Physics 11: Introductory Activity - The Simple Pendulum

Research Questions:

- ***What factor(s) determine the period (T) of a Simple Pendulum?***
- ***What effect (if any) do each of the factors have on the period?***

Learning/instructional objectives of this activity include, but are not limited to ….:

- **Experimental physics skills**
  - Experimental design
    - Planning controlled experiments; designing experimental methods; choosing appropriate equipment; optimizing experimental set-up; working effectively as a member of a team
  - Measurement
    - Use of measurement tools; careful attention to hand-eye co-ordination
    - Identifying sources of error and measurement limits
  - Graphing
    - Drawing graphs using methods standard to the discipline (physics methods)
    - Interpreting graphs by making sense of the shapes of the graphs, and what those shapes imply about data trends and mathematical patterns (pattern seeking)
    - Develop and interpret the equation of a straight line graph (equation in the form $y = mx + b$)
  - Data analysis
    - Interpreting data and drawing conclusions, including specifying and articulating the limits to the conclusions (research results tell us some things, but not everything – there will always be many questions left unanswered, and new questions will arise)
  - ***Instructional Resources:*** *Resources will be provided in the form of handouts, also available posted on the class website.*

- **Scientific literacy**
  - Write and explain your ideas and findings, in paragraph form; Appropriate use of visual representations such as diagrams, data tables, and graphs.
  - ***Instructional Resources:*** *Provided in the form of handouts (also available posted on the class website)*

- **Physics theory**
  - *Simple Harmonic Motion*, applied to the Simple Pendulum
  - ***Instructional Resources:***
    - *Notes/lessons in class (definition of period and frequency; characteristics of the "simple pendulum"; period of the simple pendulum)*
    - *A VERY USEFUL online simulation to deepen your understanding: https://phet.colorado.edu/en/simulation/legacy/pendulum-lab*

Part 1: Consider the Problem (small group discussion and idea sharing):

With your group, consider the following ideas and questions. Write and/or draw your ideas about each of the questions (rough/point form is ok).

1. Consider the term, "***Simple Pendulum***"
    a. What does the term "***pendulum***" mean? Use words and diagram(s) to define the characteristics of "pendulum". Your level of clarity and precision should be such that readers are be able to imagine both what a pendulum ***is***, and what it ***is not***.

    b. The type of pendulum we will be investigating is ***simple***, but other types of pendula (pendulums) exist outside the lab. In terms of physical design, ***differentiate*** between "*simple*" and "*non-simple*" pendula (e.g. compound pendulum, bifilar pendulum, torsional pendulum)

2. ***Period "T" (s)*** = *the time for one complete cycle of a repetitive (periodic) event*
    a. A pendulum swinging freely is an example of an object in periodic motion. Consider the world around you – both the natural world, and human created objects and concepts. List as many ***periodic events*** as you can think of:
        i. Natural

        ii. Human created objects and concepts

b. Imagine that you are observing a pendulum swinging through repetitive cycles, unobstructed (an "ideal" pendulum with no friction and no damping). How can you identify the start and end of a single cycle? (draw diagrams to show/explain your ideas).

c. In your lab, you will be using a handheld stopwatch to measure the period (T) of a pendulum.
   i. List as many *sources of error* that you can think of, inherent to using a handheld stopwatch to measure the time for the swing of a pendulum.

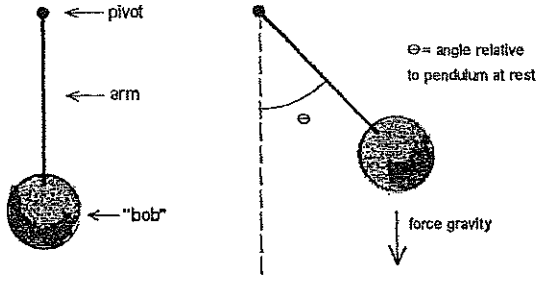
   ii. Suggest a strategy or strategies for minimizing the effects of the inherent sources of error associated with using a handheld stopwatch:

   iii. Measurement limits: considering both the measurement limit of the stopwatch (measures to the nearest _____ s), and sources of error associated with measurement technique, estimate the approximate limit to precision of your measurement of period: ± _____ s

3. **Mass "M" (kg)** = mass of the simple pendulum (in kg). You will determine the mass of the simple pendulum by using an electronic balance.
   a. List as many sources of error as you can, inherent to using an electronic balance for this purpose.

   b. Suggest a strategy or strategies for minimizing the effects of the inherent sources of error associated with using an electronic balance for this purpose:

4. **Displacement Angle "θ" (°)** = The angle relative to the rest position (vertical) that the pendulum string makes the instant before it is released (shown as θ in the diagram below).



Suggest and describe 2 different strategies for determining the displacement angle (there are 2 reasonable methods that require equipment commonly found in physics and math classrooms).

5. **Length "L" (m)** = the distance from the pivot point of the pendulum to the centre of mass of the bob.
   a. What does the term "*centre of mass*" mean?

   b. List sources of error associated with measuring the length of the pendulum.

   c. Estimate the limit to which the length can be measured: ± _____m.

6. When performing the lab you will collect data and complete the data analysis. You will take measurements for 10 different data points, and complete 3 trials for each data point.
   a. Why do scientists typically complete multiple trials for each data point? What is the advantage of multiple trials (rather than just one)?

   b. After you graph the data, what evidence will you look for to determine whether or not 10 data points is sufficient? (perhaps more than 10 are needed? Or, perhaps fewer than 10 would be sufficient?)