Creating Science – Density Cylinders

Did you know that water can float – on water! How?? ***#CreatingScienceDensityCylinders***

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, y5: Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)

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)
- Use and influence of science 4: Science knowledge helps people to understand the effect of their actions (ACSHE062)

Cross curricular outcomes

Visual art

- Foundation to Year 2 Content Descriptions: Use and experiment with different materials, techniques, technologies and processes to make artworks (ACAVAM107) *and* Create and display artworks to communicate ideas to an audience (ACAVAM108)

Science vocabulary words

Tier 1 (Everyday words) – salt, water, cylinder.

Tier 3 (Specialised vocabulary)

- Density. A quality of an object or material that defines how 'squished up' it is, or in maths speak – its mass divided by its volume. Pins are dense, feathers are not – even if they weigh about the same.

Warning

- Lots of water and salt, please exercise appropriate caution.
- Avoid spills and falls.

Preparation

- Water, lots of it.
- Towels for cleaning up spills – even more.
- Small plastic cups.
- 1 teaspoon for each group.
- Rinse tanks, to rinse out the teaspoons.
- A long, thin, tube. A narrow flower vase will sometimes do the trick.
- A 'float' – polystyrene balls, matchsticks, or floating beads.

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:

This activity is very difficult for this age group without adult help. You may want to try for two or three colours, rather than six.

Children at this age can have difficulty with focus. Avoid tangents if you're attempting to make a key point.

Middle:

This activity is well suited to this age group.

Teen:

Extra work may be required to challenge teen learners. Consider the elaborate activities, and making stronger connections to real life applications.

Engage

- Perform a 'Bob the Blob' activity. (See www.CreatingScience.Org)
- Ask students why things float. Explain floating and sinking from the Bob the Blob activity.

Explain: Today we're going to try and understand **density**.

Explore

Allow students to explore the Bob the Blob, and try to explain why it floats and sinks. Encourage and validate student explanations of density. 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

Explain: density is how squished up something is.

Ask: What's heavier, a tonne of bricks, or a tonne of feathers?

Answer: They weight the same.

Ask: So what's the difference? Density!

Optional story: Archimedes and the king's crown (appendix) – how to measure the volume of irregular objects.

More thorough explanation:

Density is how *squished up* a material is. For example, when you spread yourself out, you become less dense. When you squish yourself up, you become *more dense*.

You weight hasn't changed, but your size has.

And in the same way, whenever you eat, you become heavier! Your size might not change, but you now weigh more. You have become more dense. (And, yes, every time you go to the toilet you don't change size, but you do lose weight. So you become less dense!)

We can have some fun with this, because:

- Things that are less dense than water will float in it.
- Things that are more dense than water will sink in it.

And now we're going to make **water float on water**, by making some of the water *less dense*, and some of the water, *more dense*. Just wait and see!

Advanced groups

This is the equation for understanding density:

$$P = \frac{m}{V}$$

- Where P = density (because it was not originally in English, and uses the Latin letter *rho*)
- m = mass, or weight, usually grams or kilograms
- V = volume, usually in cm^3 or litres.

So if you know the volume of a substance, you can tell its weight by multiplying it by the density.

And if you know the weight of a substance, you can get its volume by dividing its weight by the density.

Elaborate

Help students build a density cylinder

Stage 1: Divide

1. Find out how much water you need to fill up your cylinder.
2. Divide that into six cups equally.
3. Make the water in each of the cups a different colour. Good luck, time to get out your colour mixing skills!

(colours are an example only – you can make up your own order and style of colours)

Stage 2: The 'Saltening'.

At the moment each liquid is about the same density.

You need to increase the density – a great way to do this is to make each liquid weigh more, without changing how much space it takes up (its volume).

And a simple way to increase water's weight (and not it's volume), and thus it's density is to add salt.

Salt will hide among the water particles, fitting quite neatly. This makes the water heavier with the extra salt, but its volume does not increase at all[1]!

So beginning at the colour you want at the top, and add NO SALT. Moving down the line, add one extra spoon of salt, so: 0, 1, 2, 3, 4, 5.

MAKE SURE your spoons of salt are all exactly the same size. Tiny errors in measurement can add up to make two different colours almost exactly the same density, and we don't want that today. Make sure you stir the salt in, but there's no need to heat anything today.

Teaspoons of salt =

5 4 3 2 1 None

Of course, your colours may look entirely different – that's just for effect!

Stage 3: the density cylinder

You now need to pour the liquids in beginning with the DENSEST. That is, you begin with the SALTIEST!

> If you get that stage wrong, all your colours will mix. And that's OK – after all, experiments are for learning new things!

We're found you need a **FLOAT** to buffer the water, and turn the water running down the side into a gentle trickle that won't mix up your colours. The float should always float to the top of the water column.

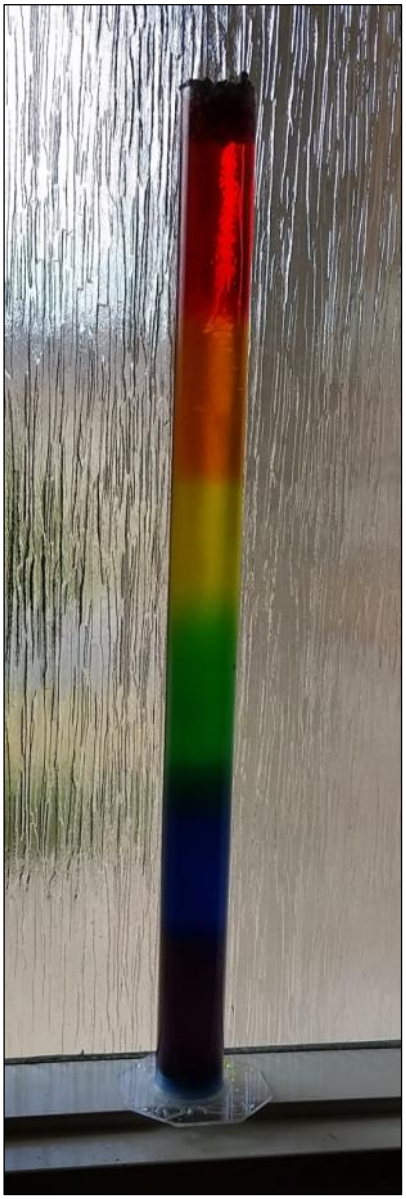
Make sure you put the water in slow and careful!

[1] Well, almost

Your float may be made out of anything that floats on fresh water, but you'll need about 5 to 10cm of it:

- Matchsticks work, but can get stuck, so you'll need to poke them to get them to rise back up to the top after every colour fill.
- Plastic beads which float on fresh water can be great, and reusable, but you'll need a LOT
- Dozens of balsawood cubes might work.
- Polystyrene balls, or bean bag filler, works a *treat*, but it's a mess for the environment (see our lesson on plastics). You can rip up a polystyrene cup or two – that's always fun. If you use beanbag beans (which work brilliantly), prepare for a real MESS!

Pour each colour in, beginning with the saltiest, SLOWLY AND CAREFULLY, making sure water runs down the side of the cylinder so that it doesn't splash down and mix the colours up. This requires patience and skill, and someone must be holding on to the tube at all times. It's tricky!



When you're done, you can remove the float (if you're careful) and you have your very own successful – not too mixed up – cylinder of different densities.

Amazingly, it will last several days, if not weeks, before the salt will diffuse throughout the cylinder.

Other ways to float

You may notice that the top water seems a little warmer than the water you are using. That's because warm water floats! Water loses its density as it becomes hotter – all those bouncing around particles can make the water swell *just* a little.

If you heat up the lowest colour of water it will eventually rise to the top, mixing as it goes. Can you make a density cylinder built on heat, rather than on salt content? (Send pictures!)

What floats?

If you know the exact density of each layer of water you **should** be able to predict where some other object might float.

Try building a float that will sink in normal water, but not in the deepest layer of salt.

You can calculate it exactly if you know the weight and density of your float.

Or you can try to build a Bob the Blob (see activity) that only *just* sinks in normal water. Do you think Bob will float all the way down to the bottom of the tube?

What else can you find that will float half way? Try:

- A piece of carrot
- A fresh egg
- A boiled egg with its shell off.
- Cherry tomato
- Plastic beads
- Bottle top
- Popcorn kernel
- A pebble – with polystyrene tied to it.

What doesn't float?

Sometimes things fail to float because the water underneath them is suddenly less dense than the object itself, and down it goes.

One tragic example is when volcanic action fills the water with millions of teeny bubbles, making the water as a whole less dense. It has made entire boats start sinking, and the water cannot support the people either. Some think this might be what causes the mysterious disappearances of the Bermuda Triangle.

Can you think of any other examples?

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. 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 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:

Find out what students know about density:

- What do they believe about why things float?
- Have they heard about Archimedes and what he discovered?

Formative

Check students are working with density, rather than mere 'weight' as a concept. It's quite tricky for some, and takes time.

Summative

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

So what?

Water can float – on water of a higher density.

(density, not weight or air, will determine why things float)

Creating Science

Science content

As students learnt about density and built their own density cylinders, they could see that;

- Chemical sciences, y5: Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)

Science inquiry skills

As students learnt that liquids could float on liquids, they saw that;

- 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 students safely disposed of their dangerous salt water and polluting floats, they;

- Use and influence of science 4: Science knowledge helps people to understand the effect of their actions (ACSHE062)

Archimedes

Take 24 feb 17 from http://archimedespalimpsest.org/about/history/archimedes.php

THE PUZZLE OF KING HIERO'S CROWN

THE "EUREKA" STORY
ILLUSTRATED BY KEVIN KALLAUGHER.

Read the Story »

King Hiero had commissioned a new royal crown for which he provided solid gold to the goldsmith. When the crown arrived, King Hiero was suspicious that the goldsmith only used some of the gold, kept the rest for himself and added silver to make the crown the correct weight. Archimedes was asked to determine whether or not the crown was pure gold without harming it in the process. Archimedes was perplexed but found inspiration while taking a bath. He noticed that the full bath overflowed when he lowered himself into it, and suddenly realized that he could measure the crown's volume by the amount of water it displaced. He knew that since he could measure the crown's volume, all he had to do was discover its weight in order to calculate its density and hence its purity. Archimedes was so exuberant about his discovery that he ran down the streets of Syracuse naked shouting, “Eureka!” which meant “I've found it!” in Greek.

(A very brief overview – is it entirely accurate? Check out https://www.math.nyu.edu/~crorres/Archimedes/Crown/CrownIntro.html taken 24th of feb 2017 for a suggestion on a more accurate experiment that might have saved an honest goldsmith’s life…)