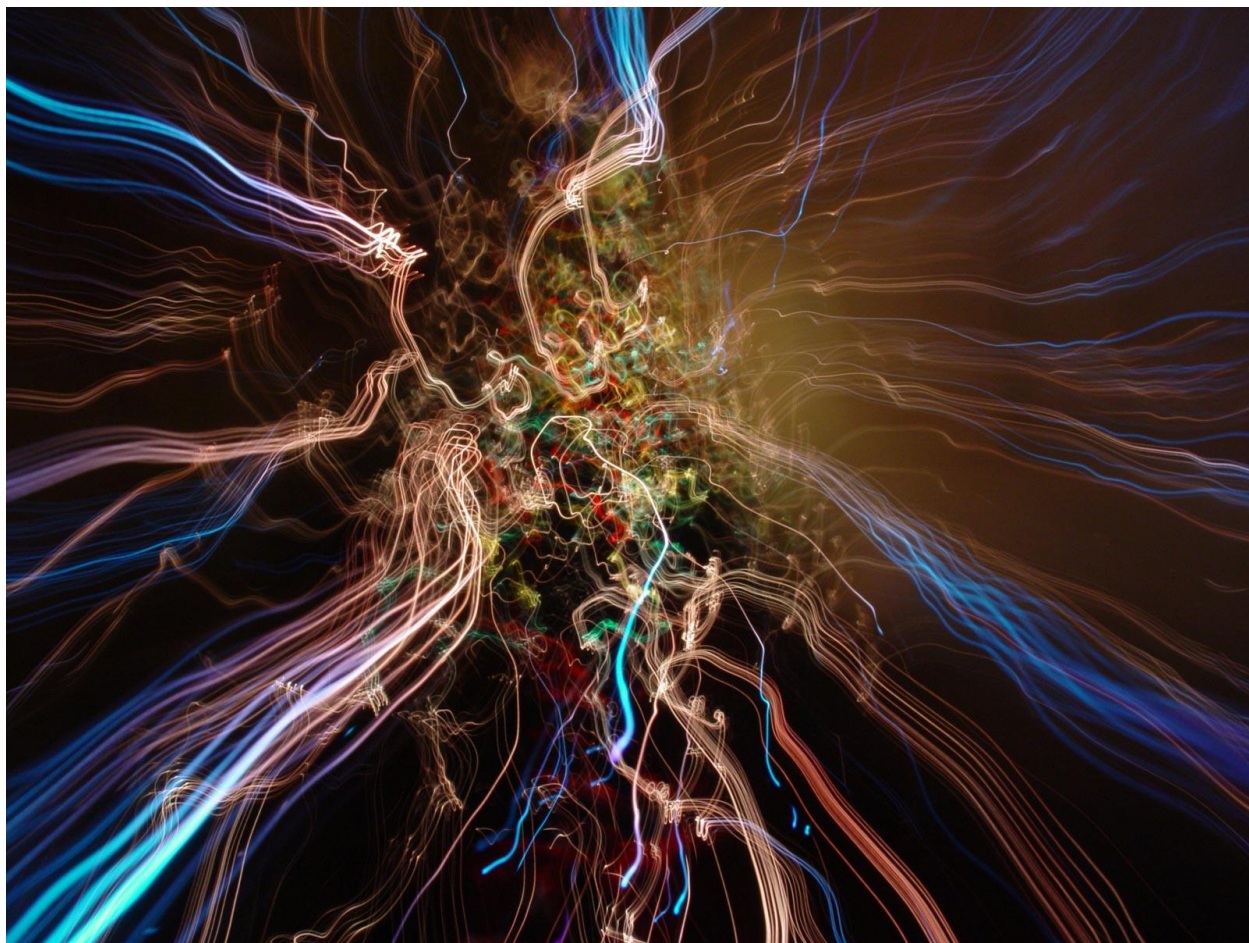


The Power of Light!

Light and Luminescence Science



Friday Funday Laboratory Notebook

Name:

Team:

Experiment #1: Chemiluminescence – Building a Glowstick

Guess how glow sticks work before beginning the experiment.

Background: During chemical reactions between substances energy may be released. In most cases, energy will be released in the form of heat. However, in some reactions, energy can instead be released in the form of light. In this experiment we'll examine the phenomena known as chemiluminescence, wherein a reaction will release light but not heat.

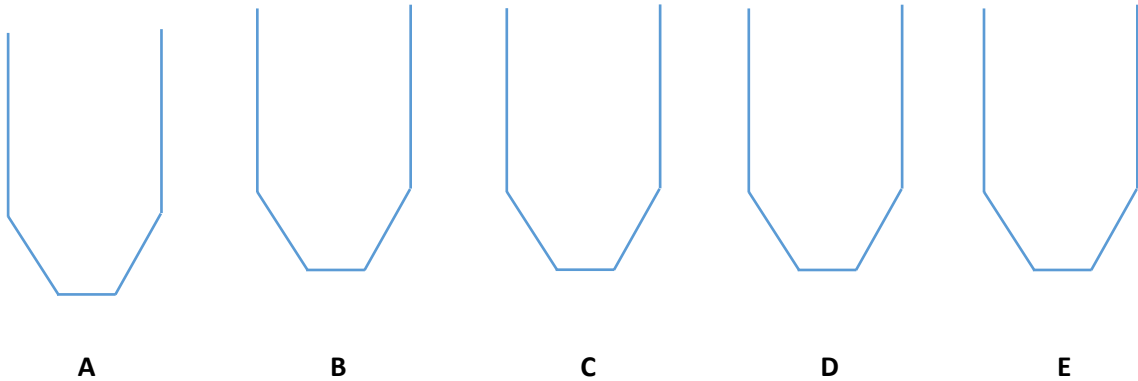
Procedure (Check off the circles as you complete):

- Acquire 5 centrifuge tubes (10 mL) with caps. Label them A-E.
- Acquire a small graduated cylinder.
- Acquire the four dye packets, labeled:
 - Eosin Y (Orange Dye)
 - Rhodamine B (Red Dye)
 - 9,10-bis(phenylethynyl)anthracene (Green Dye)
 - Fluorescein (Yellow Dye)
- Measure 5 mL of Luminol into each of your 5 centrifuge tubes.
- Pour the four dyes into individual centrifuge tubes; leave one centrifuge tube without dye.
- Add 5 mL of 30% Hydrogen Peroxide into each centrifuge tube.
- Cap the tubes tightly and shake.

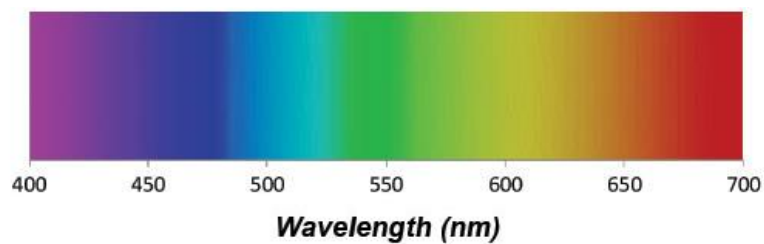
Safety Alert: Hydrogen Peroxide is toxic! Do not open the tube!

Observations:

- Observe the different colors and intensities (bright, slightly bright, mostly dim, dim):
Write your observations below in the tubes labeled A-E.



- Compare the colors to the visible spectrum:



- What do the different wavelengths mean? Why are some of the reactions brighter than others?
- Do the tubes feel warm? Is there still energy being released? What kind of energy?

Experiment #2: Fluorescence, Black Lights, and Sunscreen:

Background: In the previous reaction, energy held in chemical bonds was converted to energy in the form of light. This is a type of **luminescence** known as chemiluminescence. In this experiment we'll look at a type of **luminescence** known as fluorescence. Instead of chemical energy being converted to light energy, we'll convert one wavelength of light energy into a different wavelength.

Procedure (part 1) (Check off the circles as you complete):

- Individually acquire five 20 mL flasks.
- Label the flasks A-E.
- Grab one each of the colored highlighters. Be careful, they have already been opened.
- Fill each of the flasks halfway with tonic water.
- Remove the felt from each highlighter pen and soak them in separate flasks of tonic water.
- Allow the felt to soak for a few minutes.
- Have your Grad Student shine a black light on your solutions.
- Have your Grad Student shine a black light on a white piece of paper.

Observations (part 1):

- How bright is the blacklight reflecting off the paper?

- What happens when a blacklight is shown on the five solutions?

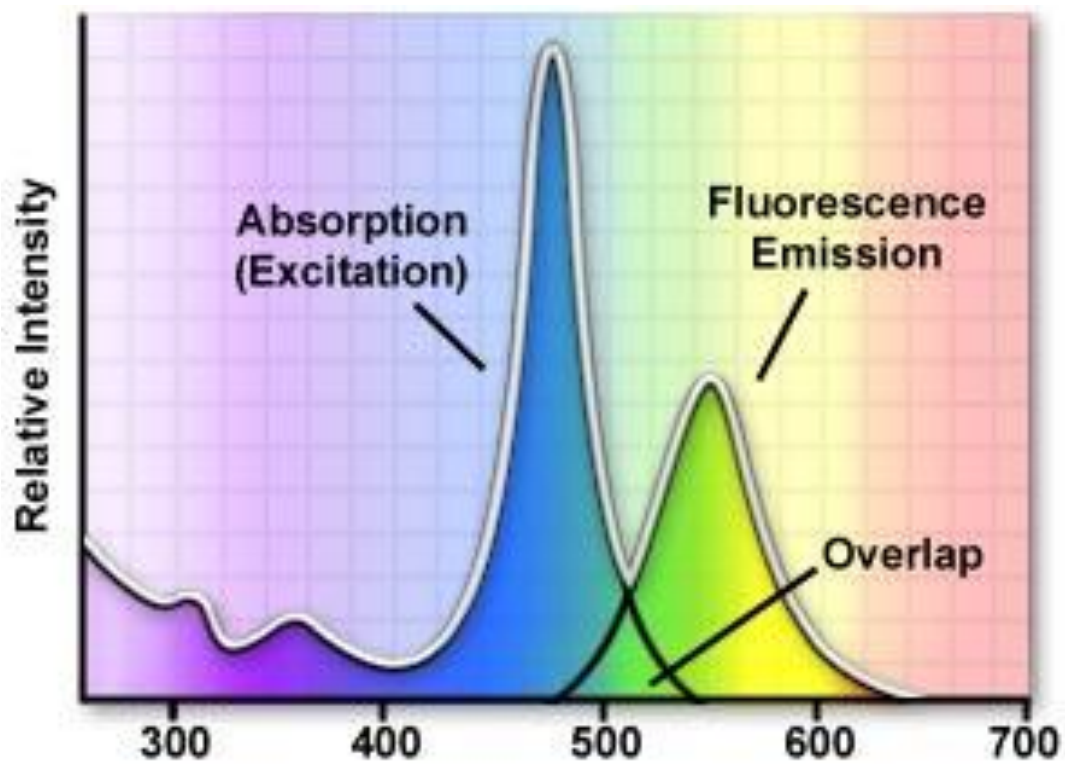
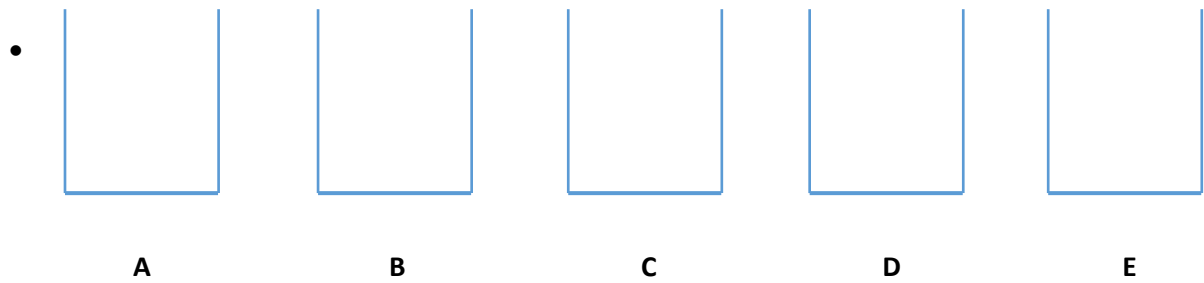
-
- Diagram showing five empty rectangular boxes labeled A, B, C, D, and E, intended for drawing the structures of the five isomers of C₅H₁₀.

- Individually acquire three 15 mm x 150 mm petri dishes. Label them 1-3.
- Fill the petri dishes halfway with ethanol.
- Dissolve 5 drops of sunscreen into petri dish A.
- Dissolve 10 drops of sunscreen into petri dish B.
- Dissolve 15 drops of sunscreen into petri dish C.
- Place petri dish #1 on top of each of the flasks and have a Grad Student shine UV light on it.

- Repeat the process for petri dishes #2 and #3.

- Does the amount of sunscreen appear to have an effect? (yes / no)
- What does the sunscreen do?

- Re-record observations for the five flasks when petri dish C is placed on top of them. The one with the most sunscreen.



Experiment #3: Fluorescence Forensics

Case Background: A fourth type of luminescence is known as bioluminescence. This is the production of light from a living organism. These days' scientists can use genes from luminescent creatures (such as a firefly) and express them in a different living organism (like a mouse)! However, bioluminescence testing in large mammals is strictly forbidden by U.S. law.

Earlier this morning a pair of bioluminescent kittens was found on the 2nd floor of Klamath. The police are threatening to shut down the entire chemistry department (including the mad duck science Friday) unless we hand over the culprit. Luckily for us we found the hand written recipe that the guilty graduate student used to create the bioluminescent kittens. Let's use fluorescence to catch this villain!



Bioluminescence kittens!

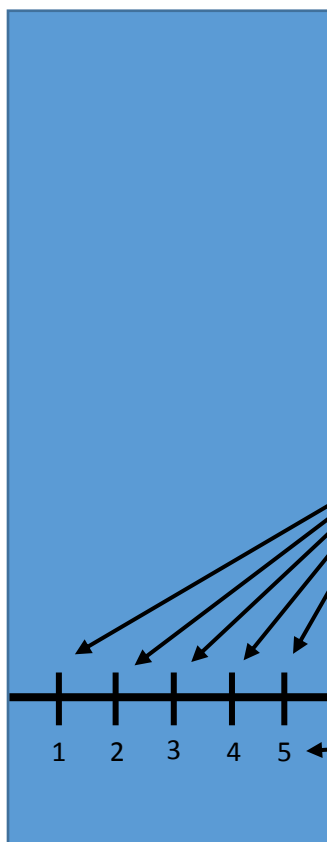
Procedure (Check off the circles as you complete):

- Take the evidence and rip it up (no seriously).
- Acquire a few pieces of the shredded evidence, make sure there is writing on the pieces.
- Take four pieces of 1 x 1 inch paper squares.
- Use each of the four suspected pens to color in one of the 1 x 1 squares. Keep track of which squares were colored with which pens.
- Acquire five scintillation vials with solvent (methanol) inside. Label the vials 1 – 5.

- Place the pieces of shredded evidence into vial #1. Label this vial “unknown”.
- Place the four 1 x 1 inch squares into the remaining vials. Fill out the “vial” table on the next with the brand of pen.
- Let the solvent dissolve the ink for a minute.
- In the meantime acquire a TLC plate. You want to draw a line, with a pencil, a few centimeters from the bottom of the plate
- You’ll then want to draw 5 equidistant ticks through this line (an example is shown on the next page). Label those ticks 1 – 5.
- Use five different capillary tubes to spot your TLC plate. Your Grad Student will show you how to do this.
- Acquire a 100 mL beaker and add 5 mL of solvent mixture to it (ethyl acetate : ethanol : H₂O 7:3:2).
- Gently place the TLC plate into the beaker and cap the beaker.

Vial	Type of Ink
1	Unknown
2	
3	
4	
5	

Use a pencil and ruler to draw a line a few centimeters above the bottom of the TLC plate.



TLC Spot	Type of Ink
1	Unknown
2	
3	
4	
5	

Use a pencil and draw five roughly equidistant vertical tick marks.

Use a pencil to label the five tick marks.

- Allow the TLC solvent to climb 3/4ths of the way up the TLC plate. Then remove the TLC plate.
- Allow the plate to dry.
- Use a UV light (340 nm) to visualize the different compounds. Circle them with a pencil.

Observations:

- Considering the past two modules, what is the UV light doing in this experiment?
- What's happening on the TLC plate?
- Which pen was responsible for writing the bioluminescence recipe? How do you know?

Experiment #4: Phosphorescence & Glowing Paint (Dark Room Experiment)

Background: In the previous experiment we demonstrated how a material could convert one form of light into a different form. However, in that experiment the material stopped glowing once the UV light was turned off. This occurred because the material could only store the energy, contained in the light, for an extremely short period of time. In this experiment we'll learn about phosphorescence, a form of luminescence in which the material holds onto the incoming energy and slowly releases it over time.

Procedure (Check off the circles as you complete):

- Acquire a small vial of glow paint & a paint brush.
- On four separate sheets of paper write your first name using the paint.
- Ready a phone camera (make sure the flash is off).
- Hold an infrared light 2 inches above the first piece of paper. Shine the light for 20 seconds.
- Immediately after turning the light off take a picture of your name.
- Repeat the process on the second sheet of paper while using an incandescent bulb.
- Repeat the process on the third sheet of paper while using a fluorescent bulb.
- Repeat the process on the final sheet of paper while using a UV lamp.

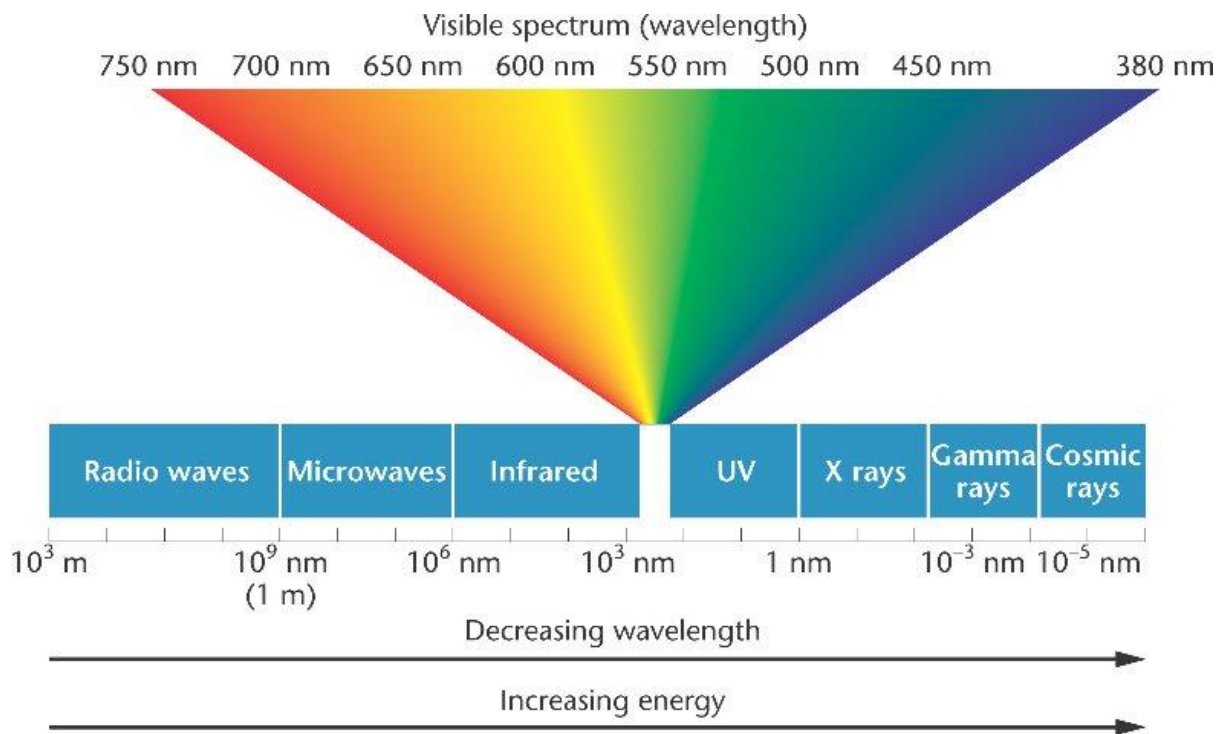
Note: Allow a Graduate Student to handle the UV lights. Do not look into these lights while they are on.

- Compare all four sheets of paper side by side.

Observations:

- Rank the four papers from brightest to darkest.
- Which lamp made the paint glow the brightest?
- Which lamp had the least effect?

- What caused the lights to have different effects?



Bonus Activity:

- Use the paint to paint a square.
- Now use a blue laser pointer to draw your name in the square.

Experiment #5: Controlling Light with Heat (Dark Room Experiment)

Background: The previous experiments have all focused on different forms of luminescence. In each case we demonstrated that light is a form of energy. As a form of energy, we were able to convert between different types of light. In this experiment we'll take another look at chemiluminescence. Since chemiluminescence is really just the release of energy during a chemical reaction we should be able to control the light by controlling the rate of the reaction! Thus, we can control how much energy is generated.

Procedure (part 1) (Check off the circles as you complete):

- Acquire 9 glow sticks, three of each color (red, blue, green).
- Acquire 3 flasks. Label them A-C.
- Fill Flask A halfway with hot water.
- Fill Flask B halfway with luke warm water.
- Fill Flask C halfway with cold water.
- Crack the 9 glow sticks and place three of each color into the flasks.
- Wait for 1 minute.
- Exchange the glow sticks in flask A and flask C.

Observations (part 1):

- Which bath has the brightest glow stick? How come?
- When the glow sticks from A and C are switched what happens? Why?
- Does the color of the glow stick change anything?

Procedure (part 2) (Check off the circles as you complete):

- Leave the glow sticks in the flasks for at least 1 minute after exchange A and C.
- Acquire nine glow in the dark stars.
- Spread the stars out on the floor. Make sure they are all at least 6 inches apart.
- Ready a camera (make sure flash is off).
- Choose a single glow stick and remove it from its flask.
- Immediately lay the glow stick on a star so that it cuts the star in half.
- Time 30 seconds. Immediately remove the glow stick and take a picture of the star.
- Repeat the process for each of the other 8 glow sticks. Use a new star each time.

Observations (part 2):

- Rank the brightness of the stars from 1-9 (with 1 being the brightest). Use the camera images to compare.

Red (Hot)	Green (Hot)	Blue (Hot)	Red (Warm)	Green (Warm)	Blue (Warm)	Red (Cold)	Green (Cold)	Blue (Cold)

- Is there a pattern in the ordering?

- Why are some stars brighter than others?

Supplies Checklist:

- Chemicals:
 - Eosin Y (Not Hazardous)
 - Rhodamine B (MSDS Listed on Page 15)
 - 9,10-bis(phenylethynyl)anthracene (MSDS Listed on Page 16)
 - Fluorescein (MSDS Listed on Page 17)
 - 30% Hydrogen Peroxide (MSDS Listed on Page 18)
 - Luminol (MSDS Listed on Page 19)
 - Solvent Mixture (7:3:2 ethyl acetate : ethanol : H₂O)
 - Methanol
 - Ethanol
 - Tonic Water
- Other Supplies:
 - 5x 10 mL Centrifuge Tubes
 - A 10 mL Graduated Cylinder
 - 5x Scintillation Vials
 - 1x TLC Plate
 - 5x capillary tubes
 - 1x 100 mL beaker
 - 3x 250 mL beaker
 - 1x watch glass (larger than top of beaker)
 - 4x pens (preferably the same color but different brands)
 - 5x Felt tipped highlighters (all different colors)
 - Excess paper
 - 5x 20 mL flasks
 - Sunscreen
 - 9x glowsticks (3x red, 3x blue, 3x green)
 - Glow in the dark stars
 - Glow in the dark paint
 - Paint Brushes
 - Ice
 - Hot Plate
 - Infrared Lamp
 - Incandescent Lamp
 - UV Lamp

Rhodamine B:

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Acute toxicity, Oral (Category 4), H302
Serious eye damage (Category 1), H318
Acute aquatic toxicity (Category 3), H402
Chronic aquatic toxicity (Category 3), H412

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram



Signal word

Danger

Hazard statement(s)

H302 Harmful if swallowed.
H318 Causes serious eye damage.
H412 Harmful to aquatic life with long lasting effects.

Precautionary statement(s)

P264 Wash skin thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
P273 Avoid release to the environment.
P280 Wear protective gloves/ eye protection/ face protection.
P301 + P312 IF SWALLOWED: Call a POISON CENTER or doctor/ physician if you feel unwell.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove

Sigma - R6626

Page 1 of 8

P310 contact lenses, if present and easy to do. Continue rinsing.
P330 Immediately call a POISON CENTER or doctor/ physician.
P501 Rinse mouth.
Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

9,10-bis(phenylethynyl)anthracene:

2.2 GHS Label elements, including precautionary statements

Pictogram



Signal word

Warning

Hazard statement(s)

H315

Causes skin irritation.

H319

Causes serious eye irritation.

H335

May cause respiratory irritation.

Precautionary statement(s)

P261

Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.

P264

Wash skin thoroughly after handling.

P271

Use only outdoors or in a well-ventilated area.

P280

Wear protective gloves/ eye protection/ face protection.

P302 + P352

IF ON SKIN: Wash with plenty of soap and water.

P304 + P340

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.

P305 + P351 + P338

IF IN EYES: Rinse cautiously with water for several minutes. Remove

Aldrich - 264199

Page 1 of 7

P312 contact lenses, if present and easy to do. Continue rinsing.
P321 Call a POISON CENTER or doctor/ physician if you feel unwell.
P332 + P313 Specific treatment (see supplemental first aid instructions on this label).
P337 + P313 If skin irritation occurs: Get medical advice/ attention.
P362 If eye irritation persists: Get medical advice/ attention.
P362 Take off contaminated clothing and wash before reuse.
P403 + P233 Store in a well-ventilated place. Keep container tightly closed.
P405 Store locked up.
P501 Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

Fluorescein:

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Eye irritation (Category 2A), H319

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram



Signal word

Warning

Hazard statement(s)

H319

Causes serious eye irritation.

Precautionary statement(s)

P264

Wash skin thoroughly after handling.

P280

Wear protective gloves/ eye protection/ face protection.

P305 + P351 + P338

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P337 + P313

If eye irritation persists: Get medical advice/ attention.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Formula : $C_{20}H_{12}O_5$

Aldrich - F2456

f

Molecular Weight : 332.31 g/mol
CAS-No. : 2321-07-5
EC-No. : 219-031-8

Hazardous components

Component	Classification	Concentration
2-(6-Hydroxy-3-oxo-(3H)-xanthen-9-yl)benzoic acid		
	Eye Irrit. 2A; H319	-

For the full text of the H-Statements mentioned in this Section, see Section 16.

Hydrogen Peroxide (30%):

2.2 GHS Label elements, including precautionary statements

Pictogram



Signal word

Danger

Hazard statement(s)

H271

May cause fire or explosion; strong oxidiser.

H302

Harmful if swallowed.

H314

Causes severe skin burns and eye damage.

H318

Causes serious eye damage.

H402

Harmful to aquatic life.

Precautionary statement(s)

P210

Keep away from heat.

P220

Keep/Store away from clothing/ combustible materials.

P221

Take any precaution to avoid mixing with combustibles.

P264

Wash skin thoroughly after handling.

Sigma - H1009

P270

Do not eat, drink or smoke when using this product.

P273

Avoid release to the environment.

P280

Wear protective gloves/ protective clothing/ eye protection/ face protection.

P283

Wear fire/ flame resistant/ retardant clothing.

P301 + P312 + P330

IF SWALLOWED: Call a POISON CENTER or doctor/ physician if you feel unwell. Rinse mouth.

P301 + P330 + P331

IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.

P303 + P361 + P353

IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.

P304 + P340 + P310

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Immediately call a POISON CENTER or doctor/ physician.

P305 + P351 + P338 + P310

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor/ physician.

P306 + P360

IF ON CLOTHING: rinse immediately contaminated clothing and skin with plenty of water before removing clothes.

P363

Wash contaminated clothing before reuse.

P370 + P378

In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.

P371 + P380 + P375

In case of major fire and large quantities: Evacuate area. Fight fire remotely due to the risk of explosion.

P405

Store locked up.

P501

Dispose of contents/ container to an approved waste disposal plant.

Luminol:

2.2 GHS Label elements, including precautionary statements

Pictogram



Signal word

Warning

Hazard statement(s)

H315

Causes skin irritation.

H319

Causes serious eye irritation.

H335

May cause respiratory irritation.

Precautionary statement(s)

P261

Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.

P264

Wash skin thoroughly after handling.

P271

Use only outdoors or in a well-ventilated area.

P280

Wear protective gloves/ eye protection/ face protection.

P302 + P352

IF ON SKIN: Wash with plenty of soap and water.

P304 + P340

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.

P305 + P351 + P338

IF IN EYES: Rinse cautiously with water for several minutes. Remove

Aldrich - 123072

P312

contact lenses, if present and easy to do. Continue rinsing.

P321

Call a POISON CENTER or doctor/ physician if you feel unwell.

P332 + P313

Specific treatment (see supplemental first aid instructions on this label).

P337 + P313

If skin irritation occurs: Get medical advice/ attention.

P362

If eye irritation persists: Get medical advice/ attention.

P403 + P233

Take off contaminated clothing and wash before reuse.

P405

Store in a well-ventilated place. Keep container tightly closed.

P501

Store locked up.

Dispose of contents/ container to an approved waste disposal plant.