Unit 6 (Work & Energy)
Hydraulics: Exploring Water Power

Concept
Water can be used to send power through a system of mechanisms**.**

Content objective
Students explore transmission of power with water using syringes and tubing, waterwheels, and other turbines.

Language objective
Describe experiments with water systems *using target vocabulary*.

Standards

- **NGSS:**
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool
  - **K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses (if the comparison of waterwheels is conducted).
- **TEKS:**
  - **1A** Students will demonstrate safe practices and use safety equipment.
  - **2A** Students will plan and implement descriptive investigations, including asking well-defined questions, making inferences, and selecting and using appropriate equipment or technology to answer his/her questions.
  - **2B** Students will collect and record data by observing and measuring, using the metric system, and using descriptive words and numerals such as labeled drawings, writing, and concept maps.
  - **2D** Students will analyze data and interpret patterns to construct reasonable explanations from data that can be observed and measured.
  - **3A** Students will analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing.
  - **3C** Students will represent the natural world using models.
  - **4A** Students will collect, record, and analyze information using tools.
  - **6A** Students will differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal.

- **ELPS**:
  - **3D** Students will speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency. [Application for Acquisition]
  - **3E** Students will share information in cooperative learning interactions. [Communicative Competence]

Materials:
- Syringes and plastic tubing (syringes are available from veterinary supplies)
- 50 1 oz. plastic cups (medicine cups/soufflé cups) all construction and craft materials
- Quart-size zip-sealing plastic bags
- Paper towels
- Lesson handouts **4.6.1- 4.6.3**

Literature Connections
Hamish McHaggis: The Wonderful Waterwheel by Linda Strachan

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language Requirements
1. Form student pairs or groups and have each pair or group analyze and then discuss with the class one of the figures in handout **4.6.1**. 2. Ask students to talk about things we know that are full of water and whether or not they can be squeezed and made smaller (such as water balloons, water beds, or hot water bottles). 3. Put some water in a zip-lock bag and hold it up for the children to see. 4. Ask students to describe some properties of the water in the bag. (It is clear, it moves around.) 5. Ask students if they think the bag of water can be compressed and made smaller. 6. Let one student try to do this. 7. Remind the students about the mechanisms they have learned that send power through a system (gears, pulleys, levers), and ask if anyone can think of ways that water can send power through a system. (Students might say that moving water can move things.)	Students share experiences and interpretations with everyday objects or systems that use water Water can send power through a system by _____.	Syringes Tubing Gears Pulleys Levers Hydraulics

Day 2: Explore/Explain

Teacher Says/Does	Student Says/Does	Language Requirements
1. Assign student pairs, and give each a plastic "science syringe" and a few paper towels. Point out to the students that the syringe does not contain a needle and is made especially for measuring and dispensing liquids. Tell them that they should never touch syringes they find, especially any with needles on them. Students should only use "science syringes" at school. 2. Pass out a 1-ounce plastic cup of water to each group, and ask them to find a way to put at least half of their water into their syringe. After a few minutes, let some share their methods (the easiest way is to pull back on the plunger and draw water up into the syringe). 3. Discuss why it is difficult to just pour water into the syringe. (The opening is small; there is air inside keeping the water from completely filling it.) 4. As they push the water out of their syringes back into their cups, ask students to describe "water power" (The force of water can push things; the harder, or more quickly, the water is pushed out, the more power the water can have.) 5. Have the teams try these activities to explore with the syringes: o Fill the syringe with water, and have a partner cover the open end with a finger. Try to push the plunger down. What happens? (When the end is blocked, the water can't get out, and the plunger won't move.) Try to pull the plunger up. What happens? (It is difficult to pull because the end is blocked and the water inside can't stretch to fill a bigger space.) o Have teams take a length (about 3' long) of plastic tubing. Push it onto the end of one syringe, then draw some water into the syringe through the tubing. Fill another syringe with water and connect the other end of the water-filled plastic tubing to the new syringe. Now	Students explore methods to put water into a syringe, investigate some properties of a water-filled system of syringes, and discover some characteristics of water power When I push down on the plunger, the water ____ by/because _____. When I pull the plunger, the water _____ by/because _____.	Dispensing Plunger

Teacher Says/Does	Student Says/Does	Language Requirements
you have a water-filled system of syringes and plastic tubing. Have the teams find out: What happens if one person pushes down on the syringe plunger? (The other syringe plunger pushes out.) Why does this happen? [Is this 8 a bullet?] o Using the same system of connected syringes, find out what happens if one person pulls up on the plunger. (The other plunger gets drawn in.) Why does this happen? 6. Write on the chart (handout **4.6.2**) "Examples of Water Power," and ask students to make some generalizations about work that water can do, as shown by their syringe systems. Students may say water can push and pull, for example.		

Day 3: Explore/ Explain

Teacher Says/Does	Student Says/Does	Language Requirements
1. Ask the students to think of some ways the pushing power of water could be used as a mechanism to make a model move. 2. Can any of the students describe other ways water can carry force and do work? Draw a simple waterwheel (see handout **4.6.3**) on the board, and ask the students how a model of such a device might be made. Have a student trace the flow of power through the waterwheel drawing as water turns the wheel. 3. Teams may like to make simple waterwheels out of plastic bottles and other craft materials. Under the faucet, find out how certain amounts of, or pressures of water, can create different numbers of turns on different waterwheels. Compare the waterwheels for efficiency and input/output motion.	Students experiment with water wheels	Waterwheels Input/output motion

Elaborate/Evaluate

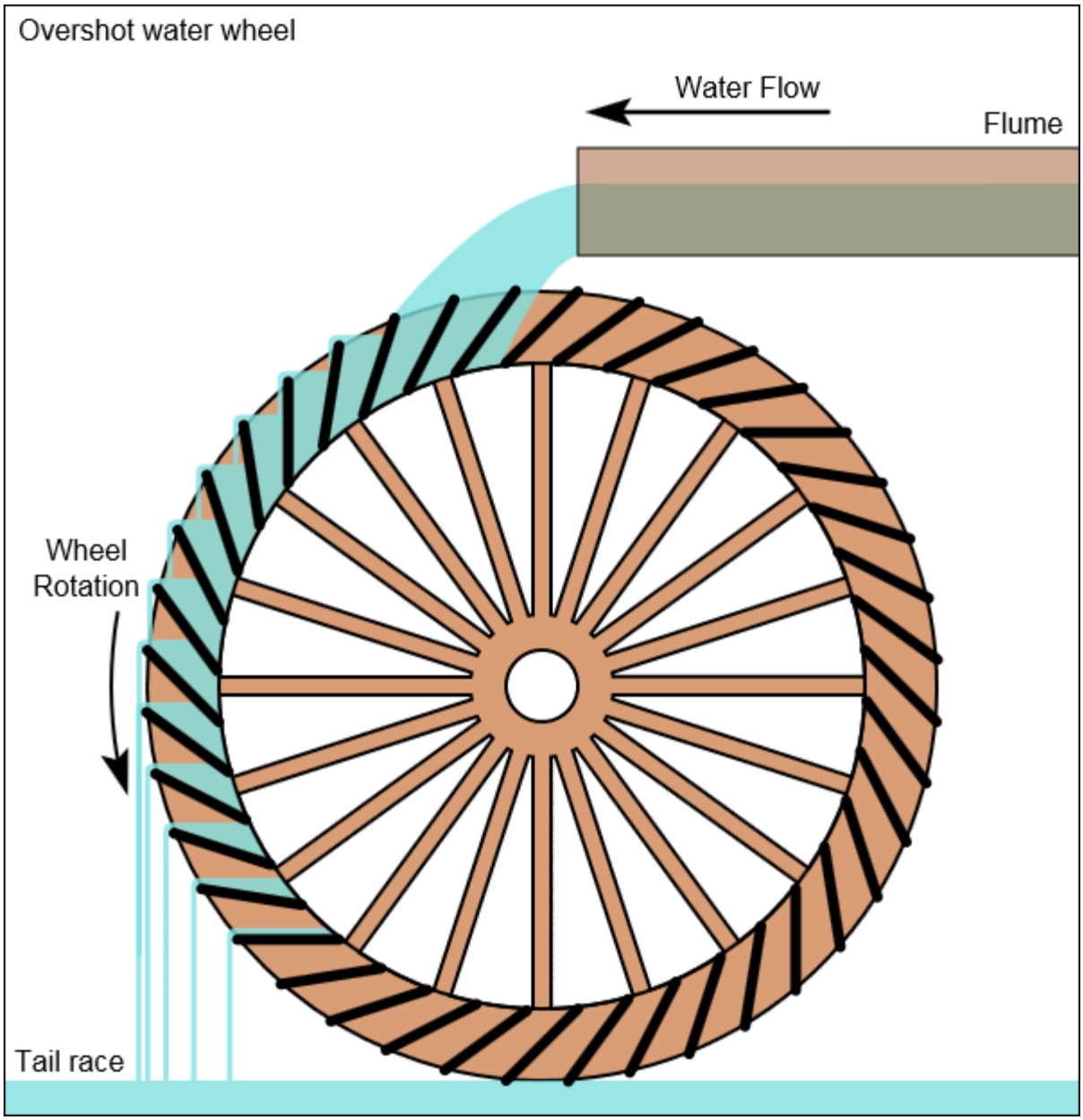
Teacher Says/Does	Student Says/Does	Language Requirements
1. **Have students watch and make comments on the following video, How the Bicycle Pump Works**: http://www.ency123.com/2013/08/how-bicycle-pump-works.html 2. Have student teams select one topic discussed in the lesson to summarize what they investigated, what they did as part of the investigation, their results, and one favorite or important idea.	Students summarize and describe their explorations with water power with the rest of the class	Waterwheels Input/output motion

What we investigated:

Techniques we used:

Our results:

Our powerful idea:


Overshot water wheel
Water Flow
Flume
Wheel
Rotation
Tail race