Investigation 1
Measurements, Units, Linear Motion

1. In mechanics, the fundamental units on which all other units in mechanics are defined are the units of _________, _________, and _________.

2. Three systems of units are commonly used in science measurements. They are the MKS, CGS, and British Engineering System. Complete the table below with the names of the units and their abbreviations.

<table>
<thead>
<tr>
<th>System</th>
<th>Unit of Length</th>
<th>Unit of Mass</th>
<th>Unit of Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>MKS</td>
<td>meter (m)</td>
<td>kilogram (kg)</td>
<td>second (sec)</td>
</tr>
<tr>
<td>CGS</td>
<td>centimeter (cm)</td>
<td>gram (g)</td>
<td>second (sec)</td>
</tr>
<tr>
<td>British England</td>
<td>foot (ft)</td>
<td>slug</td>
<td>second (sec)</td>
</tr>
</tbody>
</table>

3. A car is traveling at a constant 30 miles/hr on Pico Boulevard toward the ocean.
   
a. What is the speed of the car?

   \[
   \text{speed} = 30 \text{ miles/hr} 
   \]

b. What is the velocity of the car?

   \[
   \text{velocity} = 30 \text{ miles/hr} \text{ toward ocean (or west)} 
   \]

c. Which quantity is a scalar and which one is a vector. What is the difference between a scalar and a vector?

   - Speed - scalar - magnitude only
   - Velocity - vector - magnitude and direction

3. A truck is traveling on Ocean Park Boulevard toward the ocean.

a. If the truck is traveling at a constant velocity of 20 m/s, then how far will the truck travel in 6 seconds?

   \[
   \text{dist.} = (\text{const vel}) \times (\text{time}) = (20 \text{ m/s}) \times (6 \text{ s}) = 120 \text{ m} 
   \]

b. If the speed of the truck is changing, but its average speed is 20 m/s, then how far will the truck travel in 6 seconds?

   \[
   \text{dist.} = (\text{avg speed}) \times (\text{time}) = (20 \text{ m/s}) \times (6 \text{ s}) = 120 \text{ m} 
   \]
4. a. A physics student runs a distance of 100 m in 20 seconds at a constant speed. At what speed was the student running?

\[
\text{speed} = \frac{\text{dist}}{\text{time}} = \frac{100 \text{ m}}{20 \text{ s}} = 5 \text{ m/s}
\]

b. A second student starts from rest and then slowly increases her speed until she travels a total distance of 100 m. The total time she takes is 20 seconds. Was she traveling at a constant speed? What was her average speed?

- not a constant speed!
- avg speed = \( \frac{\text{dist}}{\text{time}} = \frac{100 \text{ m}}{20 \text{ s}} = 5 \text{ m/s} \)

Note that even though the second student was not traveling at a constant speed, her average speed is the same as the first student's constant speed, and therefore they both travel the same distance in the 20 seconds.

5. The sketch shows a ball rolling at constant velocity along a level floor. The ball rolls from the first position shown to the second position in 1 second. The two positions are 2 feet apart. Sketch the position of the ball at successive 1-second intervals all the way to the wall (neglect any resistance to the motion).

The ball is traveling with a speed of \( \frac{2 \text{ ft}}{5 \text{ s}} \) when it reaches the wall, and takes a time of approximately \( 5 \text{ sec} \).

6. The table shows data of the sprinting speeds of some animals. Make whatever computations are necessary to complete the table. Be sure to include the units.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Distance</th>
<th>Time</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheetah</td>
<td>75 m</td>
<td>3 sec</td>
<td>25 m/s</td>
</tr>
<tr>
<td>Greyhound</td>
<td>160 m</td>
<td>10 s</td>
<td>( \frac{4}{5} \text{ m/s} )</td>
</tr>
<tr>
<td>Gazelle</td>
<td>1 km</td>
<td>( \frac{1}{100} \text{ hr} )</td>
<td>100 km/hr</td>
</tr>
<tr>
<td>Turtle</td>
<td>30 cm</td>
<td>30 s</td>
<td>1 cm/s</td>
</tr>
</tbody>
</table>

\[
\text{time} = \frac{\text{dist}}{\text{speed}}
\]

\[
\text{speed} = \frac{\text{dist}}{\text{time}}
\]

\[
\text{dist} = \text{speed} \times \text{time}
\]