CATHODE RAY EXPERIMENT – INSTRUCTIONS

To perform a cathode ray experiment, set up a cathode ray tube with electrodes, evacuate the air, apply a high voltage, and observe the resulting beam of electrons (cathode rays) and their deflection by electric and magnetic fields, demonstrating their negative charge and properties. Here's a more detailed SOP (Standard Operating Procedure):

1. Setup and Equipment:

- **Cathode Ray Tube (CRT):** A vacuum-sealed glass tube with two electrodes (cathode - negative, anode - positive).
- **High Voltage Power Supply:** Capable of providing a high DC voltage (e.g., 1000-10000V).
- **Vacuum Pump:** To evacuate the air from the CRT.
- **Electrodes:** Metal plates or wires connected to the cathode and anode.
- **Optional:** Electric and magnetic field generators (e.g., plates for electric field, magnets for magnetic field).
- **Safety Equipment:** Gloves, safety glasses, and appropriate grounding.
- **Fluorescent Screen:** To visualize the cathode rays.

2. Preparation:

- **Connect the CRT:**

  Connect the cathode and anode terminals of the CRT to the high voltage power supply, ensuring correct polarity (cathode to negative terminal, anode to positive terminal).
- **Connect the Vacuum Pump:**

  Attach the vacuum pump to the CRT and evacuate the air to create a high vacuum.
- **Ensure Proper Grounding:**

  Ground all electrical components to prevent accidental shocks.
- **Safety Check:**
  Double-check all connections and ensure the power supply is switched off before making any adjustments.

3. Experiment Procedure:

- **Apply High Voltage:**

  Slowly increase the voltage from the power supply until a visible beam of cathode rays appears in the CRT.

- **Observe Cathode Rays:**

  Note the direction of the beam and its characteristics (e.g., straight line, glowing path).
- **Test for Deflection:**
- **Electric Field:** Apply an electric field by introducing charged plates near the beam. Observe the deflection of the beam towards the positive plate, indicating a negative charge.
- **Magnetic Field:** Apply a magnetic field using a magnet. Observe the deflection of the beam, which will be in a direction perpendicular to both the beam and the magnetic field, further confirming the negative charge and allowing for calculation of the charge-to-mass ratio (e/m).

Repeat with Different Gases/Electrodes:

Repeat the experiment with different gases in the CRT or different electrode materials to observe any variations in the cathode rays' properties.

Measure Deflection:

Quantify the deflection of the beam using appropriate measuring tools (e.g., calibrated scale).

Record Observations:

Document all observations, including the direction and magnitude of deflections, and any other notable characteristics of the cathode rays.

4. Safety Precautions:

- **High Voltage Danger:** High voltage can be extremely dangerous. Never touch the CRT or any high voltage components while the power supply is on.
- **Vacuum Tube Implosion:** Cathode ray tubes are fragile and can implode if damaged. Handle them with care and use appropriate stands.
- **Eye Protection:** Wear safety glasses to protect your eyes from potential hazards.
- **Proper Grounding:** Ensure all equipment is properly grounded to prevent electric shock.
- **Supervision:** If students are involved, ensure they are supervised by a qualified instructor.
- **Do not overload the power supply**

5. Analysis and Conclusion:

- **Electron Discovery:**

The experiment demonstrates the existence of electrons, which are fundamental subatomic particles with a negative charge.

- **Electron Properties:**

  The experiment allows for the determination of the charge-to-mass ratio (e/m) of electrons.

- **Cathode Ray Nature:**

  The experiment shows that cathode rays are streams of electrons.

- **Atomic Structure:**
  The discovery of electrons via cathode ray experiments led to a deeper understanding of atomic structure