Student STEM Notebook:

This is a STEM notebook that will be your guide for the week. You can print this and write in the spaces provided. Also included are the printed words to cut for the experiment on day 2.

Each day you will explore STEM tasks as a scientist. You will have the opportunity to show what you know on day 4. The STEM notebook will be a great resource to use as you plan to demonstrate what you know on day 4.

We hope you will join us for STEMXpress summer edition.

Table of Contents:

Day 1: Light Scattering / Refracting: Sunset in a cup of milk.

Answer the questions below:

What do scientists do?

_____

_____

What skills do scientists need?

_____

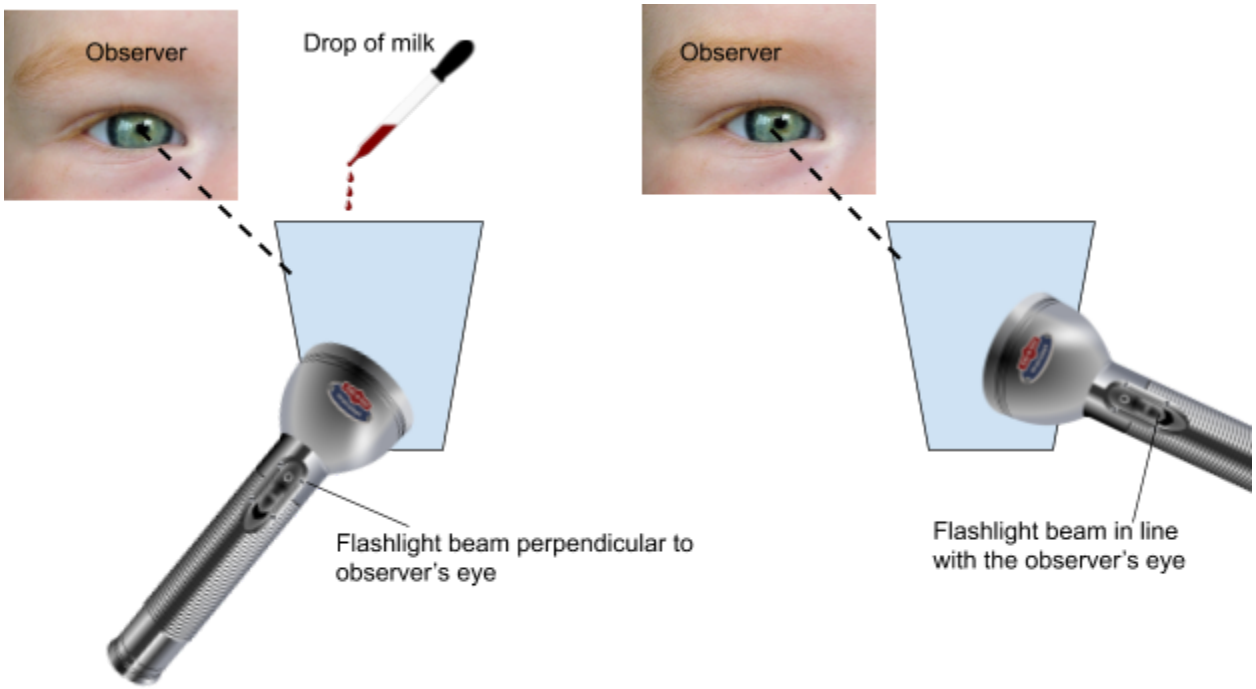
_____

Step 1: Observing and Questioning

Before we begin the experiment make sure that you are prepared to record your observations. In addition, you may write down anything that you are wondering about or any predictions you have.

What did I observe? (What do you notice about the object or event? Use your senses to describe the object or event)	**What am I wondering?** (What questions or predictions do you have about the object or event?

How can we create a sunset in a cup of milk?
Label Diagram (Illustration or Picture):



In your STEM notebook, reflect on the following questions or tasks.

1. Draw an illustration of the experiment that you performed in your notebook. Label your drawing. Use this drawing and labels to help explain the questions below.

Reflection questions:
Draw or illustrate the experiment in the box provided. Label the illustration. Use this labeled illustration in your explanations below.

1. What made the color of the light change?

2. What purpose does the milk have in the experiment?

- If the water were the earth's atmosphere and the flashlight were the sun, what can the milk droplets be equated with?

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- Which of the colors do you think are refracted most?

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- Which of the colors do you think are refracted least?

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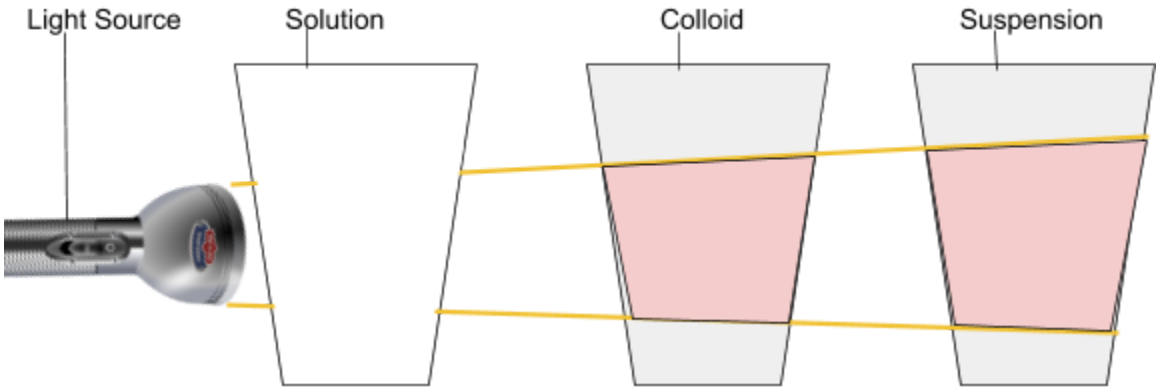
Reading: Why is the sky blue? Why can you see further underwater in a pool than you can in a lake or an ocean? Why can you see distant objects clearly on some days, and on other days, they are shrouded in a haze?

In this experiment, when you looked through the glass you may have seen the same orange and red pattern of colors that you can see when the sun goes down at sunset. If you set up the experiment correctly, you created the same physics in a cup that you can see at sunset.

Light travels in a straight line. Some objects scatter light while others do not. In the experiment light was **scattered**. When light scatters off of an object the light acts like a little marble. The different colors of light all bounce off of the large object at the same angel. This type of scattering is called geometric scattering and is the type of scattering that we see most often in our everyday lives.

White light consists of all visible colors. Shining white light on an object that is much bigger than the wavelength of the light will cause all of the different colors to all reflect at the same angle. The color patterns in the milk are the same physics that causes sunsets and blue skies. In addition, color patterns in flour and water will look similar to the milk. In the diagram below you can see the light source shining through the water, milk, and flour - water mixtures. The light beam is not visible in the water but is visible for the milk and the water-flour mixture.



Example:	Water	Milk	Four and Water
Light Beam:	Not Visible	Visible	Visible

Tyndall Effect-
The Tyndall Effect is the **Scattering** of light by particles in a colloid or suspension

Refraction is the bending of light when entering the eye to form an image on the retina. An example of refraction is the bending of the sun's rays as they enter raindrops, forming a rainbow. Milk is a liquid that is made up of protein-coated particles suspended in water. These particles are small enough to create scattering. Shining a light through a glass with milk you are able to see the same color effects as you see in the sky at sunset.

Increasing the milk droplets in the water is like increasing the water and dust particles in the atmosphere. When the sun moves to the west approaching sunset, the atmosphere through which we are looking is much thicker. This means we are actually looking through more dust and water particles.

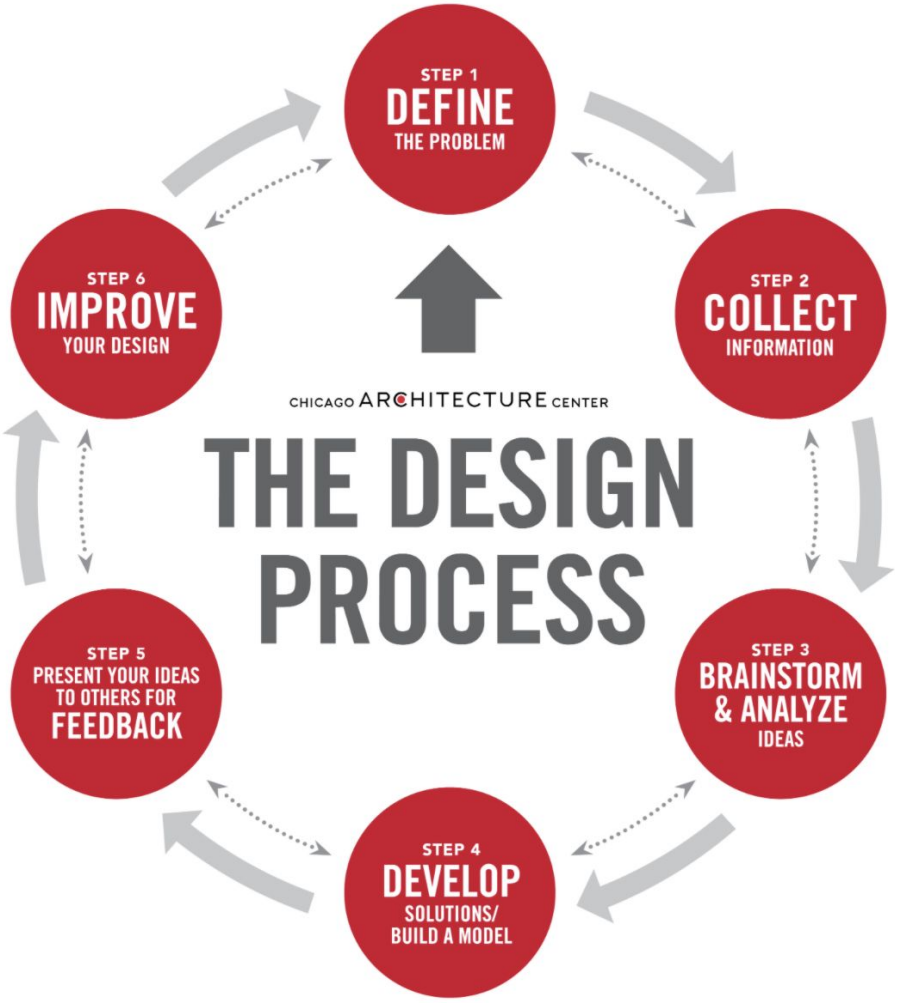
When we look to the west during sunset, we look directly into the sun rays, seeing the sun as a red ball. Looking up towards the sky when the sun is in the west, still leaves the sky blue. The sun rays are now perpendicular to the direction of our view. This difference in color is caused by the refraction of the blue light. The shorter the wavelength (blue), the more it is bent or refracted by milk droplets. This light with the longer wavelength (red) is not as much refracted and this is why the light from the flashlight is red when we look directly into it (though the beaker with milk).

Take a clear glass cup with a smooth surface and fill it almost to the top with water. Next, add milk to the cup one drop at a time. After adding each drop, mix everything together and look at a bright light bulb through the cup. Keep adding the drops of milk until the light bulb appears red or orange when viewed through the cup. You have a sunset in a cup. To heighten the effect, do this at night with all the lights turned off except the one light bulb you are looking at through the cup. Next, position yourself so that you are looking at the side of the cup relative to the line connecting the cup and the light bulb. You now see a blue color. Presto! You have the daytime sky in a cup.

Do the solid additives scatter light equally in all liquids?

THOUGHTS TO PONDER:
On day four of this week, you will have the opportunity to show what you know. Will you be able to explain how you created sunset in a cup? Will you show what you know using another experiment example? How will you show what you know about how light scatters in liquids?

Optional Extension:
(Part 1) What is the design process? Why is it helpful?



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- Step 2: Collect information: Collect sketches, take photographs and gather data to start giving you inspiration.
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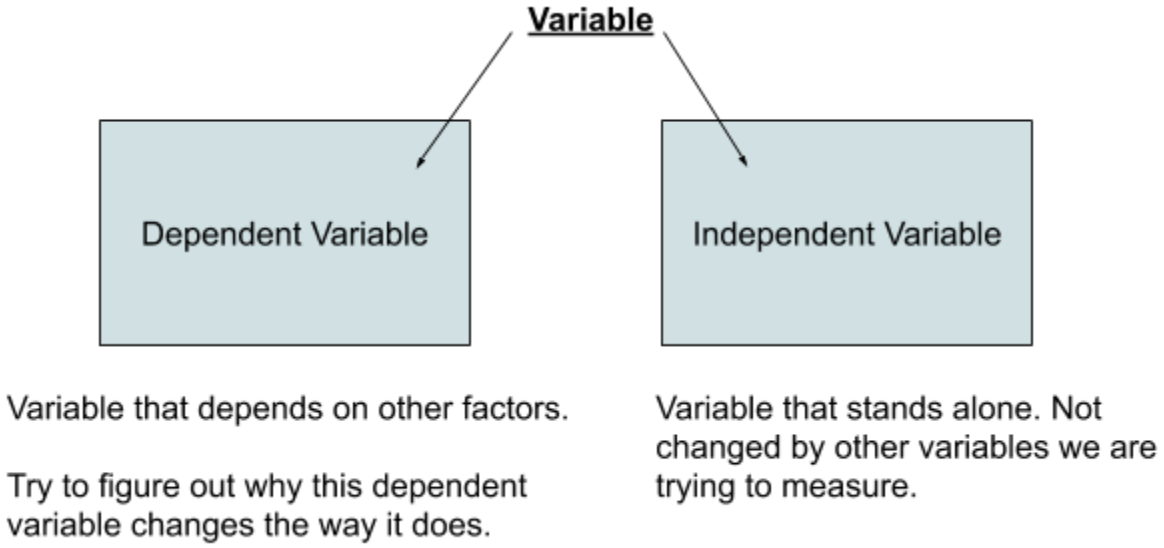
- Step 4: Develop solutions: Take your preliminary ideas and form multiple small-scale design solutions.
- Step 5: Gather Feedback: Present your ideas to as many people as possible, friends, teachers, professionals, and any others you trust to give insightful comments.

- Step 6: Improve: Reflect on all of your feedback and decide if or to what extent it should be incorporated. It is helpful to take solutions back through the Design Process to refine and clarify them.

Optional Extension Activity (Part 2):
Vocabulary: What is a **variable**? A **variable** is an object, eent, idea, feeling, time period, or any other type of category you are trying to measure. There are two different types of variables. The two different types of variables are independent variables and dependent variables.



Student: Use the design process to determine what other mixtures, solutions, or substances scatter light.

You will be given oil, corn syrup, milk, baking soda, sugar, food coloring, flour. How could you design an experiment to explore this further? You can use the design process worksheet to record your thoughts.

Reflection Questions:

- What would happen if the water was replaced with milk? As the solution is slowly poured into the glass, shine your flashlight up through the bottom. What happens to the light when more liquid is poured in?
- What would happen if the water was replaced with corn syrup? Does the syrup make the light scatter?
- What would happen if the water was replaced with cooking oil? How does the oil affect the light?
- What if you take a glass of water and replace the milk drops with flour? How does the flower affect the light?
- What if you take a glass of water and replace the milk drops with sugar? How will sugar affect the light?

- Are there other experiments you are able to conduct? Make sure you record your experiments and your results!

Planning the Experiment
What will I change?
One variable I will change:

I WILL MEASURE OR OBSERVE THE RESULT

Independent Variable

Dependent Variable

What will I not change?
What conditions will be held constant so it is a fair test?

Controlled Variable

Controlled Variable

Controlled Variable

Controlled Variable

Experiment Design and Perform
What is the question I want to explore?

If I change Independent Variable What will happen to Dependent Variable

compared to the control?

What is my hypothesis (what and why)?
Based upon my question, I predict that:

If the _____ is _____
Independent variable — how the independent variable will be changed (increased or decreased, heated or cooled, moved)

Then the _____ will _____
Dependent variable — how the dependent variable will be affected (increased or decreased, heated or cooled, moved)

I think this will happen **because** _____

_____

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Day 2 Light Reflection: Funny Reflections

Today you will find out how light reflects. Remember to use your senses when you complete this experiment.

LIst what are the senses that scientists use when they observe:

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Step 1: Observing and Questioning
Before we begin the experiment make sure that you are prepared to record your observations. In addition, you may write down anything that you are wondering about or any predictions you have.

What did I observe? (What do you notice about the object or event? Use your senses to describe the object or event)	**What am I wondering?** (What questions or predictions do you have about the object or event?

Vocabulary:
Symmetry: the quality of being made up of exactly similar parts facing each other.
Reflectional symmetry: is also called bilateral, line symmetry or mirror symmetry. It occurs when a line is drawn to divide a shape in halves so that each half is a reflection of the other.

How can we create reflectional symmetry with letters and words?
Label Diagram (Illustration or Picture):

In your STEM notebook, reflect on the following questions or tasks.

Draw an illustration of the experiment that you performed in your notebook. Label your drawing. Use this drawing and labels to help explain the questions below.

Procedure:

1. Print the following words on separate pieces of blank paper in large even capital letters. You may wish to use a sharpie black marker to print the words.

   CHEEK, BIKE, DECIDE, BOX, CHICK, CHOKE, BOOK, HIDE, CODE, DOCK, COOKIE

2. Cut each piece of paper in half, right through the middle of each word. Leaving the lower half of the word on the paper.

3. Now place the mirror vertically against the paper (perpendicular on the table) and look in the corner of the paper and the mirror.
4. Do this for each one of the words

Questions:

1. Will this experiment work with any printed word? How do you know?

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2. Which of the letters, when cut in half, will appear whole with the mirror above it?

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3. Which of the letters, when cut in half vertically, will give the other half in the mirror, when the half letter is held against it?

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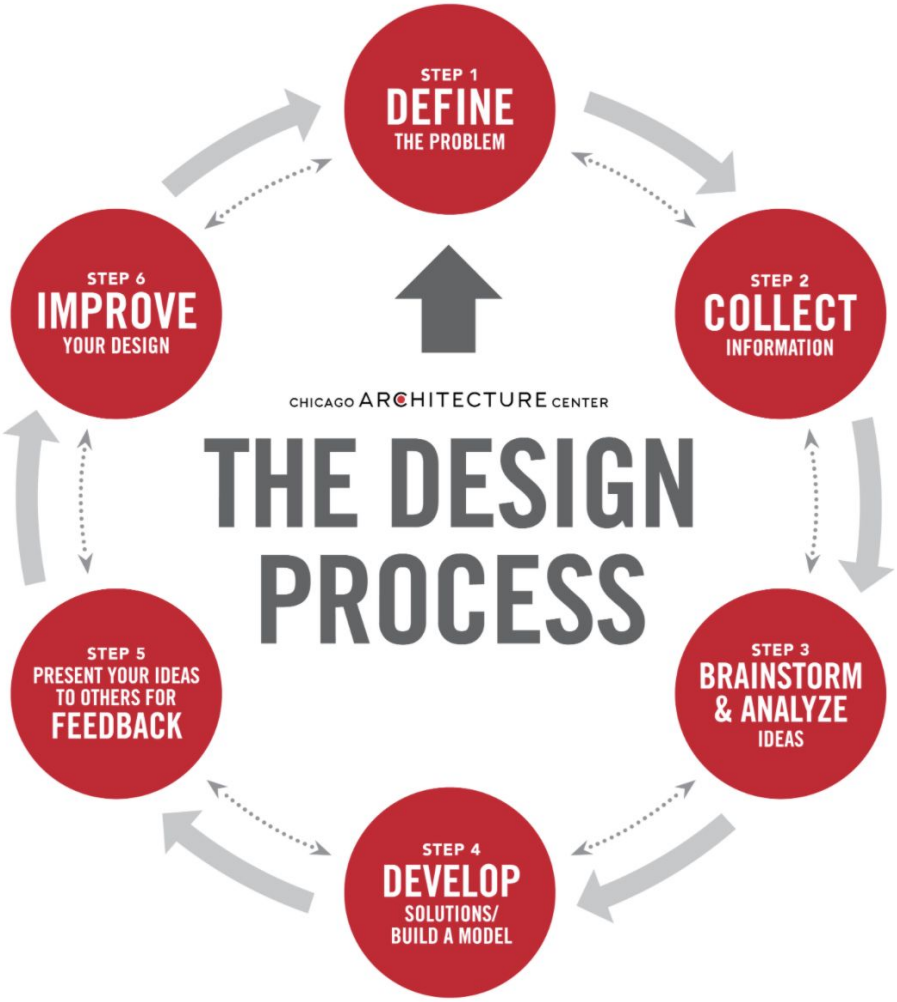
Reading:
When you look into a mirror the image you see is called a **reflection**. A reflection is the production of an image through a mirror. Light and sound are also able to be reflected. Have you heard an echo or sound waves reflected from a surface? Have you ever had to put on sunglasses near a lake because the sunlight was being reflected from the surface of the water? This experiment explores reflection by holding part of the word up to a mirror and looking at the reflection. Some of these words looked complete in the reflection while others looked like nonsense. What caused this?

Another concept that is explored in this experiment is called **symmetry**. **Symmetry** is made up of exactly similar parts facing each other. When you held up words into the mirror, were some of the words symmetrical, or exactly the same in the reflection in the mirror? Yes! Some objects are **symmetrical.**

In this experiment some of the words that you looked at demonstrated **reflectional symmetry**. Reflectional symmetry occurs when a line is drawn to divide a shape or a word in halves so that each half is a reflection of the other. Some of the words demonstrated reflectional symmetry while other words did not demonstrate reflectional symmetry. Some shapes will also demonstrate reflectional symmetry while others will not? Which shapes demonstrate reflectional symmetry? Shapes are circle, square, rectangle, triangle, rhombus, heptagon, parallelogram, hexagon, star, heart, cross, scalene triangle, right triangle, crescent (and others).

THOUGHTS TO PONDER:
There are more than one line of symmetry in some shapes or objects such as circles, squares and triangles. On day 4 of this week you will show what you know. Will you be able to explain

reflectional symmetry? Will you show what you know using a shape or an object? How will you show what you know from the experiment on day two?
Optional Extension:
(Part 1) What is the design process? Why is it helpful?



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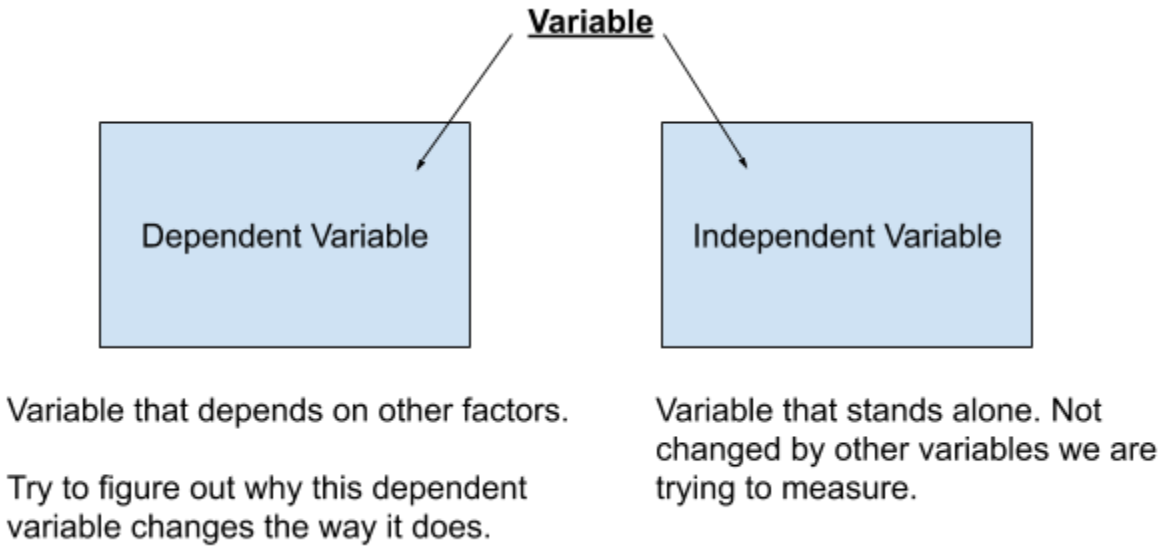

Student: Use the design process to determine what other shapes or objects show reflectional symmetry.

You will be given a variety of paper shapes. Shapes are circle, square, rectangle, triangle, rhombus, heptagon, parallelogram, hexagon, star, heart, cross, scalene triangle, right triangle, crescent (and others). How could you design an experiment to explore this further? You can use the design process worksheet to record your thoughts.

Student Reflection Questions:

- What shapes show reflectional symmetry? How do you know?
- What objects show reflectional symmetry? How do you know?
- Some shapes or objects, such as circles, squares and triangles, have one or more lines of symmetry. How do you know?

Planning the Experiment

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One variable I will change:

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I think this will happen **because** _____

Day 3: Characteristics of Matter - Density: Float the egg with salt

Today you will learn about water density. Remember to use your senses when you complete this experiment.

Before we begin, what do you think will happen to an egg in a glass of water? Do you think it will float? Why or why not?

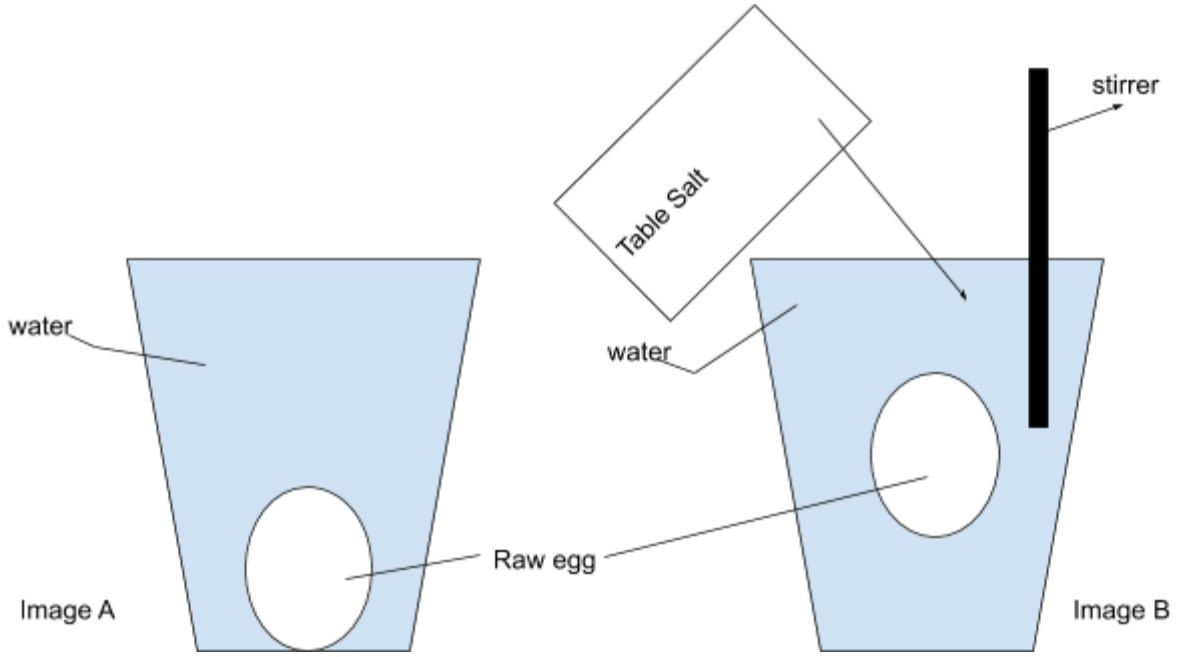
_____

_____

Step 1: Observing and Questioning
Before we begin the experiment make sure that you are prepared to record your observations. In addition, you may write down anything that you are wondering about or any predictions you have.

What did I observe? (What do you notice about the object or event? Use your senses to describe the object or event)	**What am I wondering?** (What questions or predictions do you have about the object or event?

Vocabulary:
Density: The ratio of its mass (m) to its volume (V), a measure of how tightly the matter within it is packed together.
Mass: How much matter there is in an object.



Step 2:

In your STEM notebook, reflect on the following questions or tasks.

Draw an illustration of the experiment that you performed in your notebook. Label your drawing. Use this drawing and labels to help explain the questions below.

Step 3:
Reflection Questions:

1. Compare the two glasses. Why does one egg stop in the middle of the glass?

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2. What would the density of the raw egg be compared to pure water?

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3. What are we comparing, when we want to know whether an object will float in a particular liquid or not?

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4. Would an egg float in alcohol? In corn syrup? In oil?

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5. How can we determine the volume of an egg?

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_____

6. How can we calculate the density of an egg?

_____

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_____

_____

Reading:
From the behavior of the egg in water, it can be seen that the density of the raw egg is a little larger than that of pure water. It can actually be determined by weighing the egg and finding the volume of it by measuring the displayed water (the difference between the water levels), and by dividing this volume into the mass (weight) of the egg.

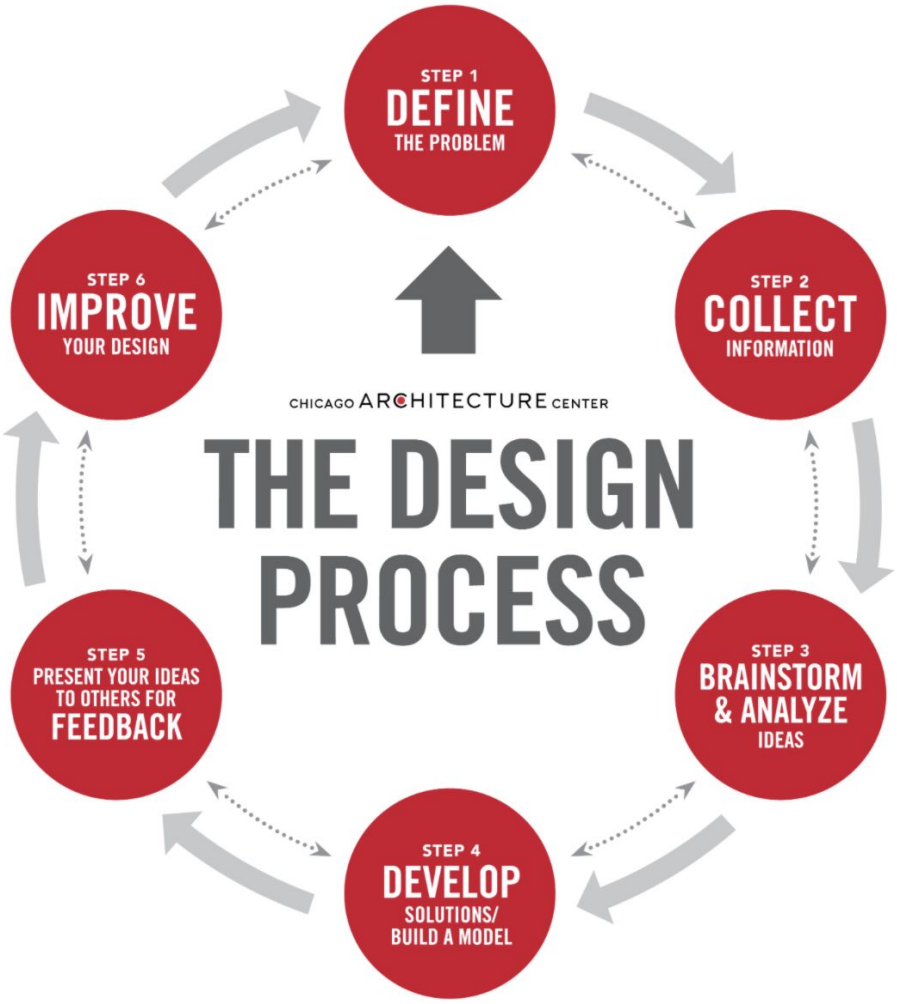
By adding the salt to the water, the density of the water is increased. The mass of the displaced water is therefore also increased, and as this mass equals the buoyant force, the egg gets a larger force acting upwards upon it, and thus at a certain moment floats up. At this moment, the buoyant force is equal to the egg's mass. For this same reason, it is much easier to swim in sea water compared to fresh water.

Thoughts to Ponder:

Other chemicals may affect water density. On day 4 of this week you will show what you know. Will you be able to explain density and mass? Will you show what you know using other substances added to water? How will you show what you know from the experiment on day three?

Optional Extension:

(Part 1) What is the design process? Why is it helpful?



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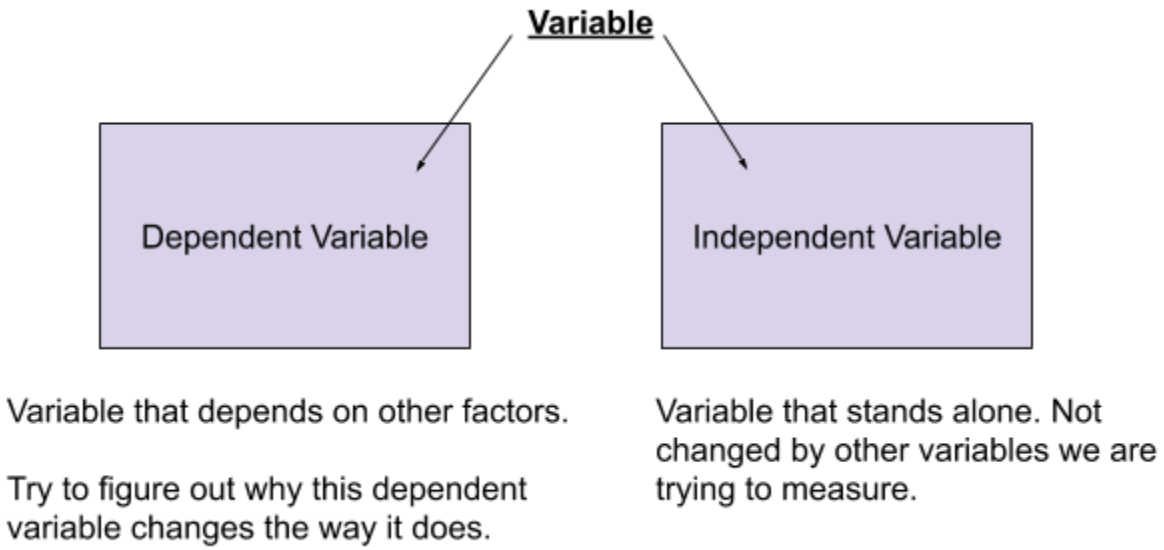

Student: Use the design process to determine what other substances affect water density. How could you design an experiment to explore this further? You can use the design process worksheet to record your thoughts.

Student Reflection Questions:

- How do substances added to water affect water density? How do you know?
    a. Add sugar, corn syrup, baking soda, (other)

Planning the Experiment

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One variable I will change:

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Dependent Variable

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Experiment Design and Perform
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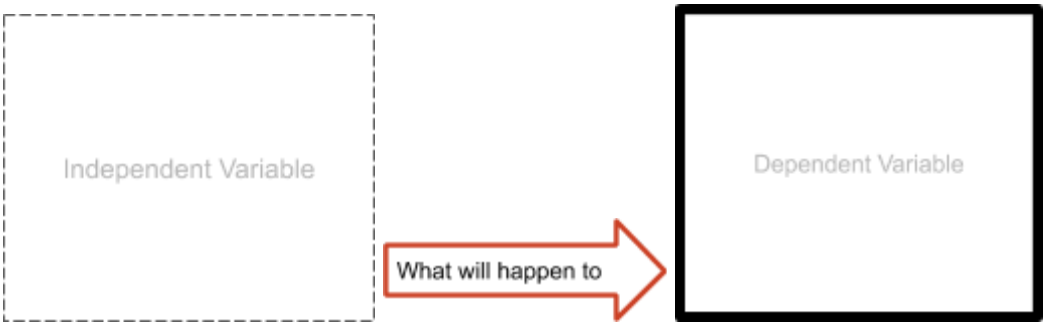
If I change 

compared to the control?

What is my hypothesis (what and why)?
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I think this will happen **because** _____

_____

_____

_____

_____

_____

Day 4: Show what you know

Congratulations you have made it to day four. This is a special day, because today you show what you know! Use this choice board and submit the evidence on Flipgrid.

Flipgrid link: https://flipgrid.com/f8e837a2 or scan the

New to Flipgrid? No problem! Check out this cheat sheet here to get started.

Resources:

Liem, T. L., (1987) Invitations to science inquiry (2nd ed.). Lexington, MA: Ginn Press.
Make an Egg Float: https://www.youtube.com/watch?v=3nJ5R6baL90
Scatter Light Experiment: https://sfa.cems.umn.edu/light-refraction-experiment
Sunset in a Cup Experiment:
https://wtamu.edu/~cbaird/sq/2015/09/23/can-you-make-a-sunset-in-a-cup-of-milk/
Design Process: https://discoverdesign.org/handbook
Day 2 Printed words: Print the pages. Use scissors to cut the word on the red dotted line.

CHEEK

BIKE

DECIDE

BOX

CHICK

CHOKE

BOOK

HIDE

CODE

DOCK

COOKIE