Creating Science – Solvents, solutions & sneaky, sneaky Iodine.

Atoms often change colour as they rearrange. Hide Iodine, and find it again! #CreatingScienceHidingIodine

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 6: Changes to materials can be reversible or irreversible (ACSSU095)
- Chemical sciences 7: Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113)

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)
- Evaluating 7: Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements (ACSIS131)

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 1 (Everyday words) – Iodine

Tier 2 (Dual meaning)

- Chemical – in common usage usually refers to a dangerous liquid. In science, it is used to describe any material made of atoms, even those that aren't dangerous at the time. The air, for instance, is made up of chemicals such as nitrogen, oxygen, and carbon dioxide to keep the planet warm enough to live on. Water is a chemical, as well as having other chemicals inside it, many of which are beneficial to human life such as calcium. Please be sure to use the science version of a word in science class: Chemical means made of matter.

Tier 3 (Specialised vocabulary)

- Solvent: A chemical that can dissolve another chemical.
- Solute: The chemical that was dissolved.

- Solution: the resulting mix of solvent and solute. Sugar water is one example, as is the air (made up of many chemicals dissolved together.)
- Iodine: atom number 53, a purple-black metallic solid, it is often brown in mixtures, or can form a purple gas. It is important in medicine and mental health.
- Iodide: Iodine, except it is all alone as an individual atom in a mixture. It is often very clear.

Warning

- Bleach, or sodium hypochlorite, is undeniably dangerous stuff. Limit contact with children at all times, and manage appropriately. Aside from bleaching clothes, skin, and hair, and aside from being a potentially dangerous and very painful eye irritant, hypochlorite solutions liberate toxic gases such as chlorine when acidified or *heated*. The reaction with ammonia or with substances that can generate ammonia can produce chloramines which are also toxic and have explosive potential.
- Iodine will dye things brown. *Every* things: Plastic, skin, clothes, hair. Please be careful and exercise all appropriate caution.
- Hypo, or Sodium thiosulfate, is generally considered really very safe. Nevertheless, do not ingest, and treat as a dangerous chemical for safety sake.
- While all chemicals in this lab are disposable down the sink, please rinse sink and equipment and all materials thoroughly.

Preparation

- A safe place to work – a metal sink or outside on the grass.
- Iodine solution (Potassium iodine 5% with copper sulphate 5%).
- Bleach (5% Sodium hypochlorite).
- Hypo in crystalline form (Sodium thiosulfate).
- Two test tubes, skewer for stirring, two pipettes (one for hypo and the other for iodine), 100ml water, 2 safety bins for all ingredients (the rest goes safely down the sink).
- For the demonstration: a cup of water and tablespoon of sugar.

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:

As a demonstration only, although with proper safety and adult help it can be a close up demonstration. Adults only to handle bleach please. Kids will need to be reminded to be patient if they want to observe the experiment properly, it takes 5+ minutes for the Hypo to dissolve.

Middle:

This activity is well suited to this age group, though watch for rushing and careless behaviour.

Teen:

These reactions used today are *not simple*, and we challenge high school students to explain them in precise terms.

Learning Intent (student friendly)

'We are learning to' (WALT) – 'hide', and 'find' iodine.

Success criteria

'What I'm looking for' (WILF). – An accurate description of the chemical process which hide and reveal the iodine.

Student learning goals

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

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?

- Successful hiding and finding of iodine.
- Accurate description of the processes.
- Creative and practical suggestions for further experiments.

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 does it mean to dissolve?

Demonstrate: a ¼ spoon of icing sugar in a cup of water will dissolve. But the sugar HAS NOT disappeared, it's just **invisible**, but it's still very much there as our taste buds will tell us.

Further demonstrations of dissolving:

- A fog machine releases water into the air. Water evaporates but is still there. Gather the water again as condensations around a cold object, such as a cup of ice.
- Dissolving salt in water makes the salt disappear, but letting the water evaporate can leave the salt behind, which may form into regular square crystals.

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!

Explain: whenever you mix a solid, such as sugar, into a liquid, such as water, the solid might start to dissolve.

- The chemical that dissolved the solid is called the solvent.
- The chemical that was dissolved is called the solute.
- The resulting mix is called a solution.

Solutions are a mix of chemicals.

- Sometimes those chemicals react to form new solids, called a **suspension**. Eventually the solids will fall out, usually floating to the bottom as a coloured powder.[1]
- A **solution** will often remain clear and will never settle out.

Tell students: today we are going to:

1. Make a solution by dissolving a chemical.
2. Then use this solution to change another solution of iodine and make it *invisible* even though the iodine is still there.
3. Bring back the iodine using a new solution.

In other words, we're going to: Play 'hide and seek' with Iodine!

Activity: Solvents, solutions, and sneaky Iodine!

Discuss: Safety instructions and preparations for:

- Bleach.
- Iodine solution.
- Disposal of all chemicals.

Perform activity, see appendix.

[1] So what's it called when two liquids are mixed, and slowly settle out, such as the oil and water of some salad dressings? They're known as **immiscible** fluids. It's called a colloid when those particles are made so small that they cannot separate, for example, mayonnaise.

Explain

Help students to explain their four observations. Reward every sincere attempt.

Explain: Scientist use the following ideas to explain the observations.

1. As the Sodium Thiosulphate dissolves in the water, it is noticeably less dense. Thus, the dissolving Hypo tends to rise.
    a. The lower density of the hypo dissolved in water makes the light change speed, and thus also direction, leading to those 'heat waves' you might have noticed over a toaster or over the road on a hot day. Ironically, the hypo is not hotter, but it is less dense.
    b. If you were *really careful* you might have noticed that the dissolving of hypo in water is an endothermic reaction – the test tube got just a little **colder**. Feel it and find out!
2. As you place Hypo into your five drops of Iodine solution, the chemicals react. This makes the iodine change, 'hiding' the iodine even though it is still there![2]
3. As you add water to the mix, it dilutes it further as a solution – but the iodine (as iodide) is still there, as well as some other chemicals such as sulphates and copper (depending on how you made your iodine), making the solution just a touch cloudy, maybe blue.
4. The bleach causes the iodine to become visible again, showing that the iodine was there all the time – it was simply hiding!

Trouble shooting

Half the groups will try to drop the iodine directly into the 50ml of hypo. It will 'hide' all the iodine instantly. Remind them to put the iodine in the second test tube first!

It is not necessary to add 50ml of water to your iodine/hypo mix, but it does make it easier to see and thus, more dramatic.

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?

Experiment further

Try some of the following, or see what students can come up with:

- Drop iodine directly into you 50ml of hypo. What happens?
- How much bleach does it take to make the Iodine visible now?
- What happens if you put a crystal of hypo into the mixture after stage 4?

[2] There's always the chance to get more complex! Iodine is a purple black solid, but when dissolved under these conditions the iodine atoms break free into the solution, and are transparent to light, i.e., invisible.

The conservation of matter

(A good point to conclude on)

One science law, which we have never seen broken in the history of our understanding of the Universe, is the law of conservation of mass (or 'matter'). This law states that;

- Matter cannot be created or destroyed, only changed.

This means that in our chemical reactions, every single atom before the reaction is STILL THERE after the reaction, but it may have changed – into something that we cannot see; perhaps now forms a new molecule which turns into a gas and escapes. Point is, the matter is **still there**, but it's now … different.

To get more complex than that:

- In atomic reactions atoms DO break apart or merge together, but the TOTAL AMOUNT of energy and matter in the reaction is exactly the same beforehand and afterwards. So the law of conservation is maintained.
- How the universe formed from the big bang may, or may not, be a contradiction of this law – we don't know, and possibly cannot know, what was before the reaction we call the 'Big Bang'.

We saw this law in action today, as the Iodine was NEVER 'gone', only … *changed*…

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?
- ⇨ Ask students what they learnt about safety and safe handling procedures. Is there anything they feel they can improve on?
- ⇨ Explore with students ideas for improving the accuracy of the activity. Modern chemistry has equipment so exact it can measure the chemicals to several million atoms in precision – even more. For today, our accuracy of getting the measurement to about 50/50 is *really* good – but **billions of billions of billions** of atoms were at work in our experiment![3]

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?

[3] By my estimate, 14.4 x 10^24 atoms, or 14,400,000,000,000,000,000,000,000 or 14.4 billion, billion, billion.

Assessment

Prior Learning:

Perform the Engage activity. Ask: what does it mean to dissolve? What happens to things when they dissolve?

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

- That dissolved solutes no longer exist.

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.

Make up a "Chatterbox", with 8 questions and answers directly related to the activity today.

So what?

- Dissolved chemicals are STILL THERE! We can even bring them back to visibility sometimes.
- Some chemicals can be used to do things they aren't normally known for – such as using bleach, which usually makes things white or clear, to make something a dark, staining, iodine brown!
- In a chemical change, atoms are never destroyed, only changed. The same atoms at the start will always be the atoms around at the end.

Creating science

Science content

As we made mixtures to conceal, and then reveal, Iodine, we learnt that:

- Chemical sciences 6: Changes to materials can be reversible or irreversible (ACSSU095)
- Chemical sciences 7: Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113)

Science inquiry skills

As we safety performed this activity, and came up with some of our own, we;

- 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)
- Evaluating 7: Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements (ACSIS131)

Science as a human endeavour

By seeing how dangerous simple chemicals can be, and using them safely in this activity, we learnt that;

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

Appendix: Actors for today

Adapted from Wikipedia, may 2016

Sodium thiosulphate

Sodium thiosulfate (sodium thiosulphate) is a chemical and medication. As a medication it is used to treat cyanide poisoning and pityriasis versicolor.

It is an inorganic compound with the formula Na2S2O3.xH2O. Typically it is available as the white or colourless solid. The solid is an efflorescent (loses water readily) crystalline substance that dissolves well in water. It is also called sodium hyposulfite or "hypo".

It is on the World Health Organization's List of Essential Medicines, the most effective and safe medicines needed in a health system.

Iodine solution

Iodine is a chemical element with symbol I and atomic number 53. It exists as a lustrous, purple-black metallic solid at standard conditions that sublimes (goes from solid to a gas) easily to form a violet gas. The elemental form was discovered by the French chemist Bernard Courtois in 1811. It was named two years later by Joseph-Louis Gay-Lussac from this property, after the Greek ἰώδης "violet-coloured".

Iodine is the heaviest essential mineral nutrient. Iodine is essential in the synthesis of thyroid hormones. Iodine deficiency affects about two billion people and is the leading preventable cause of intellectual disabilities.

The dominant producers of iodine today are Chile and Japan. Iodine and its compounds are primarily used in nutrition. Due to its high atomic number and ease of attachment to organic compounds, it has also found favour as a non-toxic radiocontrast material. Because of the specificity of its uptake by the human body, radioactive isotopes of iodine can also be used to treat thyroid cancer.

Bleach - sodium hypochlorite

Bleach is the name given to a group of chemicals, which are used industrially and domestically to whiten clothes, lighten hair colour and remove stains. Many bleaches have broad spectrum bactericidal properties, making them useful for disinfecting and sterilizing and are used in swimming pool sanitation to control bacteria, viruses, and algae and in many places where sterile conditions are required. They are also used in many industrial processes, notably in the bleaching of wood pulp. Bleach is also used for removing mildew, killing weeds, and increasing the longevity of cut flowers.

The bleaching process has been known for millennia, but the chemicals currently used for bleaching resulted from the work of several 18th century scientists. Chlorine is the basis for chlorine bleaches: for example, the solution of sodium hypochlorite, which is so ubiquitous that most simply call it "bleach", and calcium hypochlorite, the active compound in "bleaching powder".

Complex description

While it was not the same reaction, you could start with:

https://edurev.in/studytube/Iodometric-Titration/83806803-eb16-4c15-aec8-b30458c51f6b_p

Stay tuned…

Activity – solvents, solutions, and sneaky iodine.

Question

Dissolved Iodine is deep brown. Can you make it disappear, and reappear once more?

Materials

Make sure you have all these on hand before you begin:

1. Two test tubes (clear cups will do), skewer for stirring, two pipettes (one for hypo and the other for iodine), 100ml water, 2 safety bins for all ingredients (the rest goes safely down the sink). Crystallised sodium thiosulphate, iodine solution, bleach (sodium hypochlorite).

Method

0. Safety!!!
1. Make some "Hypo".
    a. Fill a test tube with 50ml of water[4].
    b. Place 2 crystals of SODIUM THIOSULPHATE into a test tube. Swirl into a vortex to get crystals into the centre of the tube. Watch closely, what happens? **Observation 1.**
2. 'Hide' the Iodine.
    a. In another test tube, place in 5 drops of iodine solution[5].
    b. With a new, clean pipette, place <u>one drop</u> of Hypo into the iodine solution. What happens?
    c. Keep putting drops in until the iodine is all 'hidden'[6]. How many drops did it take? **Observation 2.**
    d. Place your excess hypo into the collection jar.
3. *Reveal* the iodine.
    a. Put 50ml of water into this second test tube (with iodine and hypo). **Observation 3.** It should go a little cloudy, with a stir, it may even become almost clear.
    b. Place in 1 drop of bleach (be careful!!) **Observation 4**. How many drops does it take to make the solution go brown again?[7]
4. Science is nothing without theories – now, explain your observations!

Experiment

Develop a question, run it past your teacher, and give it a go!

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[4] You can measure it out with a measuring cup, or make it up using 2 tablespoons and 2 teaspoons of water. And, since 1ml of water weighs about 1gram, you can weigh it up – put your container on some scales and tare it back to 0, then put in water until the scales measure 50 grams.

[5] Ours today was made by mixing a teaspoon of potassium iodine (in 50ml of water) with a ¼ teaspoon of copper sulphate (also in 50ml of water). The resulting mixture turns dark brown, another great reaction!

[6] The Iodine is still there, but the solution 'hides' the brown colour by making the iodine react with other atoms, and that causes it colour to change from dark brown, to clear.

[7] Note that since you diluted the iodine solution when you added 50ml of water, it will not go as dark as it was originally.

Observations – draw or record your results carefully.

1. Dissolving sodium thiosulphate in water. Draw what you see very carefully!	2. Putting Hypo into the iodine solution. How many drops of Hypo to 'hide' the iodine? What does it look like now – be exact!	3. Fill the second test tube with 50ml of water, what does it look like now?	4. Now add one drop of bleach and record your observations:

Now, can you *explain* what you have observed? That is, why did this happen?
