PHYS 211 Lab Practicum 2: Information and Guidelines

You will have **1 hour and 15 minutes** to formulate and execute a plan, and prepare a report in response to the **prompt** you are assigned from the list of three below. Use any tools and resources available in the lab to assist you. On the lab bench you will be provided with the prompt assigned to you, all necessary equipment, the Core Elements, and the lab manual. You will also be provided with paper for the written lab report. Bring your lab notebook, a pen, and a calculator with you to the practicum.

Throughout the practicum, you **must** keep a log of your experimental procedure and reasoning to be handed in as a final report for the practicum grade:

- Use the Core Elements for a lab notebook entry to guide your write-up. The write-up should include appropriate elements such as a lab header, purpose, apparatus (if applicable), procedural details, data, graphs, analysis, and a conclusion. At the end of this document, you will find a description of the Assessment Criteria.

- We will scan up to 5 pages (front and back) of your submission, including the cover page. Ideally, your written description should be 1-2 pages, with any Excel or other printouts included as separate sheets, labeled, and referred to in your write-up. **Do NOT cut-and-paste print-outs into your report pages; simply add them as additional pages at the end of your submitted report**. Do not staple.

- Include your name on each page of your report.

Please note that you will not repeat one of the previous labs; instead, you will be assigned one of the following three prompts. The numbers **will** change in the actual Practicum.

Prompt A:
An object is dropped from a set height, and video tracking software is used to obtain the object's position with respect to time, from which velocity and acceleration can be computed. The drag force has a magnitude that is proportional to the speed ($|\mathbf{v}|$):

$$|\mathbf{F}_{\text{drag}}| = b\,|\mathbf{v}|,$$

where b is the drag coefficient. Use Newton's second law and Euler's method to build a numerical model for this motion. Your model will then be used to determine an experimental value for the drag coefficient, b. The data set is provided in the public netspace folder *PHYS 211_212 Lab > 211Lab > Lab_Practicum_2 > prac2_promptA_template_fa2024*. The mass of the object will be given to you the day of the Practicum; for practice, use 8.8 grams. Use $g = 9.81$ m/s^2.

1. Save your own copy of the Excel spreadsheet containing the data set so you can edit it.
2. Fill in the parameter table and apply Euler's numerical method to evaluate the four columns of time (t), position (y), velocity (v_y), and acceleration (a_y). Do not copy formulae from previous Excel sheets.
3. Create two plots: one of y vs t, containing both the experimental and simulation data; and the other of v_y vs t, containing both the experimental and simulation data.
4. Experiment with the value of the drag coefficient to obtain a best estimate for b. This value should be included in your conclusion.

Include an example of each iterative formula you used, a print-out of the first page of your Excel spreadsheet, and a print-out of the plots of y vs t and v_y vs t, as part of your report.

OR

Prompt B:

A physical model of the human forearm can be used to study the force applied by the bicep. In this experiment, we will assume that the bicep muscle is acting at an angle of 50° with respect to the forearm, which is parallel to the ground. Assume that 250 grams (including the mass of the hanger) are attached to the model at the COM and that *no additional mass* is attached to the model at the hand.

1. Use the model of the human forearm provided in the lab room and the spring scale (which represents the bicep muscle) to measure the bicep force F_{bic}^{exp} and its uncertainty experimentally under the conditions described above. Ignore the uncertainty in your measurement of the angle.
2. Derive a formula for the theoretical value F_{bic}^{theor} . Make any necessary measurements of the model to evaluate F_{bic}^{theor} .
3. Write a conclusion including whether your experimental value is consistent with your theoretical calculation based on your analysis.

OR

Prompt C:

Measure the period of the pendulum provided, along with its experimental uncertainty.

1. Obtain a theoretical value for the period of the pendulum provided. For small amplitude oscillations of a pendulum, the period (T) of a pendulum of length (L) is given by

$$T = 2\,\pi\,\sqrt{\frac{L}{g}},$$

with gravitational acceleration $g = 9.81$ m/s^2. Ignore the uncertainty in your measurement of L.

2. Determine the period, T, of the pendulum by measuring 70 swings one time, and determine your uncertainty by measuring 1 swing ten times.
3. Write a conclusion including whether your experimental value for T is consistent with your theoretical value based on your analysis.

(Assessment Criteria on the following page.)

Assessment Criteria

Practicum reports will be assessed according to the following five criteria, each given equal weight (maximum 10 points each for a maximum 50 points total). Of greatest importance is the student's ability to clearly communicate their experiment and interpret their results.

1. A clear, concise statement of the experimental goal. (Core Elements: Lab Header and Purpose)

2. A clear, complete sketch of the apparatus and description of the experimental details, including the procedure used, choices made concerning data collection (equipment used, number of trials, etc.). It should contain enough detail to allow someone else to reproduce the experiment accurately. Where applicable the report should also include a description of uncertainties in the measurement process. (Core Elements: Apparatus and Data)

3. A complete record of data collection and presentation. This section may include tables and graphs appropriately labeled and annotated. Since any printouts will be handed in on a separate sheet of paper, figures and tables should be labeled (Fig. 1, Fig. 2, Table 1, Table 2, etc.) and referenced in the report. (Core Elements: Data, Graphs, Computer Files)

4. A clear, concise description of the analysis undertaken to achieve the experiment's goal. This description should include all analysis of uncertainties. Any calculations using the measured data should be clearly documented. If repetitive, then show one representative calculation. If Excel is used, include a printout of the sheet and annotate representative examples for what you typed into the cells. (Core Element: Analysis)

5. A final statement that summarizes the result of the experiment (quoted in correct scientific format) and the conclusions that can be drawn. If appropriate, this statement should also include comparisons between experimental measurements and theoretical values. (Core Element: Conclusion)