on a couple of books or kilogram masses. Look at the track as you release a Hotwheels car down it. If it flexes you may need some support under the middle of the track as well. You can tape the track to a stiff ruler or meter stick and then support the back end with a book. Take some masking tape and mark a 1.0 meter length of floor just off (start 2-3 cm beyond) the end of the track. This is your race course. Your job is to race two Hotwheels cars to find out which has the fastest average speed. Be sure to release each car from the same point on your track!

2. Once you have run your Hotwheels race, take your stopwatch and meter stick into the hall and design an experiment to find your own average walking speed in miles per hour.

**Data:**

**Part 1: Hotwheels Race**

1. Draw and label your set up:

   > Answers will vary. Labels should include the distances $d_1$ and $d_2$.

2. Measure the length of the inclined track, from where you release the car to the end:

   $$d_1 = \text{__________}$$  
   Answers should be in metric units, to nearest mm.

3. Measure the distance on the floor from a shortly beyond the track (a point where the car no longer touches the track) to the end of the ‘racetrack.’ (This is the distance over which your cars will race.)

   $$d_2 = \text{__________}$$  
   Answers should be in metric units, to nearest mm.

4. Find two cars that will travel the race course. This may take a few trials, since some cars have bum wheels! Briefly describe your cars:

   **Car #1:**

   **Car #2:**

   > Enough information should be given so students can identify their cars.
5. Over which distance, $d_1$ or $d_2$, is your car accelerating? How do you know?

Both. Over $d_1$ the car is accelerating because it is speeding up. I know this because the car starts from rest (zero speed) to a fast speed when it leaves the ramp. It is also accelerating over $d_2$ because it is slowing down, or changing direction. Some of the cars curve right or left after they leave the track. I know it is accelerating because if I let the car continue to move it will gradually come to rest.

6. Run your race! Measure the time for the car to cover the distance $d_2$ and enter your results below:

<table>
<thead>
<tr>
<th>Trial #</th>
<th>CAR #1</th>
<th>CAR #2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time (s)</td>
<td>Average Speed (cm/s)</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Show your sample calculation of Average speed here (just do trial #1):

List Knowns: For example: $d = 100.0 \text{ cm}$

$t = 0.95 \text{ s}$

$v = ?$

Write equation: $v = \frac{d}{t}$

Substitute and solve: $v = \frac{100.0 \text{ cm}}{0.95 \text{ s}} = 105 \text{ cm/s}$

7. What problems did you encounter in running your race?

For example: One of my cars did not continue to move in a straight line once it left the incline, so it had really covered a greater distance than the other one when it crossed the finish line. This made its speed slower than it really was. My second car didn’t travel all the way to the finish line before it stopped, so we had to choose a different car. Then everything went OK.
PART 2: How fast do you walk?

Now, use what you learned in Part 1 to design an investigation to determine your average walking speed. Make and record all necessary measurements. Be sure to use enough trials. First use the proper metric units, then convert this to miles per hour. Use the proper format for explaining your calculations.

1. Average walking speed:

   Students should organize their data neatly and have at least 3 trials of their walking speed. Proper table form is preferred. A distance of 3-5 meters or longer is better than a shorter distance, since starting and stopping are a smaller portion of the motion.

2. Now, convert this value into miles per hour:

   Students should list the conversion factors first and use the factor-label method of conversion.

Conclusions: The conclusion should state some new fact or principle they have discovered in this lab. Since they set out to race their hotwheels cars the conclusion should include a statement about which car was faster. Also, since they set out to determine their average walking speed the conclusion should also include a statement: “My average walking speed is . . . . This is . . . miles per hour.” They can also compare their walking speed to car speeds, or make an estimate of how long it would take them to walk to the store and back…. etc.