Physical Science 12b Project List

Project Schedule:

When: December 10th, 2015. Morning Session 9AM-12PM, and afternoon session 1PM-4PM

Where: Science Center rooms 102 and 106

Who: Groups of 2-4 people from common lab times.

You must attend one of the sessions in its entirety to present and watch a few other presentations.

Limit of two groups doing any one project. No overlap of projects within similar lab times. No similar projects to be presented in the same session.

Project Ideas:

Capacitance Measurement: Use the principles of capacitance to measure (choose 2)

A.) Proximity

B.) Force

C.) Liquid Level

D.) Humidity

Magnetic Tweezer: Build a magnetic tweezer setup that manipulates tiny magnetic particles viewed by a microscope. This setup is often used to manipulate and characterize bio-molecules (like DNA) or polymers.

Piezoelectricity: Piezoelectricity is the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics, and biological matter such as bone, DNA and other various proteins) in response to applied mechanical stress. Build a sensor or other application using a piezoelectric device. Grow some piezo crystals to make simple measurements.

Explore Para and Diamagnetic materials and properties: Measure the para and diamagnetic susceptibilities of various materials.

Para magnetism: A form of magnetism whereby certain materials are attracted by an externally applied magnetic field, and form internal, induced magnetic fields in the direction of the applied magnetic field.

Diamagnetism: is a property of all materials and opposes applied magnetic fields, but is very weak.

Build and Measure something with an interferometer: Interferometers are widely used in science and industry for the measurement of small displacements, refractive index changes, and surface irregularities. Build an interferometer and measure something sensitive.

LED and Photodiode Communication: Use an LED and photodiode to send information wirelessly. Then optimize the system for distance and signal strength/clarity. Try incorporating a laser, fiber optic cable or phototransistor to enhance performance

Measure temperature of a resistor w/ a thermistor: Optimize the system for sensitivity and resolution. Include a resistance bridge in your design.

Measure the resistance of metals: Develop a technique to measure the resistance of a metal. Then try a HT_c superconductor material to see if its resistance really goes to zero.

Electrostatic Steering: Develop a device that can charge a small liquid drop and then steer it electrostatically into the correct container.

Thermoelectric Cooler: Thermoelectric cooling uses the Peltier effect to create a heat flux between the junctions of two different types of materials. A Peltier cooler, heater, or thermoelectric heat pump is a solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy, depending on the direction of the current. Such an instrument is also called a Peltier device, Peltier heat pump, solid-state refrigerator, or thermoelectric cooler (TEC). It can be used either for heating or for cooling, although in practice the main application is cooling. It can also be used as a temperature controller that either heats or cools. Measure the efficiency of this device. Investigate thermoelectric power generation.

Optical and Electromagnetic Pickups: When a string passes between a LED and a photo diode; the light captured by the photo diode results in a signal that converted into electric current. Best of all it can be used on any type of string material. Not just metal like E+M pickups. First try to build a crude E+M pick-up and then explore the physics behind the much less common optical pickup.

Electronic Neuron Model: Create an electronic circuit that will model how an axon works. The circuit will include circuit analogies to sodium, and potassium pumps. Circuit should also be able to chain together and transmit the signal through many axon models. A Matlab simulation should be created to try and model your electronic neuron.

AM Radio: Build an LC circuit with variable C, characterize and find its resonance frequency using the function generator, note how the resonance frequency can be tuned. Attach an antenna and tune to frequency of a radio station. Incorporate a diode to rectify the signal and a single transistor amplifier circuit to amplify it so that one can listen to the radio station using headphones.

Joule Thief: https://en.wikipedia.org/wiki/Joule_thief . This circuit should be able to power an LED or a small light bulb using a "dead" battery, i.e. one that couldn't do the job directly. It is a neat example of a simple switching converter, which involves some nice physics of electromagnetic induction and only very basic electronics (a single transistor). Build the device, measure its characteristics, and explain how it works.

Spectroscopy: Use a spectrometer in order to analyze the light emitted by a variety of sources. In particular you will complete the following tasks:

a. Examine the continuous spectrum emitted by an incandescent lamp.
b. Determine the wavelengths emitted by a hydrogen lamp.
c. Determine the range of wavelengths emitted by four LEDs.
d. Determine the cutoff wavelength of two optical filters.

Magnetic Hysteresis: When an external magnetic field is applied to a ferromagnetic such as iron, the atomic dipoles align themselves with it. Even when the field is removed, part of the alignment will be retained: the material has become *magnetized*. Once magnetized, the magnet will stay magnetized indefinitely. To demagnetize it requires heat or a magnetic field in the opposite direction. This is the effect that provides the element of memory in a hard disk drive. Measure the magnetic hysteresis of a few different materials.

Create your own project: Start this early. Group must provide a few useful references and provide an outline for the first two week. You must show what you will begin to measure starting week one.