Creating Science – Glow Goo (Fluorescence)

Distil the chemical that makes fluoro pens fluoro! #CreatingScienceFlourescence

- *Every tube light you see works by turning UV light into visible light, i.e., Fluorescence!*

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.)

Science content

- Chemical sciences 4: Natural and processed materials have a range of physical properties that can influence their use (ACSSU074)

Science inquiry skills

- Planning and conducting 6: Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103)

Science as a human endeavour

- Use and influence of science 6: Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

Science vocabulary words

Tier 3 (Specialised vocabulary)

- Fluorescent – a material that turns UV light into visible light.
- UV – short for Ultra Violet, an invisible colour of light just beyond the purple side of the rainbow. (Although people with artificial corneas can see UV light).
- Solvent. A chemical used to dissolve other chemicals in.

Warning

- DO NOT EAT FLUORO PEN GOO! – Not because it's dangerous; you should only use non-toxic pens from the local supermarket anyway. But because it tastes ***gross***!
- You need to do this activity over a safe mat, as gathering glow goo means we're gathering the ink from PERMANENT MARKERS. Be safe, and **wear the right clothes!**
- This activity requires a petrochemical solvent, such as Methylated spirits (AKA 'Metho'.) it is HIGHLY FLAMMABLE, TOXIC TO DRINK, BAD FOR EYES. Use extreme caution, and…

DO NOT DO THIS ACTIVITY NEAR NAKED FLAMES!!!

- Safety: Also make sure you wear appropriate clothes for use with this easily staining material.
- Have on hand some paper towel for cleaning hands, rather than using clothing.

Preparation

- Some old, or new, fluoro pens, freely available at most stores.
- Two solvents – water, and methylated spirits.
- Some cups to gather the Glow Goo in, and for the solvents.
- A pipette or syringe (without the needle in) to pour the solvent in.
- Appropriate safety gear – goggles, shoes, hair tied back, clothing that doesn't mind getting stained.
- Cleaning equipment if the glow goo does spill. Paper towels and plenty of solvent. Professionals may need to be called in in the case of sever spills.

You might also like;

- Painting gear for making 'Glow Goo art.'

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 well suited to this age group if managed appropriately.

Watch carefully for spills of the staining Glow Goo.

Middle:

This activity is well suited to this group.

Teen:

Extend the learning with a challenge to **weigh** exactly how much solvent was added to the fluoro pen, and thus calculate how much of the glow goo is actually glow chemical (and how much is the solvent added today.)

Learning Intent (student friendly)

'We are learning to' (WALT) – safely collect and use glow goo

Success criteria

'What I'm looking for' (WILF) – safe management of materials and equipment. Responsible handling of a very powerful dye.

Student learning goals

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

Evidence of learning

What EVIDENCE do you have that your students have met or exceeded the learning expectations?

- Successful collection of glow goo
- Ability to explain that fluoro materials turn invisible light into visible light.
- Exceeding – ability to explain the unseen quantum effects that make glow goo glow.

Engage

⇨ Note the Learning Intention of this lesson for students.

Explore some fluoro equipment. Have students brainstorm ideas of what is happening.

⇨ Make sure all students write down any questions they may have generated during this phase regarding the topic for today.

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!

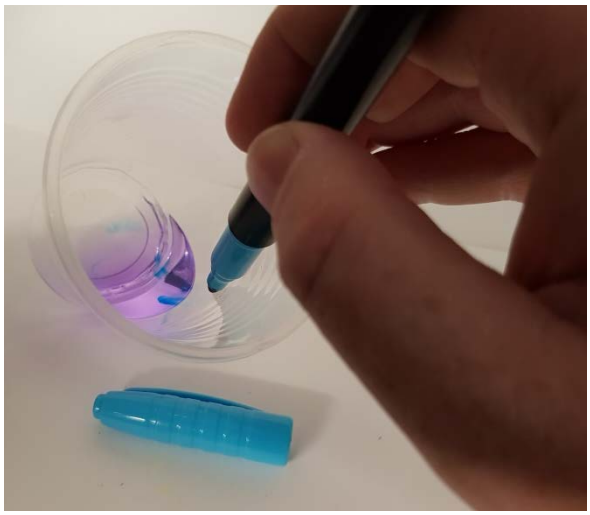
Make some glow goo!

Materials

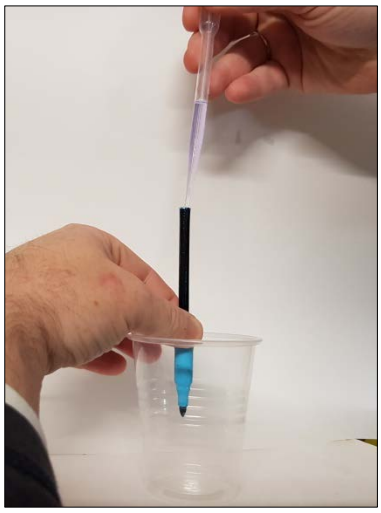
1. An old fluoro pen, even if it doesn't work anymore.
2. Two solvents – water, and methylated spirits.
3. Some cups to gather the Glow Goo in, and for the solvents.
4. A pipette or syringe (without the needle in) to pour the solvent in.
5. Appropriate safety gear – goggles, shoes, hair tied back, clothing that doesn't mind getting stained. And some cleaning equipment if the glow goo does spill. Paper towels and plenty of solvent. Professionals may need to be called in in the case of sever spills.
6. You might also like; Painting gear for making 'Glow Goo art.'

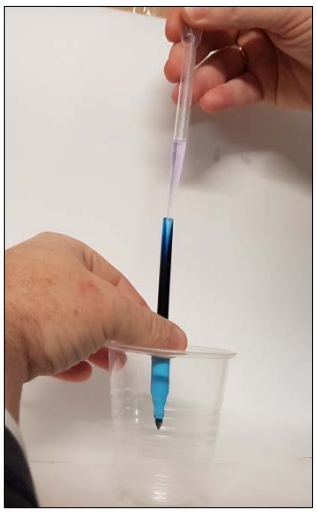
Method

1. Get out your safety gear – a safe place to work and clothes that can handle dye.
    a. Gloves, glasses, hair tied back and covered shoes please!
2. First, you need to see what kind of solvent your fluoro pen will respond to.
    a. Place a small amount of solvent in a cup, either water or Metho.
    b. Dab the nib of the pen in the solvent, and see if it leaves a wide streak of colour.
    c. If it does, you've found your solvent.
    d. If it does not, try the other solvent. This pen does not dissolve in water (clear) but will dissolve in metho (coloured purple so it doesn't look like the water, for safety).



3. Break your pen apart, though you may need some tools for this. Take out the ink container. It is usually a form of cotton wool wrapped in plastic.
4. Hold the ink container over a cup, and slowly, and gently – using a pipette or syringe, pour in the solvent at the top.
    a. If you are slow and careful no excess solvent will be wasted by washing over the sides. It takes around 20 minutes.





5. Clean up and wash up all materials carefully!

What to do with your goo?

- You can use it as a paint colour and draw with it.
- If you use a special 'spy' pen that fluoresces, you can make an invisible picture that you can only paint, or admire, using a UV light.
- Add it to Gak or Oobleck to make them fluoro too (#CreatingScienceGak) – however, it **will** stain everything it touches fluoro too!
- Seal it in a jar or test tube, and make it glow like some kind of mad scientist under UV light.
- Put drops of it in water to watch how water flows, and how the goo reacts to water.
- Make a fluorescent magma chamber. #CreatingScienceMagma

How to get rid of your goo

Disposal instructions depend on where you got your fluoro pens from, but in the bin is usually best. Most such pens designed for kids are non-toxic and biodegradable. But DO NOT EAT!!

Explain

Every time light hits an object, that light is changed.

- Some of it will be absorbed, and usually heat the object up.
- Some of it will bounce right off again, unchanged.
- And some of it will change into a different wavelength of light before leaving again.

We can get a LOT more complex than that, but this will do for starters.

For example, when light hits a green plant:

- Some of it is absorbed, and warms the plant up.
- Some of it is absorbed by the chlorophyll, and helps the plant to make its food, usually the redder wavelengths of light help with this.
- Some of it is reflected, can you guess which colour plants need the least? It's green!
- And some of it is changed into a different wavelength of light – again, usually green.

To put it way too simply – plants are *green* because they need *red* light.

So how do atoms change the colour of light? The singing eletrons (high school content)

The story is not a simply one, but we can try.

Every atom is surrounded by electrons.

Those electrons aren't just dots flying around. Think of them as … notes… it is more useful to think of electrons at this time as waves of energy, or in other words – notes. Every atom has its own chorus of 'singing' electrons!

When light hits an atom, some of that energy can be absorbed by an electron. The electron absorbs the energy by singing a new, higher, note – that is, it changes it wavelength. The atom isn't usually

too comfortable with new harmony to its song, so it will encourage the electron to go back to its original note.

The atom must 'convince' the electron to lose that extra energy to return to its original note, but it can't just choose *any* note. The atom has to emit a very specific amount of energy to get the electron back to the note it 'wants'. This energy is emitted as light, and the colour of that light can be used to tell us very precisely what atoms and chemicals are present[1]. We can even use that colour to tell us how far away and how fast those chemicals are moving relative to us[2]!

And what does that have to do with fluorescence?

There are more colours that we **cannot** see, than colours that we **can**. Examples include infrared light and ultra violet light.

Sometimes, actually often, when materials change the light they change colours that we cannot see into colours that we can.

This is what happens with fluorescent materials – they turn ultra violet light into colours we can see, often yellow, but there are others as well.

Some of those new colours are not very bright, like fluorescent red.

Some of those new colours are quite bright, but our eyes cannot detect them very well, such as blue.

But how to electrons 'sing'??

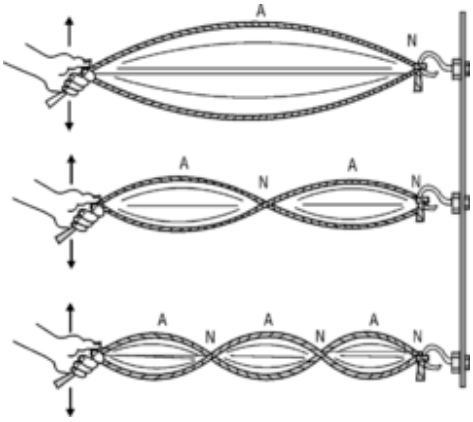
Electrons act like waves, not particles, when inside atoms.

And you know what else acts like a wave? Sound.

Have you ever played with a slinky, and made a standing wave[3]? Notice that only certain kinds of waves can be made, all else fall apart. You can make 1 wave, or double the speed to make 2, or increase again to make 3. But you can never make 3 ½ waves in slinky - whole numbers only!

It's called harmonics, and musical instruments do the same trick too. Trombones, flutes – you can make one note, and without changing the length of the instrument, make at least one notes even higher. That's an harmonic.

Electrons in atoms feel the same way. They bounce around like waves, but they don't want to make messy ½ waves, they make nice comfortable patterns to flow around in.



(Image taken 18 july 2018 from https://o.quizlet.com/iVBfvZwTl8rlcCoMjuF8Lw_m.png)

[1] Called Spectrometry
[2] I refer to speed radar and the like.
[3] Ever made the water splash out of a bathtub by moving back and forwards? Notice how you have to get the wave pattern just right so that it builds up on itself. That's a standing wave. No ½ or ¼ waves, you just have to get with the natural wave pattern of the bathtub. Standing waves can be very powerful. Even electricity can be made to move in a standing wave, which is one way tesla coils can be so powerful.

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?

Uses of fluorescence

Research information on one of the following:

- Lighting – most tube lights are fluorescent UV turned into other colours by phosphorous.
- Money – to help prevent counterfeiting most countries money has inviable glow dye.
- Glow sticks often use fluoro chemicals to maximise colour output.
- Biochemistry and medicine – used as a non-invasive way to detect for chemicals, such as certain chemicals in DNA.
- Forensics – special dyes can be added to a scene to glow when other chemicals are detected, such as those in human saliva and blood.
- Mechanical engineering – fluoro dye can be used to check for cracks in materials.
- Signage – fluoro paint is often used in signs, and for warning labels and vests.
- Optical brighteners – placing chemicals in laundry detergent to make them 'whiter than white' because they turn UV light into visible light, i.e., they're *glowing*.

Fluorescence in nature

Some flowers and spider webs have patterns only visible in ultra violet light. What purpose do they have? Sometimes it's just a coincidence; the chemicals have another job and just happen to fluoresce. But other times the creature makes important use of fluorescence to hunt, find mates, or survive!

- Rocks
- Fish
- Coral
- Cephalopods
- Jellyfish
- Mantis shrimp
- Amphibians
- Butterflies
- Parrots
- Arachnids
- Plants

What kinds of fluorescence are there?

Try looking up and exploring some of the following – in biological life forms how does fluoresce help them to survive?

- Biofluorescence
- Bioluminescence
- Biophosphorescence

Phosphorescence is related to fluorescence, but it emits the light much slower. This is the basis of all 'glow in the dark' toys.

Evaluate

- ⇨ Review with students what the felt they learnt from this lesson. 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:

As students explore the fluorescent toys, help them generate questions. Focus on the outcomes – how can we create the BEST scientific knowledge?

- Do glow in the dark toys glow in the light as well?
- Why do something glow, and others don't?
- What is the purpose of fluoresce?

Be sure to watch out for the following common alternative conceptions:

- Black lights aren't 'black', they're actually very bright – in a colour we cannot see!
- Bodily fluids don't *automatically* fluoresce under black light. You need to add detecting chemicals to make them show up. Most crime shows get this very wrong.

Formative:

As students are learning, help them self-monitor their own learning and achievements. Discussing the 'singing atoms' is a very abstract idea, which will require revisiting often. Younger students may simply be content with the idea that 'materials change the light that touches them' and 'we cannot see some colours of light.'

Summative:

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

Develop a board game where players must answer science questions to progress. Such as,

- What is fluorescence?
- Do some rocks fluoresce?
- What is an everyday use for fluorescence?
- Why do shrimp fluoresce?

So what?

There are colours we cannot see.

Materials change the colours, and from those colours we can learn many things. Some materials change light we cannot see into colours that we can, one example being the fluorescence of UV lights.

Fluorescence has many uses in nature and society.

Creating science

As we gathered and used our very of fluorescent Glow Goo, we learnt that;

Science content

As we gathered and used our very of fluorescent Glow Goo, we learnt that;

- Chemical sciences 4: Natural and processed materials have a range of physical properties that can influence their use (ACSSU074)

Science inquiry skills

And that we could;

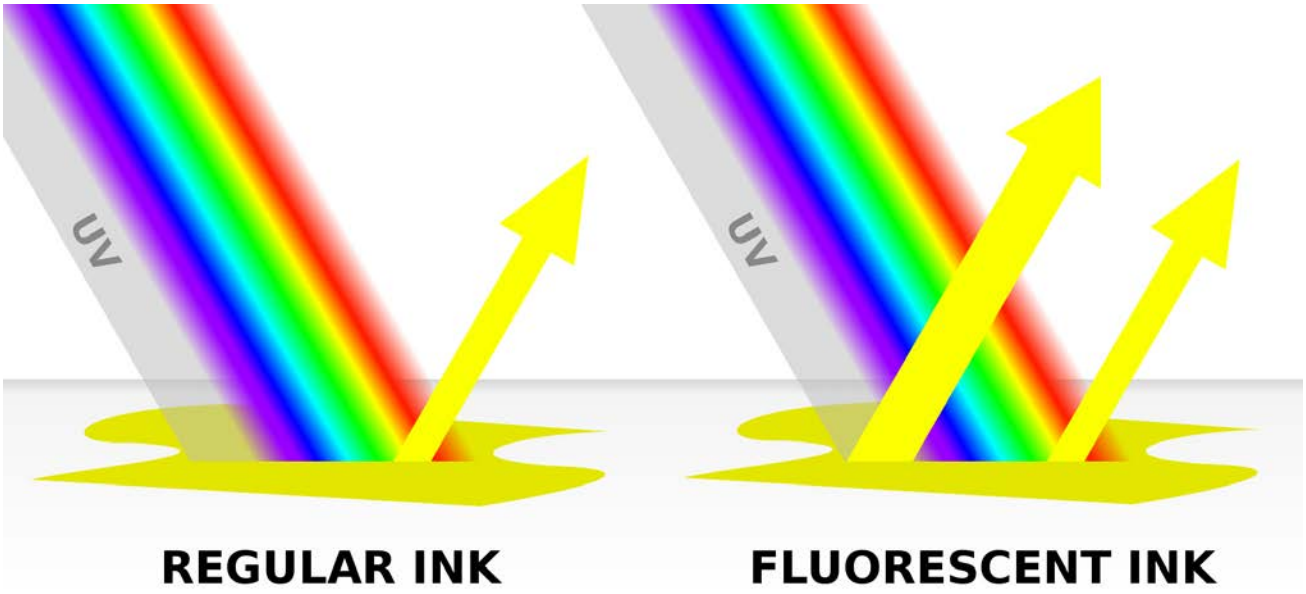
- Planning and conducting 6: Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103)

Science as a human endeavour

In exploring the uses of fluoresce in nature and society we could see that;

- Use and influence of science 6: Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

Appendix: Pics



Taken 18 may 2018 from http://wtamu.edu/~cbaird/sq/images/fluorescent_ink.png

Appendix: Notes

Cheesy video - https://www.youtube.com/watch?v=aNbfuRLSYJ0

Pen UV near UV laser lights – one at a time IF you're lucky the Aust Gov does not like to bring these into the country. https://www.aliexpress.com/item/Green-Red-Blue-Laser-Pointer-Pen-Visible-Beam-Light-Lazer-532NM-405NM-5mw-Beam-Ray-Laser/32826017144.html

Cheap UV lights, not as dependable as expensive ones, but you can get your start here. https://www.ebay.com/itm/12LED-Flashlight-UV-Ultra-Blacklight-Light-395-nM-Inspection-Lamp-Torch-LED-H/312094324072