

# Do the Science

Lesson Title **Inputs and Outputs** FOSS Levers and Pulleys; Investigation 4, Pulleys at Work; Part 1: Effort in Pulley Systems.

Grade level: 6-8

**Unit Learning Target:** Explain how any system could be part of a larger system or could have its own smaller systems and how the output of one system can be the input of another system. 6-8 SYS A and C

**Lesson Learning Target:** *What are the students expected to be able to do? (Compose in student language.)*

I can describe systems and subsystems and label where the output of one system becomes the input of another system.

**Previous Lesson Target:** I can define and give at least three examples of input and output of a system.

**Next Lesson Target:** I can diagram and explain how one system can be a subsystem of another system.

**Learning Task:** Build a two-pulley system that will move a load. Discover that energy output of one system can become energy input to another system.

**Key Vocabulary Terms for Lesson** (all have been previously used in the unit): •*Systems*, •*Subsystems*, •*Energy/Effort*, •*Load*,  
•*Input*: the addition of matter, energy, or information to a system.  
•*Output*: matter, energy, or information that flows out of a system.

## Do the Math/Science

*Use lenses of both learner and teacher. Examine your thinking. What concepts/ skills/reasoning did you use to solve the task? Identify those that represent prior knowledge.*

- Students need to understand that effort is energy. The term “effort” in the FOSS lesson represents energy going into the system.
- To avoid confusion concerning energy input to the pulley system, remove the arrows from the FOSS Teacher Sheets #21 and #22.
- The content in this FOSS lesson is about mechanical advantage. The ratio of the total input/output of a system is equal to the mechanical advantage.
- Mechanical advantage is a ratio of the output force compared to the input force. See a sample lesson that relates input and output to mechanical advantage at this site: <http://tonto.eia.doe.gov/kids/resources/teachers/pdfs/elem%20inter%20pulleys.pdf>
- Have students label input and output in two colors on the pulley system diagrams (FOSS Teacher Sheets #21 and 22)

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Time	Draft the lesson flow	Anticipated responses	Remember	Formative Assessments
~60 min.	<p>How should the lesson progress? [Share the target both visually and verbally at the beginning and the end of the lesson. Remind students of the target throughout the lesson.]</p> <p>Post the lesson target: <b>Label where the output of one system becomes the input of another system.</b></p> <p>Follow the lesson outline for <i>FOSS Levers and Pulleys</i>; Investigation 4, Pulleys at Work; Part 1: Effort in Pulley Systems.</p> <p><b>In step 6:</b></p> <ul style="list-style-type: none"> <li>Point out that the ropes lifting the load can help us determine how much effort or <b>energy</b> is flowing into the system. This is called <b>input</b>. Each rope that lifts the load has input in the system.</li> <li>Administer the formative assessment, "No Hands Questioning."</li> <li>On Student Sheet #20, have the students add "Input" to the column heading "Number of ropes lifting the load."</li> </ul> <p><b>In step 10:</b></p> <ul style="list-style-type: none"> <li>On Teacher Sheet #21 model how to label each lifting rope, "Input" with an arrow pointing up. Label the rope that the load is pulling down, "Output" with</li> </ul>	<p>What correct/incorrect student responses can we anticipate? What is our reasoning?</p> <p>To make the lesson standards language friendly, be sure the students:</p> <ul style="list-style-type: none"> <li>Understand that effort is the <b>energy flowing into the system</b> and that effort is also called <b>input</b>.</li> <li>Understand that <b>output</b> is the <b>energy flowing out of the system</b> that lifts the load.</li> </ul>	<p>Is there anything specific the teacher should remember to do? Not to do?</p> <p>Refer to the lesson target at the beginning of the lesson, throughout the lesson, and again at the end of the lesson.</p> <p>In addition to the student materials listed, also make copies of Teacher Sheets #21 and 22 for each student.</p> <p>Standards vocabulary:</p> <p>The force you exert on the machine: <i>Energy flowing into the system</i> = Effort = Ropes that support the load = <i>Input</i></p> <p>The force the machine exerts: <i>Output = Energy</i> flowing out of the system to lift the weight = load</p>	<p>What do we want the learners to know? How will we know learning expectations are met? What will be our evidence?</p> <p><b>In step 6:</b> <b>No Hands Questioning</b> (Students do not put their hands up, they are called on randomly.) <i>Science Formative Assessment</i>, P. Keeley</p> <ul style="list-style-type: none"> <li>Teacher asks the class why a rope that lifts the load in a pulley system has <i>input</i>.</li> <li>Teacher uses wait time.</li> <li>Teacher calls on John and listens to his response.</li> <li>Teacher uses wait time after John's response.</li> <li>Teacher asks, "What do others think about John's idea?"</li> <li>Teacher uses wait time.</li> <li>Teacher calls on Sara and listens to her response.</li> <li>Teacher uses wait time.</li> <li>Teacher asks if anyone has anything to add or has a different idea to share.</li> <li>Teacher uses wait time.</li> <li>Teacher asks, "Robert, what are you thinking right now?"</li> </ul> <p>Look for an understanding that the effort/energy <i>flowing into</i> a pulley system to support the load is input of energy.</p> <ul style="list-style-type: none"> <li>Teacher uses wait time.</li> </ul>

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	<p>an arrow pointing down.</p> <ul style="list-style-type: none"> <li>• Lead the students to identify the first two-pulley system on Teacher Sheet #22 as a combination of the pulley systems on Teacher Sheet #21.</li> <li>• Have the students work together in their groups to decide how to label the inputs and output on this system.</li> <li>• If anyone is having trouble, refer them back to the systems on sheet #21 and what they already know about the subsystems.</li> <li>• Where is the output of the top pulley system? How does this output affect the lower pulley system?</li> <li>• After allowing time for each group to come to a solution, select one group to present their idea.</li> <li>• Allow time for questions and clarification.</li> <li>• Have the students individually label input and output forces on the other system on Sheet 22.</li> </ul> <p>Continue lesson as in the teacher's guide.</p>			<ul style="list-style-type: none"> <li>• Teacher asks, "If the energy that flows into the system and lifts the load is called the input, what could we call the energy that flows out of the system when the load is lifted?"</li> <li>• Continue. . . .</li> </ul> <p>Look for an understanding that the effort/energy going out of the system is the energy/effort <i>flowing out</i> of the system to lift the weight. Therefore, we could call it the output</p> <p>Without teacher help, the students will correctly label input and output forces of the second pulley system on teacher sheet number 22.</p>
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