

Unit 5 (Mechanisms): More Rotary Motion: Exploring with Pulleys

Concept

Pulleys change direction of rotation; pulleys in a series increase power to do work.

Content objective

Explore how pulleys work to change direction of motion and increase power in lifting.

Language objectives

Make black box thinking predictions using the *conditional tense* and the structure, “*If..., then*”.

Orally discuss the characteristics of pulleys using *descriptive vocabulary*.

Standards

- **NGSS:**
 - o **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.
 - o **K-2-ETS1-3.** Analyze data from testing two objects designed to solve the same problem in order to compare the strengths and weaknesses of each.
- **TEKS Science:**
 - o **5A** Students will measure, compare, and contrast physical properties of matter, including size, mass, volume,
 - o states (solid, liquid, gas), temperature, magnetism, and the ability to sink or float.
 - o **6A** Students will differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal.
 - o **6D** Students will test the effect of force on an object such as a push or a pull, gravity, friction, or magnetism.
- **ELPS:**
 - o **1A** Students will use prior knowledge and experiences to understand meanings in English. [Prior Knowledge]
 - o **3E** Students will share information in cooperative learning interactions. [Communicative Competence]
 - o **3H** Students will narrate, describe, and explain with increasing specificity and detail as more English is acquired.

Materials

- o Pulleys, rope or string, spring scales
- o Load to lift (e.g., a bucket of blocks)
- o Stand or location to hang pulleys (e.g., monkey bars, hook hanging from ceiling, swing set, chart tablet stand, coat rack)
- o Lesson Handouts **4.5.1- 4.5.3**

Literature Connections

How to Lift a Lion by Robert E. Wells

Day 1: Engage/Explore

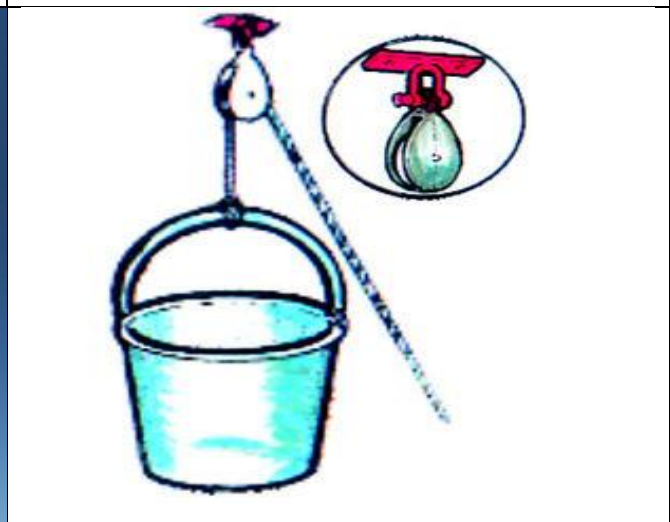
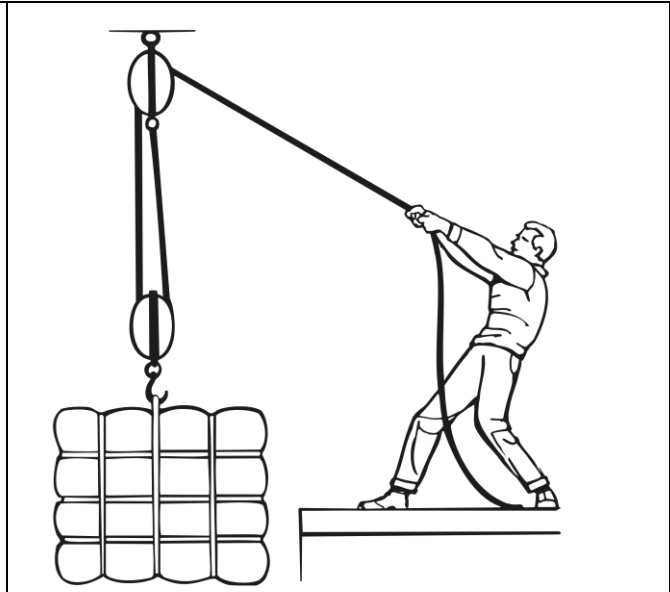
Teacher Says/Does	Student Says/Does	Language Requirements
1. Take the students outside and look at the flag on your school flagpole. Ask the students to talk about how the flag is hoisted up so high by such short people as children. Give them time to talk about how it might be done. Perhaps someone can lower and raise the flag for the children to see. Do the children know the name of the mechanism that lets you pull down on a rope and make something go up? 2. Form groups of students and give each group one of the pictures from handout 4.5.1. Have each group discuss what it sees in the assigned picture, and have each identify examples of something similar that the students have seen in their lives. Have each group share one sentence describing the assigned picture, and one sentence about something similar the students have seen in their lives. 3. Tell the students that a pulley is a wheel that changes the direction of movement; pulleys are often used to lift objects. Demonstrate by hooking a pulley up to a stand, then passing a cord over it and through the groove in its edge. Hook a load, such as a bucket of blocks, on one end of the rope and ask a student to pull down on the other end. Ask students to discuss the following question in pair-share: How does the pulley change the direction of movement? 4. Place a loop in the rope or string and place the hook of a spring scale in the loop; raise the bucket up by pulling on the top of the spring scale. You can see on the scale roughly the force it takes to raise the bucket of blocks. 5. Ask the students to help you draw a Black Box Model for what is happening (see handout 4.5.2).	Students discuss pictures that illustrate pulleys and share their prior knowledge and experiences with pulleys Students apply black-box modeling thinking to pulleys	Pulley Black-box modeling

Day 2: Explore/Explain

Teacher Says/Does	Student Says/Does	Language Requirements
1. Have students discuss in pairs or in groups how simple pulleys work based on previous activities or based on using the figure contained in handout 4.5.2 2. Ask students if they can find a way that a series of pulleys can be used to do more work than one pulley. One way is to run the rope through a second pulley that hangs on a loop of the rope. Try this and use the spring scale with the same load. What happens? 3. Using the figures in the handout, invite students to talk about the possible advantages of using more than one pulley. Discuss the concept of mechanical advantage. 4. Do the students know examples of how pulleys are used to lift very heavy objects? (A block and tackle is a set of pulleys that can be used to lift an engine from a car.) 5. Let teams of students work with sets of pulleys, the spring scale, and loads to lift. Have students record the force (as measured by the spring scales) for each load lifted. Try various combinations; then write the data in a chart. 6. If students add one more pulley into the system, there are more sections of rope sharing the load. Students may see a pattern of mechanical advantage provided by an increased number of rope sections and write it in the data table. NOTE: The friction in the axle of the pulley across the surface of the groove may affect readings of force on the spring scale.	Students experiment with simple pulleys; discuss visuals of simple pulleys, and discuss the mechanical advantage of a system of pulleys	Single pulley Clamp Spring scale Mechanical Advantage In a simple pulley, the clamp serves to _____. The spring scale is attached at the end of the loop in order to _____.

Day 3: Elaborate and Evaluate

Extensions into the Disciplines	Student Says/Does	Language Requirements
Evaluate 1. Have students complete the paragraph on handout 4.5.3 using the words in the word bank. 2. Allow them to form groups to create a presentation in which they respond to the following questions using their own words: • What are pulleys? • What do pulleys do? • What are some advantages of a pulley? • What are some examples of pulleys?	Students summarize their learning about pulleys by creating a presentation	Pulleys

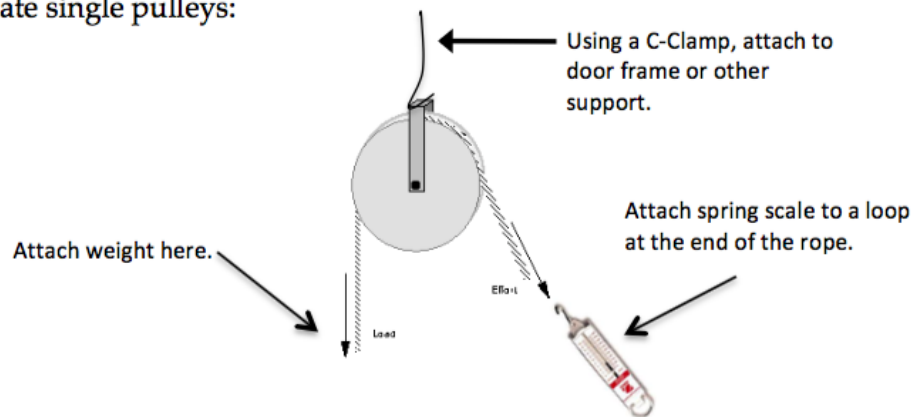


Black Box Model

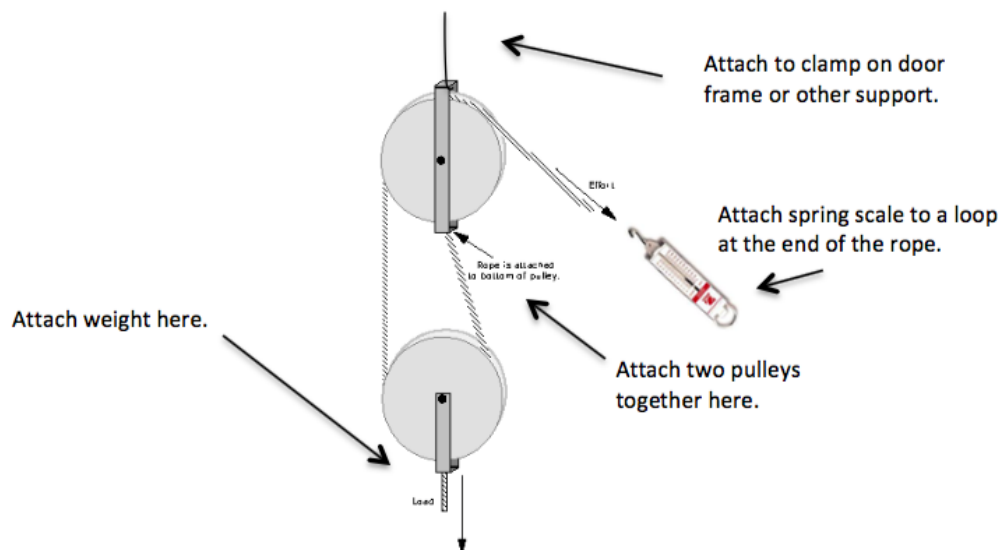
input -> X -> output

pull down -> -> bucket goes up

Investigate single pulleys:



Investigate mechanical advantage with pulleys:



change	raising a flag on a flagpole
Systems of pulleys	wheel-and-axle mechanisms
can reduce	engines

Complete the paragraph below by choosing the appropriate word from the following options.

Pulleys are _____ with grooves that guide a rope or a belt. Pulleys _____ the direction of effort, and, if used in sets, _____ the effort needed to do work. Pulleys are used in many applications, such as _____, lifting a garage door, and lowering a bucket into a well. _____ in a block and tackle can lift _____ out of cars.

Questions to answer in groups:

- What are pulleys?
- What do pulleys do?
- What is the advantage of a pulley?
- What are some examples of pulleys?