Climate Change — Watery Going to Do?

Target Grade: Elementary/Middle School
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Brief Overview

The mentees in this lesson will be learning about climate change and how important it is to combat it by investigating the relationships by various weather and earth systems. It is important to understand how climate change works in order to be equipped to take action against it, so the lesson will end with a module on sustainable energy that comes from responsible natural resource management. They will get to participate in a lesson that is different from previous lessons that were mostly physics based and explore some environmental science for the first time.

Teaching Goals

- Understanding climate change and human impact on global atmospheric temperatures
    - **Climate change:** the change in global or regional climate patterns widely associated with humankind's contribution to atmospheric pollution through the release of fossil fuels and the unsustainable use of finite resources
    - **Weather**: the state of the atmosphere at a specific place and time (e.g. rain, sunshine, wind, etc.)
- Understanding the water cycle and how climate change affects it
    - **The Water Cycle:** the existence and movement of water in, on, and above Earth
    - **Condensation:** the conversion of vapor or gas into liquid
    - **Evaporation:** the conversion of liquid into vapor or gas
    - **Precipitation:** condensation of atmospheric water that falls under pressure, e.g. rain, snow, hail
- Understanding the movement of warm and cold air and water and how it affects our weather and climate
    - **Convection currents and gulf streams** — how they intensify storms and affect regional weather patterns
- Understanding the importance of renewable and sustainable energy in combating climate change
    - **Hydropower:** flowing water creates energy that can be captured and converted into electricity
    - Benefits and drawbacks of hydropower: sustainable only if properly managed,

increases water pollution, expensive, but very powerful

Careers and Applications

Environmental engineers are becoming more and more necessary as we as humans bring ourselves closer to climate catastrophe. They help find new and inventive ways to sustainably manage our societies by using environmental science. Environmental engineers have the challenge of solving our environmental problems while ensuring that humans and our societies can still survive.

Agenda

- Introduction
- Module 1: shaving cream one (5-10 min)
- Module 2: two bottle one (5-10 min)
- Module 3: water wheel one (15-20 min)
- Conclusion

Introduction

Ask the mentees if they know what climate change is and what they know about it. Explain that climate change means that the earth is getting hotter overall, and this increase in temperatures is affecting lots of different things in the world, including regional weather patterns. Make sure to emphasize that climate change is a really big problem, but that the future is in their hands — they have the pattern to turn things around by participating in sustainable practices and advocating against harmful ecological Note: if the kids disagree with the very existence of climate change and will not budge on this, try to get them to realize that it's important to learn about our earth processes either way.

Module 1: Purple Rain (10 min)

Introduction

In this module, kids will be learning about the water cycle by observing small scale demonstrations. They will then combine their knowledge of the water cycle with information about weather patterns to see how climate change can affect atmospheric systems.

Teaching Goals

1. **Climate change:** the change in global or regional climate patterns widely associated with humankind's contribution to atmospheric pollution through the release of fossil fuels and the unsustainable use of finite resources
2. **Weather:** the state of the atmosphere at a specific place and time (e.g. rain, sunshine, wind, etc.)
3. **Three steps of the water cycle**
    a. **Condensation:** the conversion of vapor or gas into liquid
    b. **Evaporation:** the conversion of liquid into vapor or gas
    c. **Precipitation:** condensation of atmospheric water that falls under pressure, e.g. rain, snow, hail

Background for Mentors

Climate change is the increase in global atmospheric temperatures due to the increase in

CO_2 levels emitted by the burning of fossil fuels. Fossil fuels include petroleum, coal, and natural gas, and we use them to drive our cars, heat our homes, and provide electricity. Fossil fuels are used everywhere — almost every activity we engage in requires some use of fossil fuels. When fossil fuels are burned, CO_2, a heat-trapping gas, is released into the atmosphere along with other "greenhouse" gases that prevent energy from the sun's refracted rays from going back out into space. The increase in greenhouse gases and CO_2 has lead to an increase in global atmospheric temperature and is greatly affecting many, if not all, of the ecological systems on, in, and above Earth.

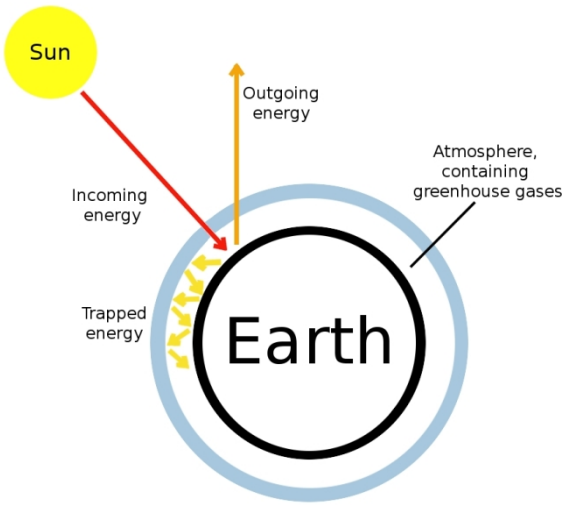


Figure 1: The Greenhouse Effect (www.simpleclimate.wordpress.com)

Climate change affects regional weather patterns by increasing the intensity and frequency of extreme weather events such as storms, heavy downpours, droughts, and floods. Storms and downpours occur because warm air contains more water vapor, making more water available to storms. This "extra" heat present in both the atmosphere and the warmer oceans make storms much more intense and damaging since they have an abundance of heat energy to feed off of. In this first module, we will just be focusing on the water vapor aspect and how the water cycle is affected by climate change.

Materials

- 12 small clear plastic cups
- Paper towels
- 3 ice cubes
- Hot water
- 1 glass jar
- Shaving cream
- Food coloring

Procedure

1. Start by filling one of the cups up with water and marking the initial water level with a sharpie. Place it near a sunny window and leave it for the rest of the lesson.
    a. By the end of the module, some of the water should have **evaporated**. Mark

the new level with a sharpie. If it happens to be cloudy, you can either put the cup under a lamp or just skip this demo.

2. Give each group of students two plastic cups and one ice cube. Fill one cup at each group up with hot water.
3. Place the other cup on top of the water-filled cup. Place the ice cube on top.
    a. Water will **condense** at the top as the heat rises and cling to the cup in little droplets. This is how clouds are formed!
4. Give each group one more cup. Fill the cup about ⅔ full with water.
5. Spray a generous amount of shaving cream on top of the water. This will be the "cloud."
6. Instruct the groups to pour a few drops of food coloring onto the shaving cream. The food coloring will be the "rain." The cloud will become heavy and will then "rain" down into the cup, just as clouds do when they fill with condensation and then **precipitate**.
7. Explain how this relates to climate change — *the hotter the atmosphere, the more vapor there is to condense, which means precipitation will be a lot more extreme.* This is bad for the environment because it can cause soil erosion, flooding and property damage. It also makes storms a lot worse, which we'll see in the next module...

Figure 2: Precipitation demo (www.playfullearning.com)

Additional Notes for Mentors

If the mentees are being extra energetic that day, you might want to just demo all of Module 1 instead of letting the kids work with it hands-on. This way you can speed things up or slow them down if you need to and avoid potential food coloring messes. If you do decide to make this module interactive, let the kids experiment with the rain — see how many drops in takes to make the clouds heavy enough, use different colors, or dilute the food coloring to see if it affects the precipitation.

Module 2: Convection (10 min)

Introduction

After being introduced to the water cycle in the first module, students will learn how the process of convection causes evaporated water to form clouds and how global warming is causing stronger storms. Students will be shown a visual demonstration of convection using warm and cold water.

Teaching Goals

1. **Convection: The flow of heat caused by hotter and thus less dense matter to rise and move from a hotter region to a cooler region**
2. **Clouds and thunderstorms are formed by heat from the sun causing warm air to rise**

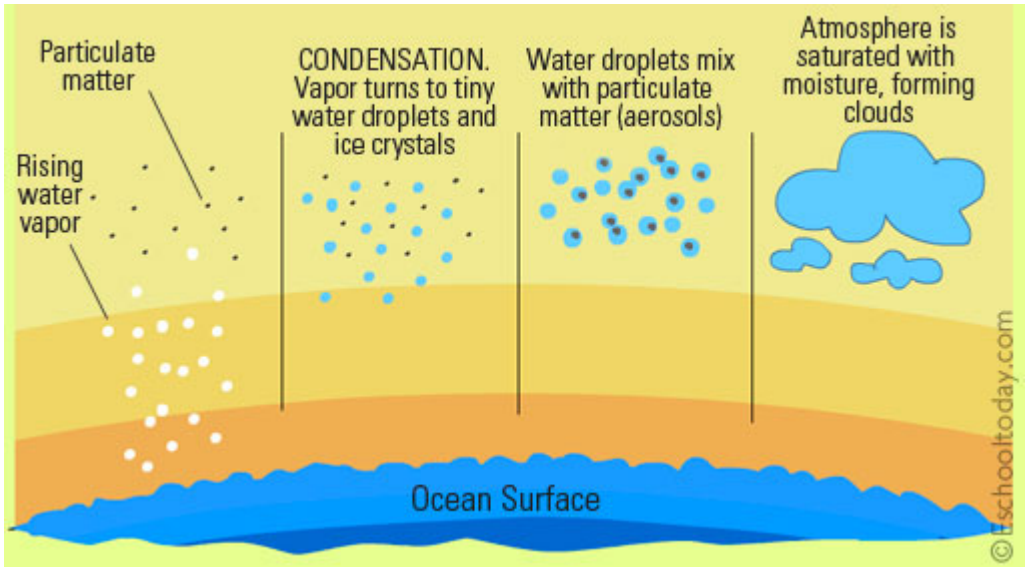
Background for Mentors

Convection is the process by which heat is transferred through the movement of molecules from a hotter region to a cooler region. Since the concept of convection is relatively intuitive and should be easy for students to understand, after doing the demo mentors should talk about one example of convection in the water cycle.

The sun heats the surface of the earth, and this heat is transferred to the surrounding air close to the ground through the process of conduction. Since this air is warmer and less dense than the surrounding air, it will continue to rise higher and higher into the atmosphere through the process of convection.

Eventually, the air and water vapor in the air will cool and condense, releasing heat and forming a cloud. Heat helps the cloud grows bigger and causes it to hold more moisture and sometimes electricity, which results in thunderstorms.

Scientists believe that the excess heat trapped in the atmosphere due to global warming causes more water vapor to evaporate, creating more bigger and more intense storms.



Materials

- 4 bottles of the same size
- 2 index cards
- Hot and cold water
- Food coloring

Procedure

1. Fill two bottles with hot water and two bottles with cold water.
2. Add one color of food coloring to the hot bottles, and another color to the cold bottles.
3. Cover one index card on the mouth of one of the hot bottles. Invert it directly on top of one of the cool bottles. (The bottles may not balance by themselves, so hold on to them if they are wobbly)
4. Ask the students what they think will happen when you remove the index card blocking the flow of water between the two bottles. There should be no color change (since the hot water is already on the top).
5. Repeat step 3 and 4 but place a cold water bottle on top and a hot water bottle on the bottom. Ask the students what they think will happen (the colors should mix)

Module 3: Hydropower (20 min)

Introduction

In this module, students will be making a water wheel out of cork and curved plastic. They will then pour water over the wheel in order to lift up a weight. This demonstrates the power of renewable energy sources such as running water (rivers, etc.) and simulates how this

power can be converted into useful work. Although in this case the kinetic energy of the water is being converted into potential energy, many dams use a similar wheel mechanism to generate electrical energy.

Teaching Goals

4. **Renewable Energy:** Energy sources that can be renewed within a reasonable timespan, e.g. running water, wind, the sun, etc. as opposed to fossil fuels, which can take millions of years.

5. **Hydropower:** The energy that humans use directly from a conversion from the energy of running or falling water.

Background for Mentors

Hydropower is one of the most widespread applications of renewable energy generation in the modern world. In this module, we will be simplifying down to a simple water wheel that converts the potential energy of falling water into the kinetic energy of the wheel into the potential energy of a weight being lifted.

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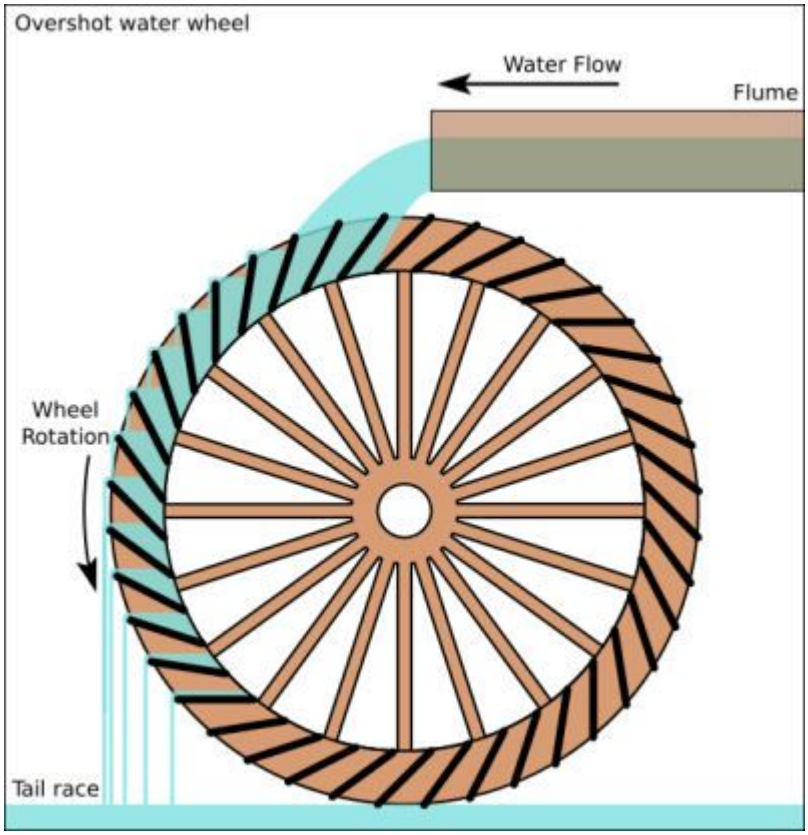

This is a slightly more advanced diagram of the water wheel that will be constructed at site. However, this demonstrates the reason why the plastic fins must be curved towards the source of water. The fins must be curved so that they are able to contain the water for a longer amount of time. This means that the force that is being transferred does so for a longer amount of time, resulting in a more efficient conversion of energy. In an alternate

design, the wheel would be enclosed so that no water can leave while it is travelling downwards.

To go into slightly more detail on the force conversion, in the beginning the water has potential energy by virtue of being at a higher point relative to the wheel. As it falls, in gains kinetic energy and transfers force onto the wheel fins. Because the wheel is fixed in the middle but given freedom on the axis to rotate, this force applies torque to the wheel based on its diameter, and how much it ends up moving depends on the wheel's mass/moment of inertia. In our setup, the weight will be connected to the skewer that will be used as the axis. When the wheel spins, the skewer will "wind up" the weight, thus lifting it.

In a typical hydroelectric dam, which is the modern application of these concepts, the spinning wheel powers a generator, which moves a magnet across coils that induce electrical power.

Materials

- 1 pre-cut soda bottle
- 8 pre-cut rectangular fins
- 1 pre-cut cork per group
- 1 wooden skewer per group (careful, sharp)
- 1 pair of scissors per group
- A roll of string per site
- 1 weight per group (assorted coins in a bag, etc.)

Procedure

8. **(PRE-SITE)** Using scissors, cut the bottle into three sections: top, middle, and bottom. The height of the middle piece will be the length of the wheel fins. The top part will be discarded
9. **(PRE-SITE)**Cut a triangular piece out of the bottom piece so that the water can easily escape
10. **(PRE-SITE)**Using scissors, cut the middle ring into 8 identical rectangular pieces.
11. **(PRE-SITE)** Using an x-acto knife, cut 8 evenly spaced slits into the cork where the wheel fins will go.
12. **(MENTORS TO GUIDE MENTEES ON REMAINING STEPS DURING SITE)**
13. Insert the wheel fins into the slits snugly
14. Use the skewer to impale the cork lengthwise
15. Use the skewer to impale the bottom piece of the bottle such that the side with the triangular piece cut out is perpendicular to the skewer
16. Take the cork off the skewer and put it back on inside the bottom piece, and insert the skewer across onto the other side, so that the skewer can move freely and the cork is situated over the bottom piece
17. Tie a string onto a weight, and tie the other side of the string to one end of the skewer such that the skewer does not spin on the string
18. Pour water on the wheel outside

Additional Notes for Mentors

At first, don't curve the wheel fins, but ask students what could make the contraption more efficient. This will let them apply the engineering and design process to see what could make this simple machine work slightly better. Ask questions about whether or not it is better to have bigger or smaller fins, a lighter or heavier wheel, etc. to get their minds flowing. If a student is having trouble understanding why this contraption works, analogize to something simpler, e.g. a prize board that you spin.

Conclusion

Mentors should recap the concepts of the water cycle, convection, and summarize again how a dam works. They should also ask the kids to list one example of how global warming is affecting earth's weather systems and explain why developing renewable energy infrastructure is important.

References

- "Water is Water," Mariah Bruehl, Playful Learning. https://www.playfullearning.net/resource/water-is-water-3-experiments-for-kids/
- "Severe Weather 101", The National Severe Storms Labratory https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/
- https://www.youtube.com/watch?v=x8xow_R0YRI&fbclid=IwAR0rTx_uXMssYg7EVl3bq0C2xq2jmH535J7zc2bRVcpIag74H6al7hLmsew (MODULE 3)

Summary Materials Table

Material	**Amount per Group**	**Expected $$**	**Vendor (or online link)**
Extremely Specific Item Name	1 per student		Amazon
1 2L soda bottle	1	$2	Any convenience store
1 x-acto knife	1	$10	Amazon
Cork Stopper	1	$1	Amazon
Wooden Skewer	1	$2	Amazon
Scissors	1 (can share)	Already own?	N/A
String	1	Already own?	N/A
Weights (assorted coins, etc.)	1	0	Mentor's wallets
Water bottles	4		
Food coloring	1		

Index cards	2		