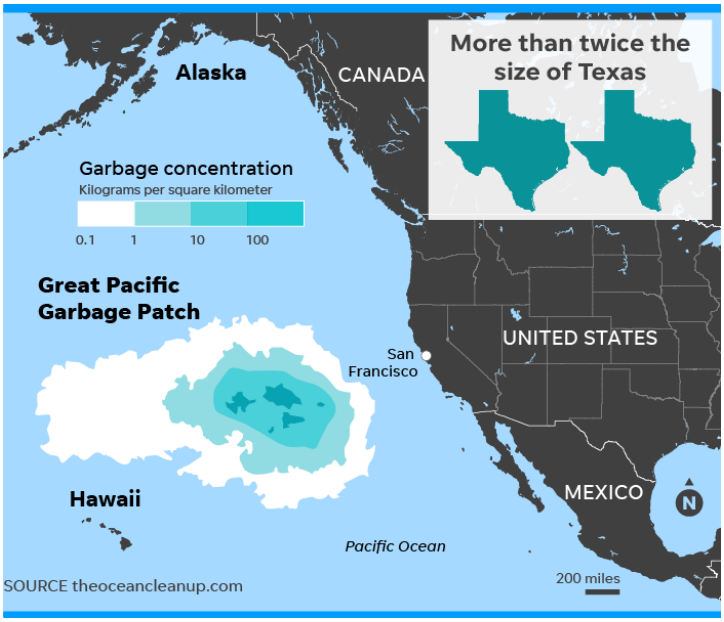
Reclaiming Waste

Floating somewhere between California and Hawaii, there is a large mass of garbage that is growing in size every day.

The Great Pacific Garbage Patch is a huge collection of electronic waste, plastic waste, chemical waste and, many other types of debris, that spans and area almost twice the size of Texas, and that is only including the solid mass of floating plastic.

The giant trash heap was first discovered in the 1970's and is still growing to this day. It's even possible that some of your waste ended up in it too!



How would you explain the term "waste" to someone from another planet?

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Collecting Control Data:

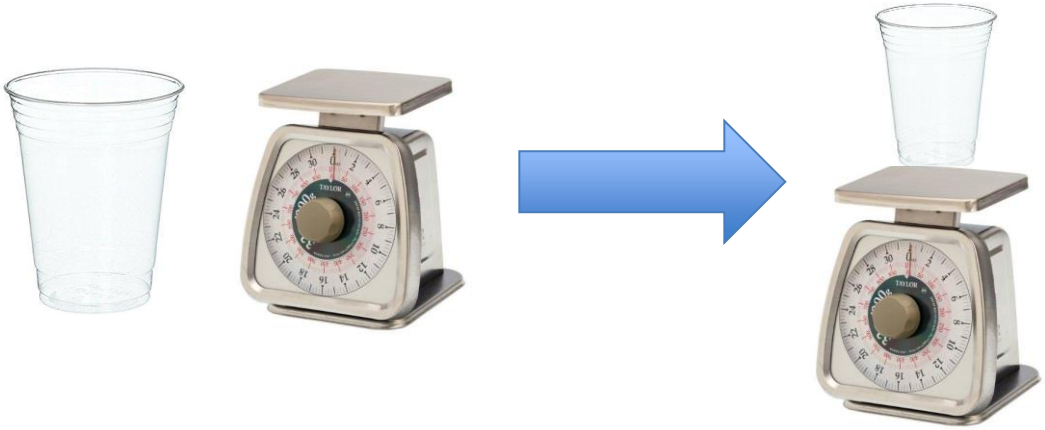
During this activity, we will be weighing the mass of the solution before and after the test in order to find out how much waste we are removing. We do not want to include the weight of the water and cups, so we will need to weigh them and subtract it from the total weight of the solution and the cup.

Materials:

- Scale
- Clear Plastic Cup
- 4 oz of Water

Procedure:

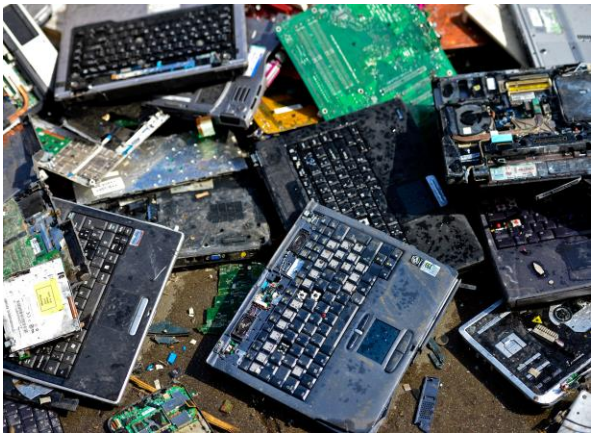
1. Pour the water into the cup
2. Place the cup onto the scale
3. Record the *weight of the cup* in the table below
4. Repeat steps 2 and 3 for 2 more trials and calculate the average



Control Data	Trial #1	Trial #2	Trial #3	Average: (Trial 1+ Trial 2+ Trial 3)/3
Weight of the Cup and Water (grams)				

Experiment #1: Recovering Metals

Setting the Scene:



There is a significant amount of electronic waste in the Great Pacific Garbage patch that contains metals that have a magnetic component. A large amount of metal is discarded in many different forms making it necessary to be able to separate the metals from each other.

Brainstorm:
How would you go about separating out the metals from the waste? Choose one method and think about the pros and cons of it. Doodle your concept below.

What do you think somebody does with the metal once they get them out of the Great Pacific Garbage patch?

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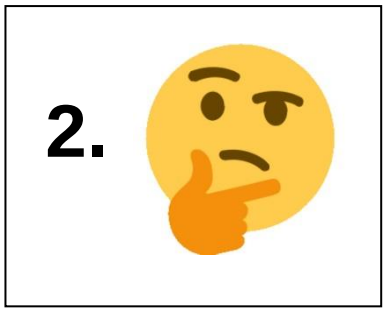
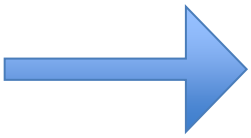
The Set Up:

1. Get a cup of “waste” from your teacher and Start your timer.
2. Record the *weight of the “waste” cup* in the table below.
3. Without putting the magnet inside the cup, find a way to collect the metals in the solution.
4. Repeat your method a few times until there is no longer a reaction to the magnet.
5. Stop the timer and record the *total amount of time* it took to remove all magnetic metals in the table below.





Be sure to time how long it takes to remove all magnetic metals and record in the table below.

Collecting Data:

Record your data in the table below

Test #3: Magnetic Separations	Trial 1	Trial 2	(Trial 1 + Trial 2) / 2
Weight of Cup Before Separation (grams)			
Weight of Cup After Separation (grams)			
Weight Removed from Cup (grams)			
Time to Separate (seconds)			

One way to separate them is to utilize the fact that only certain metals are attracted to magnets, or magnetic. The three main magnetic metals are **Iron**, **Cobalt**, and **Nickel**. This is not the only way to separate metals from a solution since not all metals are magnetic. Using the differences of weight between metal and other objects, you can separate metals from the solution since they will most likely sink to the bottom.

Reflection:

Engineers try to make processes efficient. How could you possibly reduce the amount of passes necessary to completely separate the metals from the solution?

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What might be some ways to remove the metals left over in the solution?

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Experiment #2: Recovering Plastics

Setting The Scene:

Large pieces of plastic make up the majority of the Great Pacific Garbage Patch. Unlike many objects, plastics are not biodegradable and will not decompose if left alone; they will only break into smaller pieces, which can still be detrimental to the ecosystem. In order to be able to collect some of these objects, we must first have a method to separate these objects from both the water and the garbage patch itself.

Brainstorm:

Do you think all the plastic in the Pacific Garbage Patch is floating on the surface?

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Why do you think that way?

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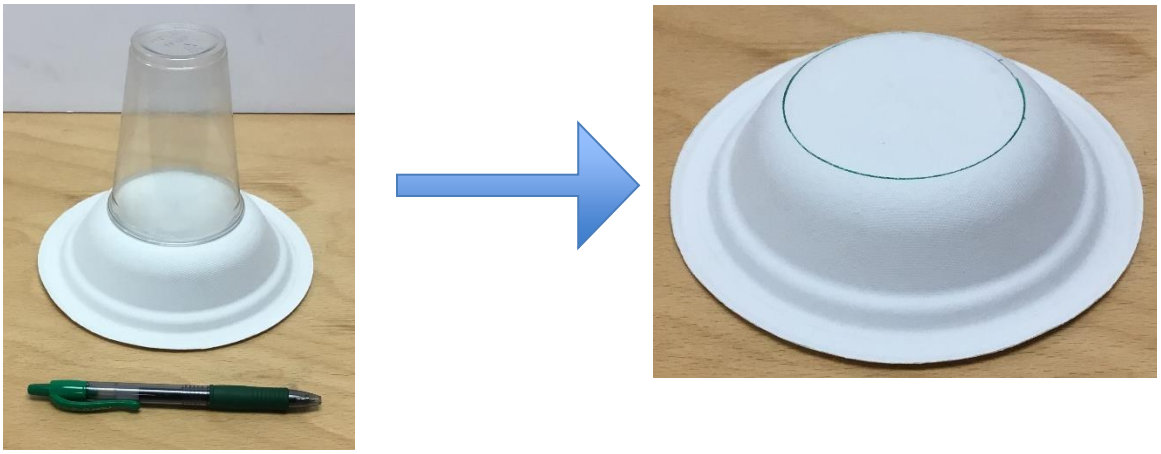
Get Creative: Design something that will remove ALL plastic from the water. Feel free to discuss ideas with a partner. Doodle your design below.

The Set up:

You have been hired by the University of Pittsburgh's Mascaro Center for Sustainable Innovation to design a filter station to remove plastics from the Monongahela River to decrease the risk of river animals swallowing plastic. They have asked you to design a screen to filter out the plastics and allow water to pass through.

Procedure:

1. Weigh the trash solution in the cup



2. Using the clean cup, trace the rim around the bottom of the bowl.
3. Create small holes in the bottom of the bowl using either a pencil, or scissors making sure to stay inside of the circle you traced.

4. Place your homemade screen on a clean cup.

Be sure to time the separation, starting when you begin pouring the mystery solution.

5. Start the timer and begin pouring the trash solution through the screen into the clean cup. Stop the timer when there is no more solution falling through.

6. Weigh the solution a second time after the separation to determine the amount of waste removed during this separation. Calculate this by subtracting the mass before from the mass after.

Gathering Data:

Test #2: Screen Separation	Trial 1
Weight of Cup Before Separation (grams)	
Weight of Cup After Separation (grams)	
Weight Removed from Cup (grams)	
Time to Separate (seconds)	

Did you filter out all the plastic? How long did it take?

Yes or No _____seconds

Engineers have to consider efficiency in their designs. How might you be able to remove more of the plastic in less time? Discuss your ideas with your partner.

Redesign your screen and sketch your new pattern on the image below:

Build this second design. Test and compare the data between this trial and Trial 1 to see if you can speed up the separation!

Test #2: Screen Separation	Trial 1	Trial 2
Weight of Cup Before Separation (grams)		
Weight of Cup After Separation (grams)		
Weight Removed from Cup (grams)		
Time to Separate (seconds)		

Reflection:

What did you notice between Trial 1 and Trial 2?

Would you say your filter is successful? What data can you use to prove that your filter works?

What characteristics make for the best filter?

Knowing what you know now, what plastic could you live without? Why is this a good choice?

Experiment #3: Recovering Liquids

Setting the Scene:

The great pacific garbage has many liquids mixed in as well that we must also consider cleaning. As mentioned earlier, there is a fair amount of chemical waste that is also present in the pacific garbage patch. This will often come in the liquid state, which often makes it difficult to separate it from the Pacific Ocean water.

Different substances have different densities, making it impossible for them to mix with each other. When multiple insoluble substances are combined, the densest liquid will always sink to the bottom, while the least dense will rise to the top.

Brainstorm:

Given the following list of substances that are insoluble in water, how would they layer them from top to bottom in a body of water?

Liquid Substance	Density
Maple Syrup	1.37
Water with food coloring	1.00
Vegetable oil (yellow)	0.91
Honey	1.36
Rubbing alcohol (colorless)	0.87
Dawn dish washing liquid (blue)	

Liquid Substance	Layer
	Top
	Bottom

What might be some pathways for liquid waste to get into the ocean?

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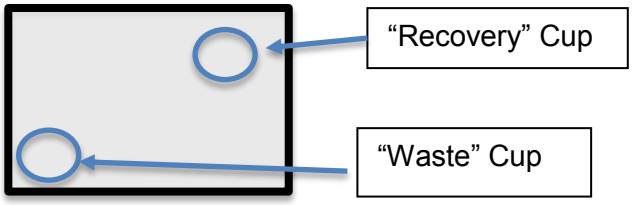
The Set Up:

You are an environmental engineer hired by the Environmental Protection Agency (EPA) to capture oil leaking from a tanker into Lake Erie. You must design a method to remove as much oil as you can without removing any water from the lake. The EPA have given you some design constraints that you must follow.

Design Constraints:

1. Your "waste" cup and "recovery" cup must be at the opposite corners of an 8.5" x 11" piece of paper.



2. The cups cannot be lifted off the paper.
3. You will have _____ minutes to complete your oil recovery.
4. Your team will be removed from the project if any oil is spilled on the paper.
5. Your team will be removed if any oil is found in your water.

The team that has the most water in their "waste" cup will be deemed the winner.

Design your Method by listing your steps below. Be as detailed as possible.
(You may want to consider speed of recovery, the total of amount of oil you need to recover, the thickness of the oil layer etc.)

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Collecting Data:

Experiment #3: Reclaiming Waste	Trial 1	Trial 2	(Trial 1 + Trial 2) / 2
Weight of “waste” cup Before Separation (g)			
Weight of “waste” cup After Separation (g)			

Reflection:

How might waves and currents affect the removal of liquids in a body water?

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Using your knowledge from the activities you just completed. What order would you remove the waste from the Pacific Garbage patch? Why would choose this order?

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