

# Lab 2: Free-Fall Guide/Rubric

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For Lab 2, you are responsible for ONLY these five sections of the formal report:  
Research Question, Data Collection, Analysis, Appendices, Conclusion

Use the following lists as a GUIDE as you write the report.  
I will use it as a RUBRIC when I grade the report.

## Research Question:

1. One RQ relating to strings and screws and rhythms. This question should include:
  - a. All of the relevant givens, i.e. everything the reader needs to know to understand how strings and screws make rhythms;
  - b. The independent variable;
  - c. The dependent “variable”;
2. A second RQ relating to the nature of free fall.
  - a. This question should specifically mention the three different “types” of motion you tested for;
  - b. This question may actually contain a couple of questions.

## Data Collection:

1. basic setup of strings & bolts prior to drops;
2. *brief* description of each string that was tested (including some *mention* of the mathematical pattern used, but save the details for Analysis);
3. in parentheses: where specifically in the appendices the position/interval diagrams of *each* string can be found;
4. how strings were arranged before dropping;
5. how observations were taken during the drops;
6. what was observed (heard) during each drop;

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### Analysis:

1. How screw positions were calculated for each string
2. Evenly spaced string:
  - a. Discussion of the **counterfactual** scenario: **IF** this string had produced a steady rhythm, what **would** we conclude about time intervals, distances, and therefore about average speed?
  - b. What did the ACTUAL observed rhythm tells us about time intervals between screws?
  - c. Compare observations about time intervals to distances traveled.
  - d. Relate time and distance to average speeds.
  - e. Draw conclusion about speed of screws over time.
3. Square Pattern String
  - a. What the ACTUAL observed rhythm tells us about time intervals between screws.
  - b. Compare observations about time intervals to distances traveled.
  - c. Explain why a beat can be used as a unit of measurement in this situation.
  - d. Relate time and distance to average speed: COMPUTE average speeds in appropriate units.
  - e. Draw qualitative conclusion about speed of screws over time.
  - f. Compute change in speed from screw to screw: what pattern is found?
4. Cube Pattern String
  - a. Counterfactual: IF this string had produced a steady rhythm, then...
    - i. What would we conclude about time intervals?
    - ii. Calculate average speeds [in cm/beat].
    - iii. Compute changes in average speed.
    - iv. Discuss: what is happening to speed over time **in this counterfactual scenario**? What is happening to acceleration over time?  
**REMEMBER**, the above steps (i-iv) are about a counterfactual: they are **NOT** about what you found in the lab. They are about what you **WOULD** have found **IF** the cube string had produced a steady rhythm.
  - b. Discuss **actual** observed rhythm: what conclusion do we draw from it?

### Conclusion:

1. State answers to both RQs.
2. Mention possible sources of error/uncertainty and how they might affect your conclusion. (Do not stress about the formal concept of uncertainty or formal error-analysis; the discussion of error/uncertainty should be informal & qualitative. We will introduce formal uncertainty methods in another couple weeks.)

### Appendices:

1. Any formulae or calculations relevant to computing screw positions.
2. Interval & position diagrams for all three strings.
3. Computed differences in intervals, differences in differences, etc.
4. Any other data you deem relevant.