Mississippi State University
Department of Physics and Astronomy
PH 2223 Lab

The Scientific Method

One of the ways by which physical knowledge is created is by observing a process and trying to quantify the parameters involved within a system (Such as time, mass, force…). But remember that the theoretical preposition has to be supported by experimental results. We are going to do the reverse here. We are going to do an experiment and then draw out a theory.

What system are you going to observe?

What fundamental parameters, do you think, are involved with this system? Name as many as possible.

Let us do a simple activity to demonstrate a very powerful tool in physics.
Consider the system where a small body of mass *'m'* is coming (neglect the effects that rotational dynamics introduces) down an inclined plane (inclined at an angle $'\theta'$ to the horizontal ground). Using concepts learnt in Physics I, you know that the force exerted on the small body by gravity along the inclined plane is $F = m.g.\sin(\theta)$ (where all the symbols represent the conventional parameters). Therefore the force 'F' is dependent on quantities such as $'m','g','\theta'$. But using the concepts you learnt in Lab 1, you know that $'m','g','\theta'$ are not dependent on each other. Write down the units of force. Now multiply all the units on right hand side (that of $'m','g',' \sin\theta\ '$). Do they match? (Please show your work)

We will use this tool to find out the terms in a physical expression. Let us consider a system where the function variables are all independent (just like $'m','g','\theta'$) and let us invent something! Experiment suggests that the magnetic force on a charged particle depends on magnetic field *'B'* which has the units of $Kg.s^{-1}.C^{-1}$. Also when I increase the velocity of the charged particle, it is observed that the force on it due to a magnetic field increases. Can you cook up an expression for *'F'* in terms of magnetic field and certain other parameters by using the tool we developed in this exercise? Can you express your equation in any other form?

This extremely powerful tool is known as dimensional analysis (for obvious reasons).
If you did everything right, you just discovered the Lorentz Force which was derived by Sir Hendrik Antoon Lorentz in 1892 with mathematical rigor.

Coming back to the system we are studying in this lab, concoct some equations (At least 2) between the parameters you listed as fundamental to the system in a question above. Defend your arguments with valid statements and observations.

Challenging:
An experiment always has some systematic error related to it. How do you think this affects the interpretation of experimental data? Does it limit our ability to come up with theory out of experiments? As a result, do you think it is easier to come up with a theory out of an experiment or to verify a theoretical preposition with the help of an experiment?