Directions

You will be participating in an ***Orientation Lab*** that is designed to:

- Introduce you to the physics laboratory
- Cover basic observation and data collection techniques
- Explore interesting physics phenomena not covered in our regular lab schedule.

The Orientation Lab consists of 3 experiments, each using different equipment. Your lab group will rotate through 3 stations. Your lab instructor will notify your group when it's time to move to the next station.

Students will work in groups, but each student will individually complete and submit the provided laboratory report. All data tables and questions you need to answer may be found in the report. Before leaving, be sure your instructor has signed all the required pages of your report.

Produced by the Physics Staff at Collin College

Experiment 1: THE OUDIN COIL

The Oudin coil is a high voltage transformer designed to produce high voltage discharges similar to a Tesla coil. The Oudin coil was invented by Paul Marie Oudin and Jaques d’Arsonval around 1899. This Oudin coil’s transformer generates 1200 volts (but very low current). The output voltage of the primary coil is connected to capacitors which discharge to a high voltage coil. The circuit is designed to oscillate at 500,000 Hz. The output of the Oudin coil is adjusted by turning the knob on the end of the unit which varies the distance of the vibrating contacts. The adjustment varies the voltage and the spark length.

The Oudin coil is used for leak detection in vacuum systems, lamps, double-pane windows and similar devices to determine if a good vacuum is maintained.

Warning - Never touch the high voltage output. The high frequency oscillations generate electromagnetic interference up to a meter away. It may interfere with sensitive electronic equipment nearby including pacemakers. Small amounts of ozone gas are formed by the sparks.

Procedure:

1. First you will observe the effect of the Oudin coil on a 5" Clear Globe Bulb using the Visualizer accessory. The bulb is illustrated on the cover of this document. The Visualizer with bulb should be attached to the Oudin coil. Never insert or remove the tip or Visualizer when the unit is on.
2. Plug the coil into a standard outlet. Turn the knob at the base of the unit fully counterclockwise (do <u>not</u> turn the adjusting knob). Then turn the knob clockwise and push the button on the side of the unit which is a spring loaded on-off switch. As the knob is turned the vibrating contacts close and allow sparks to form either from the spark tip or in the Visualizer.
3. The Visualizer shows lavender colored discharges. If you compare this to an argon discharge tube in the lab you will see that it also gives a lavender colored light. Light bulbs generally have argon gas added to minimize evaporation of the tungsten filament at the high temperatures caused by the current flowing through the filament.
4. Try touching the bulb at various points with a pen or pencil held in your hand (you may get a small shock if you use only your finger). Notice that the electrical current is drawn from the light bulb filament (as “streamers”) to your pen or pencil and though your body to ground. You have just completed your first electrical circuit in lab! You may feel a tingling sensation as the electrical current travels along your body.
5. Next, turn off the power and remove the Visualizer/bulb attachment from the Oudin coil and replace with the pointed metal tip.
6. With the power turned back on, bring the U-shaped fluorescent tube near the Oudin coil in the manner illustrated in the following photo (the rubber gloves shown are not

necessary). Observe that electrical current travels from the coil through one end of the tube, then through your hand holding the tube and back to ground.

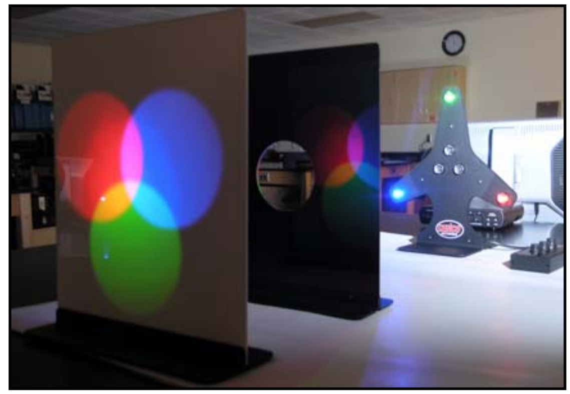
7. Try lighting the bulb by touching it with the Oudin coil on the same side as the hand holding the bulb.
8. Next try lighting the tube by bringing the Oudin coil near it but without touching the tube.
9. Be sure to answer all the report questions based on your observations of this experiment.

Experiment 2: COLOR MIXING

In this experiment you will use a LED color mixer to mix light colors of various intensity and observe how those colors interact with each other. This experiment will illustrate the physics of light in art and painting, and you will note some differences between mixing colors of light and mixing colors of pigments used in paint.

Each color of light is of a different wavelength, with white light comprised of the wavelengths of all colors in the visible spectrum. The perceived color of an object depends on the wavelength the object reflects and/or absorbs, and the color of light shining on it. The reflected color is the color we perceive. An object that reflects all wavelengths appears white; an object that absorbs all wavelengths appears black.

Additive Color Mixing



Additive color mixing refers to the mixing of the three primary colors of visible light (red, green, and blue) to create secondary colors. *Note that these are not the same as the primary colors for paint.*

Procedure:

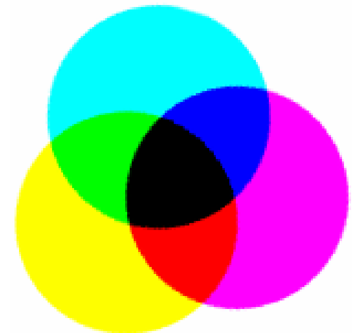
1. Set up the color mixer using the black screen with the hole in the center (as illustrated).
2. Turn all three knobs on the unit counter-clockwise to set the color intensity to zero for each color.
3. Slowly turn the knob for “red” clockwise. Observe the differences in the light as you vary the intensity. Repeat this for the green and blue light.
4. Turn all three knobs on the control so that the LEDs are at 100% full intensity.
5. Identify the colors you see at each overlap on the projected image (answer the related report question). The color produced by the overlap of two other colors is called a secondary color.
6. Turn the blue LED to 0% intensity and observe the color yellow on the screen.
7. Turn the red LED to 0% intensity with the blue and green LED’s at 100% and observe the color cyan blue projected on the screen.
8. Turn the green LED to 0% intensity with the blue and red LED’s at 100% and observe the color magenta projected on the screen.
9. Adjust the intensities of all three LEDs in various combinations. As you adjust the intensity of each you can vary the colors created on the projection screen. This is how a color monitor or TV creates the different shades of color.

Subtractive Color Mixing

Subtractive color mixing starts with the presence of all colors of light (white). In the case of the color mixer, you will project the LEDs against a white background and subtract some of the reflected light.

Procedure:

1. Set up the color mixer using the clear screen with the black hole in the center.
2. Make sure all the control knobs are set at 0. Set the switch on the control unit to “inner” before turning back on the unit.
3. Use the knobs on the control unit to adjust each color to 100% intensity. Adjust the red and blue intensities to obtain the best white color in the background pattern.



4. Adjust the screen with the hole in it until you see the colors illustrated to the right. Name all the colors that you see (answer report question).
5. Subtractive color mixing absorbs color and reflects the light that you see. The black light in the center of the color pattern is absorbing all the colors so you have no light being reflected back to the eye.
6. Remove Screen A (the screen with the black circle in the center) and observe the pattern on the screen.
7. Place you hand about 30 cm from the projection screen and note the color pattern (called “colored shadows”).

More Color Mixing

Another way to visually see color mixing in action is by spinning the Color-Changing Top shown. Spin the top and observe the color patterns produced. Spin the top with varying speeds and note any changes in the color patterns produced.

Experiment 3: THE DIFFUSION CLOUD CHAMBER

The diffusion cloud chamber is an instrument used to detect ionizing radiation and as a means of studying subatomic particles. Ionizing radiation includes beta particles (electrons), alpha particles (helium nuclei) and gamma radiation (high energy photons) along with a variety of particles, primarily muons, from outer space known as cosmic rays. Cloud chambers have been taken down into mines and up in high altitude aircraft to study cosmic rays.

CTR Wilson was interested in the causes of cloud formation in the 1890s and started work to experimentally form clouds in small containers. Wilson perfected his expansion cloud chamber in 1911. In the Wilson cloud chamber water vapor is saturated and by expanding the volume of the chamber the vapor cools and starts to condense. The condensate is a very fine mist in the chamber that appears to fall like tiny rain drops. Very early in his studies Wilson determined that ions can act as nuclei for condensation of the vapor. Wilson saw trails forming in the condensate that he interpreted as ions moving through the chamber. Wilson shared the 1927 Nobel Prize in physics for his work. In 1932 C. Anderson using a cloud chamber discovered positrons (positive electrons) whose existence had been predicted earlier by P. Dirac as part of the development of quantum mechanics. Anderson later received the Nobel Prize for his discovery of the positron. In 1936 Anderson and S. Neddermeyer discovered muons using a cloud chamber. By using a strong magnetic field, the tracks of charged particles can be curved, with positive particles curving in one direction and negative particles curving in the opposite direction. Photographs of the curved tracks can be analyzed mathematically to determine the energy of the particles and their charge to help in the identification of the particles.

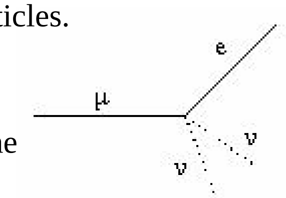
The diffusion cloud chamber was developed by A. Langsdorf in 1936. The diffusion cloud chamber is mechanically simpler than the expansion cloud chamber. The fine mist is formed using an alcohol such as isopropyl, ethyl or methyl in place of water vapor. A temperature difference of about 100°C is required between the top and bottom of the chamber for the mist to form. Dry ice has been used over the years to create the needed temperature differential. More modern cloud chambers use the Peltier effect to create the cold temperatures required without the need for dry ice.

Procedure:

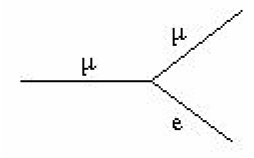
1. The cloud chamber should already be set up and operational. It is located near the laboratory sink as it must be cooled with a steady flow of cold water. The cloud chamber is a delicate instrument and may be easily permanently damaged, so be sure to not alter any of its settings
2. With the cloud chamber operational, look into the chamber. You are looking for tiny bubble tracks left by ionizing radiation. These tracks are difficult to see and are constantly appearing and disappearing. You may need to change your viewing angle during observation. The following photo was taken of the bubble chamber in our laboratory and illustrates what you are looking for. Check with your instructor if you are not able to see any tracks.

3. See how many types of track patterns you can observe. Dense, short tracks are produced by alpha particles. Beta particles produce faint tracks that are often curved or crooked and may cover most of the length of the chamber. Electrons produced from gamma rays hitting atoms leave tracks like those of beta particles.

4. More exotic bubble tracks may also be seen. A track which goes straight, then "kinks" off to the left or right sharply is most likely a "muon decay" as illustrated by the diagram. The two neutrinos (the dashed lines) are not detected in the chamber.



5. Look for three tracks which meet at a single point. In these events, one track is an incoming cosmic ray. This particle hits an atomic electron. The electron and the outgoing cosmic track are the two other tracks.



6. Look for a very windy, jagged track.  This is "multiple scattering", as a low-energy cosmic ray bounces off of one atom in the air to the next.

7. Be sure to leave the bubble chamber on and operational when you have completed this experiment.

Name: ________________________ Section: ___________

UNIVERSITY PHYSICS II

ORIENTATION LAB

www.ccccd.edu/physics

COLLIN COUNTY COMMUNITY COLLEGE

R E P O R T

Complete all tables and answer all questions for each experiment you participated in. To receive a grade for the Orientation Lab, be sure your instructor signs your report before leaving the lab.

Experiment 1: THE OUDIN COIL

Questions

1. Why do you think the Oudin coil is safe to use even though it produces 1200V of electricity?

2. While using the Visualizer and bulb, you observed electrical "streamers" leaving the bulb filament. How is this phenomenon similar to a lighting strike?

3. If you touched the bulb with your finger, describe any sensations you felt during the experience.

4. When using the U-shaped bulb in step 6 of the procedure, why was part of the bulb not lit? Explain any differences you saw with the bulb being lit in steps 6 and 7.

5. Why would wearing rubber gloves not make any difference in this experiment? With that in mind, why would wearing a rubber rain suit not protect you from being struck by lightning in a storm?

6. In step 8 of the procedure, you were able to light the bulb with the Oudin coil without direct contact. In other words, you were able to force an electrical current through the bulb. Discuss how you think this is possible.

Experiment 2: COLOR MIXING

Additive Color Mixing
Questions

1. Why does an apple look red? What color would an apple appear to be in green light?

2. Identify the colors you see at each overlap on the projected image in step 5 of the procedure. What three colors are the secondary colors of light?

3. If you have any art experience, you may know that the primary colors for paint (or pigments) are cyan, yellow, and magenta. But these are the secondary colors for light. Why? (*Additional note*: The secondary colors for pigments are the primary colors of light)

Subtractive Color Mixing
Questions

4. Identify the colors you see at each overlap on the projected image in step 4 of the procedure. What three colors are the secondary colors of light?

5. In step 6 of the procedure you removed Screen A. Describe the color pattern produced. Why is the center of the color pattern now white instead of black?

6. Describe the color shadow patterns you saw produced in step 7 of the procedure.

More Color Mixing
Questions

7. When you spun the top in the procedure, was the resulting color pattern due to additive or subtractive color mixing? Describe the patterns you saw.

Experiment 3: THE DIFFUSION CLOUD CHAMBER

Questions

1. What are the three main types of ionizing radiation?

2. Who invented the first cloud chamber?

3. Describe the types of bubble tracks you observed in the bubble chamber and identify which particle most likely produced them.

INSTRUCTOR SIGNATURE: ________________________________

Your instructor must sign your report for you to receive a grade for this Orientation Lab.