

# Lab 4: Guide/Rubric

JOHN JAY COLLEGE OF CRIMINAL JUSTICE, THE CUNY  
PROF. MAX BEAN

For Lab 4, you are responsible for these seven sections of the formal report:  
RQ, Data Collection, Diagram, Analysis, Uncertainty, Conclusion, Appendices

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 the initial challenge. This RQ should...
  - a. mention all relevant givens & constants—everything that was fixed about the experimental setup (the use of a weapon to create consistent initial velocity, where & how the weapon was aimed & position);
  - b. state clearly and specifically what variable was pre/retro-dicted.
2. *If* you completed the second challenge, a second RQ relating to that challenge, including the same elements listed for the first RQ.

## Data Collection:

First Challenge:

1. what photogates were used for;
2. how photogates work (i.e. what exactly they measure);
3. how photogates were arranged & positioned;
4. discussion of any issues of accuracy considered in arrangement of photogates (this is especially relevant if only one photogate was used);
5. description of trials involving photogates (i.e. what happened in each trial);
6. in parentheses: where specifically in the appendices the data can be found;
7. precise description of any other measurements taken (from where, to where);
8. setup for final test;
9. results of final test.

Second Challenge (if you got to it):

1. description of any new measurements taken for this challenge
2. setup for final test;
3. results of final test.

## Diagram:

1. A general diagram showing:
  - a. the weapon, the path of the bullet, the cup;
  - b. the initial height, the range, distance from bullet's landing point to cup.
2. A close-up diagram showing:
  - a. the weapon, the photogate(s), the bullet's path through the gates;
  - b. the measured displacement used in the velocity calculation;

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**Analysis:**

## First Challenge:

1. What equation did you use to calculate velocity through photogates?
2. What did you do with raw time from the photogates to get time interval?
3. What did you use as a displacement & why was this the relevant displacement for the time interval found from the photogates (a diagram may help)?
4. In parentheses: where specifically in the appendices can the calculated speeds be found?
5. What equation did you use to calculate air time?
6. Why is this equation applicable in this scenario?
7. What values did you substitute in for each variable in this equation—and *WHY*? (This is a big one—there's a good deal to be said about this.)
8. What equation did you use to calculate range (and why is this equation applicable, if it's not a definition)?
9. What values did you substitute into this equation...
  - a. and why?
  - b. In particular, why does it make sense to use the velocity found through the photogates in this equation to calculate the range for the whole trip?

## Second Challenge:

You must provide an equally detailed description of the math relevant to the second challenge—but of course, you did not have to redo the photogate calculation for the second challenge, so you will not have to discuss that.

**Uncertainty:**

1. Briefly introduce the concept of uncertainty.
2. List each measurement device used in the lab, what measurements it was used for, and the associated measurement uncertainty interval.
3. State which method of uncertainty calculation was used.
4. Provide calculated uncertainty intervals for each calculated variable.
5. In parentheses: state where specifically in appendices uncertainty calculations can be found.

**Conclusion:**

1. State answers to both RQs.
2. Mention possible sources of error and how they might have affected your final calculated values.
3. Provide uncertainty intervals for final calculated variables (horizontal range for challenge 1, initial height for challenge 2).
4. If bullet did not land in cup, compare calculated uncertainties to actual observed distance from cup & discuss.

**Appendices:**

1. All raw data.
2. Calculated velocities from photogates (presumably in the same table as the raw data from the photogates).
3. Uncertainty calculations.
4. Any other data you deem relevant.