Safety:

- Handling Chemicals:
    - Use pipettes or droppers for transferring liquids to avoid spills
    - Open bottles and containers slowly to avoid any reaction from pressure build-up
    - Handle all chemicals with care, and avoid any direct skin contact
- Chemical Mixing:
    - Add chemicals slowly and in the correct order, as specified in the experimental procedure
    - Mix chemicals in a well-ventilated area or under a fume hood if possible
- Exposure Prevention:
    - Do not touch your face, especially your eyes or mouth, while handling chemicals
    - If a chemical splashes on your skin or in your eyes, immediately rinse the affected area with water for at least 15 minutes and seek medical attention
- During the Reaction:
    - Stand back from the reaction vessel to avoid inhaling any fumes
    - Never look directly into the container as the reaction occurs
    - Do not lean over the reaction vessel; vapors can be harmful

Materials:

- Luminol powder
- Sodium hydroxide (NaOH) or potassium hydroxide (KOH)
- Hydrogen peroxide solution (H_2O_2), typically 3%
- Distilled water
- Copper(II) sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$) or another catalyst like potassium ferricyanide or sodium carbonate (for a more environmentally friendly version)
- Beakers or flasks
- Measuring spoons or scales
- Pipettes or droppers
- Stirring rod or magnetic stirrer
- A dark room to observe the glow

Procedure:

- Prepare the Luminol Stock Solution:

a. Measure out approximately 0.2 grams of luminol powder
b. Dissolve the luminol in about 100 mL of distilled water

c. Add a few grains (less than 0.1 g) of sodium hydroxide or potassium hydroxide to the solution to make it alkaline, which helps in the dissolution of luminol. Stir until the luminol is completely dissolved.

- Prepare the Catalyst Solution:

a. If using copper(II) sulfate pentahydrate, dissolve about 0.1 grams in 100 mL of distilled water to create a 0.1% copper sulfate solution

- Prepare the Hydrogen Peroxide Solution:

a. Dilute the 3% hydrogen peroxide with an equal volume of distilled water to make a 1.5% solution. For example, mix 50 mL of 3% H_2O_2 with 50 mL of distilled water

- The Chemiluminescent Reaction:

a. In a dark room, combine the luminol solution with the copper sulfate solution in a clean beaker
b. Quickly add an equal volume of the diluted hydrogen peroxide solution to the mixture
c. Stir the solution rapidly with a stirring rod
d. Observe the blue glow that is produced almost immediately

What is Happening:

- When the hydrogen peroxide is added, it reacts with the luminol in the presence of the hydroxide ions. This reaction forms an unstable intermediate product
- The unstable intermediate is then oxidized by the hydrogen peroxide, and as it returns to a lower energy state, it releases the energy in the form of a photon, which we see as light
- The catalyst (copper(II) sulfate in this case) speeds up the reaction without being consumed in the process. It allows the reaction to proceed quickly enough at room temperature to produce a noticeable amount of light

Chemical Reaction:

Luminol + O2 → 3-AP A (aminophthalate ion) + light

Where 3-APA is the aminophthalate ion, the oxidized product of luminol

- The light emitted is typically blue, with a wavelength of about 425-430 nm. The amount of light produced is pretty small, and is a good demonstration of a concept known as quantum yield, which is the efficiency with which chemical energy is converted into light energy. In this reaction, the quantum yield is high enough that the glow can be seen quite clearly in a dark room.

- Fun fact: The chemiluminescence reaction involving luminol is also practical in forensic science, where it is used to detect trace amounts of blood at crime scenes, as the iron in blood can also catalyze the luminol reaction, producing a glow that indicates the presence of blood.

Clean up:

- Neutralize the remaining reaction mixture with a dilute acid, such as vinegar, if a strong base was used
- Clean all equipment thoroughly with soap and water