EXPERIMENT MANUAL

GLOWING CHEMISTRY

WARNING. Not suitable for children under 10 years. For use under adult supervision. Contains some chemicals which present a hazard to health. Read the instructions before use, follow them and keep them for reference. Do not allow chemicals to come into contact with any part of the body, particularly the mouth and eyes. Keep small children and animals away from experiments. Keep the experimental set out of reach of children under 10 years old. Eye protection for supervising adults is not included.

WARNING — Chemistry Set. This set contains chemicals and/or parts that may be harmful if misused. Read cautions on individual containers and in manual carefully. Not to be used by children except under adult supervision.

THAMES & KOSMOS

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Please observe the safety information on the front cover and pages 5 through 13, and the first aid information on this page.

Safety and disposal information for the UV light

- ››› NOTE! Only suitable for children at least 10 years of age. Instructions for parents or other responsible persons are included and must be followed. Save the packaging and instruction manual, as they contain important information.
- ››› The lamp battery should only be inserted or changed by an adult.
- ››› Protect the lamp from moisture.
- ››› You will need one AAA battery (1.5-volt, type LR03), which is not included in the kit due to its limited shelf life.
- ››› Non-rechargeable batteries are not to be recharged. They could explode!
- ››› Rechargeable batteries are only to be charged under adult supervision.
- ››› Rechargeable batteries are to be removed from the toy before being charged.
- ››› Different types of batteries or new and used batteries are not to be mixed.
- ››› Batteries are to be inserted with the correct polarity.
- ››› Exhausted batteries are to be removed from the toy!
- ››› The supply terminals are not to be short-circuited. A short circuit could lead to overheating of circuits and battery explosions. Be sure not to bring batteries into contact with coins, key chains, or other metal objects. Avoid deforming the batteries.
- ››› Do not throw used batteries into the household trash. They must be delivered to a local collection station or to a store that accepts used batteries for disposal. That way, they can be disposed of in an environmentally responsible manner.

In addition to a certain amount of visible light, the UV lamp primarily emits energy-rich ultraviolet light. Therefore, do not shine it directly in your eyes or into the eyes of another living creature!

Notes on disposal of electrical and electronic components

None of the electrical or electronic components in the UV lamp should be thrown into the regular household trash at the end of their lifespan; instead, they must be delivered to a collection location for the recycling of electrical and electronic devices. The symbol on the product, instructions for use, or packaging indicates this.

The materials are reusable in accordance with their markings. By reusing or recycling used devices, you are making an important contribution to the protection of the environment. Please consult your local authorities for the appropriate disposal location.

First aid in case of accidents

Advice in case any accidents should happen during experimentation.

- ››› **1. In case of eye contact:** Wash out eye with plenty of water, holding eye open if necessary. Seek immediate medical advice.
- ››› **2. If swallowed:** Wash out mouth with water, drink some fresh water. Do not induce vomiting. Seek immediate medical advice.
- ››› **3. In case of inhalation:** Remove person to fresh air.
- ››› **4. In case of skin contact and burns:** Wash affected area with plenty of water for at least 10 minutes.
- ››› **5. In case of doubt,** seek medical advice without delay. Take the chemical and its container with you.
- ››› **6. In case of injury** always seek medical advice.

Poison Control Centers (United States)
In case of emergency, your nearest poison control center can be reached everywhere in the United States by dialing the number:

1-800-222-1222

Local Hospital or Poison Centre (Europe)
Record the telephone number of your local hospital or poison centre here:

Write the number down now so you do not have to search for it in an emergency.

When in doubt, seek medical advice without delay. Bring the chemical and its container with you. In case of injury, always seek medical advice.

An experiment to hit the ground running

Not everything is the way it seems...
Try it, and prepare to be surprised!

Beads in the sunshine

You probably know that sunlight tans skin. But it can bring out other colors as well.

YOU WILL NEED

› **Beads**
› **Petri dish**

HERE'S HOW

1. Place a few of the white beads in the lid of the Petri dish and take the lid out into the sunshine. Watch what happens.

2. Now cover the beads and wait a few minutes.

WHAT'S HAPPENING?

The beads contain a certain colorless substance that only becomes colorful when it comes into contact with a component of sunlight. When you shield it from the light, it turns pale again. You can perform this experiment many times over and over.

WANT TO LEARN MORE?
Then come along and marvel at more luminous effects...

What's in your experiment kit:

Checklist: Find – Inspect – Check off

✔	No.	Description	Quantity	Item No.
❍	1	Safety goggles	1	052297
❍	2	Pipette	2	232134
❍	3	Red film	1	713929
❍	4	Luminol (5% mixture with sodium sulfate), 3 g	1	033482
❍	5	Potassium hexacyanoferrate(III), 6 g	1	033492
❍	6	Sodium carbonate, 12 g	1	033412
❍	7	UV Lamp	1	713927
❍	8	Test tubes (with built-in spoon)	3	702781
❍	9	Double-headed measuring spoon	1	035017
❍	10	Petri dish	1	702184
❍	11	Large measuring cup	1	702810

IMPORTANT!

You will find safety information about the chemicals on page 10.

✔	No.	Description	Quantity	Item No.
❍	12	Blue lid	1	087087
❍	13	Small measuring cup	1	061150
❍	14	White lid	1	061160
❍	15	Stirring sticks	2	705727
		Bag holding parts 16-18		774551
❍	16	Lid opener	1	070177
❍	17	Beads	6	713967
❍	18	Star, glow-in-the-dark	1	704325
❍	19	Cardboard insert with black light theater	1	713926

GOOD TO KNOW!
If you are missing any parts, please contact Thames & Kosmos customer service.

Any materials not included in the kit are indicated in *italic script* under the "You will need" heading.

You will also need:
Any materials that are not included in the kit can be obtained from your household, from nature, or from the supermarket or drug store. These materials are listed in *italic text* in the "You will need" section of each individual experiment. The following is a list of items that may not be available in every household or that are particularly important:

For the experiments in the "Invisible Light" chapter (E 1 – E 14):

One AAA battery (1.5-volt, type LR03); small Phillips-head (crosshead) screwdriver; horse-chestnut or buckeye tree bark (*Aesculus* trees); soap bubble solution; foodstuffs: banana, tonic water, bitter lemon drink, curry powder, Chelidonium (celandine) plant; colored highlighters; black paper

For the experiments in the "Mysterious Glow" chapter (E 15 – E 22):

Small flashlight; foodstuffs: radishes, meat; sugar cubes; dish washing liquid; coffee filters or paper towels and 100 mL hydrogen peroxide, H_2O_2 (3% aqueous solution; 1 mol/L)

Due to legal restrictions and limited shelf life, hydrogen peroxide cannot be included in chemistry experiment kits. The ordinary commercial 3% solution (stabilized) may be obtained from any drug store. Please note the expiration date and decant no more than 100 mL hydrogen peroxide into a brown plastic bottle with a childproof lid for your child's use.

Request to parents:
Please keep additionally required chemicals (such as hydrogen peroxide) locked away and only give your child the amount required for the experiments.

››› TABLE OF CONTENTS

TIP!
You will find additional information in the "Check It Out" sections on pages 32-33 and 46-48.

SAFETY INFORMATION

Dear Parents,

With this chemistry experiment kit, you and your child will be entering the fascinating world of chemical light generation and fluorescence.

It is natural to have questions about the safety of a kit that contains chemicals. The experimental equipment in this kit meets U.S. and European safety standards, which specify the safety requirements for chemistry experiment kits. The standards impose obligations on the manufacturer, such as forbidding the use of any particularly dangerous substances. The standards also stipulate that adults should assist their children with advice and assistance in their new hobby.

››› Read and follow these instructions, the safety rules and the first aid information, and keep them for reference.

››› The incorrect use of chemicals can cause injury and damage to health. Only carry out those experiments which are listed in the instructions.

››› This experimental set is for use only by children over 10 years.

››› Because children's abilities vary so much, even within age groups, supervising adults should exercise discretion as to which experiments are suitable and safe for them. The instructions should enable supervisors to assess any experiment to establish its suitability for a particular child.

››› The supervising adult should discuss the warnings and safety information with the child or children before commencing the experiments. Particular attention should be paid to the safe handling of acids and alkalis (bases). (Hydrogen peroxide is a weak acid and sodium carbonate is a weak base.)

››› The area surrounding the experiment should be kept clear of any obstructions and away from the storage of food. It should be well lit and ventilated and close to a water supply. A solid table with a heat resistant top should be provided.

››› Emphasize to your child the importance of following all of this information, and the importance of carrying out only those experiments that are described in this manual. Inform your child, but do not frighten him or her — there's no need for that.

SAFETY INFORMATION

- While experimenting, please be careful not to let the chemicals come into contact with the skin, eyes, or mouth. Do not inhale chemical dust or powder. It is also important not to let the chemicals, or the solutions prepared with them, get into the hands of small children.

- Help your child find a suitable experiment area. A sturdy table with a tough, heat-resistant surface is a good work surface for chemistry experiments. The surroundings should be free of all obstacles and away from food storage areas. It should be well lit and ventilated, and equipped with a water supply.

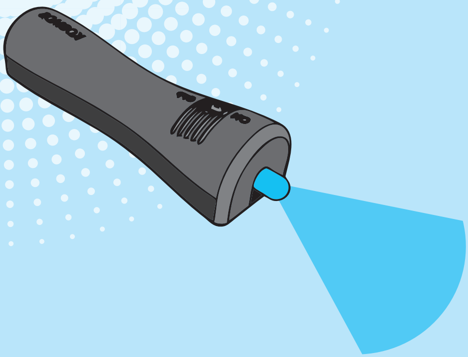
- The work area should therefore not be in the kitchen — chemicals should be kept strictly segregated from foods and kitchen equipment! A lockable basement room would be ideal, so no small children or pets can get into the chemicals and inadvertently swallow them.

- For the experiments with luminol solutions and the UV lamp, it is important to be able to darken the room. None of the containers or equipment items that are used in the experiments should be used in the kitchen afterwards. It is recommended that all equipment be washed immediately after completing an experiment.

- When performing chemistry experiments, it is important to wear suitable clothing (see page 8) and the safety goggles. Please be sure to get any required equipment and chemicals ready before starting an experiment.

- Your assistance in setting up the UV lamp will be particularly important for the experiments with UV light, especially opening the battery compartment lid with a small Phillips-head screwdriver and inserting the AAA battery (1.5-volt, type LR03) in the right direction.

- Because ultraviolet light is a little more high-energy than visible light, your child should never shine the lamp's light into his or her own eyes or the eyes of anyone else. Of course, ordinary sunlight does contain a large portion of ultraviolet light as well.



- Offer a helping hand when your child wants to cut out and assemble the black light theater, and offer yourself as an audience for your child's initial theater performances. Encouraged by your applause, other creative black-light performances before larger audiences will be sure to follow!

Here's wishing you lots of fun with the experiments!

Instructions for using the safety goggles (article no. 052297; part no. 1)

Important! Wear your safety goggles during all chemistry experiments!

Use

The safety goggles are only to be used with the experiment kit. No other type of application is permitted. Wear the goggles in such a way that the eye region is protected. If necessary, adjust the elastic band to the head circumference of the child. The safety goggles should be used together with contact lenses. Wearers of corrective eyeglasses need special safety goggles for people who wear glasses.

Duration of use

Always wear the safety goggles when performing your experiments. Not intended for long-term use. The duration of wear should not exceed the time of the experiment.

Storage

Store safety goggles at room temperature in a dry room. After the experiment, return them to their place in the kit box to keep them from being scratched.

Cleaning

Do not clean the safety goggles when they are dry. Clean them with plain water and, if necessary, with a mild household liquid detergent, and then dry them off afterwards with a soft cloth.

Maintenance

In case of defective safety goggles or scratched lenses, exchange the goggles for an equivalently constructed pair.

Inspection

Check the safety goggles to make sure they are in good condition, and replace them if they are damaged.

Warning

Some extremely sensitive individuals may under certain circumstances experience an allergic reaction to skin contact with some materials.

Replacement

These safety goggles are available as a replacement part.

The safety goggles are tested per European Directive 89/686/EWG (on personal protective equipment).

Notified body

Certification center 0197
TÜV Rheinland Product Safety GmbH
Am Grauen Stein
D-51105 Köln, Germany

Manufacturer

Franckh-Kosmos Verlags-GmbH & Co. KG
Pfizerstraße 5-7
70184 Stuttgart, Germany

Basic rules for safe experimentation (safety rules)
Before beginning the experiments, please read the following information carefully. That way, you can easily avoid any possible dangers.

1. Read these instructions before use, follow them and keep them for reference. Pay special attention to the specified quantities and the sequence of individual steps. Only perform the experiments specified or suggested in this manual. It is pointless and potentially dangerous to experiment with unfamiliar materials.

2. Keep young children, animals and those not wearing eye protection away from the experimental area.

3. Always wear eye protection. Wear your safety goggles when performing chemistry experiments or handling chemicals. If you wear glasses, you will need protective goggles for eyeglass wearers. Always wear appropriate work clothes (an old smock with long sleeves and smooth gloves).

4. Store this experimental set out of reach of children under 10 years of age. For example, this could be inside a lockable cupboard.

5. Clean all equipment after use. Use warm water with a little dish soap, and rinse everything well with clean water afterwards. Be sure to use a dedicated washcloth for this — never use a sponge or rag from the kitchen! Finally, let everything dry on a paper towel.

6. Make sure that all containers are fully closed and properly stored after use. They can be stored in the chemistry kit box.

7. Ensure that all empty containers are disposed of properly.

8. Wash hands after carrying out experiments. Gather up all your equipment and clean your work area. If any chemicals get onto your skin by mistake, rinse them off immediately under running water.

9. Do not use any equipment which has not been supplied with the set or recommended in the instructions for use.

10. Do not eat or drink in the experimental area. Do not use any eating, drinking, or other kitchen utensils for your experiments, unless they are specifically recommended. Keep equipment segregated from kitchen utensils in order to prevent them from getting mixed up.

11. Do not allow chemicals to come into contact with the eyes or mouth.

12. Do not replace foodstuffs in original container. Dispose of immediately. When you are experimenting with foodstuffs (e.g., curry powder, tonic water or other drinks, cooking oil), decant the needed amount into a labeled measuring cup. Dry samples, such as radishes or meat, can be brought to the experiment area on a paper towel.

13. Ensure that the containers with the liquids are out of reach of children under 10 years of age. Label all containers with their contents.

14. Never work alone. An adult should always be present. Let your parents know when you go to collect luminescent samples (such as chestnut or buckeye tree bark) from nature, or when you perform experiments outside.

15. Have your parents give you whatever additional materials you will need for your experiment, and get it ready before you start.

16. Note the information on the chemical vial labels, the information about hazardous substances (chemicals) on page 10, and the safety notes accompanying the individual experiments. With any additionally required materials (such as hydrogen peroxide), always note the warnings on the packaging.

Information about hazardous substances (chemicals)
Please note the following hazard and precautionary statements for the chemicals contained in this kit and chemicals recommended for purchase:

Luminol mixture (5% mixture with sodium sulfate)
Not classified as a hazardous mixture.
Nevertheless, we recommend:
Do not breath dust. Do not get in eyes or on skin. If necessary, obtain appropriate first aid information or medical advice.

WARNING

Sodium carbonate
Causes serious eye irritation.
Avoid breathing dust. – Wear eye protection. – IF IN EYES: Rinse carefully with water for several minutes. If possible, remove any contact lenses. Continue rinsing. If eye irritation persists, get medical help.

Potassium hexacyanoferrate(III)
Avoid release to the environment.

Hydrogen peroxide (3% aqueous solution)
Not classified as a hazardous solution.
Nevertheless, we recommend:
Do not get in eyes or on skin. If necessary, obtain appropriate first aid information or medical advice.

WARNING! The following applies to all chemicals: Store locked up. Keep out of reach of children.
This primarily applies to young children, but also to older children who — unlike the experimenter — have not been appropriately instructed by adults.
Also follow this precautionary statement: IF SWALLOWED: Get immediate medical advice/attention and have product container or label (of chemical substance) at hand.

For the sake of environmental protection: Dispose of contents/containers (of no-longer-needed chemicals) to a hazardous waste disposal location.

Notes on disposal for chemistry experiments
The very small quantities of minimally hazardous chemicals used in these experiments do not pose any great danger to the environment.

››› The **liquids** can be poured directly down the drain. Be sure to rinse well afterwards so that no residues remain behind.

››› **Solid waste,** such as chestnut or buckeye tree bark, leftover foodstuffs, paper towels, or filter paper, can be thrown into the garbage can (not the kitchen trash).

››› **Materials that have been soaked** in chemical solutions (e.g., coffee filters or paper towels) should be carried with the double-headed measuring spoon to the household garbage. Important! Do not grab with your hands!

››› **Chemical residues** in the chemical vials can be taken to a hazardous waste disposal facility with an adult, if you no longer need to use them. That way, they will be sorted along with other laboratory residues and disposed of properly.

TIPS AND TRICKS

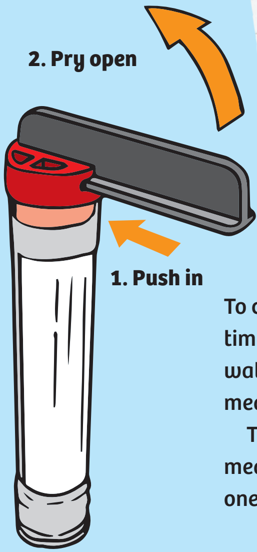
There are some tools in your kit, such as the chemical vials (parts no. 4-6), the lid opener (part no. 16), the pipettes (part no. 2), the test tubes (part no. 8), and the double-headed measuring spoon (part no. 9), that you will be using frequently in your experiments. You will need the UV lamp (part no. 7) for the exciting experiments with invisible light, and the red film (part no. 2) will be used to make a red-light lamp to protect against glare while performing experiments. On this page and the next two pages, you will learn everything you need to know about these components!

The chemical vials

The chemical vials have a large chamber for larger quantities and a small chamber for chemicals that you will only need to use in small amounts. The size of the vial is determined by the minimum required size of the labels. The vials are equipped with safety closures in order to prevent small children from getting into them.

<u>How to open the chemical vials:</u>

Sometimes, some of the chemical will stick to the inside of the lid. To prevent any of it from falling onto your hand or your work surface, bang the bottom of the vial against the table before you open it. The illustration shows how to use the lid opener to open the safety closure. Always take just the amount that you will need for the experiment, and immediately re-close the vial.



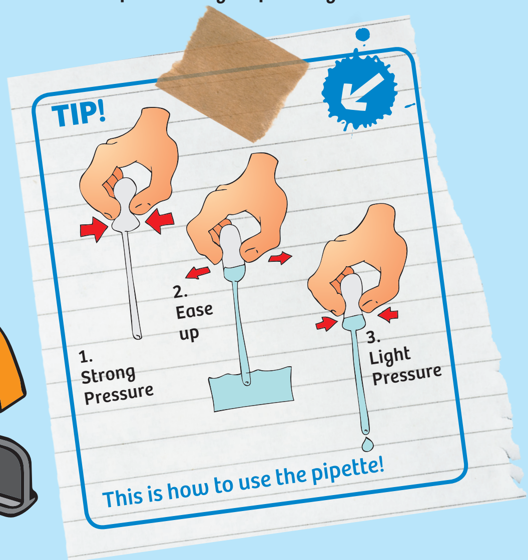
Since the lid opener will always be needed to open the chemical vials, it is not specifically listed in the "You will need" sections.

The pipettes

You will use the pipettes to add liquids drop by drop or to transfer liquids from one container to another.

<u>How to use the pipette:</u>

1. Squeeze the upper part of the pipette between thumb and index finger, and dip the tip of the pipette into the liquid.
2. As soon as you ease up on the pressure, the liquid will rise up the pipette.
3. By careful control of the pressure, you can make the liquid slowly drip out again.

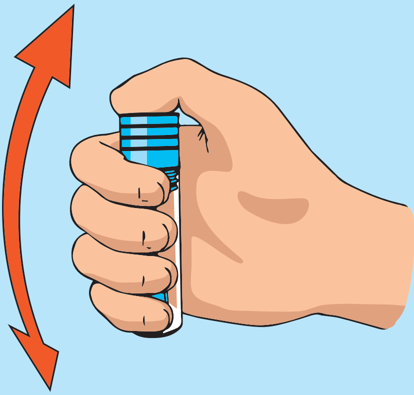


To clean it, fill and empty the pipette several times with soapy water and then with plain water, and let it dry standing up in a large measuring cup.

The "one full pipette" quantity indication means the amount sucked into the pipette after one firm squeeze.

The test tubes

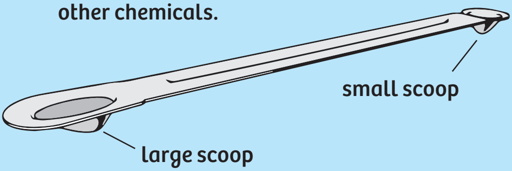
The test tubes are used as mixing and reaction vessels. You can close a test tube securely by turning and pushing in on the blue lid with the built-in spoon until it hits the stop. When you open the lid, be sure not to pull it off with a jerk, because the liquid inside could spray (particularly from the spoon). If you want to shake a liquid inside the test tube, it is important not to let the lid come loose. Therefore, be sure to hold your thumb over the stopper as shown in the illustration.



The double-headed measuring spoon

Use the double-headed measuring spoon to remove chemicals from the chemical vials and measure them out. The indication “1 large spoon” means you should use the large end, while “1 small spoon” means to use the small end, with the scoop completely full in each case.

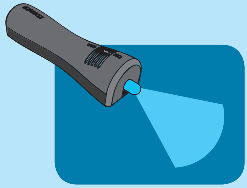
Rinse and dry the double-headed measuring spoon after each use, so you don’t contaminate other chemicals.



The UV lamp

This little flashlight will be one of the most important components in your kit, because its light can make materials glow with luminescence. In addition to a little visible light, it mainly emits invisible ultraviolet light, or UV light for short.

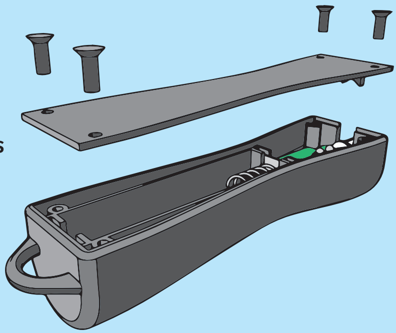
When the experiment requires the UV lamp, you will see this picture in the instruction manual.



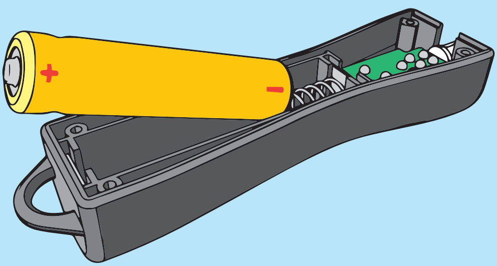
To make it work, you will need a 1.5-volt battery (AAA, or type LR03) and a small Phillips head screwdriver.

<u>How to insert the battery:</u>

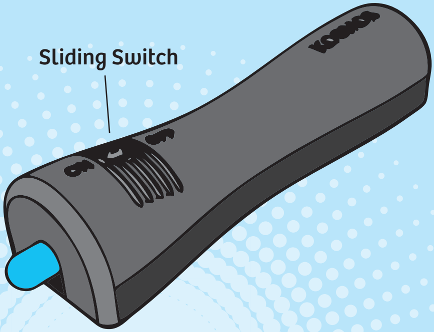
1. Use a screwdriver to loosen the four little screws underneath the lamp and lift off the lid.



2. Insert the battery into the battery compartment in the correct polarity direction and screw the lid back on again.



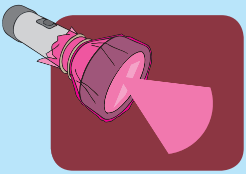
3. To turn it on, push the small sliding switch forward. Now, the lamp will shine with a blue light.

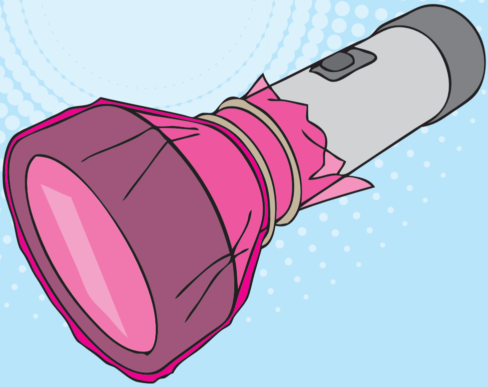


If the lamp only shines weakly or doesn't shine at all, the battery may be used up. In that case, switch it out for a new one as described before. If you anticipate not using the UV lamp for a long period of time (more than a month), take out the battery first.

The red light lamp

The chemistry experiments (E 15 – E 22) have to be performed in a dark room in order to be able to observe the luminescence effects. Of course, if it's dark it can be difficult to do something like pour a liquid from one container into another without spilling something. You should therefore first convert an ordinary flashlight into a red light lamp, similar to the ones that photographers use in their dark rooms. The red light won't blind your eyes nearly as much as white light would. *Whenever you need it, you will see this picture.*



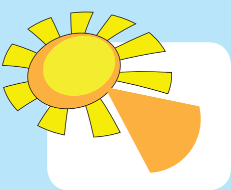


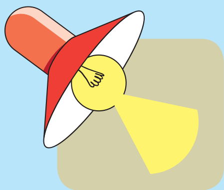
How to make your red light lamp:

1.Fasten the red film around a small household flashlight with a rubber band. That's all there is to it!

Other lighting modes

Sometimes, you will want to use other kinds of lighting if you want your experiments to go well.
Whenever you need to use direct sunlight, you will see the picture on the left.
If you need ordinary room lighting, you will see the picture on the right.



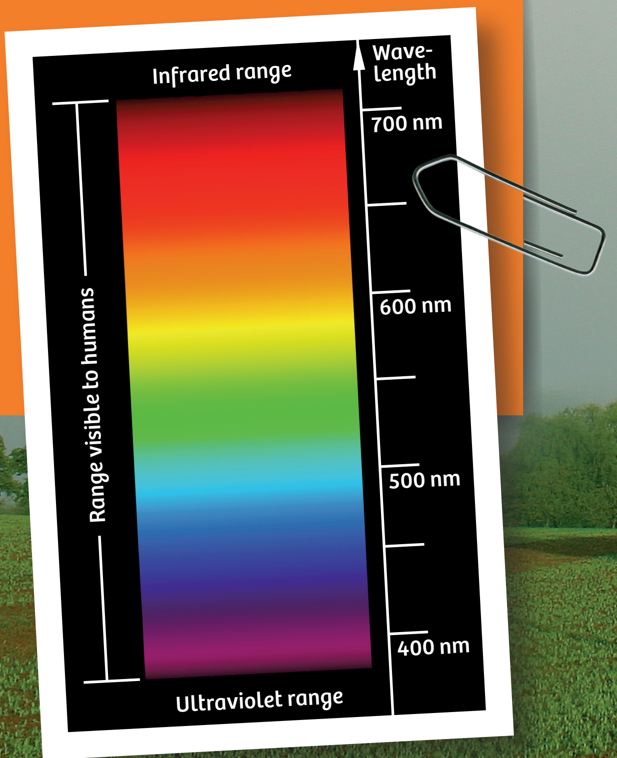


Invisible Light

Did you know that the sun emits invisible light in addition to visible light? In a rainbow, you only see the colors that are visible to your eye. In fact, though, there is an infrared band bordering the red, and an ultraviolet light range begins where violet ends. It's just that our eye cannot perceive them.

But ultraviolet light (or UV light for short) displays some astonishing properties.

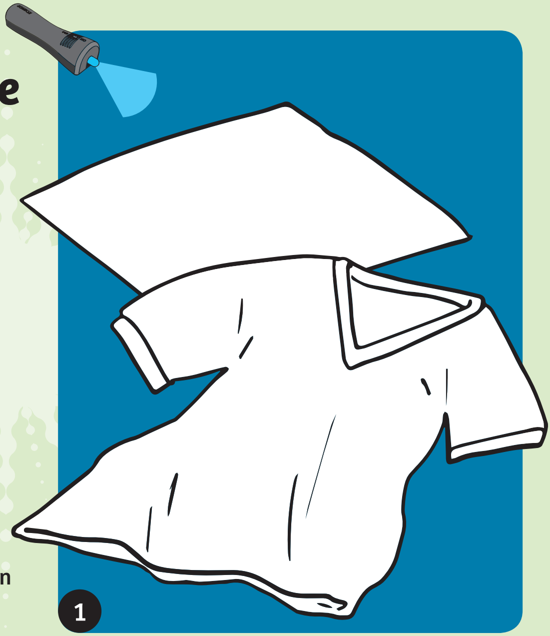
You will learn about some of these properties in the experiments that follow, with the help of a special lamp that produces mostly UV light in addition to a little visible light.



EXPERIMENT 1

Shirts with a light blue glow

Test your UV lamp and make an astonishing discovery in the process!



1

YOU WILL NEED

› UV lamp

› *White paper, articles of clothing, etc.*

HERE'S HOW

1. In a dark room, turn on the UV lamp and point its beam at a sheet of white paper or an article of white clothing (shirt, undershirt, t-shirt, blouse, etc.).

WHAT'S HAPPENING?

The white materials glow with a mysterious light blue light. There are chemical substances in the piece of clothing that absorb the UV light and convert it into visible light. This phenomenon is known as **fluorescence**.

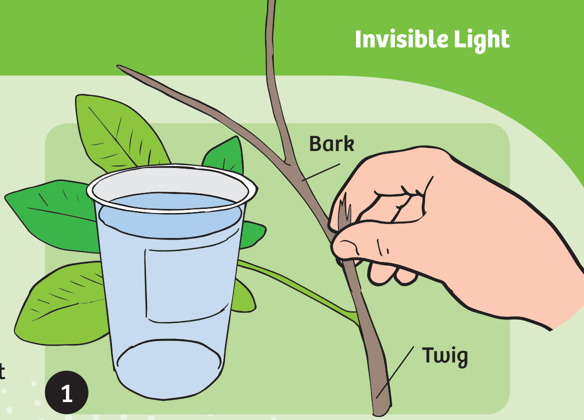
Detergent manufacturers add fluorescent substances (known as brighteners) to their products to make your washed laundry whites look more dazzling. Paper manufacturers use the same method to make their white paper look brighter.

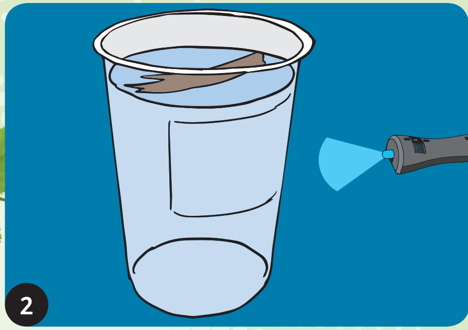
Some dance clubs use UV light (also known as black light) to create special effects for the customers' enjoyment, by making the white parts of their clothing glow as they dance.

EXPERIMENT 2

Blue clouds from chestnut tree bark

UV-fluorescent materials can also be found in nature. There's a particularly pretty fluorescent substance to be found in the bark of the horse-chestnut tree and buckeye trees.





YOU WILL NEED

- UV lamp
- Large measuring cup
- Small measuring cup
- *Bark from a horse-chestnut tree or buckeye tree**
- *Fine paintbrush*
- *Colored paper*

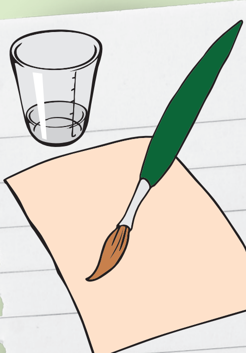
**Horse-chestnuts and buckeye trees (genus Aesculus) can be found across North America and Europe. If you search the web for Aesculus, you can find the common names for the species that grow in your area.*

HERE'S HOW

1. Peel a small piece of bark off a freshly-cut chestnut twig (young growth). Fill the large measuring cup with cold water.
2. Go inside a dark room, shine the UV lamp on the measuring cup from the side, and float the piece of chestnut bark on the water. Right away, you will see magnificent light blue clouds spread out through the water.
3. Switch on the room light and turn off the UV lamp. The clouds will disappear. After a little while, the water will turn brown.

WHAT'S HAPPENING?

Aesculus tree bark contain a material called **aesculin** (pronounced ess-cue-lin), which converts UV light into visible, light blue light.



BONUS EXPERIMENT: Secret messages

You can use your aesculin solution to make invisible ink. Swirl a little rind in a small amount of water in the measuring cup for a few minutes, but pull it out before the water turns brown. You can use this as an invisible ink to write secret messages with a paintbrush, which will be visible under UV light after the ink dries. Use colored paper without any brighteners, and be sure it's not a kind of paper that turns slightly brown when you paint on it.

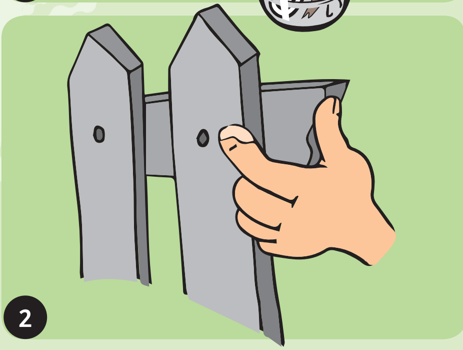
EXPERIMENT 3

Looking for clues

You can also use aesculin solution in some fun games, such as an evening treasure hunt.

YOU WILL NEED

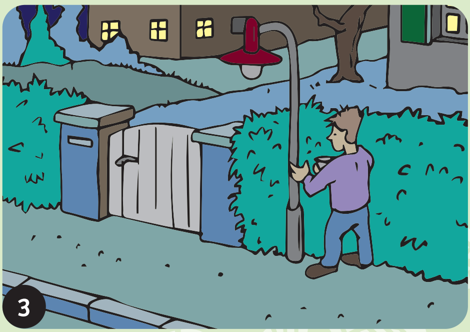
- UV lamp
- Small measuring cup
- Stirring stick
- *Bark from a horse-chestnut tree or buckeye tree*



HERE'S HOW

1. Place some finely-chopped chestnut or buckeye tree bark in the measuring cup along with a little water, and stir several times with the stirring stick over the course of an hour. Then fish out the rind and throw it away.
2. Take your aesculin solution outside when it's dark. Dip your finger into the solution and smear a little onto a smooth surface, such as a fence board or lamppost. It will be practically invisible at first, but it will glow brightly in the light of the UV lamp. Test your markings!
3. Now it's time to organize a sort of treasure hunt with a friend. One of you can first go and mark a certain route with the aesculin solution. The other follows a little later and has to use the UV lamp to try to discover the markings and follow them to find a hidden reward.

   Don't forget to wash your hands after you get home.



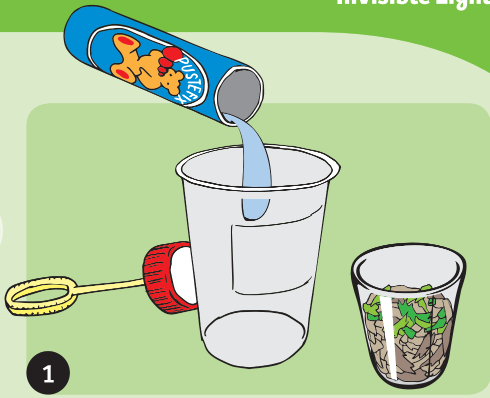
WHAT'S HAPPENING?

The aesculin from the bark makes the drops glow under UV light. Marks left on smooth surfaces will even glow after they have dried. On something like a rock, on the other hand, the aesculin disappears fairly quickly. So it's best to run a few tests beforehand.

EXPERIMENT 4

UV-fluorescent soap bubbles

You can't normally see soap bubbles in the dark. But with the help of aesculin and the UV lamp, you will be able to blow some bubbles with a ghostly glow.

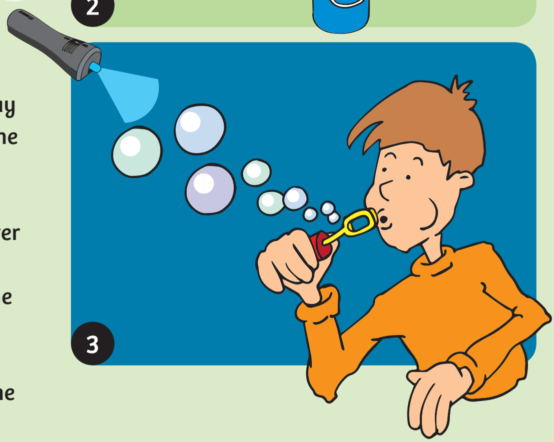


YOU WILL NEED

› UV lamp
› Large measuring cup
› Small measuring cup
› Stirring stick
› *Horse-chestnut or buckeye tree bark*
› *Soap bubble solution (toy store)*

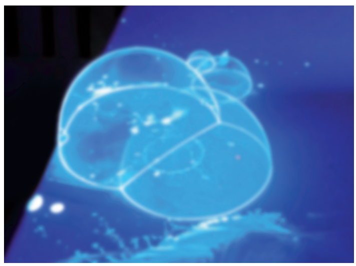
HERE'S HOW

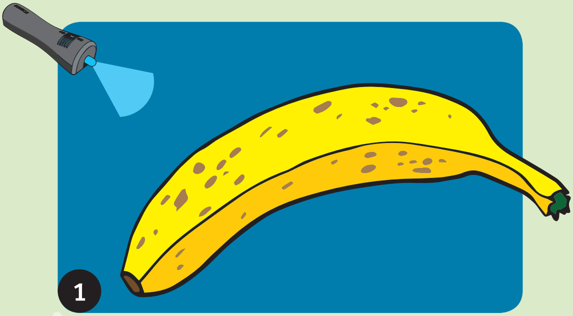
1. Fill the small measuring cup about halfway with finely-chopped chestnut bark. Pour the soap bubble solution into the large measuring cup and add the chestnut bark.
2. Stir now and then with the stirring stick over the course of an hour. Then, carefully pour the brown solution off the bark (leaving the pieces of bark behind) and back into the original soap bubble container.
3. Blow soap bubbles in the dark and shine the UV lamp on them.



WHAT'S HAPPENING ?

The soap bubbles glow light blue in the dark. The aesculin dissolves out of the bark and colors the soap solution. That's why the soap bubbles glow under UV light, with the bubbles that settle onto smooth surfaces looking particularly pretty.





EXPERIMENT 5

Bananas in UV

Even today, it's still possible to make new discoveries with UV light. It was only in 2008 that a certain scientific observation about bananas was published. You can test this observation yourself with the help of your UV lamp.

YOU WILL NEED

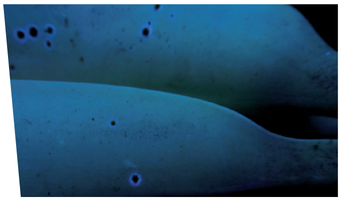
› UV lamp
› Small measuring cup
› Large measuring cup
› White lid
› Stirring stick
› *Banana*
› *Tonic water and bitter lemon drink (e.g., Schweppes), from the supermarket*

HERE'S HOW

1. Let a fresh banana sit for a few days, checking it each day under the UV light in the dark. Pay particular attention to the brown spots.

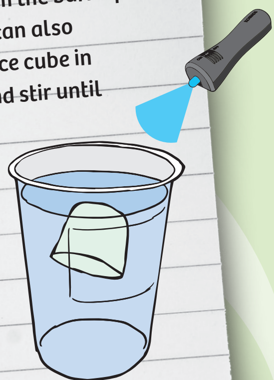
WHAT'S HAPPENING?

All around each of the brown spots, you will notice a light blue glowing ring. The glow is presumably caused by a substance produced when the leaf pigment known as chlorophyll breaks down. Chlorophyll is also contained in the banana peel, where it is covered with yellow.



BONUS EXPERIMENT: Glowing liquids

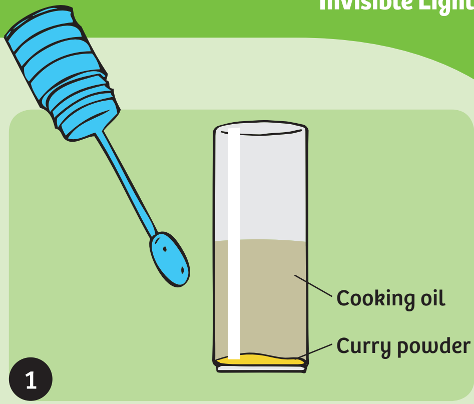
Bananas aren't the only thing that will glow light blue under UV light. The slightly cloudy effervescent drinks known as tonic water and bitter lemon do it too. See for yourself! They contain **quinine**, a bitter substance obtained from the bark of the cinchona tree. Quinine used to be used as a medicine for malaria. You can also create a really cool light effect with quinine by making a tonic water ice cube in the freezer: Fill the small measuring cup halfway with tonic water, and stir until all the air bubbles have disappeared. Put the lid on the measuring cup and place it in the freezer until the tonic water is frozen solid. Place your special ice cube in the large water-filled measuring cup, turn out the light, and observe it under the UV lamp as it melts! After your experiment, pour the measuring cup contents down the drain.

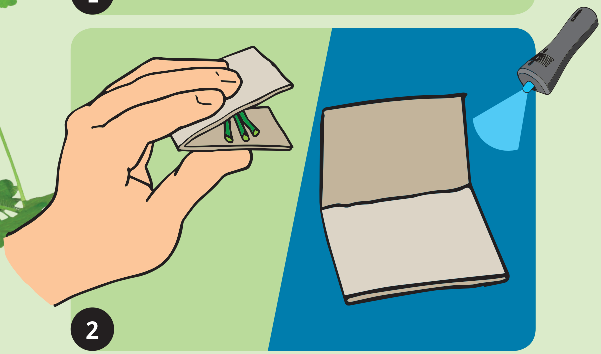


EXPERIMENT 6

Hunting for plants

Plant compounds don't just glow with a light blue — there are other completely different colors to discover as well.





YOU WILL NEED

- **UV lamp**
- **Test tube**
- *Curry powder*
- *Cooking oil*
- *Celandine plant (botanical name: Chelidonium)*
- *Cardboard*

HERE'S HOW

1. Fluorescent curry powder:

Look at some curry powder under your UV lamp in the dark.

Then, mix a little curry powder with some cooking oil in a test tube, and let it sit for about half an hour while stirring occasionally. Then view the test tube under your UV lamp in the dark.

2. Fluorescent celandine sap:

Pick a few stalks of celandine and press them in a folded piece of cardboard until some milky sap comes out. Shine your UV lamp on the celandine-stained cardboard in the dark.

Avoid getting the celandine juice on your fingers, and thoroughly wash your hands immediately after the experiment!

WHAT'S HAPPENING?

Both plants contain UV-fluorescent substances that only become visible when viewed under the UV lamp. The curry powder glows with a pretty orange light. This luminescent orange material (called **curcumin**) comes from yellow curcuma or turmeric, a spice that gives all curries their characteristic color. Depending on taste and region, curry powder also consists of lots of other spices, such as coriander, cumin, and pepper. When the powder is dissolved in oil, you can observe a really striking luminescent effect. The strong yellow fluorescence of the celandine is produced by the chemical **berberine** contained in its latex sap.

UV detective

Your UV lamp is capable of making all sorts of natural and artificial substances glow. See what you can get your hands on.

YOU WILL NEED

› UV lamp
› *Various household or office items*

HERE'S HOW

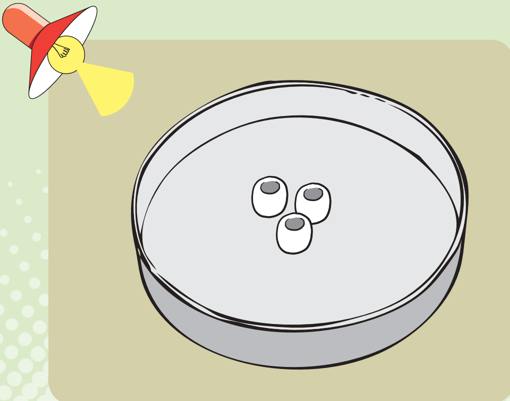
1. Walk through the house (in the dark) and try testing everything you can find to see whether it glows under the light of your UV lamp.
2. For example, you might have luck with reflective vests, text highlighters, sticky notes, security strips on paper money, stamps, discarded glow sticks, and of course paper. Test your teeth and clothing too. Sometimes, threads of dust will show up as bright dots on dark clothes.

WHAT'S HAPPENING?

A lot of objects contain colors or dyes that are fluorescent or particularly bright in the daylight. They will also glow under a UV lamp. In reflective vests, these fluorescent materials help to make them extremely eye-catching. Some bank notes contain a UV-fluorescent security strips that make them easy to recognize as authentic, and that therefore also make them hard to counterfeit.

EXPERIMENT 8

Beads under UV light

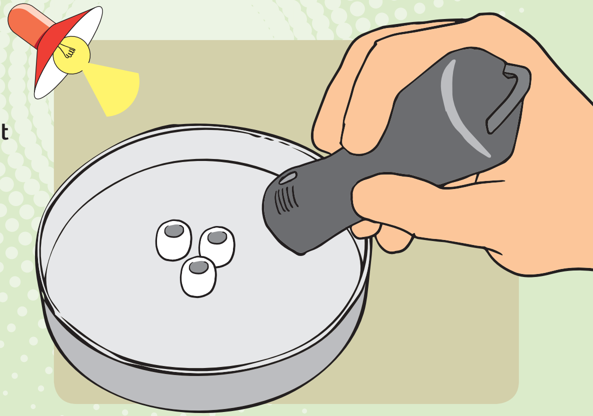


You already saw in the very first experiment how the white beads turn blue in the sunlight. Will they also turn color under the light of a lamp? And what could possibly make them do that?

YOU WILL NEED

› UV lamp
› Beads
› Petri dish

HERE'S HOW



1. Place the beads in the lid of the Petri dish, set the lid in a room with low light, and wait a few minutes. The beads will stay white.
2. Shine the UV lamp on them from a short distance away.

WHAT'S HAPPENING?

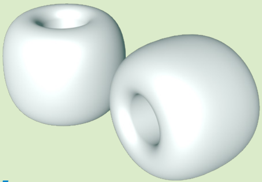
Within a few seconds, the beads will turn blue. The experiment demonstrates that the beads actually only respond to UV light. Normally, the dye contained in them remains colorless. It only takes on a blue color when it is illuminated with UV light. Ordinary artificial light leaves it unaffected. Once the UV lamp is turned off, the beads lose their color again in a few minutes.

UV from the sky

As the last experiment showed, the beads work well as indicators for UV light. It is well known that sunlight includes a portion of UV light. But can you also be exposed to any UV light if you sit in the shade or when the sky is cloudy? See for yourself!

YOU WILL NEED

› Beads
› Petri dish
› *Watch*
› *Pen*



HERE'S HOW

1. Place the white beads in the Petri dish again and take them outside while keeping the dish covered with your hand. Find a place in the shade, not in the direct sun.
2. Take your hand away and count the number of seconds before the colors appear. Compare how long it takes depending on whether the sky is clear or overcast. See if the time of day has any influence. Record your findings in this table:

Type of light	Time (in seconds)
Shade	
Sunlight, clear sky	
Slightly overcast sky	
Very overcast sky	
Morning	
Midday	
Evening	

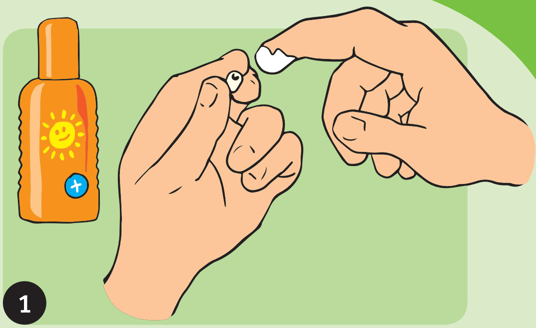
WHAT'S HAPPENING?

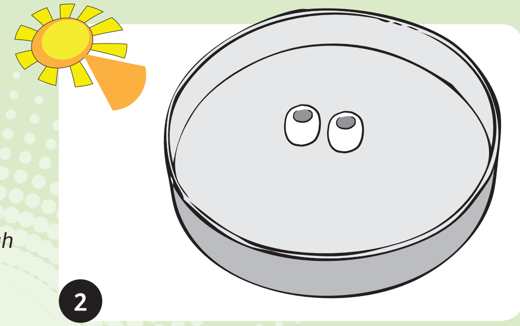
The experiment shows that there's also some UV light in the shade. In fact, it is even possible to tan in the shade, even though it takes longer than in full sunshine. Of course, when the sun is low in the morning or evening, and especially when the sky is heavily overcast with clouds, the UV radiation is much less intense.

EXPERIMENT 10

Sunscreen

The sun's UV light can give skin a nice tan, but it is not without its dangers. For example, you can get sunburned if you expose your skin to the sun. You can protect yourself by rubbing in a little sunscreen. Do you think it might also shield the beads from UV light?



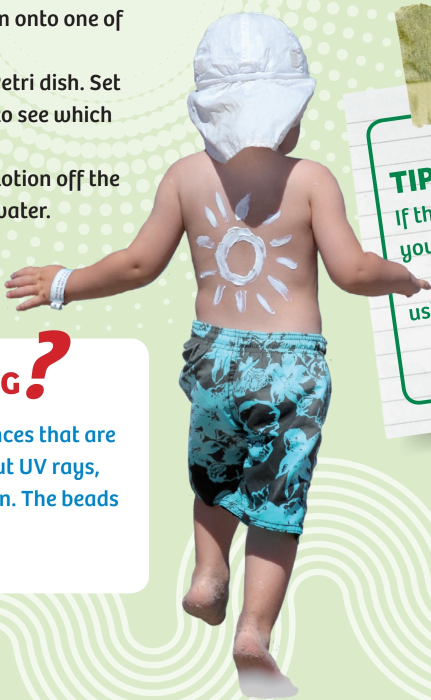


YOU WILL NEED

› UV lamp
› 2 Beads
› Petri dish
› *Sunscreen lotion (sun protection factor as high as possible, maybe 30-50)*

HERE'S HOW

1. Rub a thin coating of sunscreen onto one of the beads.
2. Place both beads in the open Petri dish. Set the dish in the sun and watch to see which bead changes color faster.
3. When you are done, wash the lotion off the bead with some warm soapy water.



TIP!
If the sun isn't shining, you can still perform the experiment using the UV lamp.

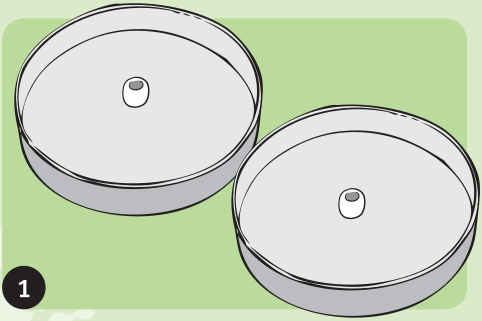
WHAT'S HAPPENING?

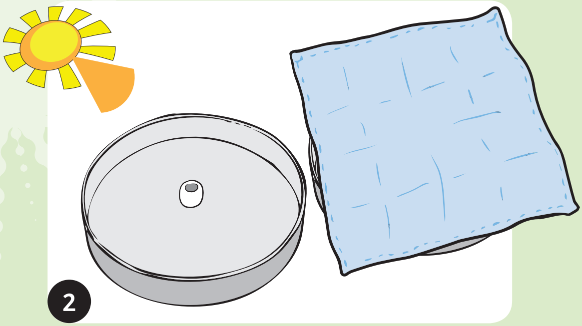
Sunscreen contains substances that are very effective at filtering out UV rays, and thus protecting the skin. The beads show how well it works.

EXPERIMENT 11

Through clothing too

It's especially easy to get sunburned when swimming at the beach. Do you think a shirt might help protect you against the sun's rays?





YOU WILL NEED

› Petri dish
› 2 Beads
› *Handkerchief or shirt*
› *Watch*

HERE'S HOW

1. Place one bead in the Petri dish lid and one in the bottom part of the dish.
2. Now set one of the beads in the full sun, and the other under a dry shirt or handkerchief. Compare how quickly they turn color. Record the time.
3. Get the shirt/handkerchief nice and wet and repeat the experiment. How big of a time difference is there now?
   Note down your findings in this table:

Bead...	Time (in seconds)
...in full sun	
...under dry shirt/cloth	
...under wet shirt/cloth	

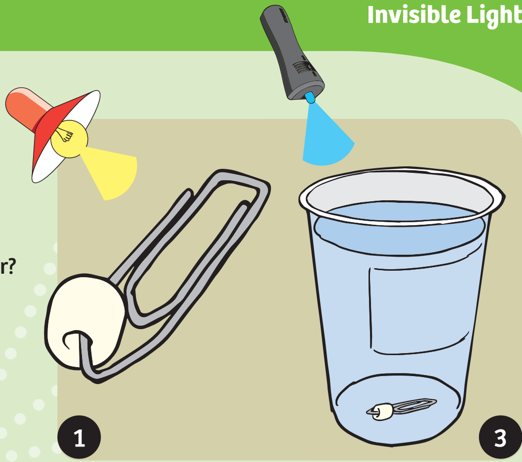
WHAT'S HAPPENING?

A thin piece of clothing, such as a t-shirt, will only filter out a portion of the UV light. If the fabric is wet, it filters out even less. So it won't do you much good if you try to use a wet shirt to keep from getting sunburned while swimming.

EXPERIMENT 12

Under water

Do you think UV light can also penetrate water?



YOU WILL NEED

- › UV lamp
- › Large measuring cup
- › Bead
- › *Metal paper clip*
- › *Watch*
- › *Flashlight*

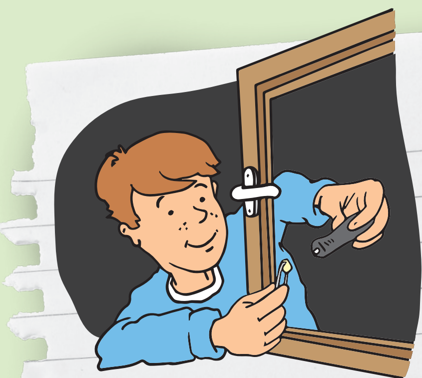
HERE'S HOW

1. Thread a bead onto the paper clip. This will keep the bead from floating.
2. Fill the measuring cup with water and drop the bead and paper clip into it. Make sure they sink to the bottom.
3. Shine the UV lamp into the water from above. Switch off the light every once in a while to check if the bead has turned color.
4. Repeat the experiment without water, but keeping the distance between the UV lamp and the bead the same. Compare the amount of time that the bead takes to turn blue. Record your findings in this table:

WHAT'S HAPPENING?

The bead changes color in about the same amount of time both with or without water. The layer of water lets the UV light through, in other words. In fact, even half a meter of water will only reduce the UV light by about a quarter. Now you understand why it's so important to protect yourself with waterproof sunscreen even when you're swimming in the water.

Bead...	Time (in seconds)
...under water	
...without water	



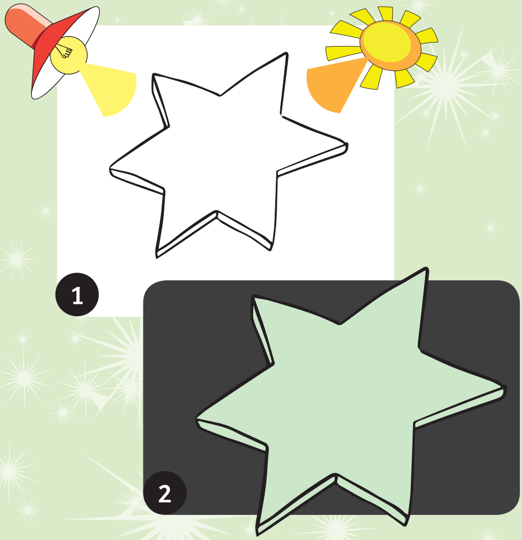
BONUS EXPERIMENT:
UV through glass

When it's dark, open the window, hold a bead in front of the window pane, and shine the UV lamp on it from the other side of the glass. Keep checking for the blue color with the flashlight. You will see that it turns color almost as quickly as without the glass. So the UV light emitted by the lamp penetrates the glass pretty well.

EXPERIMENT 13

A star shines in the darkness

The objects investigated up to now will only emit light while you shine UV light on them. The star is a different case.



YOU WILL NEED

- › UV lamp
- › Star
- › *Bright lamp*

HERE'S HOW

1. Place the star under a bright light or in the sunlight for a moment.
2. Take the star into a dark room. It will emit a weak greenish light, which will gradually get weaker over the course of about an hour.

BONUS EXPERIMENT:
Star with UV lamp

Shine the UV lamp on the star in a dark room. It will shine brightly because the material used in it is also fluorescent. And it keeps shining because it absorbs the UV light.

WHAT'S HAPPENING?

The star contains a substance that stores the incoming light energy and then gradually emits it in the form of light. This phenomenon, known as **phosphorescence,** is used in materials such as glow-in-the-dark paints. It comes in handy for warning signs that must be visible in the dark, and in alarm clocks meant to be visible in a dark bedroom. There are even winter coats that come with a glowing element, so children wearing them are easier to see in the dark.

EXPERIMENT 14

Black light theater

There are theaters that use UV light (also known as black light) to perform special effects by shining powerful UV lamps on an otherwise completely darkened stage. You can also create a miniature black light theater with the help of your UV lamp and some stick puppets.

YOU WILL NEED

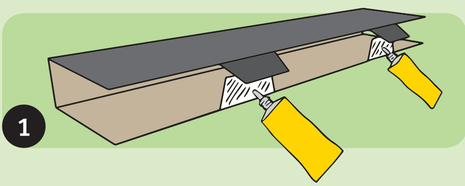
- **UV lamp**
- **Stirring stick**
- **Small measuring cup**
- *Glue*
- *Scissors*
- *Text highlighters in fluorescent colors (neon markers)*
- *Black paper*
- *White paper*
- *Chestnut tree bark*
- *Paintbrush*

HERE'S HOW

To assemble the black light stage, you will need the cardboard insert from the experiment kit box. First remove all the other materials, pull out the black divider, and remove the cardboard insert. Put all the materials back into the box right away so nothing gets lost.

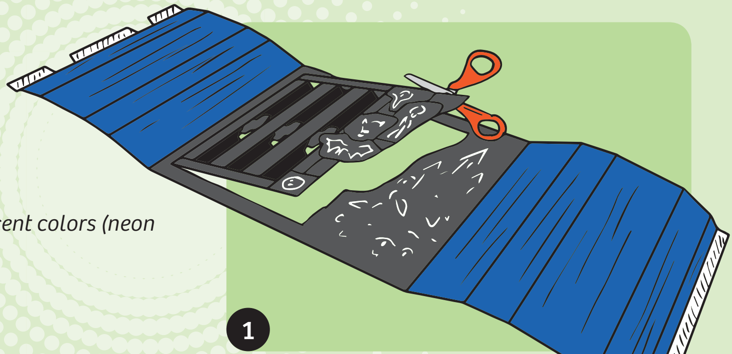
Assembling the lamp stand:

1. Bend the small divider tabs down and glue them together in such a way that the black tabs are on the outside (in other words, only apply the glue to the surface with the dashed lines, and then press together).

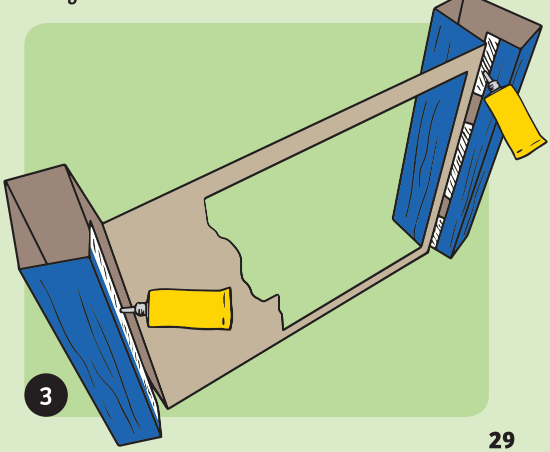


Assembling the theater stage:

1. Unfold the cardboard insert, cut out the inner part along the green line, and set it aside. The resulting black frame will be your stage.
2. Color the light areas of the reef, the small fish and the bubbles, with your bright highlighters.

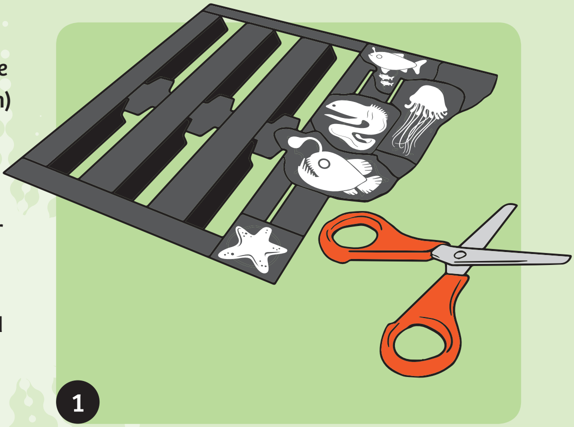


3. Fold the dark blue stage feet on the sides back into their original shape, and glue them together from behind by once again applying the glue to the surface with the dashed lines and pressing the surfaces together.



Assembling the stick puppets:

1. Now you will need the inner part. Cut out the 5 shapes (two fish, eel, jellyfish, and starfish) along the blue lines. It will look nicest if you cut them away from the black background as tightly as possible.
2. Color the light areas of the figures with your bright highlighters, in any way you like.
3. Now, for each of the figures, cut out a black stick and glue the matching figure to the end of the stick. Your spooky creatures of the night are now ready.



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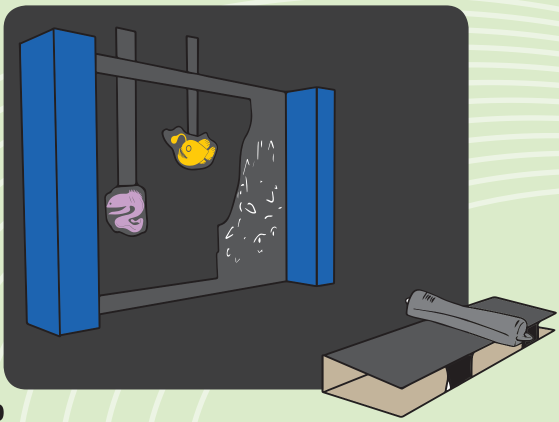
The black light theater begins:

Find a room that you can make nice and dark, and place the theater stage on a table where your audience will be able to see it easily. Set the lampstand and UV lamp about half a meter away, so the stage area is well illuminated. Your own clothes should be as dark as possible so that you are practically invisible. Think of a grisly story for your characters. If you move the spooky shapes from above behind the stage frame and accompany them with eerie sounds, a midnight clock-stroke, or weird voices, your characters will come to life!

3



TIP!
Always practice your black light show at least once before performing it in front of an audience.

More suggestions for the black light theater:

• You can create your own UV-fluorescent objects and "performers" in various ways, such as by cutting out white paper (colored with your markers, if you like), or painting objects with aesculin solution, or (even better) using your own glow-in-the-dark paint pens on black paper. If you then glue your figures onto black cardboard strips, you can move and control them from above just like the others.

• You can also place UV-fluorescent objects on the stage in the dark, and then switch on the lamp to make it seem as if they appeared out of nowhere.

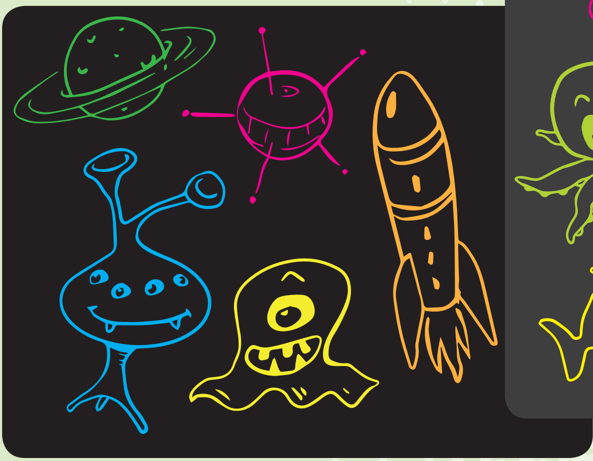
•Adorn the stage with various items made of black paper, either fixed in place or movable with black paper strips. That way, you can hide UV-fluorescent objects behind them and then make them appear as if out of thin air.

• Or replace the glowing ocean set with a new setting of your own design: Invent your own space adventure with fictional planets inhabited by four-eyed extraterrestrial life... ...or take your audience into a haunted town with glowing ghosts, bats, skeletons, and werewolves.

The possibilities are limitless — let your imagination run free!

TIP!

If you want, you can also add your glow-in-the-dark star to your black light play. With tiny dabs of sunscreen, you can even give it eyes and a mouth. In the spots where the sunscreen with UV-light blocker is applied to the star, the star will be considerably darker.



CHECK IT OUT

UV Light and the Ozone Hole

UV light

The ultraviolet range borders the violet or purple color in the rainbow spectrum. This light is more energy-rich than visible light, from which certain possible consequences follow. For example, it has a much stronger effect on photographic film (which is how it was discovered in the first place), it tans the skin, and it produces fluorescence, such as with the aesculin. Strong ultraviolet light from the sun is very useful in nature. Unlike humans, many bird species, honeybees, and bumblebees can see UV light. That is why a lot of flowers (such as dandelions and orchids) have patterns that are only visible to humans under UV light, and that are invisible to the human eye normally.

OZONE HOLE

The strong UV light from the sun reacts with oxygen in the upper layers of the atmosphere to form ozone gas, which absorbs UV light and protects us from excessive solar UV radiation. Certain gases from aerosol cans will damage this protective ozone layer and lead to "ozone holes." That is why these gases have been banned.

Brighteners...

...make laundry and paper whiter. Normally, these materials look slightly yellow even in their pure state. The brighteners capture ultraviolet light and convert it into light blue light. So laundry and paper can appear to emit even more light than the light that shines on them. The light blue mixes with the yellow tint to make white, which strengthens the light intensity even more.

Fluorescent (neon) paints...

...also capture ultraviolet and violet daylight and convert it into other colors such as red, yellow, or green. That gives them a particularly brilliant effect, and makes them useful for signals and warning signs — especially at dusk or in cloudy weather, when the daylight contains more blue. There are also some artists who work with these kinds of paints to create fantastically colorful pictures that look positively otherworldly when viewed under UV light.

Sunscreen

A certain amount of UV light is essential, producing the vitamin D3 in our skin that we all need for good health. Children in industrial regions used to be frequently sick due to the fact that the smoke from factories blocked too much sunlight.

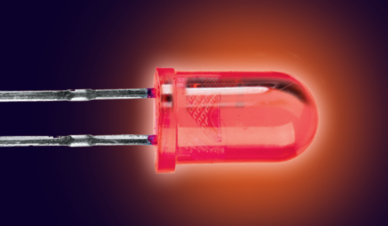
On the other hand, too much UV light can also make you sick. It causes sunburn and long-term exposure can even lead to skin cancer (no worries—the light from your UV lamp is much too weak for that). That's why you have to protect yourself from excessive solar radiation. The skin will create its own protection in the form of a brown pigment called melanin. A suntan used to be considered very cool. Today we know that too much UV light damages the skin. So you should always apply sunscreen (with the highest effective sun protection factor) before going out in the hot sun, and you should also avoid staying in the sun for too long. Sunscreen lotions contain substances that filter out the harmful portions of the UV spectrum.

Mysterious Glow

There are several completely different ways to produce light. A candle will glow thanks to its hot flame, a light bulb has a hot wire glowing inside it, fluorescent tubes contain gases that emit light when electricity flows through them, and an LED makes light from current flowing through crystals. But all these light producers mainly generate heat, and just generate light as an incidental by-product. A light bulb, for example, only converts about one thirtieth of the incoming electricity supply into light.

Nature works quite differently from that. Glowworms and fireflies, as well as luminescent deep sea fish and jellyfish, emit about 95 percent of the incoming energy as light. They do this by getting certain chemical substances to interact, which in turn emit light. Since no heat is produced, it is also known as cold light.

This experiment kit also contains a chemical substance capable of producing its own light when combined with other chemicals. It is called **luminol**, and you can use it to perform some exciting experiments.



For the following experiments, you will need a 3% hydrogen peroxide solution, which you should have an adult get for you (see page 3). You will also need a flashlight converted to cast a red light (see page 13), which will not be specifically listed in the “You will need” section.
Before performing the experiments, please read the safety information rules on pages 5 to 13 one more time, follow them, and keep them on hand for reference. Pay particular attention to the information on page 10 about the proper handling of chemicals.

Magical light

YOU WILL NEED

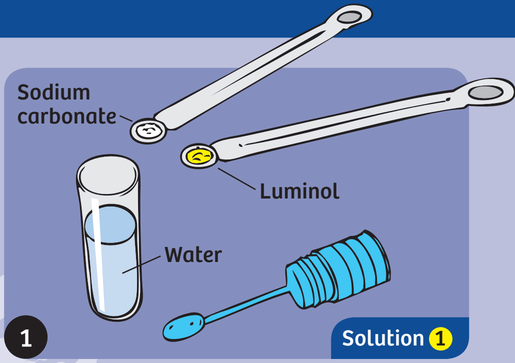
- Safety goggles
- Luminol
- Sodium carbonate
- Potassium hexacyanoferrate(III)
- 2 Test tube
- Double-headed measuring spoon
- Pipette
- Petri dish
- *Hydrogen peroxide*

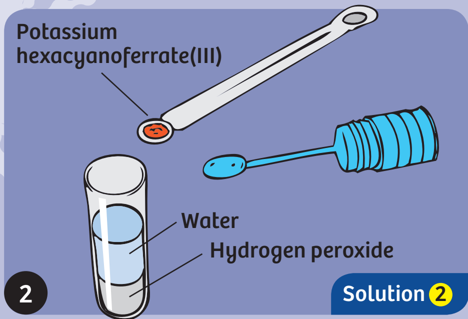
HERE'S HOW

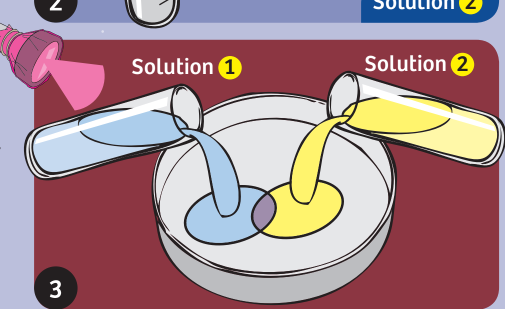
1. Fill a test tube three-quarters of the way with water and add a small spoon of sodium carbonate. Clean the measuring spoon and add a small spoon of luminol. Place the lid on, set your thumb firmly over the lid, and shake thoroughly until everything is as well dissolved as possible (Solution 1).

2. Fill the second test tube just about halfway with water, and add hydrogen peroxide with the pipette to bring the level to about three-quarters full. Then sprinkle a small spoon of potassium hexacyanoferrate(III) into it, put on the lid, and shake until everything is dissolved (Solution 2).

3. Darken the room, switch on the red light, and wait a few minutes for your eyes to adjust to the darkness. Then pour both solutions one after the other into the Petri dish and switch off the red light.







WHAT'S HAPPENING?

The liquid will glow for a few seconds with a mysterious blue light, but then the glow will quickly fade. The cause of the glow is a chemical interaction of the luminol with the hydrogen peroxide, with light emitted in the process. The name for this phenomenon is **chemiluminescence**. As with many chemical reactions, it releases energy. But unlike the combustion of wood, for example, in this case the energy is released as light rather than heat.

EXPERIMENT 16

Glowing cube

YOU WILL NEED

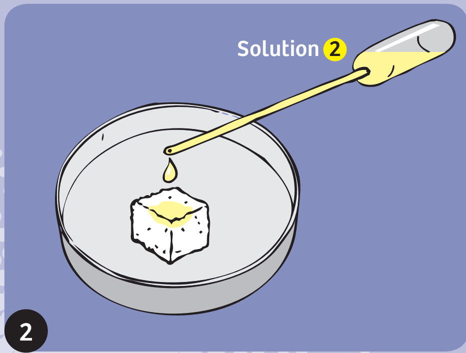
› Safety goggles
› Luminol
› Sodium carbonate
› Potassium hexacyanoferrate(III)
› 2 Test tube
› Double-headed measuring spoon
› Pipette
› Petri dish
› *1 sugar cube*

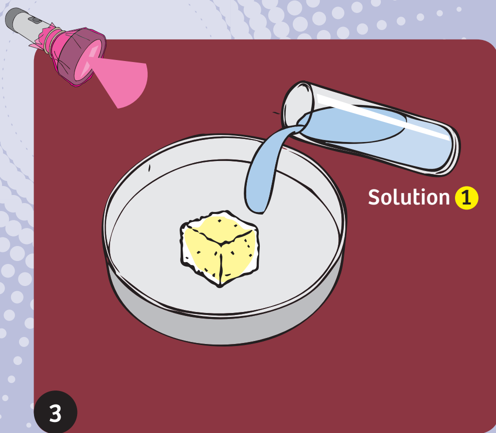
HERE'S HOW

1. Prepare Solution 1 [water + sodium carbonate + luminol] and Solution 2 [water + hydrogen peroxide + potassium hexacyanoferrate(III)] just as you did in the previous experiment.

2. Place the sugar cube in the Petri dish and use the pipette to drip about 15 drops of Solution 2 onto it. Don't let the sugar cube dissolve or crumble in the process.

3. Darken the room, turn on the red light, and wait a few minutes to get used to the dim light. Then carefully pour Solution 1 into the Petri dish (near its edge) and switch off the red light.



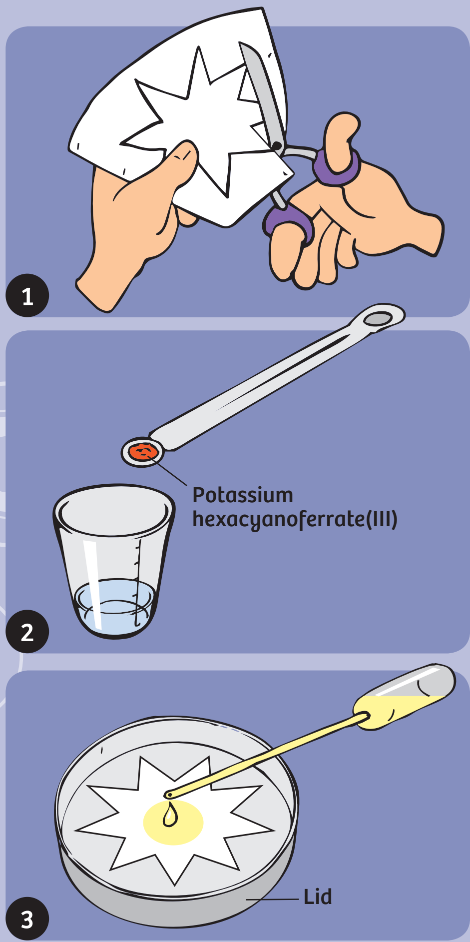


WHAT'S HAPPENING?

The sugar cube will start to glow mysteriously from the bottom. If you watch for a while, the entire cube will eventually glow. Sooner or later, it will fall apart and dissolve. Once again, what you are witnessing is the chemical interaction of luminol with hydrogen peroxide, but the reaction slowed down because of the sugar crystals. As everything dissolves into a little puddle, the liquid around the cube will glow in addition to the cube itself.

Illuminated shape

Every one of the chemicals used in the solution has a role to play, and all have to be present for the luminescence to work. But the order in which they are added makes no difference, as this experiment will show.

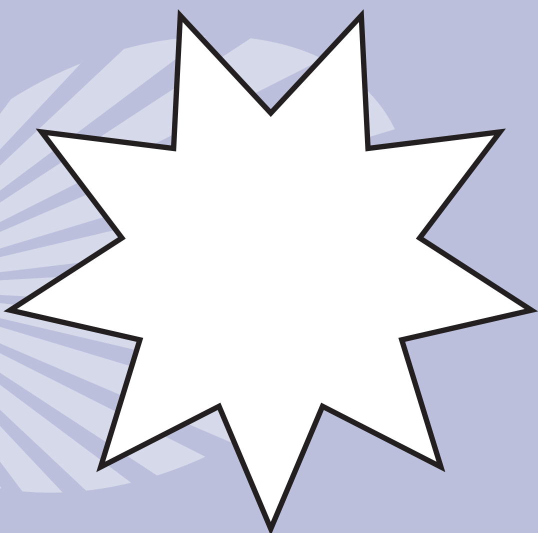


YOU WILL NEED

- Safety goggles
- Luminol
- Sodium carbonate
- Potassium hexacyanoferrate(III)
- Test tube
- Small measuring cup
- Pipette
- Petri dish
- Double-headed measuring spoon
- *Hydrogen peroxide*
- *Coffee filter or paper towel*
- *Scissors*

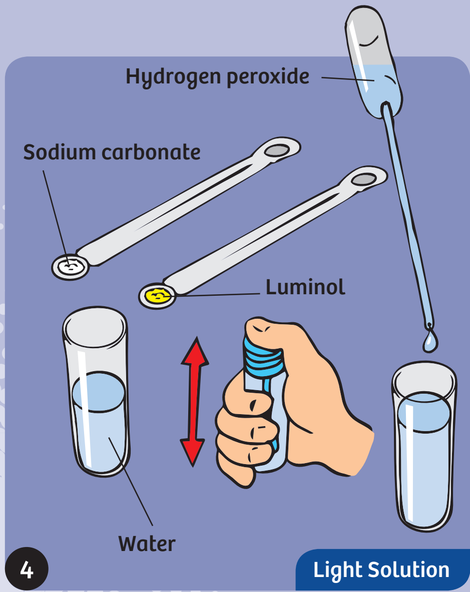
HERE'S HOW

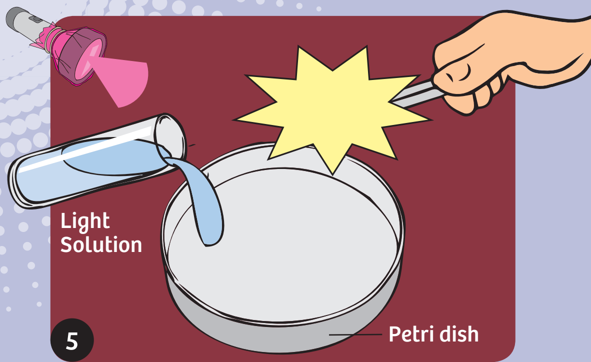
1. Cut a shape such as a star or an animal out of a coffee filter or paper towel. It has to be small enough to fit into the Petri dish.
2. Dissolve a small measuring spoon of potassium hexacyanoferrate(III) in about 5 milliliters of warm water.
3. Place the shape in the lid of the Petri dish, drip potassium hexacyanoferrate(III) solution onto it until the entire shape is fully saturated, and then let it dry (optionally on a warm heater). Repeat this twice.



4. Fill a test tube halfway with water and add a small measuring spoon of sodium carbonate. Clean the measuring spoon and then add a small spoon of luminol to the test tube. Place the lid on and shake thoroughly (thumb on top!) to dissolve as much as possible. Then use the pipette to fill it up with hydrogen peroxide. This **luminol-hydrogen peroxide-sodium carbonate solution** will be called **light solution** in the following experiments.
5. Now darken the room completely, turn on the red light, and wait a few minutes for your eyes to get used to the dim light. Pour the light solution into the bottom section of the Petri dish, and then use the double-headed measuring spoon to help maneuver the shape into the dish. Turn off the red light immediately.

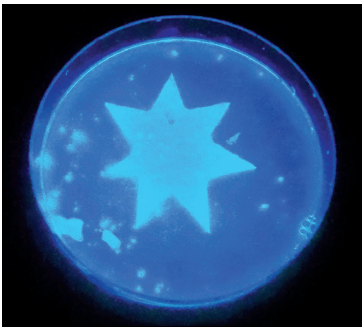
After the experiment, remove the shape with the measuring spoon and dispose of it in the household garbage.





WHAT'S HAPPENING?

The shape shines with a light blue light. The potassium hexacyanoferrate(III) gets the light-generating chemical conversion process started — the mixture of other chemicals doesn't glow yet. The reason: potassium hexacyanoferrate(III) is a chemical compound of iron, and this iron portion (chemists talk about iron-III ions) triggers the luminol reaction.



Penny in a blue sea

Potassium hexacyanoferrate(III) is not the only thing that can make the luminol start to shine.

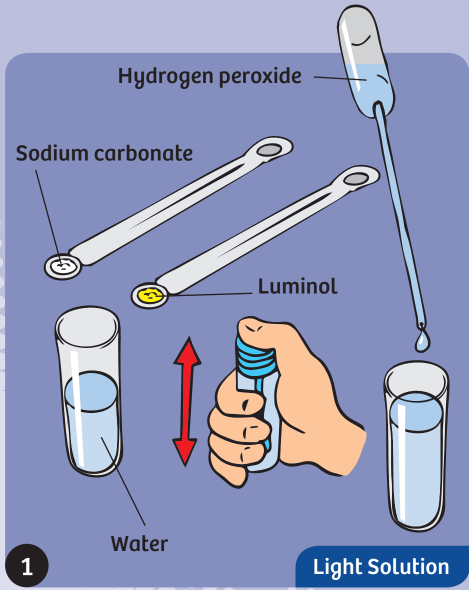
YOU WILL NEED

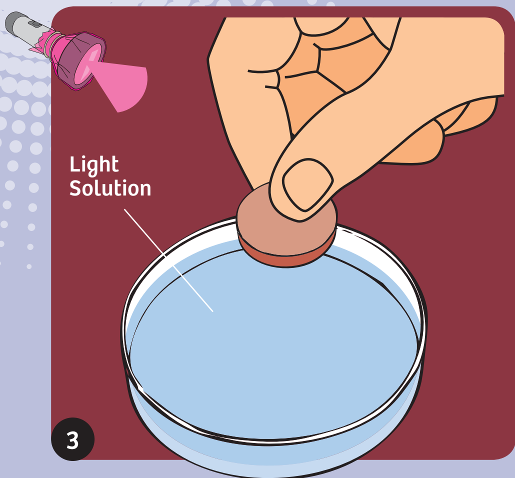
› Safety goggles
› Luminol
› Sodium carbonate
› Test tube
› Double-headed measuring spoon
› Pipette
› Petri dish
› *Hydrogen peroxide*
› *Penny (one-cent coin)*

HERE'S HOW

1. Prepare some light solution (luminol-hydrogen peroxide-sodium carbonate solution) as in the last experiment.
2. Pour the light solution into the Petri dish.
3. Darken the room completely, turn on the red light, and wait a few minutes for your eyes to get used to the dim light. Then place the penny in the Petri dish and immediately turn off the red light.

After the experiment, remove the coin from the dish with the double-headed measuring spoon and wash it off.





WHAT'S HAPPENING?

The coin starts to glow slightly — the dirtier it was, the brighter the glow. The coin is coated with copper, and copper compounds are also capable of setting off the luminol light reaction.

EXPERIMENT 19

Blood test

Sometimes, it's the FBI's task to search for tiny splatters of blood at the scene of a crime. Luminol can be helpful here, and is in fact used for this task.

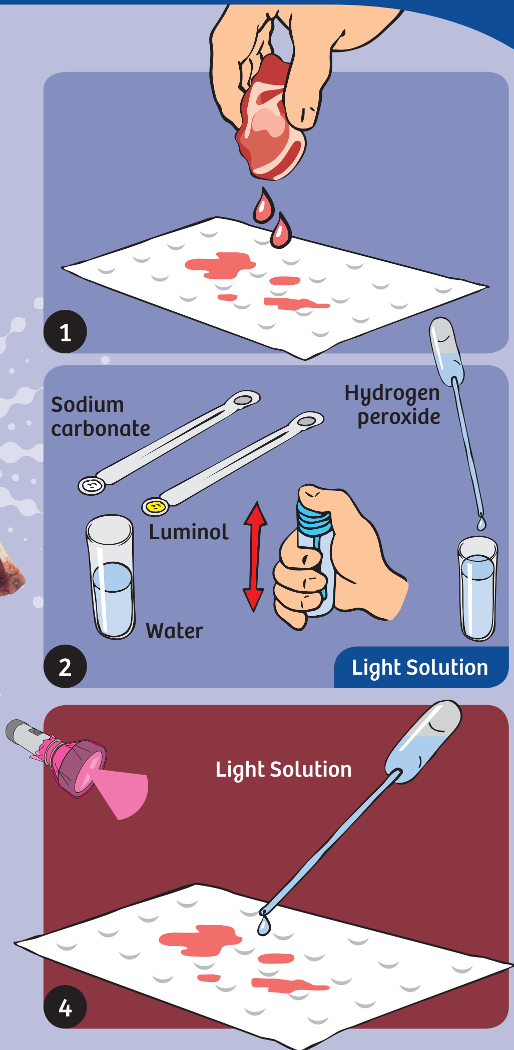
YOU WILL NEED

› Safety goggles
› Luminol
› Sodium carbonate
› Test tube
› Pipette
› Double-headed measuring spoon
› Petri dish
› *Hydrogen peroxide*
› *Paper towel*
› *Fresh piece of meat or hamburger meat*

HERE'S HOW

1. In the kitchen, drip some blood from a piece of fresh meat onto a strip of paper towel, or press a pea-sized piece of hamburger meat onto the paper. Wash your hands afterwards!
2. Prepare some more light solution as in Experiment 17.
3. Lay the blood-smeared paper towel onto the lid of the Petri dish.
4. Make the room completely dark, switch on the red light, and wait a few minutes for your eyes to get used to the dimness. Then, use the pipette to drip the light solution onto the paper towel and immediately turn off the red light.

After the experiment, dispose of the paper towel in the garbage.



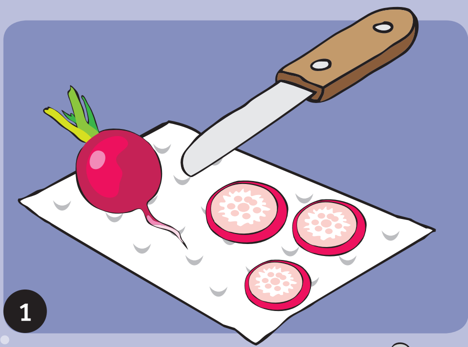
WHAT'S HAPPENING?

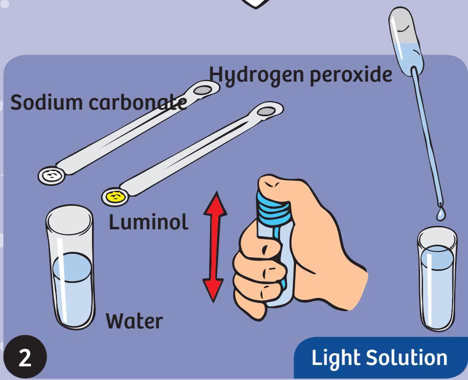
The spots that were smeared with blood glow a brighter blue than the area around them. The reason? Blood contains a red pigment called hemoglobin, which is a very complex chemical compound that contains iron. The test also works, by the way, after the blood has been drying for several days.

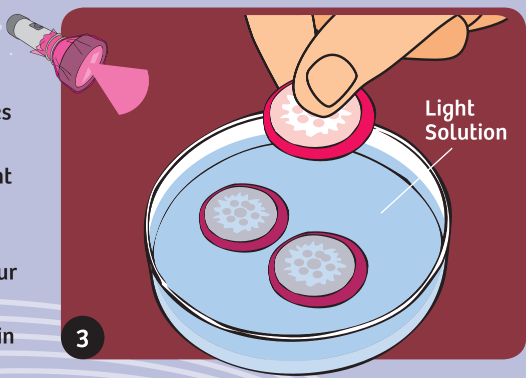
EXPERIMENT 20

Glowing radishes

The substances that support the luminol reaction can also be found in some vegetables.







YOU WILL NEED

- Safety goggles
- Luminol
- Sodium carbonate
- Test tube
- Double-headed measuring spoon
- Pipette
- Petri dish
- *Hydrogen peroxide*
- *Radish*
- *Knife*
- *Paper towel*

HERE'S HOW

1. In the kitchen, cut a radish into several slices and set them on a paper towel for now.
2. Prepare some light solution as in Experiment 17 and pour it into the Petri dish.
3. Make the room completely dark, switch on the red light, and wait a few minutes for your eyes to get used to the dimness. Then, carefully place one or several radish slices in the solution and switch off the red light. It would also work if you first placed the slices in the Petri dish and then dripped luminol solution over them with the pipette.

Dispose of the radishes in the garbage immediately after the experiment.

WHAT'S HAPPENING?

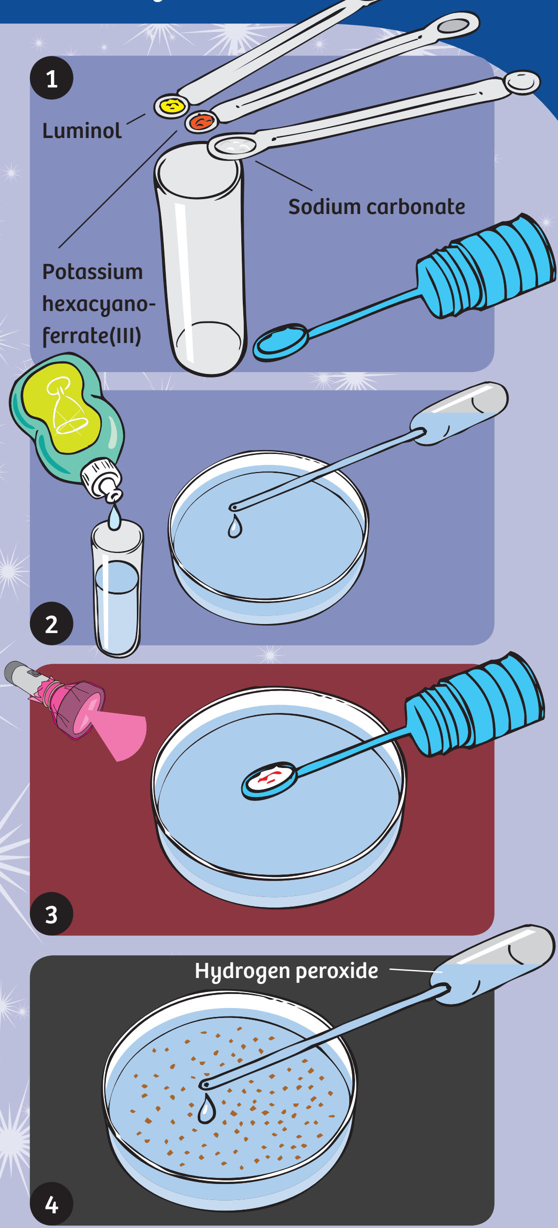
The radish slices glow with a mysterious light blue shimmer. Why? Inside the radish, as well as in horseradish, there are certain protein substances (peroxidases) that make the luminol solution glow.

EXPERIMENT 21

Glowing galaxies

YOU WILL NEED

- Safety goggles
- Luminol
- Potassium hexacyanoferrate(III)
- Sodium carbonate
- 2 Test tube
- Petri dish
- Double-headed measuring spoon
- Pipette
- *Hydrogen peroxide*
- *Dish soap*



HERE'S HOW

1. Add a small measuring spoon each of luminol and potassium hexacyanoferrate(III) and one large spoon of sodium carbonate to one test tube and mix the dry chemicals together.
2. Fill the other test tube with water and add a little dish soap. Now use the pipette to drip this soap mixture into the Petri dish until it is just covered with a thin film of soapy water.
3. Darken the room, switch on the red light, and wait a few minutes. Sprinkle the dry chemical mixture lightly over the Petri dish with the spoon built into the lid of the test tube.
4. Switch off the red light and drip the hydrogen peroxide into the dish with the pipette.

WHAT'S HAPPENING?

Galaxies will appear in the Petri dish and a chemical universe of stars will start to shine! The chemical mixture partially dissolves in the film of soapy water. As soon as you add the hydrogen peroxide, it triggers the light reaction and it's time to sit back and enjoy the star-studded light show.

Beaming smiley face

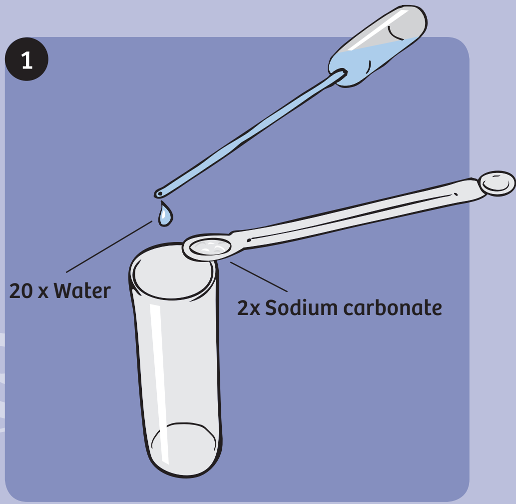
Technically, a smiley face just smiles. Our smiley, by contrast, will positively beam with joy.

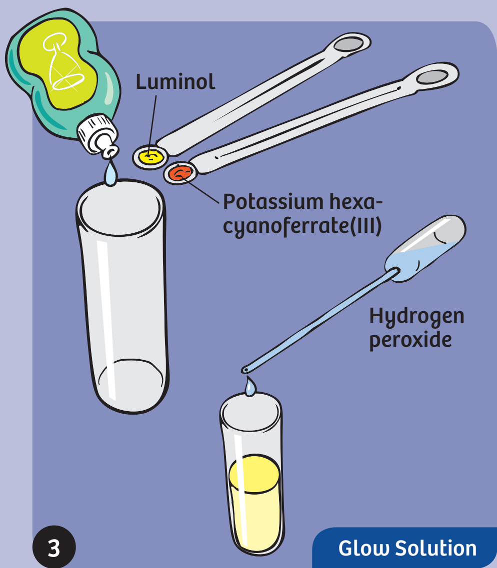
YOU WILL NEED

- Safety goggles
- Luminol
- Sodium carbonate
- Potassium hexacyanoferrate(III)
- 2 Test tubes
- Double-headed measuring spoon
- Stirring stick
- Pipette
- Petri dish
- *Hydrogen peroxide*
- *Dish soap*

HERE'S HOW

1. Add 2 large measuring spoons of sodium carbonate to a test tube and drip about 20 drops of water into the test tube with the pipette. Stir with the double-headed measuring spoon to get a thick paste.
2. Use this paste to paint the eyes, nose, and mouth of a smiley face. Let the face dry.
3. Now add a drop of dish soap, a small spoon of luminol, and a small spoon of potassium hexacyanoferrate(III) to the second test tube. Half-fill the test tube with hydrogen peroxide and stir until everything is dissolved. Your glow solution is now ready.





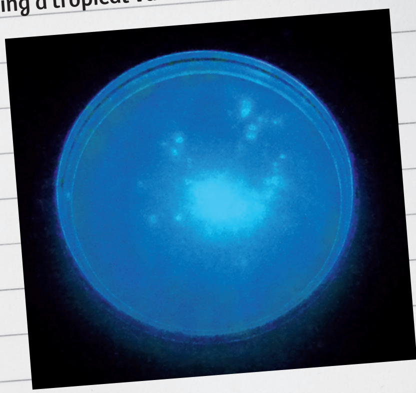
4. Darken the room, switch on the red lamp, and wait a few minutes for your eyes to adjust. Then slowly pour the glow solution into the Petri dish from the side and turn off the red light.

WHAT'S HAPPENING?

As soon as the smiley face meets the solution, is starts to glow brightly. As the sodium carbonate dissolves, everything around the face turns basic (the opposite of acidic). The light reaction can only proceed in a basic environment, and it continues until the face dissolves and gradually goes dim.

BONUS EXPERIMENT: Marine phosphorescence

In tropical seas, there are tiny creatures that sometimes collect in dense swarms. If you disturb them by splashing around, they emit a bluish-green light, forming luminous clouds in the water — an overwhelmingly beautiful sight on a dark tropical night. Even if you are fortunate enough to be taking a tropical vacation, though, you need a little luck to be able to come across this kind of marine phosphorescence. It's easier to reproduce the chemical process yourself. Simply fill the Petri dish about halfway with the glow solution and, once your eyes have had a few minutes to grow accustomed to the dark, stir the solution with the double-headed measuring spoon after dunking it in the sodium carbonate paste. You will see blue glowing clouds — just like marine phosphorescence on a smaller scale.



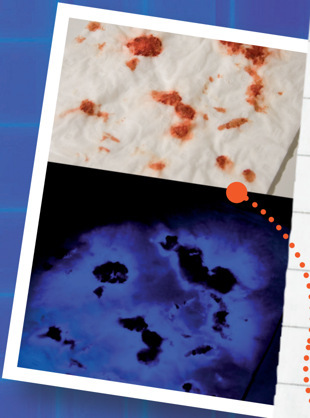
CHECK IT OUT

What happens during the light-emitting chemical reaction?

In that reaction, the luminol undergoes conversion with oxygen — a process resembling combustion. When materials undergo combustion, the energy that is released in that process is given off as heat. With luminol, on the other hand, the energy is given off as light.

The oxygen for the reaction comes from the hydrogen peroxide, and the sodium carbonate ensures that the solution is basic (the opposite of acidic), without which the substances wouldn't react.

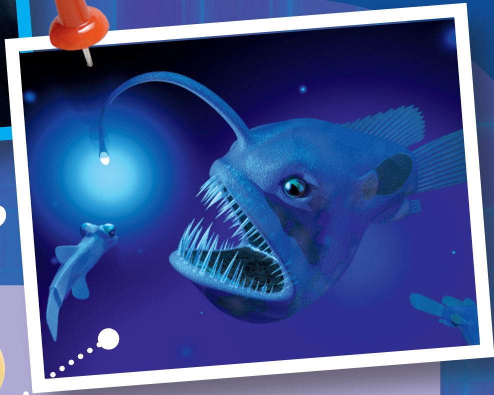
The light solution composed of luminol, sodium carbonate, and hydrogen peroxide nevertheless remains dark, as you saw in Experiment 17. It's not all that easy for the hydrogen peroxide to break down. For the light-emitting reaction to occur, you need an additive, or a so-called **catalyst**. This is the role played by the potassium hexacyanoferrate(III), for example. In Experiment 19, the traces of blood play that role, as do the radishes (which contain hydrogen peroxide-decomposing **peroxidases**) in Experiment 20. Proteins like these can be found in many living things, including humans. They always have the task of decomposing hydrogen peroxide, which accumulates in the cells as a harmful by-product and thus must constantly be eliminated.



The discovery of phosphorus

The chemical element phosphorus was discovered with the help of the light that it emits when exposed to air. Over 300 years ago, the German alchemist Henning Brand attempted to make a "philosopher's stone" (which was supposed to grant eternal life and wealth) out of urine. To do that, he heated a large quantity of urine for a long while until all the water evaporated, and then heated what remained in an enclosed glass flask. When he opened the cooled flask, it suddenly emitted bright light. Brand called the light-generating substance phosphorus, after the Greek word *phosphoros*, meaning light-bearer. This discovery was a great sensation at the time. Today we know that the process of heating urine converted naturally-occurring phosphorus compounds into so-called white phosphorous, which emits light when it comes into contact with oxygen in the air — a typical case of chemiluminescence.

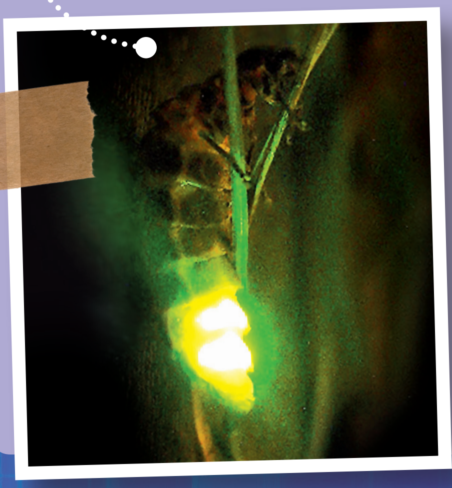
What is "bioluminescence"?



In nature, there are many living things that use cold light of the sort that you produced with luminol. You probably know about **fireflies** — little beetles that use their green light to find a mate. The marine phosphorescence that delights sailors in tropical waters comes from microscopically tiny living creatures in the water.

Cold light is especially handy for animals that live in the eternal darkness of the ocean depths. A lot of them, though, don't actually produce the light themselves. Instead, they store luminescent bacteria in parts of their bodies. **Deep-sea anglerfish**, for example, have developed a luminescent organ resembling a fishing rod, which they use to lure their prey into their mouths.

Certain deep-sea squid also hunt with the help of flashes of light. Vampire squid use the light for defense: They confuse their pursuers with a luminescent cloud of ink and use it to make their getaway.



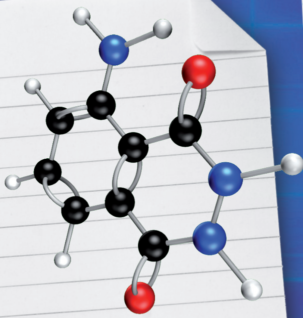
GLOW STICKS

You may know them from parties, but they are also used as emergency lights in rescue operations. They also contain chemicals that mix together when you bend the stick, which breaks a glass tube inside it. Depending on the specific chemicals used, they glow red, blue, green, pink, or yellow.

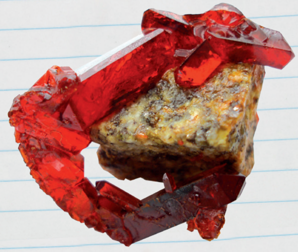
CHECK IT OUT

Luminol

In its pure state, luminol is actually a yellowish powder. The name comes from Latin *lumen* = light, and you only need a very small amount of it for light experiments. To make it easier to measure out, the luminol in your kit is mixed with a non-reactive substance, sodium sulfate.



blue = nitrogen atom
red = oxygen atom
black = carbon atom
white = hydrogen atom

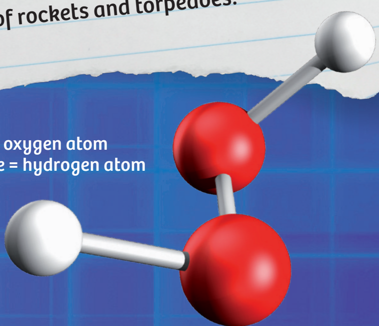


Potassium hexacyanoferrate(III)

This substance, also known as potassium ferricyanide, once went by the names red prussiate and Prussian red. It used to be produced by heating a mixture of dried blood, iron powder, and other substances. It forms nicely water-soluble red crystals.

Hydrogen peroxide

This substance is composed of a molecule almost identical to water, with the addition of an extra oxygen atom. It therefore readily releases oxygen and turns to water in the process. In diluted form, it is used for bleaching hair ("peroxide blonde") and to kill germs in medicine and water processing, and in concentrated form it is used as a source of oxygen in the engines of rockets and torpedoes.



red = oxygen atom
white = hydrogen atom

Sodium carbonate

This substance, which used to be called washing soda, is the sodium salt of carbonic acid. At one time, it was obtained from certain salt seas and used for washing clothes. Today, sodium carbonate is produced in huge quantities from rock salt and carbon dioxide, and it has many uses: in glass production, for smelting steel, in the chemical industry, for making washing detergent, and in paper production.

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