

Athabasca University

## **PHYS 201 Lab Manual - V 2.1** (Lab Information)

### **Lab Team**

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## Introduction

Lab work is an important part of the introductory physics course. It provides students with a medium to practice experimental and analytical skills and helps students to understand the basis of knowledge and the relation between theoretical and empirical work in physics.

The lab component for this course is based on the concept of the home lab, which involves performing real physics experiments outside the conventional lab setting. The list of equipment required is provided in the Lab Kit, in addition to some common household items.

## The Experiments

The PHYS 201 Lab Manual consists of the following six home labs

### **Experiment 1: The Simple Pendulum**

After completing this experiment, you should be able to

- discuss the relation between period of oscillation and parameters like mass, amplitude and length of a pendulum.
- generate linear graphs from nonlinear equations.
- perform simple error analysis.

### **Experiment 2: Thermal Expansion of Water**

After completing this experiment, you should be able to

- discuss the general relation between volume and temperature for water
- discuss the anomalous behaviour of water near the freezing point
- demonstrate such behaviour

### **Experiment 3: Charles's Law**

After completing this experiment, you should be able to

- discuss the general relation between volume and temperature for gases
- demonstrate this relation experimentally
- discuss the meaning of absolute temperature

### **Experiment 4: Specific Heat and Heat of Fusion**

After completing this experiment, you should be able to:

- define the specific heat and the heat of fusion of a material
- write the relation between heat transfer and temperature change
- make a crude measurement of the specific heat of a solid material
- make a crude measurement of the heat of fusion of ice

### **Experiment 5: Ohm's Law**

After completing this experiment, you should be able to

- state and demonstrate Ohm's Law
- discuss the difference between ohmic and non-ohmic resistance
- construct simple electric circuits
- use the multimeter to make voltage, current and resistance measurements

### **Experiment 6: Charging and Discharging of a Capacitor**

After completing this experiment, you should be able to:

- describe the charging process of a capacitor
- describe the discharging process of a capacitor
- define the time constant of an RC circuit
- Construct a simple RC circuit

## **Lab Software**

This lab requires the Logger Pro software produced by Vernier Software & Technology. It is an interface program that allows you to monitor temperature measurements on your computer. The software is also needed in the analysis of your experimental data.

Note that some of the documents in this manual are saved in the Portable Document Format (PDF), to make them more printer friendly. These files can be opened using the free Adobe Reader Software.

## Lab Equipment

When you are ready to do the lab experiments, you should request a lab kit from the Athabasca University Science Lab. The kit will be mailed to you shortly after requesting it. Sometimes there will be a waiting list if the demand for the kits is high. Note that you should be able to perform the first experiment without the lab kit. When you receive the kit package, (see picture below), make sure that it contains a card for return postage (does not apply to international students).

For video clips, you can use the Microsoft Media Player software.



### Lab Kit Contents

- |  |   |
|--|---|
| 1. multimeter (model may vary)             | 9. protractor   |
| 2. multimeter test probes and gripper ends | 10. 10 mL graduated cylinder                                  |
| 3. paper clip with known mass              | 11. 100 mL graduated cylinder                                 |
| 4. "Go! Temp" temperature sensor           | 12. stopwatch   |
| 5. circuit board                           | 13. cork plug with 1 mL pipette (with a spare cork & pipette) |
| 6. circuit board cables                    | 14. two plastic 1 mL graduated droppers                       |
| 7. light bulbs (two)                       |   |
| 8. large ohm resistors (two 10 MOhm)       |   |

## Lab Safety

Due care should be taken with moving objects, hot and cold liquids, and other potentially hazardous situations and materials. No materials used are to be connected to electrical power outlets. The level of risk involved in doing these labs is comparable to that of day-to-day activities, and care has been taken to avoid suggesting activities which produce hazards.

It is your decision to proceed with any experiment. In making that decision, you control your situation and assume any risks involved. You are responsible to act in a responsible manner to avoid hazard to yourself or others.

Neither the author of this Lab Manual, Athabasca University, or any equipment supplier can be held liable for consequences of any action undertaken in association with these laboratory exercises. If you cannot safely do these labs, please withdraw from the course.

## Evaluation

The lab component of the course is mandatory. It counts for 20% of the total course mark. You are expected to attempt six experiments, according to the guidelines presented in the Lab Manual, and prepare a lab report for each experiment. All reports should be submitted to your tutor for assessment as mentioned in the course outline. Note that it is important to accumulate a total lab average of at least 50% to pass the course.

<b>Experiments</b>	<b>Overall Mark</b>
Experiment 1	3.33%
Experiment 2	3.33%
Experiment 3	3.33%
Experiment 4	3.33%
Experiment 5	3.34%
Experiment 6	3.34%
<b>Total 20 %</b>	<b>100%</b>

If you have lab credit from elsewhere you may wish to inquire about transfer of lab credit. Such transfer and any evaluation associated with it are entirely at the discretion of Athabasca University. For more information see Physics Lab Exemptions. You will be required to submit original lab materials, done by you, for evaluation toward potential transfer of credit. You must discuss this possibility with the course coordinator before submitting any such materials.

## The Lab Report

Reports are an effective way of communicating important information, and their use is stressed in this lab. There is little point in doing a wonderful experiment with great results if you cannot

effectively communicate your findings to others. Sometimes the results will not seem so great, and writing the report will help you understand what went wrong. On the other hand, the results we are seeking are relatively straightforward, so these reports needn't be overly long.

The lab report serves several purposes and gives an organized framework for recording your procedures and results. Although some students may have encountered laboratory reports before and may feel that there is a standard format for them, this is not entirely true. In this course you will have some freedom in organizing your report. Just make sure to include the following sections:

1. **Cover Page:** The cover page should include the name and number of the course, the version of the lab manual, the title of the experiment, your name, your student ID number and the date.
2. **Proposed Theory:** Clearly state the proposed theory to be tested in the experiment.
3. **Setup and Procedure:** Give a clear and detailed description of your actions while performing the experiment. If there is more than one part to the lab, it is usually best to describe the actions and observations separately for each part. Include at least one clear picture of your setup.
4. **Data:** Organize and present the data that you collected in the experiment. You should also provide a description of the trend and behaviour of the collected data. Do not include calculations or analysis in this section of the report.
5. **Analysis and Discussion:** This is a very important section of the lab report. Give a detailed analysis of your data, showing all your calculations including sample calculations for new calculated columns in data tables. You may also need to produce graphs and perform appropriate fits using the Logger Pro. Provide a thorough discussion of the validity of the proposed theory in light of your analysis and results. A suggested analysis is included with each lab. Errors in the observations may affect your conclusions; discuss their role here.
6. **Conclusion:** Present a brief summary of your findings in this experiment, including the final numerical results.
7. **Questions:** At the end of each lab you will find one or more questions related to the experiment. Provide a detailed answer to these questions at the end of the lab report.

The marking of the lab report will be based on the marking rubric found at this link. Note that material taken from other sources, including the Internet, should be properly referenced.

## Lab Report Marking Rubrics

(Total report mark is 30)

		Mark			
		0	1	2	3
<b>Cover Page</b>		missing	included		
<b>Proposed Theory</b>		missing	incomplete	complete	
<b>Procedure</b>		missing	too brief or unclear	clear but not complete	clear and complete
<b>Pictures of Setup</b>		missing	unclear	clear	
<b>Collected Data</b>		Missing or incorrect	incomplete	complete but missing proper labels and units	complete with proper labels and units
<b>Description of data</b>		missing	incomplete	complete	
<b>Analysis</b>	<b>Calculations</b>	missing	major errors or missing important parts	minor errors or missing some sample calculations	correct and complete with all sample calculations included
	<b>Error analysis</b>	missing	partial consideration of uncertainties	Full error analysis with proper use of significant figures	
	<b>Graphs</b>	missing	included with major errors	correct but missing titles, labels or units	correct and complete
	<b>Reasoning</b>	missing or irrelevant	included with major flaws	includes many correct arguments but not complete	Correct, complete and convincing
<b>Conclusion</b>		missing	incomplete	complete	
<b>Questions</b>		missing	partially correct	correct	
<b>Overall tidiness of report</b>			acceptable	very good	