Resources for the experiments

Van De Graaff Generator: A Van de Graaff generator (VDG) works by using a moving belt to create static electricity. The belt moves over two rollers, one covered with a rubber belt, and the other covered with a metal brush. The brush contacts the belt, rubbing electrons off the belt and onto the brush. These electrons are then conveyed to a metal dome, which becomes charged with static electricity.

A capacitor is connected to the dome through a spark gap to measure the charge on the dome. The capacitor stores the charge, which can then be measured with a multimeter. The voltage is proportional to the charge on the dome.

A fun demonstration with a VDG involves launching puffed rice into the air. The puffed rice is placed on a metal plate connected to the VDG. The charged dome attracts the rice, causing it to jump off the plate and fly through the air. This demonstrates the power of static electricity and how it can be used to create movement.

Another demonstration involves flying silk ribbons. The charged dome attracts the silk ribbons, causing them to stand on end and fly up toward the dome. As the stripes get closer to the dome, the attraction increases until they fly toward it and discharge static electricity. This can create a visible spark, adding to the wow factor of the demonstration.

Experiments with VDG at ICTS: Link
Read the *Physics:* Feynman Lectures (II) Chapter 5.

Three Fascinating Physics Experiments: *Cloud Chamber, Regelation Experiment, and Boiling of Water inside a plastic syringe!*

Cloud Chamber:
Originally developed at UC Berkeley in 1938, the cloud chamber uses evaporated alcohol to make a "cloud" that is extremely sensitive to passing particles [Resources]. The cloud chamber works on the same principles that determine the formation of clouds in the sky. If air is saturated with water vapor and then cooled, tiny droplets of mist form around small particles. Similarly, in a cloud chamber, when a charged particle passes through the alcohol vapor, it ionizes the vapor molecules, forming a visible trail. This experiment has been essential in detecting and studying subatomic particles.
💡 *Bibha Chowdhuri (1913-1991) was an Indian physicist known for her work in particle physics and cosmic rays [1]. She was the first Indian woman to earn a Ph.D. in science from an Indian university. Her research included the study of cosmic rays and the production of mesons in cosmic ray interactions. The International Astronomical Union (IAU) has named a yellow-white dwarf star in the constellation Sextans south of the celestial equator, HD 86081, after her, and the star is now officially known as Bibha [2].*

1. Dr. Chowdhuri in Wikipedia; 2. A Jewel Unearthed: Bibha Chowdhuri

Building cloud chamber at ICTS: Link
Tracking video: Link
Resources: DIY Cloud Chamber, Cloud Chamber,
How to Build a Cloud Chamber!, DIY Cloud Chamber

Regelation Experiment with Ice and Guitar String:
In the Regelation experiment, we take a guitar string and pass it through a block of ice. It takes some time for the string to cut through the ice, and once it reaches the bottom, the ice refreezes behind the string, trapping it in place. This phenomenon is called Regelation, where ice melts and refreezes due to pressure changes. The guitar string has a smaller surface area, which means it applies more pressure to the ice than the surrounding air. This pressure causes the ice to melt, allowing the string to pass through. When the string reaches the bottom, the pressure is released, and the ice refreezes, trapping the string. This experiment helps us understand the effect of pressure on the melting point of ice.
Resource: Does Pressure Melt Ice?
Reading: Wikipedia

Boiling of Water due to Depressurization inside a Syringe:
When water is at atmospheric pressure, its boiling point is 100 degrees Celsius. However, if we reduce the pressure, the boiling point decreases as well. In this experiment, we take a syringe and fill it partially with water. We then close the syringe tip and pull the tail at once. Once the pressure inside the syringe decreases, causing the water to boil even though its temperature is below 100 degrees Celsius. This experiment helps us understand the effect of pressure on the boiling point of liquids.

Resource video: Boiling in a Syringe

Soap Film: The importance of theoretical and experimental studies of two-dimensional flow is well-established and well-known. These studies have significant implications for crucial topics such as two-dimensional turbulence, transition mechanisms in shear flows, and the fundamentals of two-dimensional vortex dynamics. Soap film flows provide a very convenient laboratory model for studies of two-dimensional hydrodynamics, including turbulence. Understanding it is useful for a wide variety of applications. Therefore, soap film flow provides one of the closest substitutes for a truly two-dimensional environment to study 2D turbulence.
In this experiment, the participants would be creating a vertical gravity-assisted stable soap film setup using fishing lines, dishwashing liquid, etc. This soap film is observed through the interference patterns it produces from white light falling on it.
Low Tech Soap film: 1. *Read this before doing the surprise experiment at ICTS.*
2. 🛀Soap bubbles

Brownian Motion: The Brownian motion phenomenon, as used in a classical sense, is the haphazard movement of a particle within a medium, such as dust within a fluid. However, in modern times, its theory can also be used to describe the varying behavior of a generic system interacting with the environment, such as stock prices.
The goal of this experiment is to determine Avogadro's number (N_A) from Einsteins' diffusion equation.
Detailed Experimental Report: Link, Analysis with Python 🐍: Link,
Resource: link
Documentation Python (Trackpy) 🐍: Link,
287 - Tracking particles and objects using Trackpy in python

Coupled Pendulum:
A coupled pendulum is a system of two or more pendulums that are connected in some way, such that the motion of one affects the motion of the others. One type of coupled pendulum is the Wilberforce pendulum, invented by British physicist Lionel Robert Wilberforce in the late 19th century. This pendulum consists of a mass suspended by a long helical spring, allowing it to twist the spring as it turns on its vertical axis. The Wilberforce pendulum is an excellent example of a coupled mechanical oscillator and is often used as a demonstration in physics education. Its behavior is dependent on the nonlinear interactions between the mass and spring, resulting in complex motions that are not predictable by simple linear analysis. Undergraduate students in physics can gain valuable insights into the dynamics of coupled oscillators through the study of the Wilberforce pendulum.
Resources: Coupled pendulum, Wilberforce pendulum, Vertical pendulum
The Amazing Physics Of The Wilberforce Pendulum

Interference of Sound waves:
Resources: Link1
⛷️Doppler Effect
🎆 Chladni plate

Wet-Bulb/Dry-Bulb Conundrum:
Link to resources

The Catenary:
The catenary shape has many applications in physics and engineering. It is the shape that a cable or chain takes when it is freely suspended and subjected only to its own weight. This shape is important because it minimizes the potential energy of the cable or chain, making it the most stable configuration. Examples of the catenary shape can be seen in suspension bridges, power lines, and cables used in cranes and elevators. In

addition, soap films suspended between two supports also form a catenary curve, and the shape of the human spine follows a catenary curve when the body is in a seated position. The study of the catenary shape has important implications in materials science, civil engineering, and other fields.

Resources: Wikipedia
🧝Catenary with a necklace, 💨Catenary with a soap bubble

Fluid Dynamics:

Low Reynolds number flows and reversibility (G.I.Taylor, 1967)

Magnus effect:

Physics of Football | Banana Kick | Magnus Effect , Resource

Stretch Genes:

🧬 Resource

Osmosis experiment with Eggs:

🥚 Resource

Parametric and inverted oscillator:

(Landau Lifshitz book)

What If Swings Had Springs Instead Of Ropes: Autoparametric Resonance

Self-correcting Inverted Pendulum Defies Gravity

Rolling cylinders down an incline:

Resource