

## Internal Laboratory Reports

**Unit:** Laboratory & Measurement

**MA Curriculum Frameworks (2016):** SP3, SP8

**AP<sup>®</sup> Physics 2 Learning Objectives:** SP5

**Success Criteria:**

- The report has the correct sections in the correct order.
- Each section contains the appropriate information.

**Language Objectives:**

- Understand and be able to describe the sections of an internal laboratory report, and which information goes in each section.
- Write an internal laboratory report with the correct information in each section.

**Tier 2 Vocabulary:** N/A

---

**Notes:**

An internal laboratory report is written for co-workers, your boss, and other people in the company or research facility that you work for. It is usually a company confidential document that is shared internally, but not shared outside the company or facility.

Every lab you work in, whether in high school, college, research, or industry, will have its own internal report format. It is much more important to understand what *kinds* of information you need to report and what you will use it for than it is to get attached to any one format.

Most of the write-ups you will be required to do this year will be internal write-ups, as described in this section. The format we will use is based on the outline of the actual experiment.

AP<sup>®</sup> || Although lab reports are not specifically required for AP<sup>®</sup> Physics, each section of the internal laboratory report format described here is presented in a way that can be used directly in the “design an experiment” question.

**Title & Date**

Each experiment should have the title and date the experiment was performed written at the top. The title should be a descriptive sentence fragment (usually without a verb) that gives some information about the purpose of the experiment.

---

Use this space for summary and/or additional notes:

**Objective**

This should be a one or two-sentence description of what you are trying to determine or calculate by performing the experiment.

**Experimental Design**

This is the most important section in your report. This section needs to explain:

- What you were trying to observe or measure.
- If something needed to happen, how you made it happen. A flow chart can be useful for this
- Which aspects of the outcome you needed to observe or measure. (Note that you do not need to include the details of how to make the observations or measurements. That information will be included in your procedure.)

**Qualitative Experiments**

If you are trying to cause something to happen, observe whether or not something happens, or determine the conditions under which something happens, you are performing a qualitative experiment. Your experimental design section needs to explain:

- What you are trying to observe or measure.
- If something needs to happen, what you will do to try make it happen.
- How you will determine whether or not it has happened.
- How you will interpret your results.

Interpreting results is usually the challenging part. For example, in atomic & particle physics (as well as in chemistry), what “happens” involves atoms and electrons that are too small to see. You might detect radioactive decay by using a Geiger counter to detect the charged particles that are emitted.

As you define your experiment, you will need to pay attention to:

- Which conditions you need to keep constant (control variables)
- Which conditions you are changing intentionally (independent variables)
- Which outcomes you are observing or measuring (dependent variables)

Use this space for summary and/or additional notes:

**Quantitative Experiments**

If you are trying to determine the extent to which something happens, your experiment almost certainly involves measurements and calculations. Your experimental design section needs to explain:

- Your approach to solving the problem and/or gathering the data that you need.
- The specific quantities that you are going to vary (your independent variables).
- The specific quantities that you are going to keep constant (your control variables).
- The specific quantities that you are going to measure or observe (your dependent variables) .
- How you are going to calculate or interpret your results.

Use this space for summary and/or additional notes:

A good way to record this is to use a table like the following. For example, if you were writing up the experiment described in the section, “Designing & Performing Experiments” (starting on page 40), your experimental design table might include the following:

Desired Variable	Equation	Description/ Explanation	Fixed Control Variable(s) or Constants	Quantities to be Measured	Quantities to be Calculated (Still Needed)
$\vec{F}_f$	$\vec{F}_f = \vec{F}_{net}$	Set up experiment so other forces cancel	—	—	$\vec{F}_{net}$
$\vec{F}_{net}$	$\vec{F}_{net} = m\vec{a}$	Newton’s 2 <sup>nd</sup> Law	—	$m$	$\vec{a}$
$\vec{a}$	$\vec{v} - \vec{v}_o = \vec{a}t$	Kinematics equation	$\vec{v} = 0$	$t$	$\vec{v}_o$
$\vec{v}_o$	$\frac{\vec{d}}{t} = \frac{\vec{v}_o + \vec{v}}{2}$	Kinematics equation	$\vec{v} = 0$	$\vec{d}, t$	—

**What needed to happen:**

The object needed to slide from a starting point until it stops on its own due to friction.

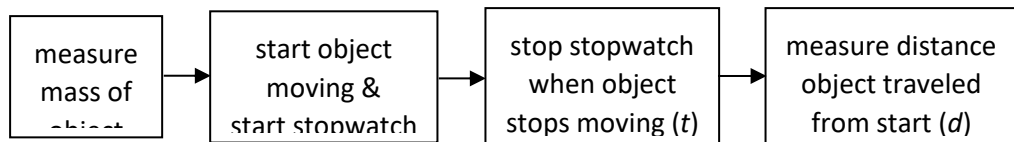
**Fixed Quantities:**

- constants: none
- control variables: final velocity  $\vec{v} = 0$

**Measured Quantities:**

- independent variables: none
- dependent variables: time ( $t$ ) using a stopwatch; distance ( $d$ ) using a meter stick or tape measure

**Flow Chart:**



Use this space for summary and/or additional notes:

**Procedure**

Your procedure is a detailed description of exactly what you did in order to take your measurements. You already identified what you needed to measure in your experimental design section. Your procedure will therefore be fairly brief and much easier to write. This section is where you give a detailed description of everything you need to do in order to take those data.

You need to include:

- A photograph or sketch of your apparatus, with *each component labeled* (with *both dimensions and specifications*), and details about how the components were connected. You need to do this even if the experiment is simple. The picture will serve to answer many questions about how you set up the experiment and most of the key equipment you used.
- A list of any significant equipment that is not labeled in your sketch or photograph. (You do not need to mention generic items like pencils and paper.)
- A narrative description of how you set up the experiment, referring to your sketch or photograph. Generic lab safety procedures and protective equipment may be assumed, but mention any unusual precautions that you needed to take.
- A descriptive list of your *control variables*, including their *values* and how you ensured that they remain constant.
- A descriptive list of your *independent variables*, including their *values* and how you set them.
- A descriptive list of your *dependent variables* and a step-by-step description of everything you did to measure their values. (Do not include the *values* of the dependent variables here—you will present those in your Data & Observations section.)
- Any significant things you did as part of the experiment besides the ones mentioned above.
- Do not start by saying “Gather the materials.” This is assumed.

Use this space for summary and/or additional notes:

**Data & Observations**

This is a section in which you present all of your data. Be sure to record every quantity specified in your procedure, including quantities that are not changing (your control variables), quantities that are changing (your independent variables), and quantities you measured (your dependent variables). ***Remember to include the units!***

For a high school lab write-up, it is usually sufficient to present one or more data tables that include your measurements for each trial and the quantities that you calculated from them. However, if you have other data or observations that you recorded during the lab, they must be listed here.

You must also include estimates of the *uncertainty for every quantity that you measured*. You will also need to state the calculated uncertainty for the final quantity that your experiment is intended to determine.

Although calculated values are actually part of your analysis, it is often more convenient (and easier for the reader) to include them in your data table, even though the calculations will be presented in the next section.

**Analysis**

The analysis section is where you interpret your data. Your analysis should mirror your Experimental Design section (possibly in the same order, but more likely in reverse), with the goal of guiding the reader from your data to the quantity that you ultimately want to calculate or determine.

Your analysis needs to include:

- A narrative description (one or more paragraphs) of the outcome of the experiment, which guides the reader from your data through your calculations to the quantity you set out to determine.
- One (and only one) sample calculation for each separate equation that you used. For example, if you calculated acceleration for each of five data points, you would write down the formula, and then choose one set of data to plug in and show how you got the answer.
- Any calculated values that did not appear in the data table in your Data & Observations section

Use this space for summary and/or additional notes:

- If you need to do a graphical analysis, include a carefully-plotted graph showing the data points you took for your dependent vs. independent variables. Often, the quantity you are calculating will be the slope of this graph (or its reciprocal). The graph needs to show the region in which the slope is linear, because this is the range over which your experiment is valid. Note that **any graphs you include in your write-up must be drawn accurately to scale, using graph paper, and using a ruler/straightedge wherever a straight line is needed.** (When an accurate graph is required, you will lose points if you include a freehand sketch instead.)

It is acceptable to use a linear regression program to determine the slope. If you do this, you need to say so and give the correlation coefficient. However, you still need to plot an accurate graph.

- Quantitative error analysis. In general, most quantities in a high school physics class are calculated from equations that use multiplication and division. Therefore, you need to:
  1. Determine the uncertainty of each your measurements.
  2. Calculate the relative error for each measurement.
  3. Combine your relative errors to get the total relative error for your calculated value(s).
  4. Multiply the total relative error by your calculated values to get the absolute uncertainty ( $\pm$ ) for each one.
- Sources of uncertainty: this is a list of factors **inherent in your procedure** that limit how precise your answer can be. In general, you need a source of uncertainty for each measured quantity.

**Never include mistakes, especially mistakes you aren't sure whether or not you made!** A statement like "We might have written down the wrong number." or "We might have done the calculations incorrectly." is really saying, "We might be stupid and you shouldn't believe anything else in this report." (Any "we might be stupid" statements will not count toward your required number of sources of uncertainty.)

However, if a problem *actually occurred*, and if you *used that data point in your calculations anyway*, you need to explain what happened and why you were unable to fix the problem during the experiment, and you also need to calculate an estimate of the effects on your results.

Use this space for summary and/or additional notes:

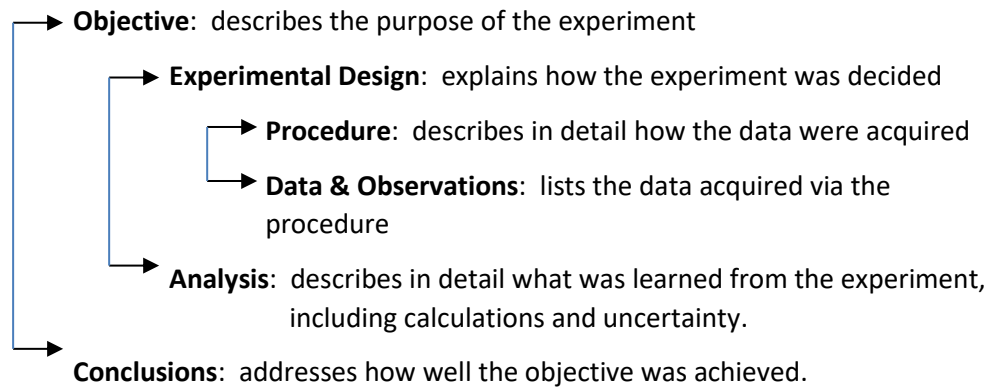
**Conclusion**

Your conclusion should be worded similarly to your objective, but this time including your final calculated result(s) and uncertainty. You do not need to restate sources of uncertainty in your conclusions unless you believe they were significant enough to create some doubt about your results.

Your conclusion should also include 1–2 sentences describing ways the experiment could be improved. These should specifically address the sources of uncertainty that you listed in the analysis section above.

**Summary**

You can think of the sections of the report in pairs. For each pair, the first part describes the intent of the experiment, and the corresponding second part describes the result.



Use this space for summary and/or additional notes: