General Guidelines

Below are general formatting requirements that apply to all assignment types and all sections. Examples for everything mentioned here can be found in the text of the example summary. Keep in mind, your TA may have additional formatting or content requirements!

Heading

- Assignment must include a heading with a title and author's names

Paragraphs

- Assignment should be written as if the reader is unfamiliar with the experiment or context
- Assignment should be written in third person perspective
- In describing actions previously taken, past tense should be used
- All content should be in sentences, a table, an equation, or a figure - no bullet points or lists
- All data reported in sentences should still include units and error when appropriate

Plots & Tables

- Plots and tables need figure (plot) or table numbers with a descriptive caption
- Plot axes must be labelled with title and units
- Plots that include multiple data sets must include a legend with labels to distinguish them
- Table rows/columns must be labelled with title and units
- Tables should be formatted as tables with borders, not a screenshot of a spreadsheet

Figures

- Figures need figure numbers with a descriptive caption

Equations

- Equations must each be on their own line and formatted as an equation
- Variables used in equations must be defined

References

- Any preferred reference system that is consistent and clear is fine (IEEE, APA, MLA, etc.)

Example Summary[1] – Hooke's Law

Author Names
General Physics I | IU Indianapolis | Fall 2024

Analysis

Analysis Guidelines	60 %

This is the big one. This section is all about stating the results of your experiment in detail, giving them context, describing the analysis you performed, and stating the results of that analysis in detail. Essentially: what did you measure, what did you do with it, and what did you find?

This should at least include: (1) all experimental results (raw data or summaries of it) in value, plot, or table form, (2) descriptions of the analysis process used to make sense of that raw data, (3) all analysis results in value, plot, or table form, (4) error values or error bars on all results when relevant along with description of what that error represents experimentally.

The above gives general types of content that will be included in this section for most experiments, but always look at the experiment handout for more details about the results and analysis you need to include for a specific experiment.

[1] This example is primarily intended to provide you with a visual representation of what a lab summary should look like. **This example is not meant to be representative of all of the content you will be expected to put in your own summary.**

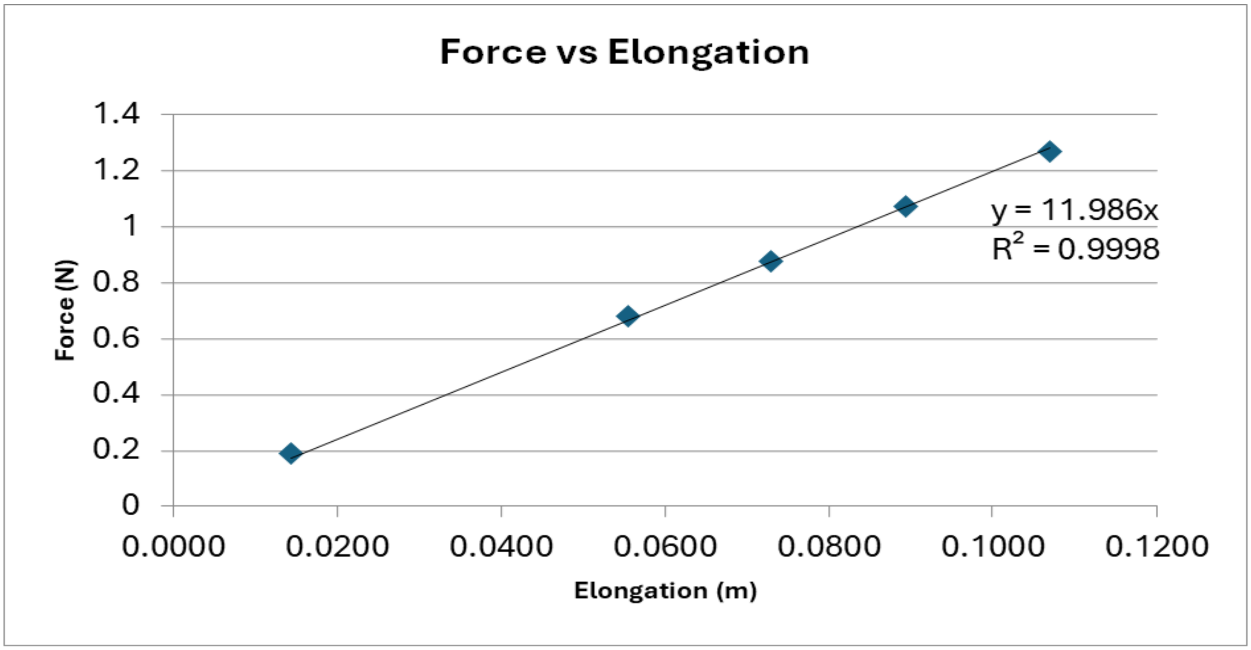

Figure 1: A force vs elongation plot for Activity 1 with a linear trendline forced through the origin. Error bars representing the standard error of the elongation are on the points but are too small to appear on the plot.

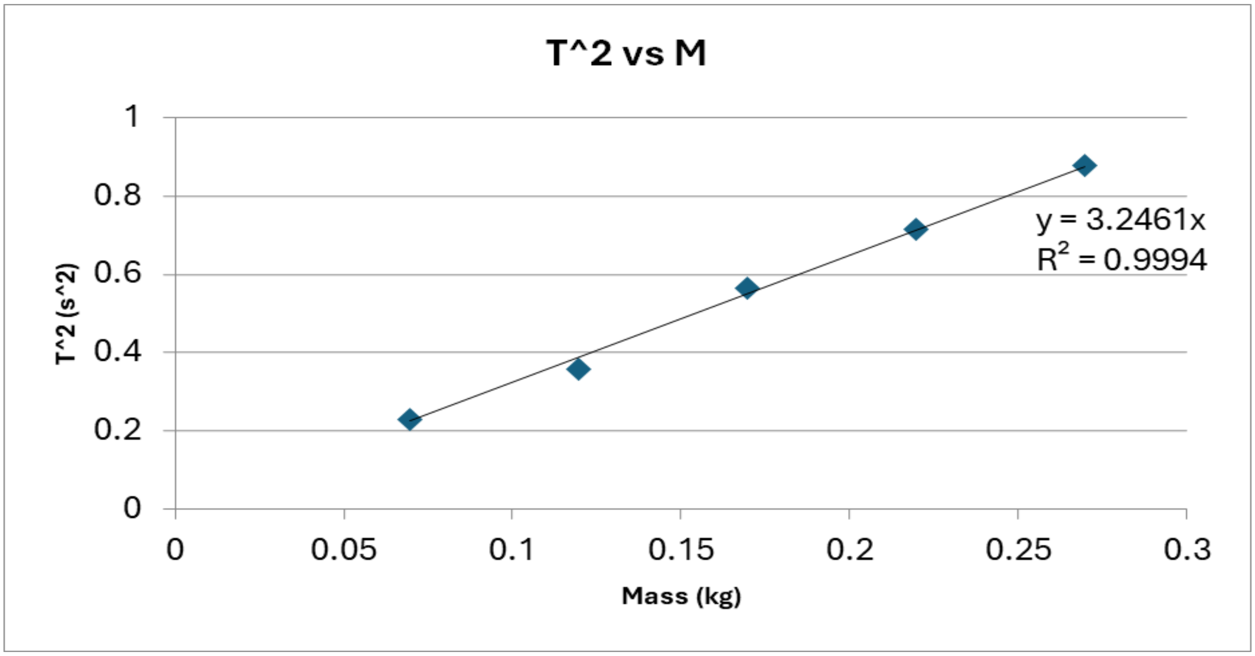

Figure 2: A Period^2 (T^2) vs mass plot for Activity 2 with a linear trendline forced through the origin. Error bars representing the standard error of T^2 are on the points but are too small to appear on the plot.

Summary Table				
k (N/m)		σK (N/m)		% diff
Act 1	Act 2	Act 1	Act 2	
11.66	12.16	0.09	0.15	4.198

Table 1: A summary of the results from Activities 1 and 2 showing the spring constant found from each method and its associated uncertainty. The percentage difference was also determined and shown in the table.

Summary

Summary Guidelines **30 %**

This section serves as a high-level summary of the content that would be in the "Theory", "Procedure", and "Discussion" sections if this were a full report. Essentially, it's a summary of the whole experimental process, the analytical process, and your results all in one section!

Should at least include (1) the objective of the experiment, (2) the experimental approach for collecting data (tools, experimental set-up, etc.), (3) the approach for analyzing data (equations, calculation methods, etc.), (4) the primary results and measurements with error (major values, trends, etc.), (5) how these results compare with theory, known results, and your expectations.

In Activity 1, we used Hooke's Law to measure the spring constant of a spring, resulting in a value of 11.66 +/- .09 N/m as the spring constant for the first activity. This was done by suspending a spring vertically from a ring stand and adding mass to the spring while measuring how far the spring was stretched. A plot of the force vs the elongation of the spring was generated. From Hooke's Law, the slope was determined to be equivalent to the spring constant, allowing for a direct measurement of the spring constant from Figure 1. The uncertainty was found to be +/- 0.09 N/m as determined from the LINEST tool.

The goal of Activity 2 was to measure the spring constant while the spring was exhibiting simple harmonic motion. The spring constant was found to be 12.16 +/- 0.15 N/m. Masses were added to the bottom of a vertically suspended spring which was stretched ~10cm each time and then released. The periodic motion was then measured using stopwatches. A plot of T^2 vs the mass was generated. The slope in this plot is equivalent to $\frac{4\pi^2}{k}$, leading to the spring constant of 12.16 N/m. The uncertainty was found to be +/- 0.15N/m, though the determination of this uncertainty was slightly more rigorous than in Activity 1, requiring error propagation.

Unfortunately, while the two values from each activity are within <5% (~4.2%), they are not in agreement with one another as neither value fits within the other's boundaries. This disagreement could be due to a myriad of potential errors. In Activity 1, the uncertainties for the length and mass measurements were deliberately chosen to be 20% of the smallest division to account for estimation errors between tick marks on the meter stick and/or the triple beam balance. Additionally, while length measurements should be made to the same point each time, there could have been slight deviations each time, resulting in random errors. There was an assumption made for the sake of time that the values printed on the masses added to the mass hanger were accurate, and this assumption could be invalid. While the generic 20% rule could account for this deviation, a simple solution of measuring the masses could have given a more accurate mass and more representative uncertainty.

Activity 2 had its fair share of errors as well. First, stopwatches were used where partners had to start and stop the stopwatches at certain intervals. This method relies heavily on reaction times, so the stopwatch may not have been started exactly when the hanging mass was released or stopped at exactly the tenth complete cycle. Additionally, the second data point in Figure 2 appears to be lower than the trendline would suggest, so it is likely that a random error (such as possibly pulling down further than 10cm) occurred to cause a lower value. On a related note, it is almost impossible to pull the hanging mass down exactly 10cm each time, so it’s likely that could be a source of noise in the data. Additionally, while the motion for the spring was intended to be only in one dimension (vertical), there is a distinct probability that the motion could have also been in the horizontal direction as well, which would have an impact on the stability and path of the spring.

Despite this myriad of potential errors, the values for the spring constant from each activity are only ~4.2% different from one another. So, while the values currently do not agree with each other, this is likely due to the relatively small uncertainties attached to each rather than a fundamental difference in the methods. That said, the relative opportunities for error seem to be greater in number for Activity 2, which is reflected by the higher uncertainty in the value of the spring constant. A photogate in Activity 2 could dramatically reduce the number of potential errors (such as reaction time), which could lead to better results. Additional trials with more masses could also improve the overall fit of the line too, and could help bring the values from each activity closer in line with one another.

Care & Professionalism Guidelines	**10 %**
This last section isn’t content you’ll include in any submissions, but it is a grading category. This category is all about the intentionality and care you display in the way your submission is written. Basically, all content should be simple to find and easy to read! No specific headings, fonts, margins, or other factors are specifically required, but the structure, format, and content must work together such that (1) all information is present and is <u>organized</u>	

clearly and logically, (2) nothing is overly distracting or difficult to read, and (3) spelling, grammar, and punctuation are acceptable.