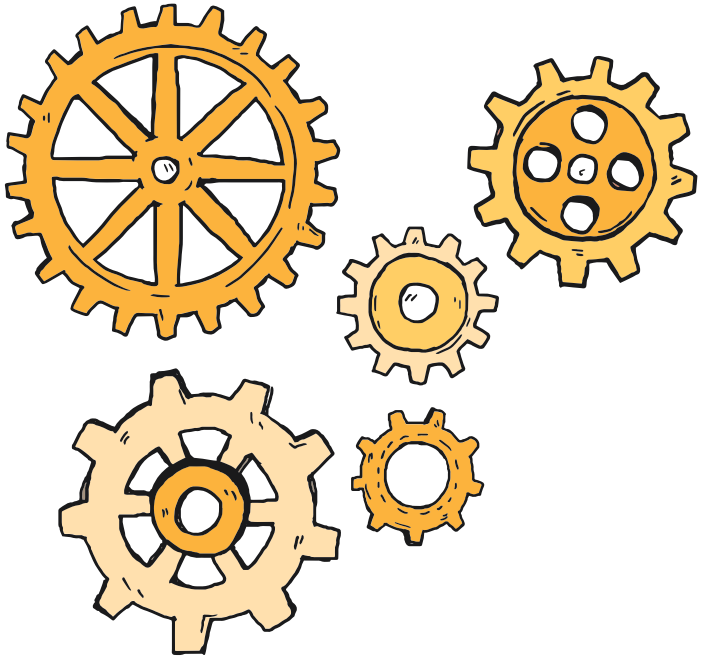
Adapting physics labs to online teaching

A survey of strategies for our 100-level, 200-level and upper division courses



General departmental strategies

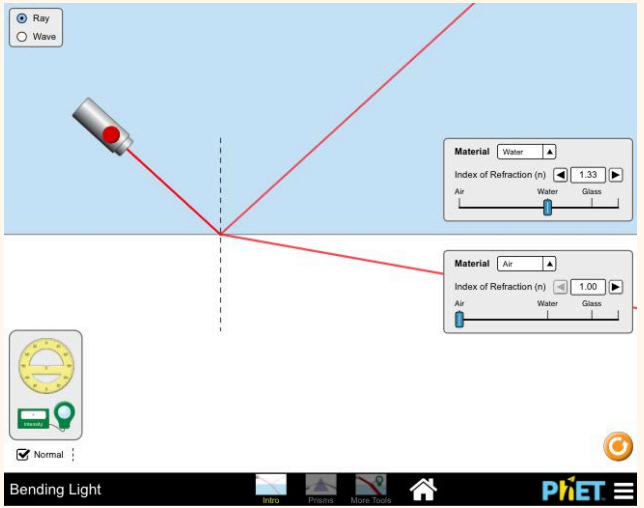
- Group collaborations and discussions using Microsoft Teams
- Shared workload for developing new labs for PHY 105
- Second year of implementing new Arduino-based labs for PHY 202 (going much better this time)

PHY 106 – Intro. Electricity & Magnetism (Spring 2020)

- These labs are a mandatory component of large enrollment classes.
  - 24 students (max) per lab
  - Typically 3 lecture sections with ~170+ students
  - 7-8 lab sections

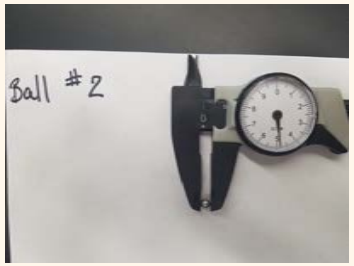
- Used online simulations and in-class discussions for the online phase of the semester.

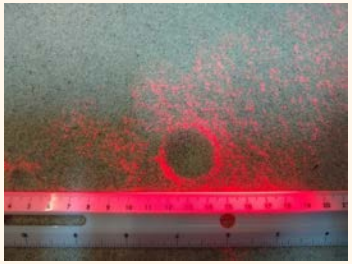
PhET refraction & reflection simulation

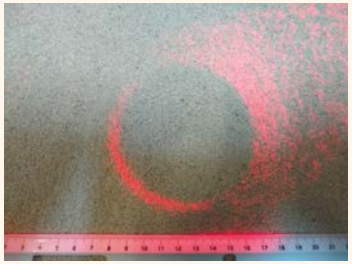


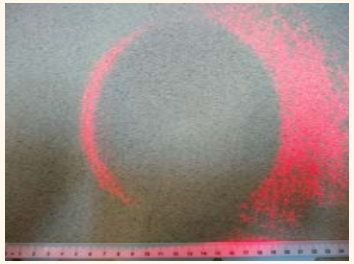
Instructors:
Sean Nolan
Doug Armstead
Graeme Rohn
Dom Mantella

PHY 201 Principles of Physics I (Mechanics) (Spring 2020)









Link to video clip

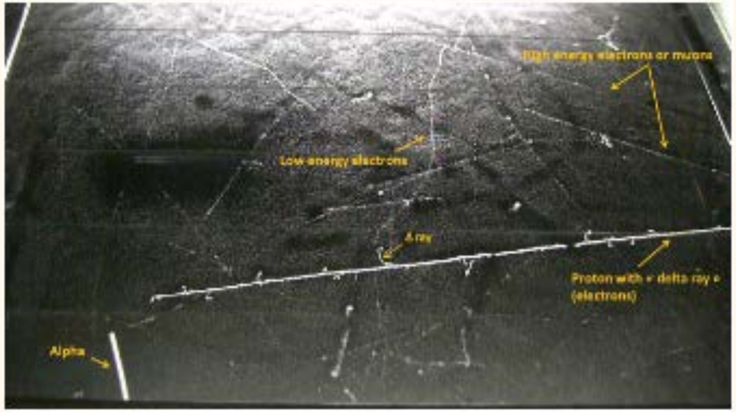
Meteor drop experiment

Instructors:
Eric Edlund
Beth Pennell

PHY 357 – Intermediate Laboratory (Spring 2020)

DIY cloud chamber

Analysis of data from CERN demos



Technical writing exercises

1 Abstract

This report discusses the history behind the development of the Cloud Chamber and its purpose. The cloud chamber constructed for this experiment was functional in creating vapor mist of isopropyl alcohol inside the chamber to be able to see the path of cosmic particles. The amount mean amount of alpha particles that passed through the chamber every minute was 6.2 with a standard deviation of 0.837. The mean amount of muons and electrons combined to pass through the chamber every minute was 26.2 with a standard deviation of 1.924.

2 Introduction

A cloud chamber is a device that can be easily constructed to track the movement of cosmic particles. The first form of cloud chamber was invented by Charles Thomson Rees Wilson, a Scottish physicist.(Gupta & Ghosh, 1946) His device is actually known as an expansion cloud chamber because it used a technique to expand the air inside the chamber, which cooled the air down inside the chamber enough to form water vapor.(Gupta & Ghosh, 1946) Even though he wasn't initially setting out to invent a particle detector, he was trying to create a device to study cloud formation and optical phenomena in saturated air, he is credited with its invention. Later on, a different version of the cloud chamber was developed by Alexander Langsdorf. He developed the diffusion cloud chamber in 1936 and this type of chamber is the type of chamber used in this experiment. Instead of using water as the substance and expanding the air inside of the chamber, the diffusion cloud chamber uses isopropyl alcohol and dry ice to create the same phenomenon.(Gupta & Ghosh, 1946)When the cloud chamber has been constructed the main idea is that the alcohol will evaporate from the top where it is room temperature, about 22 de-

can see the "trail".(Gupta & Ghosh, 1946) These cosmic particles consist of alpha particles, muons, electrons, and positrons.(Anderson, 1933) Each of these particles holds a differing amount of energy and leave their own distinct trail as they pass through the cloud chamber. The different trails are a thick and straight trail, which is the alpha particle, a thin straight trail, which is a muon or electron that hasn't been deflected, a curly or curvy track, which is an electron that has been deflected or a photo electron that is scattering.(Woithe, 2016)

3 Procedure

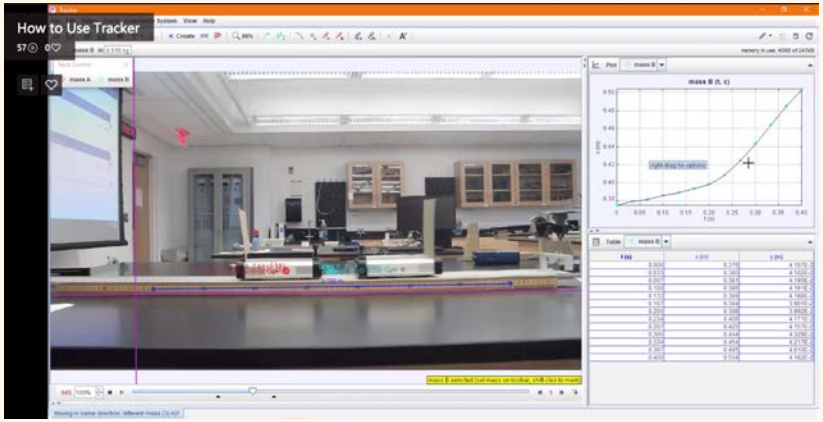
The materials used to construct the test apparatus were a rectangular plastic container, felt, insulated container, 99% isopropyl alcohol, sheet of glass, bean bag, dry ice, and an LED flashlight.(Woithe, 2016) The chamber was built, as seen in Figure 1. The insulated container was on the bottom and held the dry ice.(Woithe, 2016) Then on top of that was the sheet of glass with the lid of the plastic container duct taped to it so that the container was sealed tightly. The plastic container was then centered over the dry ice to minimize any heat transfer from the room to the sheet of glass where the ice was.(Woithe, 2016) The felt was glued and taped to the top of the plastic container to avoid the felt from coming off when the alcohol was applied. The felt and sides of the container were then saturated in the 99% isopropyl alcohol and then the plastic container was positioned and locked into place on top of the sheet of glass. The experiment was performed at night when it was dark outside so there was no other form of light in the room except for the LED flashlight.(Woithe, 2016) I wanted to increase the rate that the alcohol was evaporating from the felt at the top of the container so I heated up a bean bag in the microwave and placed it on top of the container as close to the felt as possible. After about 10 minutes, as the base of the chamber

Instructor: Dave Kornreich

PHY 105 – Introductory mechanics and heat (Fall 2020)

- **Original plan:** Reduced lab capacity
  --▻ lab cohorts meet every-other week
- **55-minute plan:** Both cohorts meet every week for 50 minutes each and spend extra time writing full lab reports
- **Study-in-place:** use a combination of recorded videos and online simulation work

Tracker app and video created by Sean Nolan

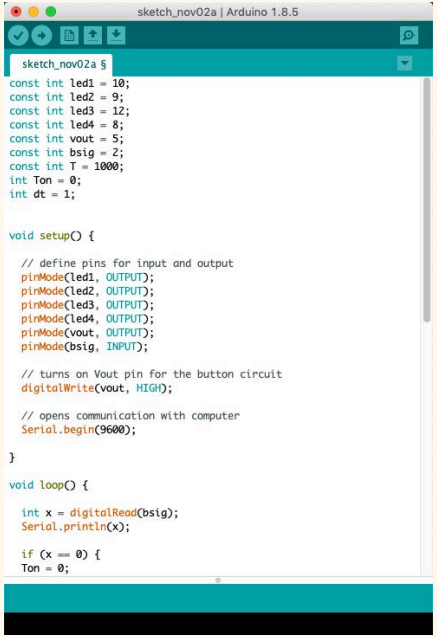


Instructors:
Sean Nolan
Moataz Emam
Graeme Rohn
Dom Mantella

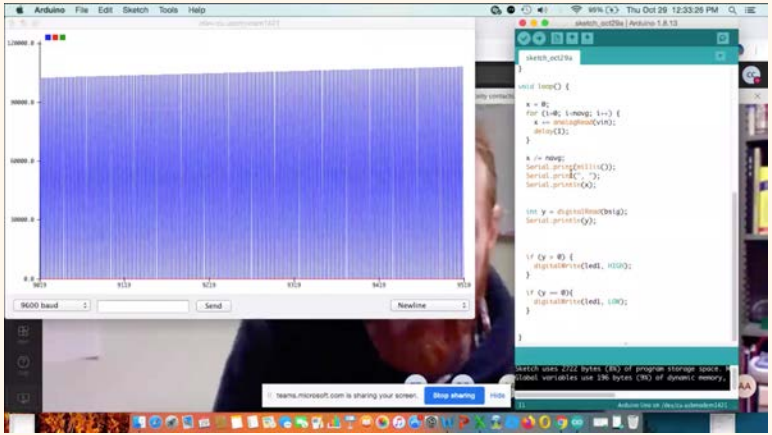
PHY 202 – Principles of Physics II: E&M (Fall 2020)

Arduino Student Kit: $65.43

Student code project



Live code debugging in online lab session



Instructor: Eric Edlund

Link to student project

Thoughts for the Spring 2021 semester

Introductory courses (PHY 106 and PHY 201)

- We are going to continue planning for both in-person labs and contingent online labs
- Look into strategies being used by other institutions

Upper division courses:

- PHY 357 is the upper division lab course for juniors & seniors
  - It is meant to be a hands-on experimental course
- 6 hours of contact time per week
- Switched from a TR schedule to a MWF schedule to give students more access in the case of continued 55-minute limitations
- We need to develop a better plan for access to upper division lab spaces:
  - Students need the 6 hours per week to complete difficult and advanced labs
  - Need a contingency plan that allows students to have access to lab spaces if we go to a study-in-place situation again in the spring