The University of Texas at Austin
Department of Chemistry
College of Natural Sciences

Luminol

Performer's Version

Safety Hazards

- Personal Protective Equipment:
    - Safety glasses/goggles
    - Nitrile gloves
    - Chemical & flame retardant lab coat
- Physical Hazards
    - Sodium bicarbonate may form combustible dust concentrations in air during processing.
    - 30% Hydrogen peroxide is an oxidizer and may intensify fire.
- Chemical Hazards
    - Sodium carbonate causes serious eye irritation.
    - Luminol causes skin irritation, serious eye irritation, and may cause respiratory irritation.
    - Ammonium carbonate monohydrate is harmful if swallowed.
    - Copper(II) sulfate pentahydrate is harmful if swallowed and causes serious eye damage.
    - 30% Hydrogen peroxide is harmful if swallowed or inhaled and causes severe skin burns and eye damage.

Materials

- 4.0g Sodium carbonate
- 0.2g Luminol
- 24g Sodium bicarbonate
- 0.5g Ammonium carbonate monohydrate
- 0.4g Copper(II) sulfate pentahydrate
- 5mL 30% Hydrogen peroxide
- Bevo Apparatus
- Large funnel
- Waste carboy

Safety Data Sheet(s)

- Sodium carbonate
- Luminol
- Sodium bicarbonate
- Ammonium carbonate monohydrate
- Copper(II) sulfate pentahydrate
- 30% Hydrogen peroxide

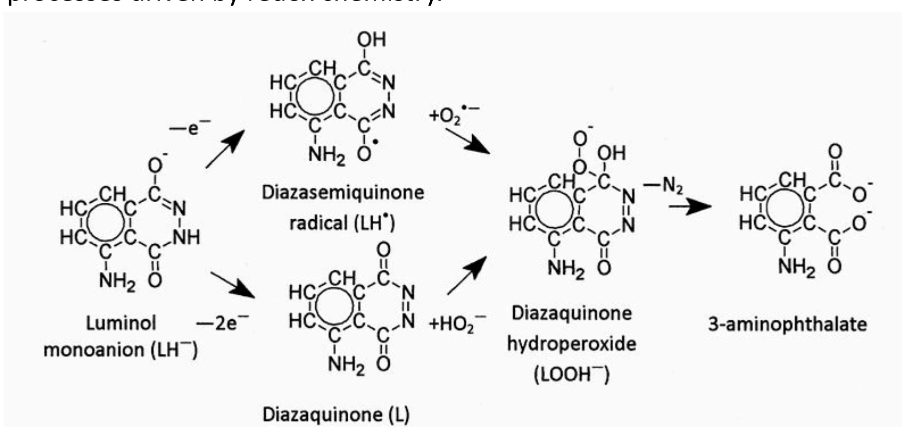
Procedure

1. Place the funnel at the opening of the separatory funnel. Make sure the stopcock is open (in the vertical position).
2. Carefully pour both Solution A and B into the funnel slowly. Try to pour at the same pace, and go slow so that the separatory funnel doesn't fill above halfway.

Pedagogy & Supplemental Information

In this striking demonstration, two solutions – one containing luminol, copper(II) sulfate, carbonate salts, and the other hydrogen peroxide – are combined to produce a vivid blue glow. The resulting luminescence is a dramatic example of chemiluminescence, the emission of light as a product of a chemical reaction. This phenomenon is distinct from fluorescence or phosphorescence in that no external light source is required to excite the molecules; instead, the energy needed for light emission is generated internally through redox chemistry.

Chemiluminescence occurs when a chemical reaction produces an electronically excited product that emits a photon as it relaxes to its ground state. In the luminol reaction, this begins with deprotonation of luminol in basic solution, forming the monoanion (LH^-), which is oxidized – facilitated by hydrogen peroxide and a Cu^{2+} catalyst—into a diazasemiquinone radical (LH•). This radical reacts with superoxide (O_2^-) to form a diazaquinone hydroperoxide ($LOOH^-$), which decomposes to release nitrogen gas and generate an excited-state 3-aminophthalate anion. As this species relaxes to its ground state, it emits blue light (~430 nm). The light emission corresponds to the energy difference between the molecule's excited and ground states, defined by its HOMO-LUMO gap, making luminol a vivid example of photophysical processes driven by redox chemistry.



This process can be interpreted in terms of molecular orbital theory. The emitted light corresponds to the energy difference between the highest occupied molecular orbital (HOMO) and the lowest unoccupied molecular orbital (LUMO) of the excited species. The photon energy (and thus the color of light) depends on the size of this HOMO-LUMO gap. In luminol's excited intermediate, the gap aligns with the energy of visible blue light, making it an ideal example to illustrate photophysical principles in a chemical context.

In the real world, luminol is perhaps most famously used in forensic science, where it is sprayed at crime scenes to detect trace amounts of blood. Iron in hemoglobin catalyzes the same oxidation reaction, causing latent bloodstains to glow faintly in the dark. Beyond forensics, chemiluminescence has broader applications in biochemistry (e.g., immunoassays using luminol derivatives), glowsticks, and analytical chemistry where light emission is used as a sensitive detection method. Demonstrations like this provide a vivid illustration of electronic structure, redox chemistry, and the practical applications of molecular science.