How to Write a Formal Lab Report

Prepare a formal lab report consisting of the sections outlined below. The report must be typed and stapled. Each student must prepare his or her own report, unless otherwise specified.

1. Top of page
   - Title of experiment, date, name of author, name of lab partner(s), course title, period

2. **Objective** – *states the purpose of the experiment*
   - State the objective of the experiment, preferably in the form of a question (ex: What is the magnitude of the acceleration due to gravity?).

3. **Theory & Hypothesis** – *outlines what you know before you begin the experiment*
   - Outline the physics behind the methods you chose to use in your experiment. In this section you should state, or derive if appropriate, the equation(s) you used in addressing the overall objective. Include a written explanation, as well as a mathematical one. End this section by stating your hypothesis. A hypothesis is a possible answer to the question stated in the objective. (ex: The magnitude of "g" is expected to be approximately 9.8 m/s^2).

4. **Methods & Materials** – *summarizes the procedure used to test the hypothesis*
   - Provide a synopsis, in narrative form, of the methods and materials used in your experiment. Include enough detail to ensure that the reader can understand what you did and how you used the equipment to collect the data and make observations.
   - DO NOT SIMPLY LIST THE MATERIALS.
   - DO NOT WRITE STEP-BY-STEP.
   - DO write as a narrative, in third person.

5. **Observations and Data** – *summarizes the facts gathered and serves as proof that supports the conclusion*
   - Summarize your observations in a paragraph, or more.
   - Summarize all data in a well-designed table(s) that include descriptive headings.
   - Show sample calculations and summarize the results in a table. Calculations must show detail and must be introduced with descriptive subtitles. Remember that these calculations serve as your argument defending your conclusion. Complete calculations using math notation software such as Equation Editor or Math Type.
   - Whenever possible, determine the percent error or percent difference of quantitative observations.
   - Create graphs whenever appropriate to illustrate the relationships between variables. Graphs must be appropriately labeled and prepared using graphing software such as Excel.

Analysis & Discussion – *critically examines the observations and data*

- Critically examine and analyze your experiment. Comment on the validity of your results. Discuss what your results show/prove. Compare your findings to those of others in the class. Outline any difficulties you encountered during the experiment that may have affected the results.

6. **Conclusion** – *answers the question stated in the objective*
   - Restate the objective of the experiment and then state your conclusion succinctly. Do not summarize what you have just written. A conclusion should clearly answer the original question stated.

Write your report to the general public – one that has a general understanding of science. Assume the reader has no prior knowledge of what you did in your experiment. In all sections it is important that you do not write "in context". In other words, you must include enough detail to ensure that the reader will be able to understand how you did the experiment and what your conclusions are without having the lab manual or instructions as a reference.

To determine if your report is well-written and easily understood have someone, such as a parent or friend, read your report. It is best to select someone who is not familiar with this course. Ask them if they understand what you wrote and if they would be able to repeat the experiment using your report as a guide.

Sample Lab Report

Determination of the Apogee of a Rocket

Borislaw Bilash II, Bill Koenig, Elise Burns, Fran Zak, Honors Physics, Period 1, Group 4
September 7, 2010

Objective

Determine the apogee of an air-powered rocket launched vertically into the air, using basic trigonometric techniques.

Theory

The height of a tall object, such as the tree depicted in Figure 1, may be determined using basic trigonometric techniques in which the height of an object is compared to an imaginary right-angled triangle. The height of the tree is represented by "h"; whereas, the observer stands at a distance "x" – measured from the line representing the object's height. From this position (point "A"), the observer uses an inclinometer or sextant to determine the angle of inclination, θ of the line AB. "h" can then be determined by calculation using the formula:
$h = x\tan\theta$. This technique can be employed to measure the apogee of a rocket launched vertically into the air.

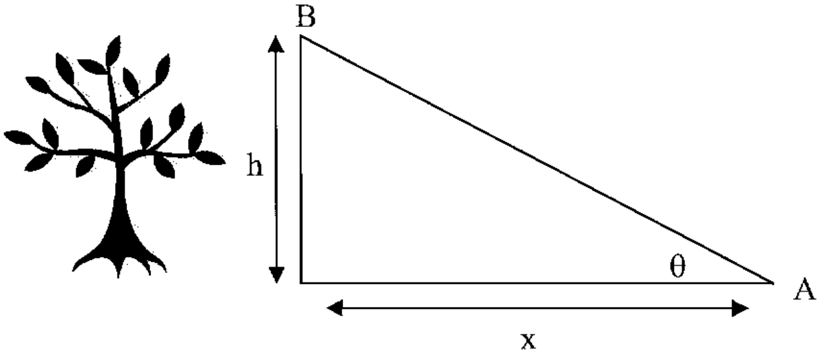

Figure 1: Imaginary triangle compared to height of tree

Materials & Methods

An air-powered rocket was launched vertically on the sideline of the football field at the zero-yard line. Students were positioned along the sideline of the football field ranging from about the 30-yard line to the 70-yard line. The football field was used as a large ruler. Once the rocket reached its apogee, students used an inclinometer to determine the angle of inclination, θ, as measured from the position of the observer. (The height of the observer was ignored, since it is insignificant when compared to the height reached by the rocket.) The distance "x" from the rocket launch pad to the observer was also measured using the lines marked on the field. These variables form an imaginary right-angled triangle as outlined in the theory section of this report. The height reached by the rocket was then calculated using the formula:
$h = x\tan\theta$.

Data & Calculations of Group 4

Trial	Distance from Launch Pad, x (Yards)	Angle of Inclination, θ (Degrees)	Height Reached by Rocket, h (Yards)
1	50	50	60
2	60	45	60
3	70	40	59

Average height Reached by Rocket = **60 yards**

Sample Calculations of Apogee Attained by the Rocket:

Height of rocket, h (of Trial 1)

$$h = x \tan\theta = (50)\tan 50° = \boxed{60 \text{ yards}}$$

Comparison of Data to Other Groups: Calculation of Average Apogee of Class
In order to rule out the possibility of a systematic error, the average height determined by this experiment was compared to that obtained by other groups in the class. The percent difference was calculated using the class average as the known value. The data provided by group 5 appears to be in error, so it was not considered when calculating the class average.

Group	1	2	3	4	5	6
Average Apogee (yd)	65	55	65	60	*135*	70

* *Results from Group 5 were not considered in the average*

Class average = 63 yd

Calculation of Percent Difference of Group 4

$$\%\ difference = \frac{|Apogee_{Class\ AVG} - Apogee_{Group\ AVG}|}{\left(|Apogee_{Class\ AVG} + Apogee_{Group\ AVG}| \div 2\right)}\ x\ 100\%$$

$$\%\ difference = \frac{|61 - 63|}{\left(|61 + 63| \div 2\right)}\ x\ 100\%$$

= 3.2% *difference*

Summary of Percent Difference for Entire Class

Group	1	2	3	4	5	6
Percent difference (%)	3.1	14	3.1	3.2	*73*	11

* *Results from Group 5 were not considered in the average*
Average Percent Difference in Class = 6.9%

Analysis & Discussion

The inclinometer used in this experiment was marked in tight increments of 5 degrees, which limits the analysis to a precision of no more than two digits. However, the results obtained in the experiment appear to be consistent from trial to trial suggesting that the data is of good quality. Furthermore, a survey of other students in class found that most students obtained results varying from 55-68 yards, with one glaring exception. Since the actual apogee of the rocket is not known or given, the percent difference between the results of Group 4 was compared to the overall class results. The fact that half of the class obtained nearly identical percent differences suggests that either the experimental error is small or that there may be a (yet undetermined) source of systematic error.

Conclusion:

The objective of the experiment was to determine the apogee of an air-powered rocket using basic trigonometric techniques. It was determined that the average apogee of the rocket is 60 yards. This result lies within 3.2% of the average which was determined by the class.

Things to notice about this report

1. The report is succinct, yet provides enough information for the reader to imagine exactly what took place during the experimentation. In fact, there is enough information here for the reader to reproduce the experiment without having to ask the author for additional information. Subtitles are used to aid the reading.
2. The report includes a title that is descriptive. Notice it does not simply read "Rocket Lab", which does not provide a clue what the report is about.
3. The principal author is identified by underlining the name. The names of partners follow, as well as the course and section number. The date the experiment was *conducted* is also included.
4. The objective clearly states the purpose. Every experiment is designed to answer a question. Although the object is not in the form of a question, it can be. (ex: What is the apogee of the rocket?). Some call this section "the problem". Experiments are designed to solve problems.
5. The theory section outlines the important scientific principles. The author uses these principles to solve the experimental problem. The theory section should outline the logic used in solving the problem. All equations that will be used in problem solving should also be introduced properly – not simply listed, but introduced in the context of the experiment. Notice that the author assumes that the reader has a basic understanding of trigonometry, yet the author provides enough detail to outline the logic behind the approach used in the experiment.
6. The Materials & Methods section summarizes how the experiment is performed. Enough information must be provided for the reader to reproduce the experiment without having to ask the author for further explanation. As you write this section, it is often advisable to give a copy of your Materials & Methods to a parent, sibling, or friend to read to verify if your explanation makes sense. Do not include a list of materials in this section. Rather, information regarding what materials are needed should be incorporated into the description of the method.
7. Data is summarized in a table. Notice that the author of this report combined the raw data (collected *during* the experiment) along with the final results of the calculations. Notice that the heading of each column makes it clear what each number represents, including the units. A sample calculation is also included to provide the reader with an understanding as to how the author arrived at their answers. A detailed error analysis is also provided.
8. The Analysis & Discussion section provides the author with the opportunity to comment on the validity or quality of the data. Any problems that arose that may have hampered the experiment should be outlined here.
9. The conclusion answers the question – no more. The conclusion is <u>not</u> a summary of the experiment. It must be succinct. In other words – answer the question!

Cenco Sargent Welch AP Physics Line

Title	SW	SK	Wards
AP Physics Lab 1: Measurement and Error	WLS1809-39	1809-39	16-0179
AP Physics Lab 2: Uniform Accelerated Motion	WLS1809-40	1809-40	16-0180
Support Stand	WLS78305-C	63080-03	15-0660
Vernier go motion detector	WLS1751-61	29911-89	16-9984
AP Physics Lab 3: Gravity	WLS1809-41	1809-41	16-0181
meter stick	WLS44696	62420-00	15-4065
Kodak Zi8 Video camera	WLS1811-58	1811-58	16-0849
AP Physics Lab 4: Horizontal Motion	WLS1809-42	1809-42	16-0182
meter stick	WLS44696	62420-00	15-4065
Photogate system	WLS1764-27	1764-27	16-6403
AP Physics Lab 5: Friction	WLS1809-43	1809-43	16-0183
Triple Beam Balance	WLS1761-69	1761-69	15-6003
Hooked Mass Set	WLS4323-10	68028-00	15-3717
AP Physics Lab 6:Hooke's law- Conservation of Energy	WLS1809-44	1809-44	16-0184
meter stick	WLS44696	62420-00	15-4065
Triple Beam Balance	WLS1761-69	1761-69	15-6003
Hooked Mass Set	WLS4323-10	68028-00	15-3717
Safety glasses	WLS40393	45208-00	15-3070
AP Physics Lab 7: Conservation of momentum - Ballistic Pendulum	WLS1809-45	1809-45	16-0185
meter stick	WLS44696	62420-00	15-4065
Triple Beam Balance	WLS1761-69	1761-69	15-6003
Safety glasses	WLS40393	45208-00	15-3070
Force probe	WLS1751-56	1751-56	16-9976
AP Physics Lab 8: Circular motion	WLS1809-46	1809-46	16-0186
meter stick	WLS44696	62420-00	15-4065
Triple Beam Balance	WLS1761-69	1761-69	15-6003
Hooked Mass Set	WLS4323-10	68028-00	15-3717
Safety glasses	WLS40393	45208-00	15-3070
AP Physics Lab 9: Static Equilibrium	WLS1809-47	1809-47	16-0187
Triple Beam Balance	WLS1761-69	1761-69	15-6003
Hooked Mass Set	WLS4323-10	68028-00	15-3717
Force probe	WLS1751-56	1751-56	16-9976
AP Physics Lab 10: Rotational Motion	WLS1809-48	1809-48	160188
Photogate System	WLS1764-27	1764-27	16-6403
Power Supply	WLS1751-95	1799-18	16 -0636
AP Physics Lab 11: Fluid Dynamics	WLS1809-49	1809-49	16-0189
meter stick	WLS44696	62420-00	15-4065
AP Physics Lab 12: Harmonic Motion in a Spring	WLS1809-50	1809-50	160190
Hooked Mass Set	WLS4323-10	68028-00	15-3717
Vernier go motion detector	WLS1751-61	29911-89	16-9984
Video Camera	WLS1811-58	1811-58	16-0849