Unit 7 (Work & Energy):
Pneumatics: Exploring Air Power

Concept
Air can be used to transmit power through a system.

Content objective
Teams explore transmission of force with air by using and analyzing syringes and tubing. They also discuss valves as mechanisms to control flow of water and air in systems.

Language objective
Students use target vocabulary to describe experiments with systems that transmit power using air.

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).

- **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:
- A zip-seal plastic bag
- Bicycle pump
- Balloons
- Balloon plugs (from a party supply store)
- Plastic syringes
- 3' pieces of plastic tubing to distribute to each group
- Construction materials
- Lesson handouts **4.7.1- 4.7.4**

Literature Connections
Wind and Water at Work: A Book About Change by Thomas F. Sheehan

Day 1: Engage/Explore:

Teacher Says/Does	Student Says/Does	Language Requirements
1. Give student groups one of the pictures from handout **4.7.1** to interpret and discuss. 2. Fill a zip-sealed bag with air by blowing into it and seal it. Hold it up for the children to see. Ask them to describe some properties of the air in the bag (It is clear, it moves around.) Have students form pairs to discuss and share answers to the following questions: How did the air get into the bag? Can the air be compressed and made smaller? 3. Let one student try to do this. Ask student pairs to talk about things we know that are full of air and whether or not they can be squeezed and made smaller (balloons, air mattresses, beds, etc.). Students may note that the bag can be squeezed and compressed to a greater degree than could a bag of water. 4. Remind the students about the mechanisms they have learned about that send power through a system (gears, pulleys, levers). 5. Ask students to think of ways that air can send power through a system. 6. Give each student pair a plastic syringe, and ask them to find a way to put air into their syringe. Let some share their methods. (The easiest way is to pull back on the plunger and draw air up into the syringe.) 7. Ask pairs to describe “air power” as they push the air out of their syringes. (The force of air can push things; the harder, or more quickly, the air is pushed out, the more power the air can have.) 8. Have student pairs or groups complete the graphic organizer (**4.7.2**) on the different systems that generate power.	Students explore the properties of air Students connect prior knowledge of gears, pulleys, and levers with systems that get power from air Students describe the concept of "air power" Air can send power through a system by _____.	Gear Pulleys Levers Air power

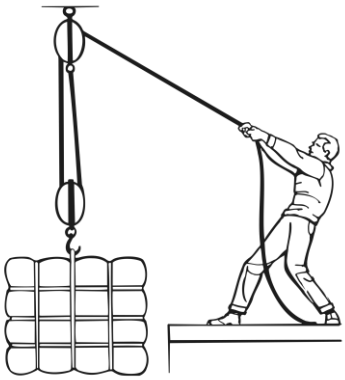
Day 2: Explore/Explain

Teacher Says/Does	Student Says/Does	Language Requirements
1. Have student teams try the following activities to explore with the syringes: 2. Fill a syringe with air 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 air can't get out and the plunger won't move much.) Try to pull the plunger out. What happens? (It is difficult to pull out because the end is blocked and the air inside can't stretch to fill a bigger space.) 3. As a whole group, discuss the way the air behaves when it is compressed compared to the way compressed water behaved in the syringe. Is there a difference in the way the two fluids respond to compression? (Air can be compressed measurably; water cannot.) 4. Have teams take a 3' length of plastic tubing. Push it onto the end of one syringe and then draw some air into the syringe through the tubing. Fill another syringe with air and connect to the other end of the same piece of plastic tubing. Now you have an air-filled system of two syringes attached with 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? 5. What happens if one person pulls out on that person's plunger? (The other plunger gets pushed in.) Why does this happen? 6. Write on the chart "Examples of Air Power" (**4.7.4**) and ask that students make some generalizations about work that air can do. They may mention that air can push and pull a syringe plunger and other things. 7. Ask the students to think of some ways the pushing power of air could be used as power to make a model move.	Students experiment with air-filled and water-filled syringes. When I push down on the plunger, the air ____ because _____. When I pull the plunger, the air _____ because _____.	Plunger Compressed air

Day 3: Elaborate and Evaluate

Teacher Says/Does	Student Says/Does	Language Requirements
Elaborate • Ask student groups to describe other ways air can push, pull, and do other work? Can groups think of mechanisms that work on the principle of air creating rotary motion? (Examples might include windmills or pinwheels.) If students made sailboats at an activity center, ask them to tell what they found about the sizes and shapes of sails that worked best. Why did certain sails work better? • Show the students the bicycle pump and ask someone to demonstrate how it works. You may be able to take the pump apart and have students locate the valve; a mechanism that permits a one-way flow of air in the pump. Explore the pump with these questions: o What happens when you push down on the pump handle? (Air comes out of the end of the hose.) o What happens when you pull up on the handle? (It is hard to pull up.) o Does air go back from the tire or ball into the end of the hose? (No) Why doesn't the air go back in? (There is a valve on the tire or ball that keeps air going one way only.) **Evaluate** • Have student pairs complete the graphic organizer (**4.7.3**).		

Systems that generate power

	
A lever generates power by_____ _____	**A pulley generates power by_____** _____
	
A bycicle gear generates power by _____	**Air can generate power by _____** _____

How air behaves when it is compressed

How water behaves when it is compressed

Characteristics of an air-filled system of two syringes

Characteristics of a water-filled system of two syringes

Examples of air power	Work that air can do

The pushing power of air can be used to _____

_____

_____