Chemical Luminescence[•]

Materials:

4.0g Sodium Carbonate Na_2CO_3
3 Liters Water
0.2g Luminol (3-aminophthalhydrazide)
24.0g Sodium Bicarbonate $NaHCO_3$
0.5g Ammonium Carbonate Monohydrate $(NH_4)_2CO_3 \cdot H_2O$
0.4g Copper (II) Sulfate Pentahydrate $CuSO_4 \cdot 5H_2O$
50 mL 3% Hydrogen Peroxide4
(2) 1 L Beakers
(1) 250 mL Beaker

Instructions:

Solution A. In a 1 L flask add 500mL of water. Dissolve the sodium carbonate, luminol, sodium bicarbonate, ammonium carbonate monohydrate, and copper (II) sulfate. Gently heat the solution if everything isn't dissolving. Dilute to a final volume of 1L.

Solution B. In a 1 L flask, dilute the peroxide to a volume of 1L with water.

Combine equal portions of Solution A and Solution B.

Discussion:

The chemical luminescence of luminol is a classic. The reaction is an oxidation, where luminol is being oxidized by peroxide in water. The luminescent product of the reaction is the aminophthalate ion. While your students will not understand this, they will understand that energy is being given off.

Reactants → Excited Product → Product + Energy (light)

The reaction of luminol and an oxidant create an excited species, with a lot of energy. Since an excited species is unstable, it must release its energy with an emission at 425 nm. (Your students can calculate the energy released in the reaction.) The light energy is not contained by anything, so light travels from the solution outward.

NOTE:

For more potential luminescent reactions, see
Chemical Demonstrations Vol. 1 Bassam Z. Shakashiri

[•] Shakhashiri, Bassam Z. Chemical Demonstrations Volume 1 pg 125-204

Alternate Chemiluminescence

Materials:

(2) 100 mL Beakers
~ 50mL of Solution A from other Chemiluminescence Experiment
~ 50mL of Solution B from other Chemiluminescence Experiment
1L Pyrex Erlenmeyer Flask
10mL water
Hot Plate
2 holed rubber stopper
(2) glass tubes fit to the holes in the rubber stopper
(2) equal lengths of clear tygon tubing
Hot Gloves
Ring Stand with round clamp.

Instructions:

Assemble the stopper: VERY CAREFULLY shove the glass tubes through the two holed stopper. Use glycerin or soap to make it easier, and never shove towards your hand. Make sure that the tubes are sticking about 2 or 3 inches into flask. On the outside portion of the stopper, fit the tygon tubing securely over the glass tubes. Holding it up, it should look like big floppy rabbit ears.

Pour solutions A and B into separate 100mL beakers. Place them in front of the ring stand. Pour the water into the Erlenmeyer flask and place it on the hotplate. Stopper it tightly with the stopper assembly. Wait until the steam is pouring out of the tubes. Wearing gloves, take the flask off of the hotplate, invert it, and insert it through the ring-stand. Have someone place a tube in each beaker. In about 20 seconds there will be a glowing fountain in the Erlenmeyer flask.

Discussion:

For the chemiluminescent explanation, please see the previous experiment.

The fountain is a result of the Crush the Can demonstration. Water vapors in the flask quickly condense into the two solutions. To equalize the pressure, a vacuum pulls in air from the outside and the solutions come with it. They solutions combine in a brilliant fountain.

NOTE: I have broken more than one Erlenmeyer flask doing this demonstration. Cool liquid hitting a hot flask is the recipe for a broken bottle. Use extreme caution and make sure the flask is made of Pyrex glass.