Unit 8 (Work & Energy):
Power-full Toys

Concept
Hydraulic and pneumatic power can be used to send power through a system.

Content objective
Create a toy that moves by hydraulic or pneumatic power.

Language objectives
Students will describe Design Brief, Black Box Model, and planning map using the *conditional tense*.
Students will explain a hydraulic or a pneumatic mechanism in a complete paragraph using *complex sentences*.

Standards

- **NGSS:**
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define a 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)
  - **K-2-ETS1-3**. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses.
- **TEKS:**
  - **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.
  - **6D** Students will test the effect of force on an object such as a push or a pull, gravity, friction, or magnetism.
- **ELPS**:
  - **1A** Use prior knowledge and experiences to understand meanings in English. [Prior Knowledge]]
  - **3D** Speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency. [Application for Acquisition]

- **3H** Narrate, describe, and explain with increasing specificity and detail as more English is acquired.

Materials

- Various construction materials
- Syringes and plastic tubing
- Recycled items, especially cereal and other boxes
- Lesson handouts **4.8.1- 4.8.2**

Literature Connections

The Boy Who Harnessed the Wind: Creating Currents of Electricity and Hope by William Kampkwamba and Bryan Mealer

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language Requirements
Place the students in teams and ask them to discuss what they know of: a) hydraulic power, and b) pneumatic power. Have students fill out the graphic organizer in handout **4.8.1** and ask volunteers to share their prior knowledge on these two concepts.	Students share their prior knowledge related to hydraulic and pneumatic power Hydraulic power is _____. Pneumatic power is _____.	Hydraulic power Pneumatic power Design Brief Black Box Model Side-view sketch Planning map

Day 2: Explore

Teacher Says/Does	Student Says/Does	Language Requirements
1. Tell students that they will work on a Design Brief in which they use hydraulic or pneumatic power to make moving parts. 2. Show students the following Design Brief: *Design and make a toy to illustrate at least one moving part that works on either hydraulic (water) or pneumatic (air) power.* 3. Remind the students how to begin work on the Design Brief: o Look at the Design Brief. o Ask questions about what the words mean. o When you understand what the words in the Design Brief mean, talk with your partner and plan what you might like to make. o Draw a Black Box Model of your system (review what this means if needed). o Draw a side-view sketch of your device. o Make a planning map. o Talk about who will do what jobs and how you will make sure both people have interesting jobs to do. You may wish to help some of the teams draw their Black Box Models. The students need to decide whether they wish to use water or air as power, and they should think about the kind of motion they wish their device to create. 4. Show students the sample Black Box Model (**4.8.2**) for air power that creates up-and- down (reciprocating) motion. 5. The Black Box Model will help students think about the system they might construct. (They may also choose from gears, pulleys, and levers, as long as the system uses air or water power as input.) 6. Let the teams work on their models.	Students form teams to discuss their design briefs, draw a Black Box Model, and draw a planning map	Hydraulic power Pneumatic power Design Brief Black Box Model Side-view sketch Planning map

Day 3: Explain/ Evaluate

Teacher Says/Does	Student Says/Does	Language Requirements
When the teams have finished their constructions, they should describe in writing what they have made and place their planning maps, side-view sketches, Black Box Models, as well as their device, on display in the Design Gallery. When presenting to the class, students should respond to these questions: o Did your team follow your planning map and sketch in making your device? o Did the Black Box Model help you think about what mechanisms might be needed in your system? o Explain how your device works. Where is hydraulic or pneumatic power used? o Did you have any problems in construction? How did you work those problems out? o What were you thinking when you selected the materials for your project? o Also, ask the rest of the class what questions they have for the team that is presenting.	Students write about their toy, and then make presentations to the class In designing, we decided to _____ because _____. We chose to use _____ for our materials because _____. Our device uses _____ power to _____. We had a hard time _____.	

Hydraulic power in our own words	
Drawing/examples we know	

Pneumatic power in our own words	
Drawing/examples we know	

input ---->	**X**	**output**
air in ---->		**back-and-forth motion**