Creating Science – Simple Spectroscopy

How can we recognise the kinds of atoms that make things up? Well, for one, we can set them on fire…

#CreatingScienceSimpleSpectroscopy

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 understanding

- Chemical sciences F: Objects are made of materials that have observable properties.
- Chemical science 5: Solids, liquids and gases have different observable properties and behave in different ways.

Also:

- Physical science 5: Light from a source forms shadows and can be absorbed, reflected and refracted.
- Chemical science 9: All matter is made of atoms which are composed of protons, neutrons and electrons.

Science inquiry skills

- Planning and conducting 4: With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment (ACSIS065).

Science as a human endeavour

- Nature and development of science 4: Science involves making predictions and describing patterns and relationships (ACSHE061).

Science vocabulary words

Tier 1 (Everyday words) – fire

Tier 3 (Specialised vocabulary)

- Spectrum – the scientific name for a rainbow.
- Spectroscopy – the science of measuring light - or more precisely, measuring rainbows. We can use this information to tell us all kinds of things, such as what materials are made from, or how far and fast things are moving.
- Copper – an orange metal used to conduct electricity.
- Strontium – a silver metal used in fireworks.
- Potassium – a soft silver metal that important for life.
- Sodium – similar to potassium, a soft silver metal necessary for life, that explodes in water.

Warning

- FIRE IS HOT:
    - All hair tied back
    - All shoes enclosed
    - No loose clothing – all clothing ready for mess! You WILL stain your clothes today.
    - All students knowing fire escape plan, "stop, drop, roll", and how to act responsibly around fire.
- Prepare the venue. Please make sure:
    - There is plenty of ventilation.
    - There is a fire resistant drop sheet for students.
    - All students are going to behave responsibly around fire.
- DO NOT attempt this activity unless you are confident that you can manage all student behaviour, and that you are willing to accept all legal responsibility for its execution and outcome.
- Copper sulphate RUSTS ALMOST EVERY METAL. Be careful.
- Potassium Iodide STAINS ALMOST EVERYTHING IT TOUCHES. Be careful.
- All chemicals should be handed in a well ventilated area.

Preparation

- Set up four stations, each with; a funnel, measurer, sprayers, some water, burner, sand and other fire safety gear, etc. Keep the fuel for the burners well out of reach.
- The chemicals from the kit (You can easily obtain MSDS for the chemicals online). We recommend the solid powder forms, which you mix with the water above to make a solution.
    - Copper sulphate (plant fertiliser)
    - Potassium iodide
    - Strontium chloride
    - Sodium Chloride (table salt)
- A burner. See images.
- DO NOT attempt this activity unless you are confident that you can manage all student behaviour, and that you are willing to accept all legal responsibility for its execution and outcome.

Learning Intent (student friendly)

'We are learning to' (WALT) – set fire to things safely, and that different materials will glow different colours depending on what that material is.

Success criteria

'What I'm looking for' (WILF) – safe behaviour and coloured fire.

Student learning goals

Help students make a self-monitored learning goal for this lesson, such as 'safely use fire to help us to recognise various chemicals'.

Evidence of learning

How will you know when the learning goal is achieved? What EVIDENCE do you have that your students have met or exceeded the learning expectations?

- Students can successfully identity the different flame test chemicals.

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 your convenience. Remember, it is not uncommon for students to only remember those points which answered their personal questions.

Younger:

Do this as a demonstration only, or with one adult per two children.

Take extra care when spraying liquids, you may wish for an adult to try it the first time.

This group may have trouble with focus. Avoid tangents when attempting to make a key point.

Middle:

This activity is suitable for this age group. You might be able to display a spectrum and point out the wavelengths of light. Giving a number to a colour opens up a whole new world of mathematics.

Teen:

Discuss how atoms create light using electron energy levels and quanta.

Engage

Discuss safety around fire.

Remember: Science is DANGEROUS[1]. This leaves us with two choices. We can either:

1. Run from it – stop doing science.
2. Learn from it – do science safely, which means MANAGE THE DANGER.

If we learn how to manage the dangers of science properly, we can have fun, and be safe, and learn from science. But we need to:

1. Be prepared! Learn from the mistakes of others so you don't have to make them yourself! Follow all safety instructions as though YOU are the one who might get hurt.
2. Learn from your own mistakes. Unexpected things can happen, but most accidents can be avoided and prepared for. Be amazing, and share your experiences so that others don't get hurt!

Explore

- ⇨ Using practical safety methods and exact measurement skills, perform the 'simple spectroscopy' activity at the end of this lesson.

Explain

Explain: Atoms are too small to see, but there are other ways we can appreciate them. Each kind of atom produces a different light. When we heat them up enough, we can often see those colours.

What makes atoms glow?

Atoms are made up of protons and neutrons in the centre, and little electrons around the outside.

One way to understand those electrons is to see them like planets spinning around a sun. Each electron planet has an orbit it likes to stay in (and they can share orbits too, unlike planets. The first orbit has 2 electrons, the second 8… and so on).

When you add energy, such as heat, the electrons can get knocked into other orbits. In order to drop back down to their preferred energy level, they have to loose energy. They do this by glowing.

Each atom emits a single photon of light in order to lose one level of energy. This photon has a very specific amount of energy depending on the atom's design. You can tell exactly what atom lost the energy by what photon of light was emitted.

[1] Because LIFE is DANGEROUS

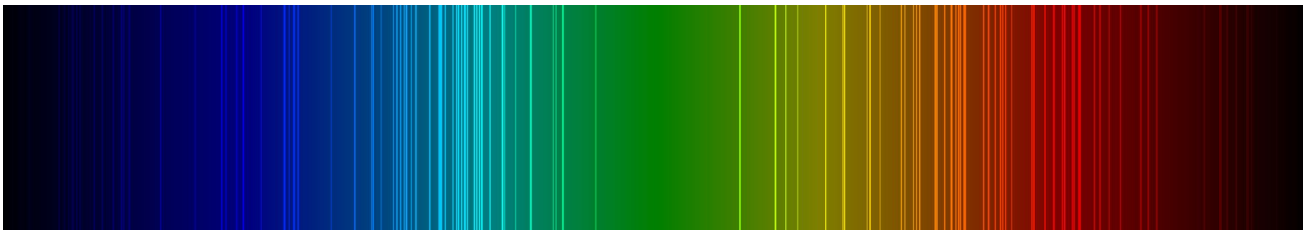
Elaborate

Note: Atoms also produce colours that we cannot see, such as infrared. Aluminium, for instance, can produce ultra violet light. So while being so scalding hot that it can melt right through your finger in a second, solid aluminium appears just as grey at it does at room temperature – which is very dangerous!

High school spectroscopy

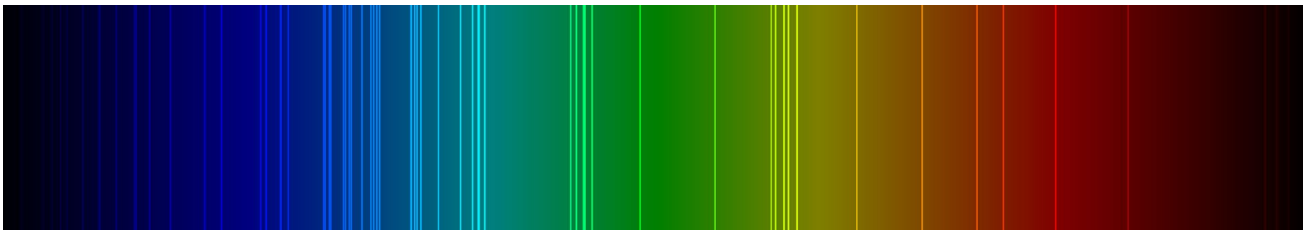
Here's a more detailed 'rainbow' of each of our chemicals today. Remember it is primarily the metal that gives out the light, not the non-metal half of the chemical (i.e., the copper, not the sulphate in copper sulphate).

Copper



https://commons.wikimedia.org/wiki/File:Copper_spectrum_visible.png This file is made available under the Creative Commons CC0 1.0 Universal Public Domain Dedication.

Potassium:



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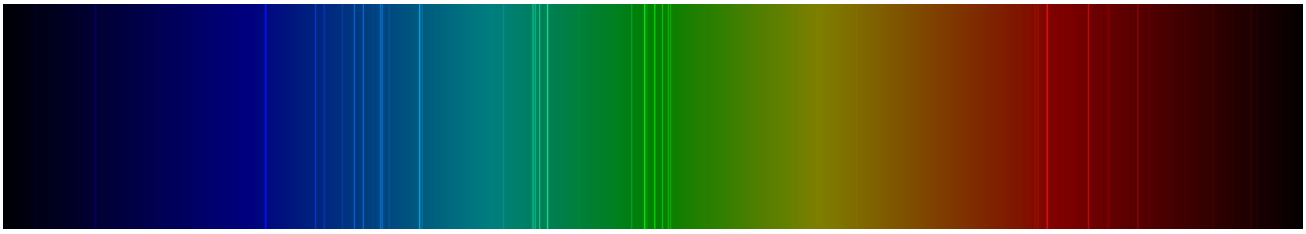
Strontium



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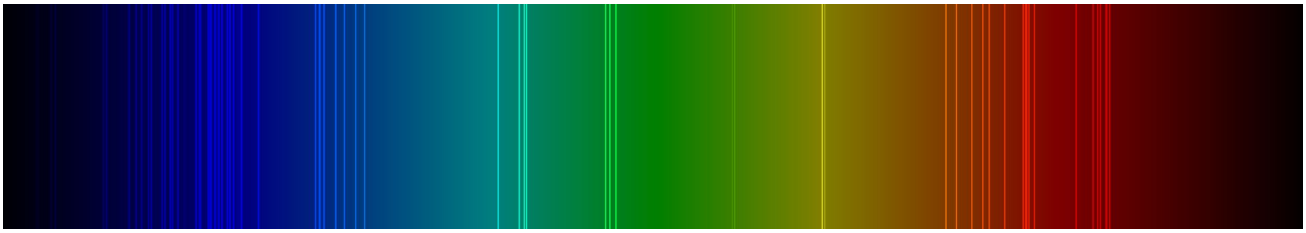
Sodium



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Evaluate

- ⇨ Review with students what they 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. Were they met?

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

- Did you achieve your learning goal?
- 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:

Take time to focus on planned content material during the engage phase, for example, survey students regarding their understanding of the concept "atom". Have them draw what they think they might look like.

Formative:

Have student tell or retell parts of their experiment, and welcome them sharing their contributions.

There are far more scientists involved in the discovery and description of the atom than this brief retell shares, and contributions may be welcomed. What about Dalton? Bohr? De Broglie? Einstein?

Summative:

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

- o Design a timeline on the *history of atomic theory*, highlighting the major experiments that changed our way of thinking, as well as the scientists involved and the countries they came from.

So what?

Science makes some very cool colours for fire, which we can explore safely if prepared.

Creating science

Science understanding

By setting fire to certain chemicals to create different colours, we can see that:

- Chemical sciences F: Objects are made of materials that have observable properties.
- Chemical science 5: Solids, liquids and gases have different observable properties and behave in different ways.

Also, as upper year levels explore the science of spectroscopy, they may learn that:

- Physical science 5: Light from a source forms shadows and can be absorbed, reflected and refracted.
- Chemical science 9: All matter is made of atoms which are composed of protons, neutrons and electrons.

Science inquiry skills - safety

By safely exploring simple spectroscopy, students can:

- Planning and conducting 4: With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment (ACSIS065)

Science as a human endeavour

As we saw that different chemicals produce predictable results under controlled conditions, we learnt that:

- Nature and development of science 4: Science involves making predictions and describing patterns and relationships (ACSHE061)

Scientist Name:

Date:

Experiment:

Activity – Simple Spectroscopy

Preparation

- Fire safety equipment: Water for **burns**, sand for **spills**. Extinguisher, fire blankets. A fire resistant surface to experiment on. Hair back, shoes on.
- Four 'mystery chemicals' labelled A,B,C,D (Copper sulphate, Potassium iodide, Strontium nitrate, and Sodium chloride.), Four empty, clean spray bottles and 4 funnels labelled A,B,C,D and four disposal bottles, labelled A,B,C,D.
- A Medium fire container – a small metal tin stuffed with towelling and drenched with methylated spirits. When not in use KEEP THE LID ON, this is ***highly flammable***.

Procedure

1. Set up laboratory. Prepare safety gear and procedures.
2. Get ONE spray bottle. Take off the lid.
3. Go to the mysterious chemical bottles. Using the same funnel per mysterious chemical (so as not to mix them up), place a ½ teaspoon of powder into your spray bottle.
4. Fill your spray bottle up with 20ml of water. BE VERY ACCURATE!
5. Put the lid on your spray bottle carefully and properly.

Now for the fire

6. On a fire resistant surface, set up your medium flame source. Keep well clear.
7. Have a grownup check your plan, and have the grownup light the medium flame source.
8. With grownup help, spray the mysterious chemical onto the fire. KEEP CLEAR!

Name your chemicals by comparing their colour with the chart provided

A	B
C	D

Clean-up

9. Make sure the fire is out, then put the lid back on the medium fire source.
10. Make sure you keep the left over chemicals in the CORRECT disposal bottle. **Do not** waste the chemicals, they can still be used. Wash down your surface thoroughly. The chemicals in this activity are best used as fertiliser, NOT put down the drain. Wash your hands thoroughly; indeed, you might even want to have a shower to be extra sure.

Simple Spectrometry

Copper

Creating Science

Strontium

By Dr Joe
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Colours are Approximate

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#CreatingScience
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Potassium

Sodium