LAB: FREQUENCY OF A TICKER-TAPE TIMER

LEARNING GOALS

Students will:

- Perform measurements using some motion equipment.
- Learn about precision and accuracy.
- Learn about the importance of using significant digits when measuring.

LAB ACTIVITY

**Purpose:** To determine the period and frequency of the ticker-tape timer.

**Apparatus:**
- period timer
- ticker tape, carbon disk
- stopwatch

**Method:**
1. Set up the timer and with it OFF, practice pulling the tape through the timer at a constant speed.
2. Draw a line approximately 10 cm from each end of the tape and using the stopwatch, and with the timer OFF, practice timing the travel from line to line.
3. When ready, turn on the timer and one person pull the tape AT CONSTANT SPEED while the other times. START the time when the first line passes the striker and STOP when the second line passes.
   *** The speed you pull through will affect the results due to the timer’s reaction time.
4. Record the number of dots printed and the elapsed time.
5. Repeat the experiment using the other side of the tape.
6. Determine the period and frequency of the timer. Show your calculations below the table.

\[
\text{period} = \frac{\text{elapsed time}}{\text{number of dots}}
\]

\[
\text{frequency} = \frac{\text{number of dots}}{\text{elapsed time}}
\]

**Observations:**

<table>
<thead>
<tr>
<th>Number of Dots</th>
<th>Elapsed Time (s)</th>
<th>Period (s)</th>
<th>Frequency (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Results of both trials for the ticker-tape timer.
Analysis:

1. Accuracy refers to the closeness of a measurement to the accepted value for a specific quantity. In this case, the frequency of the electrical socket controls the frequency of the ticker-tape timer. Use the percent error from the previous day to determine the accuracy of your results with the accepted frequency of 60 Hz.

2. Precision is the degree of agreement among several measurements that have been made in the same way. In this experiment, you completed two trials and we want to determine the precision of our measurements. If the percent difference between values is low, then we know that our experiment is producing the results that are in agreement with each other. Calculate the percent difference for your frequencies.

   \[
   \text{% difference} = \frac{\text{maximum value} - \text{minimum value}}{\text{average value}} \times 100\%
   \]

3. Discuss some potential sources of experimental uncertainty you noticed throughout this experiment.

Figure 1. Diagram indicating the relationship between precision and accuracy.
Recall that every measurement has a degree of uncertainty. It is general practice in physics to take the uncertainty to be half the smallest division of the measuring device.

Examine the following examples:

- \( \text{length} = 5.8 \, \text{cm} \pm 0.5 \, \text{cm} \)

Notice that the uncertainty corresponds to the last decimal of the measurement.

### PRACTICE

1. At a certain location the acceleration due to gravity is \(9.81 \, \text{m/s}^2\) [down]. Calculate the percentage error of the following experimental values of “\(g\)” at that location.
   - a. \(8.94 \, \text{m/s}^2\) [down]
   - b. \(9.95 \, \text{m/s}^2\) [down]

2. Calculate the percentage difference between the two experimental values (8.94 \(\text{m/s}^2\) and 9.95 \(\text{m/s}^2\)) in question #2 above.

3. Use a ruler calibrated in centimetres to measure the distance from the centre of each plus sign to the next. Include the error in your measurement.

4. The following voltage and current data was gathered to determine the resistance of a resistor.
   - a. First, fill the third column by dividing V by I. Once you have completed the column, average the values and record your result.
   - b. Plot a graph of the values. Use the slope of a best-fit line to get your resistance. Record your result.
   - c. Explain why your result in b) is more accurate than your result in a).
5. Record each measurement with the correct number of decimal places and the correct uncertainty. Assume the units are cm unless otherwise noted.

a. 

b. 

c. 

6. Three lab groups measured the time taken for a ball to roll down a ramp. They did the experiment five times each with the same ramp. Their results are shown below.

<table>
<thead>
<tr>
<th>Time for Group 1 (s)</th>
<th>Time for Group 2 (s)</th>
<th>Time for Group 1 (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.23</td>
<td>2.25</td>
<td>2.55</td>
</tr>
<tr>
<td>2.34</td>
<td>2.22</td>
<td>2.64</td>
</tr>
<tr>
<td>1.98</td>
<td>2.27</td>
<td>2.49</td>
</tr>
<tr>
<td>2.28</td>
<td>2.19</td>
<td>2.58</td>
</tr>
<tr>
<td>2.11</td>
<td>2.23</td>
<td>2.51</td>
</tr>
</tbody>
</table>

a. Calculate the percent difference for each group.

b. Which group had the most **precise** results? How does this relate to your answer from a?

c. A photo-sensor timed the ball to have actually taken 2.22 s to go down the ramp. Which group would you say is the most **accurate**? Explain.

d. Calculate the percent deviation (percent error) of each group (use their average as the experimental value and the photo-sensor as the accepted value). How do your values relate to your answer for c?