WATERWHEEL CHALLENGE- LESSON PLAN

NGSS	**MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4**
Topic and Lesson	**WATERWHEEL CHALLENGE**
Scenario	In certain areas of the world, there was not any mechanism to grind wheat to flour. It was really painful job for human to make flour. In that circumstances, Biba was not so happy for not having a type of mechanism to grind the flour. He saw his parents how they worked hard to make flour by using their hand power. It took a lot of time to get good quality flour. Grinding the wheat with stone and wood by using only hand power motivated Biba to find a solution. If you were Biba, what would you do to get a better solution for this hard work?
Investigative Phenomena	• Have you ever seen a rotate wheel that use the water power?
Overview & Objectives	**After this activity, students should able to,** • **Describe hydropower as a source of renewable energy.** • **Discuss the history and uses for a waterwheel.** • **collect qualitative and quantitative data to make claims about the effectiveness of their water wheel designs** • **Explain how engineers design and redesign hydropower technologies.** • **Identify the problem, analyze materials, brainstorm, build, and record results** **NGSS PERFORMANCE EXPECTATIONS** **Students who demonstrate understanding can:** **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
Suggested activity time	**Engage: Investigative Phenomena: (1 day)-Accessing Prior knowledge** **Explore: Hook (1 Day)** **Explain & Elaborate: (2 Day)** **Evaluate: (1 Day)**
STEM Invention Materials	➢ **Plastic Spoon** ➢ **Plastic bottle and cover** ➢ **Tape** ➢ **Plastic box** ➢ **Hot glue**
Facilitator Tips	**Team-work skills** • **Use time effectively! Assign tasks and trust your partner's skills.** • **Identify and utilize the strengths of each team member.** • **Keep on task and be sure to finish each part of the assigned question.** • **Try to use the last few minutes to check each other's work if you have split up tasks.** • **Practice working as a team or individual.**

DAY-1-DO-NOW-PART-1

1) What does this image remind you? Have you ever seen any examples of this model in your environment?

2) Have you ever seen a rotate wheel that use the water power?

DAY-1-DO-NOW-PART-2

1) What is a waterwheel?
2) How does a waterwheel work?
3) Are waterwheels still used today?

Imagine designing a water wheel such as the one in the picture
-What could you use this wheel for?
-Give an example of how this water wheel may be used….

Critical Questions

Can we build a waterwheel to generate electricity?

If so, will a waterwheel to fulfill the costumer's needs?

What are the constraints at the costumer's site?

DAY-1-PART-3

THE SCIENCE BEHIND WATER WHEEL

Have you ever seen a rotate wheel that use the water power? Today, we'll take a closer look at one invention powered by running water. Over the years, it helped humans with many important tasks. It has ancient roots, but was used until just over a century ago. What was it? The waterwheel, of course!

If so, you know that they are usually large wheels made of wood or metal. They have many blades or buckets along the outside edge. These blades and buckets take advantage of flowing or falling water to generate power. The falling force of the water pushes the paddles, rotating a wheel. This rotation of a wheel can be transmitted to a variety of machines through a shaft at the center of the wheel.

How old are waterwheels? They were first made by the ancient Greeks over 3,000 years ago. They spread across Europe and were widely used by medieval times. Separately, the horizontal waterwheel was invented in China sometime in the 1st century C.E.
Are these machines still used today? Not usually. However, they were still in use as recently as the early 20th century. You can still see waterwheels in action, though. They're often part of historical displays at museums across the United States.

How were waterwheels used in the past? Some were built next to grist mills to help mill flour. Others were built near paper mills to help grind wood into pulp to make paper. Waterwheels were also used for many other purposes. These included hammering iron, crushing ore, and preparing fiber to make cloth.

To work, waterwheels need a source of flowing or falling water. These could include streams or small rivers. Occasionally, special ponds—called mill ponds—would be built by damming a flowing stream. Today, hydroelectric dams still use the power of flowing water. They create electric power with the help of machines called turbines. Can you think of any other uses for the waterwheel? Now it is your time to build a mini-craft waterwheel.

What is hydropower?
Water power or hydropower is power from the energy of falling or running water. This energy can be harnessed for other purposes.

What is renewable energy?
Hydropower is the nation's largest source of renewable energy. Renewable energy is energy that comes from a source that is not depleted when used. This includes energy from sunlight, wind, and water.

DAY-1-PART-3

Vocabulary Terminology

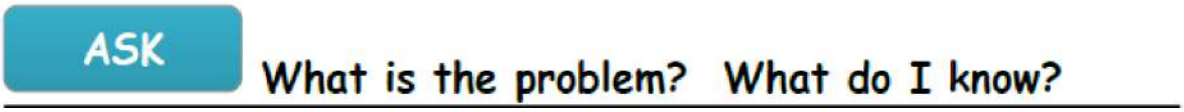
- *dam:* A barrier constructed across a waterway to control the flow or raise the level of water.
- *design:* To plan out in systematic, often graphic form. To create for a particular purpose or effect. For example, to design a power plant.
- *energy:* The ability to do work.
- *engineering design:* The process of devising a system, component or process to meet desired needs. (Source: ABET)
- *hydroelectric power plant:* A power plant that uses water turbines to generate electricity.
- *hydroelectricity:* Electricity produced by the energy of moving water.
- *hydropower:* Generating power from the movement of water. Also, called hydroelectric power.
- *kinetic energy:* The energy of motion. For example, a spinning top, a falling object and a rolling ball all have kinetic energy.
- *mechanical energy:* Energy used to create motion. It is the sum of an object's kinetic and potential energy.
- *model:* A small object, usually built to scale, that represents another, often larger object.
- *potential energy:* Potential energy is the energy stored by an object as a result of its position. For example, a roller coaster at the top of a hill, or water being held behind a dam.
- *power plant:* A complex of structures, machinery, and associated equipment for generating electric energy.
- *prototype:* A first attempt or early model of a new product or creation. May be revised many times in the process of testing and refining.
- *renewable energy:* Energy made from sources that can be regenerated. Sources include solar, wind, geothermal, biomass, ocean and hydro (water).
- *reservoir:* A natural or artificial pond or lake used for the storage and regulation of water.
- *rotational rate:* How fast something turns. A measure of speed indicated by the number of turns that take place during a period of time. For example, 100 revolutions per minute.
- *turbine:* A machine in which the kinetic energy of a moving fluid is converted into mechanical energy by causing a series of buckets, paddles or blades on a rotor to rotate.
- *waterwheel:* A wheel that rotates by direct action of water; used to generate power or do work. The wheel often includes buckets, paddles or blades to catch the water. A simple turbine.

DAY-2-PART-1

Design Brief

Background: Ask, Imagine, Plan, Develop, and Improve another solution.

In certain areas of the world, there was not any mechanism to grind wheat to flour. It was really painful job for human to make flour. In that circumstances, Biba was not so happy for not having a type of mechanism to grind the flour. He saw his parents how they worked hard to make flour by using their hand power. It took a lot of time to get good quality flour. Grinding the wheat with stone and wood by using only hand power motivated Biba to find a solution. If you were Biba, what would you do to get a better solution for this hard work?



In Your own words write what the problem is you need to solve:

_____

_____

_____

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_____

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DAY-2-PART-2

Materials

- Plastic Spoon
- Plastic bottle and cover
- Tape
- Plastic rectangular bowl
- Hot glue

Use the video as a guideline to complete the activity…
https://www.youtube.com/watch?v=s_ZpGYi4OsE&t=62s

Directions

1) **Use scissors to cut 8 plastic spoons in half at an angle.**
   - Plastic spoons can be hard to cut, so ask for help if you need it. Be careful cutting the plastic spoons as the pieces can fly off when you cut them.

2) **Cut out 8 piece spots from plastic cover to adjust your plastic spoons in it.**

3) **Insert the spoons into the outside edge of the plastic cover. Make sure all are in the same line to create a perfect water wheel.**

4) **Firmly secure the plastic spoons with hot glue.**

5) **Make a hole in the center with a craft knife.** Once you've found your center points, use a metal to make a hole by pushing it through the center of the plastic cover. The shiny metal that you see in the video clip will serve as your dowel rod and will allow the wheel to turn when water passes over the spoons. Make sure the metal is secure in the wheel because if it's too loose, the wheel won't turn.
6) **Set your wheel on the plastic rectangular bowl and fill a plastic bottle with water.** Hold the straw until you fill the plastic bottle with water and then pull of your hand from the straw**…** This will cause the wheel to turn and it should continue to spin as long as you keep pour water over it

DAY-3-PART-1

Provide details about your challenge success and failure below….

WHAT WORKS?	WHAT DOESN'T?

Ask the students and discuss as a class:

- What happened to the waterwheel as you poured water on it?

- What patterns do we see in the results? Why do teams have different average rates of rotation? What conclusions can we draw?
- To improve your waterwheel, how might you re-design your water catchers to work better?
- What happened to the rate of rotation when we added weight?
- How would engineers use this understanding to design hydroelectric power plants? (Answer: Engineers would learn about the different paddle or blade designs to see how well they moved the weight. The better the blade design, the faster the waterwheel turned and moved the weight upwards. They would use this information to design a turbine that generated the most electricity from the turning wheel.)
- How might we have altered the experiment or our methods to make a better experiment?

- Ask students to describe, in general terms, how hydropower works.
- Ask the students to brainstorm how they think they could make their waterwheel more efficient if they had additional resources (materials, time).
- Among all individual, ask students to decide which new design is the best and why?

- To use the natural water flows in a river or stream for hydropower, what type of natural river conditions do engineers require? (Answer: It must be fast-moving water.)
- What are some reasons why engineers construct hydroelectric power plants? (Possible answers: To produce electricity. To make use of a renewable energy source [water]. To produce electricity without polluting or producing greenhouse gases.)
- Why do engineers construct dams for large hydroelectric power systems? (Answer: The dam holds a great deal of water in one place to supply the kinetic energy required to turn the turbine blades.)
- How was the waterwheel you made similar to what happens in a hydroelectric power plant? (Answer: Water dropped from a container to spin the blades just like water runs from a dam to spin the blades of a turbine. The spinning waterwheel was used to do work just like the spinning blades of turbines make electricity, which we use to do work.)

Troubleshooting Tips

It is helpful to prepare and test one model waterwheel before students conduct the activity.

Make sure the dowels spin freely within the bottle openings or bottle cap holes.

DAY-4-PART-1

CER

In certain areas of the world, there was not any mechanism to grind wheat to flour. It was really painful job for human to make flour. In that circumstances, Biba was not so happy for not having a type of mechanism to grind the flour. He saw his parents how they worked hard to make flour by using their hand power. It took a lot of time to get good quality flour. Grinding the wheat with stone and wood by using only hand power motivated Biba to find a solution. If you were Biba, what would you do to get a better solution for this hard work?

Analyze the data that is provided above to state your evidence and reasoning to support your claim.

Claim: _____

_____

_

Evidence: _____

_____

_

Reasoning: _____
_____
_____

Points Earned	2	1	0
Claim	Answers the question and explanation is accurate based on data.	Answers the question which could be inaccurate based on data.	No claim or does not answer the question.
Evidence	provide accurate data from scenario that sufficiently supports the claim.	Cites data from scenario which could be inaccurate, insufficient, or does not support the claim.	Try to explain but not find real connection to evidence…
Reasoning	Cites the scientifically- accurate reason using correct vocabulary and connects this to the claim.	Cites a reason but it is inaccurate or does not support the claim. Reasoning does not use scientific terminology or uses it inaccurately.	No reasoning or restates the claim but offers no reasoning.

DAY-4-PART-2

SOLUTIONS AND IMPROVEMENT

How well did your designing waterwheel model work? What are three ways you can change your waterwheel model to make it better? List these solutions here, and then start over at the beginning of this sheet.

Solution-1/The way it looks	Solution-2/The way it works	Solution-3/why do you think it should be used?

How can you make your solutions better?

Improve

- **What did you like about your solution?**
- **What would you change to improve your design?**

DAY-4-PART-3

3-2-1 Exit Ticket Strategy

Write 3 facts about waterwheel

List 2 ways of how the waterwheel affect the human life

Write 1 question you still have about waterwheel.

DAY-5

Use Quizzes or Kahoot website word bank to create at least 20-30 questions and give it to your students. Give at least two trials, and count the last one as a real grade. In the first attempt, some students rush and can make more mistakes. Therefore, they can fail, encouragement and positive language will support your students, it pushes them to focus well and get good scores.