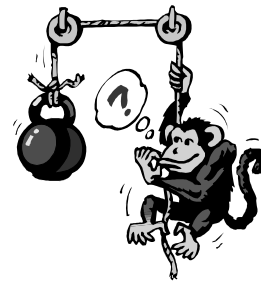




# PULLEY POWER



## **BENCHMARK and TASKS**

**SC.C.2.2.1** The student recognizes that forces of gravity, magnetism, and electricity operate simple machines.

- The student demonstrates that work is done every time a force is used to move something.
- The student identifies the six types of simple machines (screw, inclined plane, wedge, pulley, lever, wheel and axle).
- The student demonstrates how simple machines are used to accomplish work.

## **KEY QUESTION**

How can pulleys make our work easier?

## **BACKGROUND INFORMATION**

Machines are mechanical devices that often permit people to do work more easily. Work is done any time a **force** is used to move an object. There are six types of simple machines: **lever, wheel and axle, inclined plane, pulley**, wedge, and screw.

The pulley is a wheel with a groove along the edge of the wheel to hold a line or rope. Using a single, fixed pulley (a pulley that stays attached in one place, as in this activity) allows the direction of the force to be changed. When we pull down, the load is moved up. The amount of force needed to lift the tiles will be about the same both with and without a pulley. However, it will be easier to lift the tiles because pulling the rope down is easier than lifting the load up. Pulleys may be movable or fixed. They are used to raise flags, open and close drapes, lift heavy objects, create a movable clothesline, etc.

A spring scale is the instrument we use to measure the weight of an object. Weight is the gravitational force pulling an object towards the center of the earth. If weight is the force of **gravity** acting on an object when we measure weight, we are really measuring force acting on the spring. We can measure force by observing how far a spring stretches if we know how far it will stretch for a certain force or load. Most spring scales have two scales so you can measure weight in grams and force in newtons.

## **MATERIALS**

### **Teacher**

1 broom or other long, strong dowel  
1 meter of rope  
1 bucket of blocks, books, or heavy objects  
*Early Bird Physics Series*, Sally M.  
Walker and Roseann Feldman,  
Lerner Publications Co., 2002

### **Per group**

1 single pulley  
15 ceramic tiles or metal washers  
1 spring scale  
3 ft. pulley cord or rope  
1 strong, zipper-type baggie  
1 paper clip

### **TEACHING TIPS**

1. Make sure the rope or cord fits into the groove of the pulleys being used.
2. Make sure students have had experiences using spring scales. If not, you will need to allow time for exploration and instruct them in how to read a spring scale.

### **ENGAGE**

Show students the bucket of books. Lift the loaded bucket up as high as the seat of a chair. Ask the students for suggestions as to how you might make this work easier. Let students demonstrate their ideas. Demonstrate how to use the broomstick and rope to lift the bucket an easier way:

- Place the broom handle across the back of two chairs set about two feet from each other.
- Tie the rope to the handle of the bucket and drape it over the broom handle.
- Pull down on the loose end of the rope to lift the bucket up to the height of the chair seat.
- Let students who demonstrated other methods now try to lift the bucket this way.
- Discuss which way seemed easier.
- Explain that this was a simplified model of a pulley, one kind of simple machine. Remind students that there are six types of simple machines: lever, wheel and axle, inclined plane, pulley, wedge, and screw. Refer to the Tree Map the class has been keeping and tell students you will be adding examples of pulleys.

### **EXPLORE**

1. Show students the pulleys. Demonstrate how to set up a pulley system, using the pulley, the rope, and the spring scale. Discuss the pulleys that are to be used; some may have clamps while others may have hooks for hanging. Discuss the various places and ways students could set up the pulleys. Pulleys with hooks could hang from ring stands. Pulleys with clamps could be clamped to many different surfaces. One team member could hold the pulley.
2. Distribute materials to each group. Have students put 15 tiles inside the baggie, close it, attach a paper clip, and then hook it to the spring scale. This will be the load.
3. Show students how to lift the baggie straight up by slowly pulling up on the spring scale. Make sure students observe the spring scale while lifting the baggie. Ask: *How much force is needed to lift the tiles?* Have students record the force in newtons on the *Pulley Power* sheet.
4. Help each group set up a pulley system to lift the baggie containing 15 tiles. Once a pulley system has been constructed, have students attach the spring scale and measure the force required to lift the baggie containing 15 tiles.
5. Have students lift a baggie containing 10 tiles straight up without a pulley and with a pulley. Each time, the spring scale should be used to measure the units of force required, and the measurement should be recorded on the *Pulley Power* record sheet.
6. Finally, students will lift a baggie containing 5 tiles straight up without a pulley and with a pulley and record the measurements on the *Pulley Power* sheet.

### **EXPLAIN**

*Which way was easier to lift the baggie - straight up or with the pulley?*

*When you used the pulley, which way did you pull - up or down? (down – The pulley changes the direction of the force.)*

*How did the measurements on the spring scale differ with and without the pulley each time? (**The amount of force needed to lift the load of tiles will be approximately the same both ways**, but it will be easier to lift with the pulley because pulling down on the rope is easier than lifting up the load. The pulley changes the direction of the force.)*

*Was any work accomplished? (Yes, because force was used to move the baggie of tiles.)*

*How are pulleys used to help us accomplish work?*

### **EXTEND/APPLY**

1. Take a walk around the school so students can look for pulleys. Discuss why the pulleys are being used and how they work.
2. Arrange for the class to have a demonstration of how the flag is raised and lowered.
3. Share the *Early Bird Physics Books*. The titles include: *Work, Inclined Planes, Screws, Wedges, Levers, Pulleys, and Wheels and Axles*.

### **ASSESSMENT**

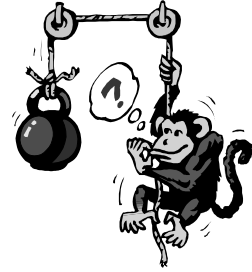
Have students reflect in their journals: *How can pulleys make our work easier?*

Investigators \_\_\_\_\_



## PULLEY POWER

Directions: Use this chart to record the data from the investigation.



<b>LOAD</b>	<b>LIFT</b>	<b>AMOUNT OF FORCE REQUIRED (newtons)</b>
<b>15 tiles</b>	<b>Without Pulley</b>	
<b>15 tiles</b>	<b>With Pulley</b>	
<b>10 tiles</b>	<b>Without Pulley</b>	
<b>10 tiles</b>	<b>With Pulley</b>	
<b>5 tiles</b>	<b>Without Pulley</b>	
<b>5 tiles</b>	<b>With Pulley</b>	