

LESSON 9

The Pulley – A Special Kind of Lever

Goal 2. Simple Machines - The student will use scientific skills and processes to explain that simple machines such as levers, pulleys, and inclined planes reduce the amount of effort required to do work.

Essential Objectives: The student will be able to construct pulley systems to demonstrate that pulleys can reduce effort but increase the distance over which effort is applied.

The student will use the following skills and processes of science:

- Use metric units when measuring or collecting data. (MLO)
- Analyze data to identify possible trends and form conclusions. (MLO)
- Provide supporting evidence when forming conclusions, devising a plan, or solving practical problem.
- Demonstrate and explain that tools enable scientists and others to observe, estimate, measure, collect, and communicate scientific data and information (i.e., size, distance, motion). (MLO)

Teacher Background:

A pulley is a simple machine made up of a wheel around which a rope or chain is passed, and is used to lift heavy objects by changing the direction of the effort force or the amount of effort force. There are several kinds of pulley systems. A single fixed pulley is very similar to a lever as its fulcrum (wheel) is halfway between the effort force (person pulling) and the resistance.

Teacher Preparation:

- Read C53 – C55 for additional background about pulleys.
- Prepare a fixed pulley system for the demonstration.
- Make a transparency of TRG p. 56, “Class Data Table”

Materials Provided in the Kit:

For Teacher Demonstration:

- Pulley
- Ruler
- String
- Wooden block

For Each Group of Four Students:

- Two pulleys
- One meter of string
- Ruler
- Wooden block

Engagement:

1. Gather students in the discussion area and explain that they will be investigating a special kind of pulley in today's investigation.
2. Show them a single fixed pulley system with a weight attached and have students Think-Pair-Share to describe how the pulley is like a lever.
3. Record student responses on chart paper and post them for reference after the lesson.
4. Explain to students that they will have an opportunity to confirm or change their thinking about the similarities of the pulley and the lever in today's lesson.

Exploration:

1. Distribute a copy of *Discovery Works, Energy, Work, and Machines* to each pair of students and have them open to page C48, "The Pulley-A Special Kind of Lever."
2. Have students use strategic reading behaviors for reading to perform a task to preview the components of the investigation.
3. Clarify students understanding of the procedures, and distribute materials for the investigation.
4. Explain to students that they will follow the procedures on C48 and C49, Steps 1-7, to conduct the investigation.
5. Distribute Student Response Booklets to each student and have them open to SRB pp. 25-26, "Fixed and Movable Pulleys."
6. Explain to students that they will record the data from the investigation on Part I of the lab sheet. They will record their analysis of the data and conclusions on Part II of the lab sheet.
7. Direct students to work in their cooperative groups to conduct the investigation.

Explanation:

1. After students have completed the investigation and SRB pp. 25-26, have them discuss their results with the whole class.
2. Chart each group's data on a transparency of TRG p. 56, "Class Data Tables for Fixed and Movable Pulleys." Discuss similarities and differences in data from different groups and possible reasons for them.
3. Discuss the students' responses in Part II of the lab sheet.
4. Direct students to open the *Discovery Works* books to C53 and read about single fixed pulleys and single movable pulleys. When they have finished reading ask them how the article helped them to better understand the ways in which these pulleys work.

Class Data Table for Fixed and Movable Pulleys

Kind of Pulley Used	Weight of Object to Lift	Distance to Lift Object (m)	Amount of Force (N)		Work (J)
			Prediction	Actual	
SINGLE FIXED					
SINGLE MOVABLE					

Answer Key

- 3. When you used a movable pulley, in what direction did you pull on the string? In what direction did the object move?

Upward

- 4. Compare the weight of the object with the force you used to lift the object with a movable pulley.

Responses should indicate that the force needed to lift the object was much less than the weight of the object.

amt of force less than weight

- 5. What conclusions can you make about how each pulley arrangement helped you do work on the object?

Both pulleys made the force required to lift the objects less. The movable pulley reduces the effort force less than the single fixed pulley.

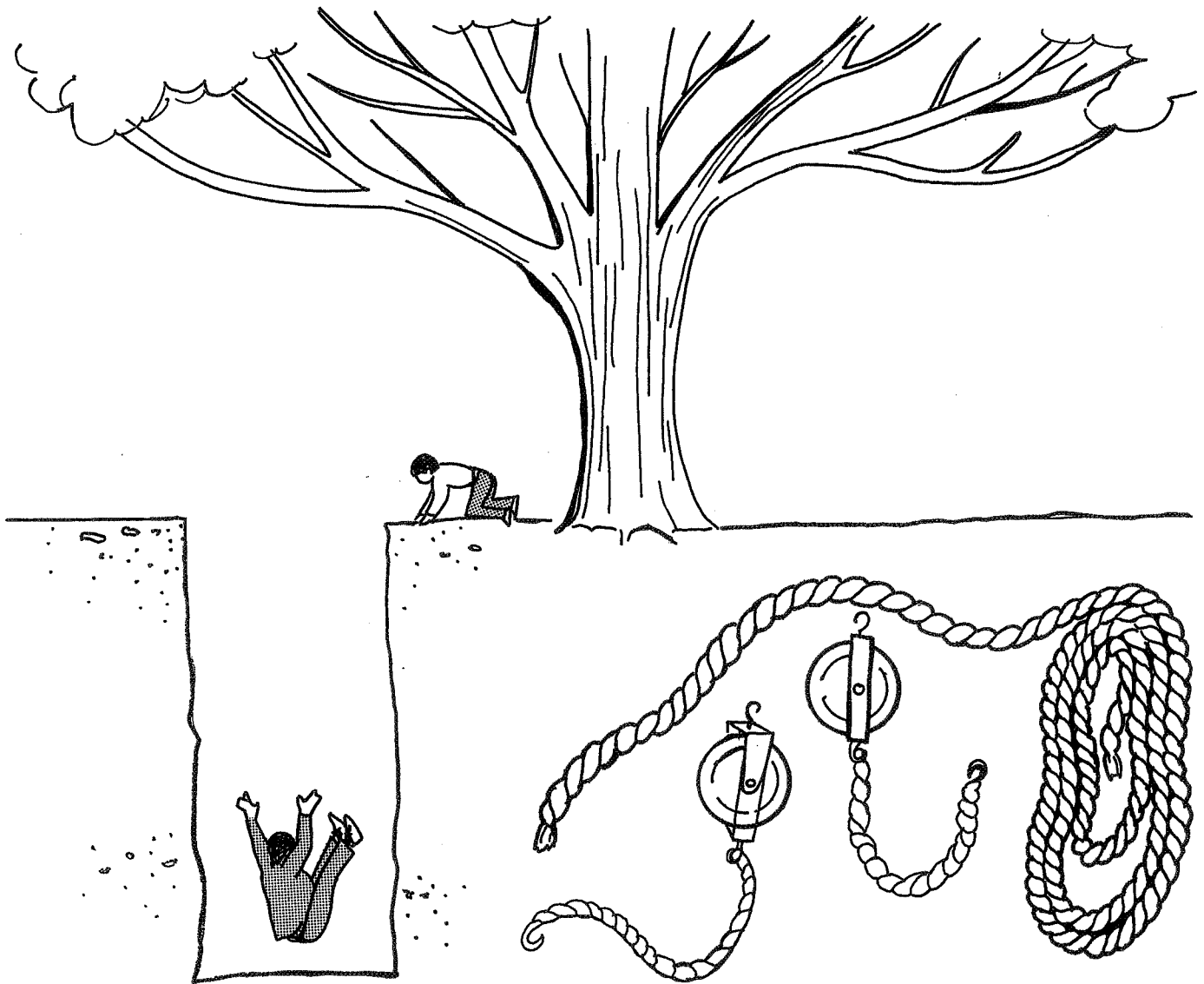
*more force
less effort
more*

- 6. How are a single fixed pulley and a first class lever similar? Support your answer with evidence from your investigations.

In a single fixed pulley, the pulley acts as the fulcrum between the force and the resistance. In a first class lever the fulcrum is also located between the force and the resistance. Refer to investigation for examples.

Both have a fulcrum

SOLVING A PROBLEM WITH A PULLEY



ACTIVITY

Imagine that a large man has fallen into a deep hole with slippery sides. Try as he will, he cannot climb out. At the top of the hole there is a long rope and a pair of pulleys that he was carrying to a job. Traveling with the man is a thin, but clever child. The man can shout instructions, but he cannot expect the child to run for help or pull him up. What should he tell the child to do in order to help him out of the hole? Write the directions. Then draw a picture of what you suggest.
