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| **Lesson Title :** Framing the Problem | **Unit #:****1** | **Lesson #:****1** | **Activity #:****1** |
| **Activity Title:** Introduction to Big Idea |

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| **Estimated Lesson Duration:** | 9 days |
| **Estimated Activity Duration:** | 3 days |

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| **Setting:** | Classroom |

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| **Activity Objectives:** 1. Students will be able to identify a negative effect of metal in water.
2. Students will be able to make an evidence-based claim about water quality.
3. Students will be able to make a claim about how contaminated water affects life.
4. Students will be able to identify the steps of the engineering design process.
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| **Activity Guiding Questions:**1. How does consuming metal affect living things?
2. How do molecules in water interact with cells and living organisms?
3. How can I find out if water is safe to sustain life?
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| **Next Generation Science Standards (NGSS)**  |
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| **Science and Engineering Practices (Check all that apply)**  | **Crosscutting Concepts (Check all that apply)** |
| [x]  Asking questions (for science) and defining problems (for engineering) | [ ]  Patterns |
| [x]  Developing and using models | [x]  Cause and effect |
| [x]  Planning and carrying out investigations | [ ]  Scale, proportion, and quantity |
| [x]  Analyzing and interpreting data | [ ]  Systems and system models |
| [x]  Using mathematics and computational thinking | [ ]  Energy and matter: Flows, cycles, and conservation |
| [x]  Constructing explanations (for science) and designing solutions (for engineering) | [ ]  Structure and function.  |
| [x]  Engaging in argument from evidence | [x]  Stability and change.  |
| [x]  Obtaining, evaluating, and communicating information  |  |

| **Ohio’s Learning Standards for Science (OLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| [ ]  Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| [x]  Demonstrating Science Knowledge **(D)** |
| [x]  Interpreting and Communicating Science Concepts **(C)** |
| [x]  Recalling Accurate Science **(R)** |

| **Ohio’s Learning Standards for Math (OLS) and/or** **Common Core State Standards -- Mathematics (CCSS)** |
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| **Standards for Mathematical Practice (Check all that apply)** |
| [x]  Make sense of problems and persevere in solving them | [x]  Useappropriate tools strategically |
| [x]  Reason abstractly and quantitatively | [ ]  Attendto precision |
| [x]  Construct viable arguments and critique the reasoning of others | [ ]  Look for and make use of structure |
| [ ]  Model with mathematics | [x]  Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, OLS and/or CCSS):** |

**Ohio’s New Learning Standard: Science Inquiry and Application (p. 228):**

During the years of grades 9 through 12, all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas:

* Identify questions and concepts that guide scientific investigations;
* Design and conduct scientific investigations;
* Use technology and mathematics to improve investigations and communications;
* Formulate and revise explanations and models using logic and evidence (critical thinking);
* Recognize and analyze explanations and models;
* Communicate and support a scientific argument

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

1. Copper chloride ([Link](https://www.carolina.com/specialty-chemicals-b-c/cupric-chloride-dihydrate-laboratory-grade-500-g/856440.pr?question=copper+chloride+blue))
2. Engineering Design Process (1.1.1c)
3. Brine Shrimp Worksheet (1.1.1a)
4. Brine Shrimp Data Sheet (1.1.1b)
5. Water testing strips ([Link](https://www.amazon.com/Drinking-water-test-strips-MHT/dp/B073X3NZRS/ref%3Dsr_1_3?ie=UTF8&qid=1513802378&sr=8-3&keywords=water+testing+strips))
6. Cell Organelle Matching Worksheet (1.1.1d)

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| **Teacher Advance Preparation:** |

**Day 1**

Create six stations around the room, each station with the following materials:

*Station 1:* A picture of Flint, Michigan water ([Picture](https://rampages.us/smithjc27/wp-content/uploads/sites/16553/2016/05/flint-water-top-compressed.jpg))

*Station 2:* A sample of muddy pond water contained inside a water bottle

*Station 3:* A picture of an African child scooping water from a stream ([Picture](https://s-media-cache-ak0.pinimg.com/originals/b5/fb/23/b5fb23c0a61a6c1d4a9db9ba83ae4bd1.jpg))

*Station 4:* A picture of a ship dumping oil into the ocean ([Picture](http://worldmaritimenews.com/wp-content/uploads/2015/02/WWF-Pushes-to-Stop-Dumping-at-Great-Barrier-Reef.jpg))

*Station 5*: Dark water coming out of a pipe into a river ([Picture](http://caribbeannewsservice.com/now/wp-content/uploads/2016/12/water-pollution.jpg))

*Station 6:* A picture of trash in a water source near homes ([Picture](http://www.worldofmatter.net/files/styles/flexslider_full/public/content/slideshows/EK_CBG_01/ek_cbg_environmental_006.jpg?itok=haTh8VnD))

**Day 2**

Prepare five water samples for each group.

*Sample 1*: Tap water

*Sample 2*: Pond water

*Sample 3*: Water with dissolved lead (use chemistry teacher’s chemicals)

*Sample 4*: Water with dissolved copper (1 mg/L) (using copper sulfate, place 1 g in 1000 mL)

*Sample 5*: Salt water (120 mg/L)

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| **Activity Procedures:** |

**Day 1: Introducing the Big Idea**

1. Break students into groups of three (heterogeneous grouping) and provide each individual

student with a packet of post-it notes.

1. Create six stations around the room, each station with the following materials:
	1. *Station 1:* A picture of Flint, Michigan water ([Picture](https://rampages.us/smithjc27/wp-content/uploads/sites/16553/2016/05/flint-water-top-compressed.jpg))
	2. *Station 2:* A sample of muddy pond water contained inside a water bottle
	3. *Station 3:* A picture of an African child scooping water from a stream ([Picture](https://s-media-cache-ak0.pinimg.com/originals/b5/fb/23/b5fb23c0a61a6c1d4a9db9ba83ae4bd1.jpg))
	4. *Station 4:* A picture of a ship dumping oil into the ocean ([Picture](http://worldmaritimenews.com/wp-content/uploads/2015/02/WWF-Pushes-to-Stop-Dumping-at-Great-Barrier-Reef.jpg))
	5. *Station 5*: Dark water coming out of a pipe into a river ([Picture](http://caribbeannewsservice.com/now/wp-content/uploads/2016/12/water-pollution.jpg))
	6. *Station 6:* A picture of trash in a water source near homes ([Picture](http://www.worldofmatter.net/files/styles/flexslider_full/public/content/slideshows/EK_CBG_01/ek_cbg_environmental_006.jpg?itok=haTh8VnD))
	7. *Sample 6*: Running water at a facet in the room
2. Instructions to students:
	1. At each station, write one adjective you feel describes your emotions after studying the materials.
	2. Keep the post-it note with you as you move to the next station.
	3. This activity should be silent (no talking during the stations)
3. When students are done studying the pictures, ask the groups to compile their post-it notes and narrow them down into one emotion their group felt about the pictures as a whole.
4. Ask each group to share out their thoughts about the gallery walk activity to the class.
5. Ask students if they think this type of water is found here in the United States?
6. State the big idea for the lesson: Water Contamination (ask students)
7. Show students a video clip about Flint, Michigan water crisis ([Video](https://www.youtube.com/watch?v=nTpsMyNezPQ))
8. Ask students to formulate two essential questions on notecards as a group and give back to the teacher.
9. Collect the notecards and keep for Day 3 lesson.

**Day 2: The Hook**

1. Prepare five water samples for each group.
	1. *Sample 1*: Tap water
	2. *Sample 2*: Pond water
	3. *Sample 3*: Water with dissolved lead using lead nitrate
	4. *Sample 4*: Water with dissolved copper using copper chloride
	5. *Sample 5*: Salt water
2. Tell students that they have been asked to harvest brine shrimp and their goal is to provide these shrimp with the best environment using an evidence-based claim.
	1. Note: Students will not receive the actual brine shrimp, but will engage in this scenario.
3. Show students the water testing strips and discuss the data they will be collecting.
4. Pass out data collection sheet (1.1.1a)
5. Ask students to create an evidence-based claim as to why they chose a particular environment for the shrimp.
	1. For groups that do not complete data collection in time, give students a completed data sheet to analyze during day 3 (1.1.1b)

**Day 3: Data Discussion & Finalize Essential Question**

1. Allow students time to finish data collection and pass out data sheet to analyze (1.1.1b)
2. When all groups are done, have each group share what water source they chose and why to the rest of the class reading their claim.
	1. Possible discussion questions include: a) how would placing brine shrimp in a non-conducive environment affect them, b) how would your choice change if we were placing a gold fish into the environment, and c) how does the water affect cells?
3. While students are collecting data, write six to seven essential questions on the white board.
4. Have students individually read each essential question and then share their top question with a neighbor.
5. Have students break into their lab groups and share out their top question and why.
6. Narrow down the list to one essential question by voting.
7. Introduce students to the Engineering Design Process (EDP) diagram by describing each step (1.1.1c)
8. Conclude class with a class discussion of the EDP and how this process is used in other facets of their lives.
9. Assign the Cell Organelle Matching Worksheet for homework (due tomorrow).

**Formative Assessments:**

* Evidence-based claim written on a small piece of paper
* Essential questions on notecard
* EDP discussion

**Summative Assessments:**

* None

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| **Differentiation:**  |

* None
* Grouping based on the results of a sociogram and personality survey given to each student.
* Supplemental data sheets provided to some students.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson. |

**Day 1**

*Revisions to Lesson*- The gallery walk was done independently and then students got into groups. This allowed students to work at their own pace. After students compiled their post-it notes, students were asked to share out their thoughts.

*Successes*-Day 1 lesson was very successful. Students loved getting out of their seats and looking at the pictures. Making the activity silent was very important because this maximized the attention students gave during the activity. Afterwards, allowing students to discuss the images as a class allowed for a deeper conversation about the societal impacts of water contamination. Ending with the Flint, Michigan news clip was perfect for sparking interest in the big idea.

*Shortcomings*- No shortcomings were noted.

**Day 2**

*Revisions to Lesson-* Since the brine shrimp were not developed by the time the experiment was to be conducted, students wrote an evidence-based claim based about which aquatic environment they believe is most conducive for brine shrimp. Each student group shared out to the class which environment they thought was most suitable and supported with evidence. Questions that were used to guide students include a) how would placing brine shrimp in a non-conducive environment affect them, b) how would your choice change if we were placing a gold fish into the environment, and c) how does the water affect cells? Another revision involved using one water testing strip rather than offering various tools. Using one strip expedited the testing process.

*Successes-* The water pH, copper concentration, and lead concentration was obtainable using the water testing strips. The preparation for this lab went smoothly with the help of the chemistry teacher. Student conversations were thoughtful and scientific.

*Shortcomings-* Actually conducting an experiment with the brine shrimp was not possible due to time constraints. The brine shrimp ended up being a lot smaller than I anticipated and took a very long time to develop. Instead of working with the brine shrimp, students conducted their water tests and developed an evidence-based claim about which environment is most sustainable for brine shrimp. Many students used the internet to learn more about brine shrimp while others browsed through a fact sheet provided with the lab kit. The hypothetical scenario of brine shrimp was effective because it provided a purpose to the water testing.

Another failure includes the water testing strips. The data was not readable on some of the strips and therefore, students were given a mock data sheet to analyze the next day. Students then used this data sheet to develop conclusions (1.1.1b). Lastly, the copper powder that was purchased over the summer did not dissolve in water. The chemistry teacher showed me how to prepare a 1mg/L copper water sample using copper chloride. This was extremely effective and was also used during the design challenge.

**Day 3**

*Revisions to Lesson-* Since I did not ask students to put brine shrimp in their chosen environment and the water testing strips were not entirely effective, students were given a mock data sheet at the start of the lesson (1.1.1b). Students used this data sheet to develop their own conclusions about which environment is most conducive for brine shrimp. When there were discrepancies in claims, I allowed students to debate their thoughts using evidence.

*Successes-* Giving students the mock data sheet was extremely effective. Even though the water testing strips were not the most effective, this activity still gave students a chance to make scientific decisions using data. The second part of the lesson involving the essential questions was also successful. Placing the top questions on the board was effective and allowing students to discuss their top choices allowed for a feeling of autonomy in the decision making process.

*Shortcomings-* Not all students were heard when deciding on an essential question. Allowing students to do a think-pair-share would be more effective. This revision was made in the day 3 lesson above.