Adapted to STEMAZing ECE Format by
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Density: Salty and Sweet

NOTE: Children should always be given ample time to experiment, notice, and wonder before they are provided an explanation.

Always engage children with our two favorite questions:

What do you notice? What do you wonder?

Resist the urge to answer any questions children have while exploring. Instead, respond back with questions to children and let them make sense of the world. Sample questions you might use: What do you think? Do you notice any patterns? What could we change? Can we test something else? What can we try next? If children ask a testable question, which they could answer by doing an experiment, talk through with them how they might design a test to help answer their question. As much as possible and within reason, let them actually test their questions by trying the experiments they propose.

Learning Objectives

Children will…

- make observations using their senses.
- start to learn the rule for when an object will sink and when an object will float.
- start to learn you can change the density of water by dissolving salt or sugar in it.
- compare similarities and differences between two different experiments.
- wonder about related ideas and experiments they might try.

Vocabulary (See **What the heck? Explanation of Science** at the end for definitions.)

Density	Liquid	Gravity
Mass	Sink	Force
Volume	Float	Solid
Fluid	Buoyancy	Soluble
Gas	Weight	Suspended

Materials

One fresh raw egg (still in its shell)	Tall glass or clear plastic container	Sugar (about ½ cup)
Water	Salt (about ¼ cup)	Measuring spoon (½ tsp)
		Measuring cup (1 cup)

Key Question for Experiment 1

Will an egg sink or float in water?

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Notice and Wonder Developmentally Appropriate Practice

1. Pour 1 cup of fresh tap water in the glass and take out the egg.
2. Have children observe the glass of water and the egg.
3. Ask them to predict whether the egg will float or sink when placed in the water.
4. Put the egg into the water. (If the egg is fresh, it will sink. If the egg happens to float, it should be thrown out. This is an indicator it has gone bad. Get some fresh eggs and try this phenomenon again.)
5. Tell the children the egg sank to the bottom because the egg is more dense than the water.
6. Let children add a ½ teaspoon of salt to the water.
7. Keep a tally of how many ½ teaspoons of salt the children add.
8. Stir the water until the salt has completely dissolved and you can no longer see salt crystals at the bottom of the glass.
9. Repeat steps 6-8, adding ½ teaspoons of salt. After each ½ teaspoon of salt is added, observe and record any changes the children notice.
10. After the egg starts to float (and DO NOT mention this will happen, let the children make this observation), make a note of the number of ½ teaspoons it took to get the egg to float.
11. Tell the children the egg is now floating because it is LESS DENSE than the salty water.
12. Continue adding ½ teaspoons of salt and stirring the water to dissolve it. Once the children notice the egg is floating higher in the water, you can stop.
13. Tell the children as the salt water gets even more dense by adding more salt, the egg will float even higher. You can mention how this even happens with people and, if possible, show them photos of people floating in the Dead Sea, which is REALLY salty. You can find more information about this and a photo here: https://www.worldatlas.com/articles/the-world-s-most-saline-bodies-of-water.html

Children should notice…

- after a few ½ teaspoons of salt, the water starts to get a little hazy.
- after a certain number of ½ teaspoons of salt have been added, the egg will start to float. (DO NOT tell children we expect this to happen. Let them observe this on their own. Make a note about how many ½ teaspoons of salt you added to get the egg to just start floating.)
- after more salt is added to the water, the egg will float higher in the water.

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Key Question for Experiment 2

Will adding sugar to water also make an egg float?

Notice and Wonder Developmentally Appropriate Practice

1. Pour 1 cup of fresh tap water in the glass and take out the egg.
2. Have children observe the glass of water and the egg.
3. Ask them to predict whether the egg will float or sink when placed in the water. Now that they have had an experience to draw from, ask them why they think the egg will sink or float in the fresh water. Do not correct children who predict the egg will float rather than sink. Let them make their claim and then let them make another observation to allow them to make sense of the world. You can then ask children if they think a fresh egg will always sink in fresh water. You may also explain to them that if a raw egg floats, it has likely gone bad and should be thrown out.
4. Put the egg into the water and let it sink.
5. Tell the children the egg sank to the bottom, just like before, because the egg is more dense than the water.
6. Tell children that this time, instead of adding salt, you will be adding ½ teaspoons of sugar. Ask them to make some predictions about what will happen. Refer back to observations they saw in the first phenomenon, if necessary. For instance:
    - They noticed the water got hazy as salt was added. Do they predict that will happen when sugar is added?
    - They noticed the egg started to float after enough salt was added. Do they predict the egg will float when they add sugar to the water?
    - They noticed the egg floated higher in the water when even more salt was added. If they think the egg will float, do they predict the egg will float higher when even more sugar is added?
7. Let children add a ½ teaspoon of sugar to the water.
8. Keep a tally of how many ½ teaspoons of sugar the children add.
9. Stir the water until the sugar has completely dissolved and you can no longer see the crystals at the bottom of the glass.
10. Repeat steps 7-9, adding ½ teaspoons of sugar. After each ½ teaspoon of sugar is added, observe and record any changes the children notice.
11. When you get to the same number of ½ teaspoons of sugar as it to ½ teaspoons of salt to make the egg float, make sure the children observe the egg is still not floating. Ask them if you should keep adding sugar to see if it will float.
12. Keep repeating steps 7-9, until the egg does start to float. After the egg starts to float (and DO NOT mention this will happen, let the children make this observation), make a note of the number of ½ teaspoons of sugar it took to get the egg to float.
13. Continue adding ½ teaspoons of sugar and stirring the water to dissolve it. Once the children notice the egg is floating higher in the water, you can stop.

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Children should notice…

- the water stays clear when adding sugar. It does not get hazy like when you added salt to water.
- the egg does not start to float after the same number of ½ teaspoons of sugar are added compared to salt. It takes more ½ teaspoons of sugar to make the egg float than salt. (DO NOT tell children we expect this to happen. Let them observe this on their own. Make a note about how many ½ teaspoons of sugar you added to get the egg to just start floating so they can make this comparison.)
- after more sugar is added to the water, the egg will float higher in the water.

Differentiating Developmentally Appropriate Practice

For younger children, you could simply do the above experiments qualitatively. That is to say, just add salt to fresh water and stir until the egg floats. Then repeat the experiment with sugar until the egg floats. Still have them make predictions, notice, and wonder, but the quantitative data collection can be skipped.

Extensions for Additional Learning

As always, ask the children throughout the experiment what they notice and what they wonder. If their wonder questions are testable, as much as possible and within reason, let them actually test their questions by trying new experiments.

See below for examples of what they might wonder and experiments they might do to test their wonderings.

- I wonder what would happen if we tried this with a hard-boiled egg?
  - Let them try it! Hard boil some eggs and repeat the experiments. Be sure they make a prediction about whether or not the hard-boiled egg will sink for float. When you are done, have them compare what was the same and what was different when they used a hard-boiled egg compared to a fresh raw egg.
- I wonder if a fresh egg would sink for float in… [you name the liquid – apple juice, soda, milk, etc]?
  - If you have the liquid on hand, let them try it out. Be sure to have them make a prediction beforehand and tell you why they made that prediction. Do not confirm or make your own prediction. This would be a great time to say you do not know if they are right or wrong, if it is true that you really don't know. This models that you are learning something new with them. Then, try the experiment and observe what happens.
- I wonder if adding baking soda [or brown sugar or powdered sugar or sea salt] to water would make the fresh egg float?
  - Let them try it! Repeat the experiment using a different powder. When you are done, have them compare what was the same and what was different when they used salt and sugar.

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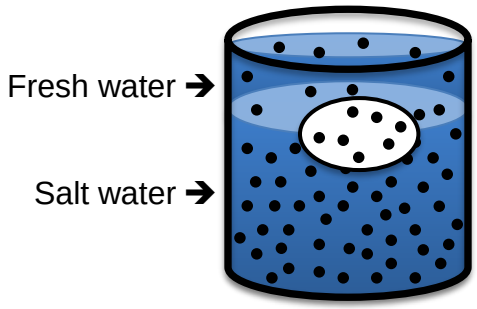
Bonus Experiment: Once you get the egg to float on really salty water, you can tip the glass a bit and gently pour fresh water into the top of the glass. The fresh water, which is less dense than the salt water and the egg, will float on top of both. Now the egg will be suspended in the middle between the fresh water and the salty water.



SAFETY CONCERNS

- Be sure to always wash your hands after handling uncooked eggs because they may carry salmonella.

AZ Early Learning Standards

Science Standard - Strand 1: Inquiry & Application - Concept 1: Exploration, Observation & Hypotheses
The child observes, explore, and interacts with materials, others, and the environment.

Science Standard - Strand 1: Inquiry & Application - Concept 2: Investigation
The child researches their own predictions and the ideas of others through active exploration and experimentation.

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Density: Salty and Sweet

What the heck? Explanation of the Science (Vocabulary in bold.)

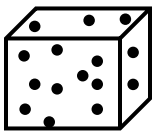
These phenomena can all be explained using density. What is density? Technically, **density** is the ratio of an object's **mass** to its **volume**. **Mass** is the amount of matter in an object. **Volume** is the size of the object.

IMPORTANT NOTE: Mass is not the same thing as the weight of an object. **Weight** is the **force** (pull) due to **gravity** on an object. For example, your mass (the amount of matter you are made up of) would not change if you were standing on the Moon's surface. However, your weight would change (it would be less) because the strength of gravity on the Moon is less than the strength of gravity on Earth. It should also be noted that the weight of an object does not determine whether it sinks or floats in a fluid. **Fluid** is a term used to describe either a gas or a liquid. So, air (a **gas**) is a fluid and water (a **liquid**) is a fluid. The density of an object compared to the density of the fluid it is in determines whether it will sink or float. More on this below.

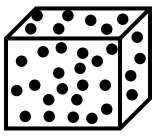
In equation form: $$density\ (\rho) = \frac{mass\ (m)}{volume\ (V)}$$

Density is a measure of how much matter is packed into an object. You cannot easily compare the density of two **solid** objects unless they are both the same mass or both the same volume (size).

Two solid objects with the same volume but different masses.



Less Dense



More Dense

If two solid objects are the same size, as shown above, then the one with less mass is less dense. The object with more mass packed into the same volume is more dense. The more matter packed into a certain volume or object, the greater its density. If it has less matter packed into a certain volume, then it is less dense.

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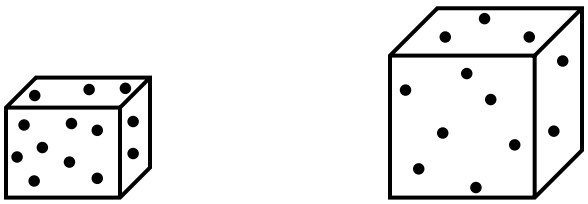
Two solid objects with the same mass but different volumes.



More Dense Less Dense

If two solid objects have the same mass, as shown above, then the one with a smaller volume is more dense. The object with the same amount of matter spread throughout a larger volume is less dense. If an amount of mass is packed into a smaller volume, the density is greater than the same mass packed into a larger volume.

So, what determines if a solid object will **sink** (fall to the bottom) or **float** (rise to the top) of a fluid?

Here is the rule:

A solid object will **SINK** if it is MORE DENSE than the fluid it is in.

A solid object will **FLOAT** if it is LESS DENSE than the fluid it is in.

Video Lesson: https://bit.ly/SciShowKidsSinkFloat

NOTE: An object DOES NOT sink or float because it is lighter or heavier. The weight of an object DOES NOT determine if it will sink or float. The object's density compared to the fluid it is in, as noted in the rule above, is what determines if it will sink or float. Just because an object is heavy, or weighs a lot, does not mean it will sink. Think about a big ship, which weighs a lot, and still floats. It floats because it is less dense than the water it is in. Just because an object is light, or weighs a small amount, does not mean it will float. Think about a small pebble, which weighs just a little, but will sink when placed in water. The small pebble sinks because it is more dense than the water. **PLEASE be careful to reference density and not weight when describing why something sinks or floats.**

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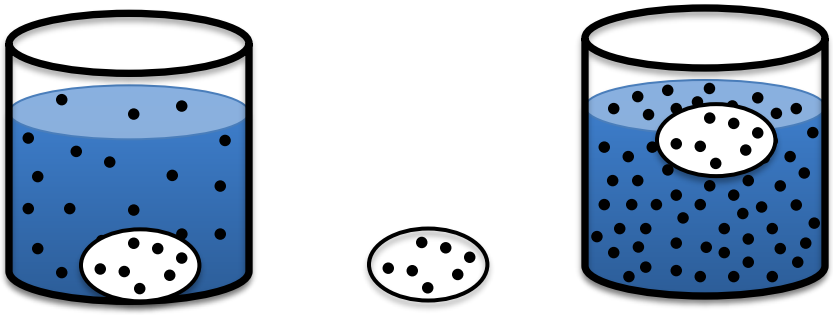
What the heck? Explanation of Salty and Sweet Experiments

You will put an egg in fresh water and it will sink. We know from above the egg will sink because it is more dense than the water, as shown below on the left.



Egg sinks in fresh water | Egg | Egg floating on salt or sugar water

As you add salt or sugar to the water, it dissolves and fills in spaces between the water molecules. This extra mass added to the same volume of water, makes it more dense. If you add enough salt or sugar, the salty/sugary water will eventually have a density greater than the density of the egg. When you reach that point, the egg will float. The egg is now less dense than the salty/sugary water so it will float.

If you continue to add even more salt or sugar after the egg is floating, it continues to make the salty/sugary water even more dense. This causes the egg to float even higher on top of the salty/sugary water. The closer the density of the egg is to the salty/sugary water the lower it floats on top. The bigger the different between the egg's density and the denser salty/sugary water's density, the higher the egg will float on top – more of it will be exposed above the surface of the water. The ability of an object to float on top of a fluid is called **buoyancy**.

It will take more ½ teaspoons of sugar than salt to make the egg float in a cup of water. A ½ teaspoon of normal table salt has a mass of about 10 grams while a ½ teaspoon of sugar has a mass of about 6.5 grams. It takes more ½ teaspoons of sugar than salt to get the egg to float because it takes more sugar to add the same amount of mass to the water. Adding more mass dissolved within the water, without changing the volume of water, means more mass is packed into the same volume. More mass in the same volume, as discussed above, increases the density of the salty/sugary water. The more salt and sugar you add, the more the density of the salty/sugary water increases.

If you are having different groups of children explore these phenomena using different fresh eggs, you might find it takes two ½ teaspoons of salt and four ½ teaspoons of sugar to get one egg to float in the cup of water. Then, a different egg might take seven ½ teaspoons of salt to float and thirteen ½ teaspoons of sugar to float. You are not doing the experiment wrong when you get different results like this. Remember, eggs do not all have the same starting density. So, some will take more and some will take less salt or sugar to get them to float. The ratio of salt to sugar should be about 1:2. So, in

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general, if it takes three ½ teaspoons of salt to get the egg to float, it will likely take close to six ½ teaspoons of sugar to get it to float. Some older students might notice this if they have data from multiple eggs. *(Thank you to Colton, Jace, Jillian, and Joy for exploring these phenomena and contributing to this explanation.)*

Children will notice the salty water starts to look a hazy white color and the sugary water remains clear. Table salt has an anti-caking agent in it to absorb humidity. This keeps the salt from clumping. These agents are not **soluble** (do not dissolve in water). Instead of dissolving, they wind up **suspended** (floating) throughout the water. Sugar does not have these anti-caking agents. This difference explains why the salty water is hazy and the sugary water remains clear. You can find the anti-caking agent listed on the side of the salt when you buy it. Generally, the anti-caking agent used in salt is either sodium aluminosilicate (most common) or calcium silicate.

(Thank you to Zeke Kossover, educator at the Exploratorium, for his help with the explanations above.)