Creating Science – Glow sticks and Chemiluminescence

How do atoms make light? *#CreatingScienceGlowSticks or #ChemicalScienceChemiluminescence*

Suggested Outcomes

(NOTE: This is by no means an exhaustive list of possible outcomes, neither is it intended that ONLY these outcomes can or should be met. Science is a deeply interrelated activity, and you may find cross curriculum links you can and should use.)

Chemical science 2: Different materials can be combined, including by mixing, for a particular purpose

Chemical science 4: Natural and processed materials have a range of physical properties; these properties can influence their use

Chemical science 6: Changes to materials can be reversible, such as melting, freezing, evaporating; or irreversible, such as burning and rusting

Chemical science 8: Chemical change involves substances reacting to form new substances

Science vocabulary words

Tier 1 (Everyday words) – chemical.

Tier 3 (Specialised vocabulary)

- Luminescence: Glowing
- Chemiluminescence: Glowing by mixing chemicals

Warning

See attached warning sheet

- Broken glass
- Hydrogen peroxide is a poison

Preparation

Safety

- Standard safety: gloves, glasses, lab coats, shoes on, hair back, etc.
- A 'lab' – table with a wide container on it.
- A nearby bin for plastic and glass
- A bucket of water
- A sink for washing away chemicals. They are generally non-toxic and biodegradable.

Chemicals

- Glow sticks, thicker the better.
- A pinch of bicarb to increase the alkalinity of the glow chemical
- Hydrogen peroxide 6%, available from most chemists.
- Hot and cold water, in two clear cups.

Equipment

- Sticky tape that can go around a glowstick, clear packaging tape is best.
- Knife to cut glowsticks – grownups only
- Plyers, or hands to snap glass.
- Towel for drying glass
- A clear plastic cup to contain the glow chemical
- A series of pipettes labelled H2O2 for hydrogen peroxide.
- Several other pipettes for other uses.

Can't wait to see you all next Monday, don't forget

- Safety clothes for science, we're working with bleach and glow goo!
- Gloves, glasses, hair tied back and covered shoes.
- If anyone has any large diameter glowsticks to bring along, they'd be put to good use!

Suggestions for other year levels

As always, more material is presented here than can be used by the average class during the average lesson time. However, since the students questions can and should guide student learning, more material is presented for you convenience. Remember, it is not uncommon for students to only remember those points which answered their personal questions.

Younger:

This activity is better done as a demonstration with this age group

Middle:

This activity can be used to highlight dangers in science, and must be performed with care.

Teen:

As with most science, this activity possesses genuine danger is used with malicious intent. Be wary whom you allow to participate in this activity.

Learning Intent (student friendly)

Safely explore the glow stick reaction

Success criteria

Does temperature affect chemical reactions?

Student learning goals

Help students make a self-monitored learning goal for this lesson.

Evidence of learning

Successfully diagramming the results on their answer sheet – hot water makes the goo glow more, cold water effectually switches it off. However, cold water keeps it going longer…

What I already know

Find out what students already understand about the topic by;

- Asking what a chemical reaction is.
- Asking if they think temperature affects chemical reactions, and why?

Ideas for monitoring

Are students practicing safe conduct?

Help students note changes to reactions in the chemicals.

Engage

- ⇨ Note the Learning Intention of this lesson for students.
- ⇨ Make sure all students write down any questions they may have generated during this phase regarding the topic for today.

Ask: What makes light? How do chemicals make light.

Demonstrate the activity for today, being sure to focus on safety instructions.

Ask: What effect does temperature have on the chemical reaction?

Explore

- ⇨ Encourage and validate student explanations of this phenomenon. You may like to ask students to write or draw their explanation personally to avoid embarrassment to students unfamiliar with this material. Remember, 'I don't know' is a valid explanation in science – it is the beginning of learning new things!

Have students perform the experiment

Explain

Chemiluminescence

Put simply, when some atoms rearrange to form new shapes and molecules, they sometimes need to release a little energy to do that. And, sometimes, that energy is released as light.

Why?

Because atoms have hands, and they often hold on to each other to form all kinds of shapes and patterns. But they often hold on very tight – with heat around there's a lot of energy about. Sometimes when the let go, it's like a great spring springing loose, and things go flying!

We can use that chemical energy to do work – very, very tiny work on a very tiny scale.

What else do we use this for?

From Wikipedia 27 apr 18: A standard example of chemiluminescence in the laboratory setting is the luminol test. Here, blood is highlighted by luminescence upon contact with iron in hemoglobin. When chemiluminescence takes place in living organisms, the phenomenon is called bioluminescence. A light stick emits light by chemiluminescence.

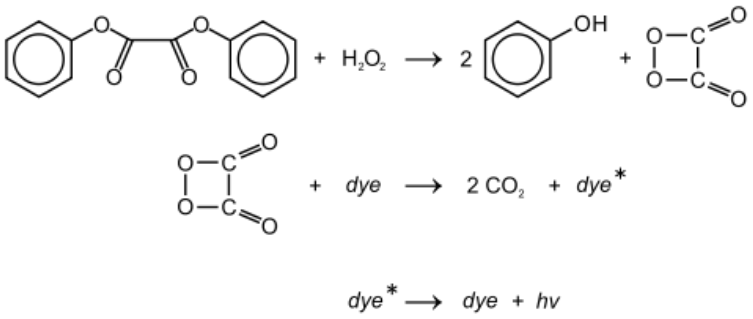
Elaborate

- ⇨ Ask students if they can design new ways to test this explanation, is it really sufficient? Can they think of further or better explanations, and the experiments needed to test them?

High school

Check out the chemical details at https://en.wikipedia.org/wiki/Diphenyl_oxalate

The reaction rate is pH dependent, and slightly alkaline conditions achieved by adding a weak base, e.g., sodium salicylate, will produce brighter light.



1. The ester combines with hydrogen peroxide to make 2 phenol molecules, and a peroxyacid ester.
2. The peroxyacid is broken down by the die to make two carbon dioxide molecules and one over excited dye molecule.
3. The dye 'calms down' by emitting one little photon of light.

Evaluate

- ⇨ Review with students what the felt they learnt from this unit. Did they have any questions at the start that they feel were answered?

Success criteria

- ⇨ Review the Learning Intentions of this lesson with students. Was it met?

At the end of each class, review the learning objective and see how we did. Ask:

- Did you achieve your learning goal?
- What did You learn?
- What worked to help you achieve it?
- What might you do better next time?
- (If needed) where can you go for extra help or information?

Assessment

Prior Learning:

Quiz, hangman, Anticipation guide (T/F pretest), demo's (what will happen, why, why do you think I'm going ot do the next step?), annotated student drawings (pretest with labels), KWL.

Focus on the outcomes – how can we create the BEST scientific knowledge?

Formative:

As students are learning, help them self-monitor their own learning and achievements.

Summative:

Help students consider ways they can communicate their new understanding to others, just as scientists need to do.

So what?

Most chemical reactions require special environment; temperature and acidity to name just two.

The chemical reactions that keep our body working are a really important example. Eating right can really help.

And when we get sick, our body can raise our temperature to speed up certain chemical reactions, in order to help fight off the disease.

Creating science

Science content

Hot things react faster (usually)

Science inquiry skills

Safety is important in science

Exact measures are helpful in science

Scientist names:

What you are testing:

Independent variable:

Dependent variable:

Glowsticks, Chemiluminescence, and temperature.

Does the temperature effect the rate of chemical reactions?
Does the acidity/alkalinity affect that availability of reactions?

1/ SAFETY!

- Gloves, goggles, hair back, shoes on, GLASSES, lab coats please!
- Set up this entire activity in a large container. Have a bucket of water on hand.

2/ Collect your glow goo:

- Have a grown up cut off the plastic end of the glowstick. If you accidentally cut the glass, throw it out and start again.
- PLACE THE GLOWSTICK INTO YOUR BUCKET OF WATER! Remove the glass tube CAREFULLY!! (You may need to cut both ends off your glowstick to achieve this)
- Wash and thoroughly dry your glowstick glass tube. If it breaks, chuck it out, start again.
- Wrap your glass tube entirely in sticky tape.
- Have a grownup break your glass tube while you COLLECT THE LIQUID that comes out into a plastic cup.
- Throw out and clean up any remaining materials.

3/ Activate your glow goo

- Place a pinch of sodium bicarbonate into the collected glow goo. **What happens?**
- Using the pipette supplied, CAREFULLY place a drop of 6% Hydrogen Peroxide into the glow goo. **What happens?**
- Count how many drops you need to get the goo to glow nicely.

4/ Experience the glow goo

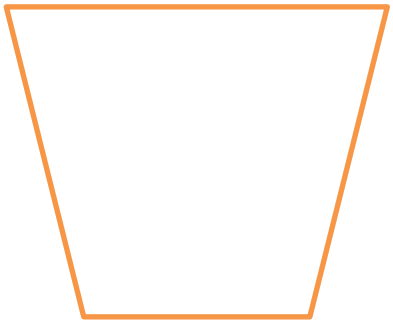
- Using a different pipette, GENTLY collect some glowing glow goo, and put one drop into the hot water. Hold the nozzle under the water's surface to make a drip. **What happens?**
- Collect the drip from the bottom of the hot water. DON'T RUSH or it will all mix up.
- Put the drip into the cold water. **What happens?** Now, can you answer: **Why?**

Can you explain your observations? What questions do you have? Now CLEAN UP CAREFULLY!

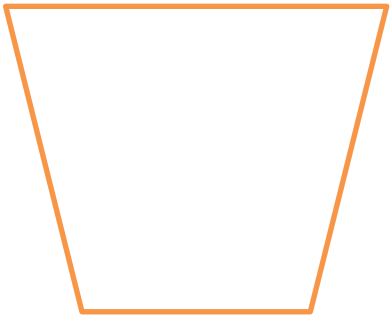
Results:

Draw or describe a picture of what happens in the;

Cold water



Hot water



Danger!

Always wear gloves, eye protection, keep hair back and feet covered!!

Hydrogen peroxide is a cleaning agent and bleach. It is corrosive to the skin, eyes, and respiratory tract – it HURTS, and is poisonous to drink. That's why we use a bucket, and pipettes.

Glass is inert and safe to touch, and is one of the toughest natural substances known. But when it breaks it can form extremely sharp edges. These can stab into your skin without you even realising until the pain sets in.

Diphenyl oxalate ester is responsible for the glow in a glow stick. The reaction with hydrogen peroxide causes it to glow by reacting with the die and creating 2 pheonols and 2 molecules of carbon dioxide gas. It isn't terribly dangerous, but too much in the wrong place will kill you.

Boiling hot water can damage your skin and hurt for weeks afterwards. Be careful!