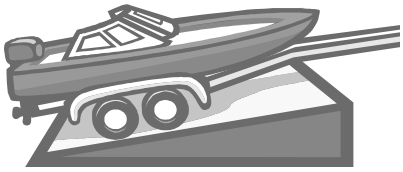


ARE YOU SO INCLINED?

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 do we use inclined planes, screws, and wedges to help us accomplish work?

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 – machines with few, if any, moving parts: **lever**, **wheel and axle, inclined plane**, **pulley**, wedge, and screw. An inclined plane enables an object to be moved with less force. An inclined plane, such as a ramp or a sliding board, is a simple machine that has no moving parts. The use of a ramp makes it easier to move objects up and down over a distance. The angle of an inclined plane affects how much force is needed to move a load up or down. The greater the angle of the incline, the greater the amount of force needed. Stairs and escalators are inclined planes. An inclined plane enables us to use less force to do about the same amount of work by distributing the force over a greater distance. A screw is an inclined plane wrapped around a shaft. Jar lids, bolts, and drills are screws. A wedge is also a modified incline plane. A wedge is usually made up of two inclined planes placed back to back. Wedges are used to separate two objects from each other or to split a solid object. Force is applied to the wide end of the wedge, which forces the narrow end into the object. The object widens at this opening, thus allowing the wedge to penetrate deeper each time force is applied. Nails, knives, and pins are wedges.

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

Per group

markers
tape
markers
1 flat board or other surface for the inclined plane
1 spring scale
6 or more books of the same thickness
scissors
1 strong, zipper-type baggie
1 paper clip
Are You So Inclined? data sheet
1 metric ruler
1 cup of popcorn kernels or rice
(or other mass, such as metal washers)

Per student

half sheet of paper
pencil

Teacher

1 pulley
1 pair of scissors
1 nail
1 jar with screw type lid
1 ramp
1 toy car with a wheel and axle
Early Bird Physics Books, Sally M. Walker and Roseann Feldman, Lerner Publications Co., 2002
Simple Machines, Lola M. Schaefer, Benchmark Education Co.

TEACHING TIPS

1. Give students ample time to explore with spring scales before doing the activity. Explain that force can be measured in units called newtons (N). Have students locate the N scale on the spring scales before starting the activity.
2. Folded game boards (e.g., Monopoly, checkers) can be used as inclined planes.

ENGAGE

1. Display a ramp, a pulley, a jar with a screw-type lid, a pair of scissors, a toy car with a wheel and axle, and a nail. Ask students to think about what these items have in common. After allowing time for students' responses, explain that these are all examples of simple machines (ramp – inclined plane, pulley, screw-type lid – screw, scissors – lever, toy car - wheel and axle, and nail – wedge). Ask: *Why do you think people use machines?* Explain that machines are mechanical devices that allow people to accomplish work. Sometimes they save time and/or energy.
2. Share the book, *Simple Machines*, by Lola M. Schaefer
3. Tell students there are six types of simple machines: the lever, the wheel and axle, the inclined plane, the pulley, the wedge, and the screw. Write these on a chart in the form of a Tree Map. As students discover examples of these simple machines, they can be added to the Tree Map throughout the unit of study.

4. Explain that in this activity students will be exploring three of the six types of simple machines: inclined plane, wedge, and screw.

EXPLORE (Part 1)

1. Distribute the materials and record sheet to each group. Allow time for students to explore the spring scales. Teach them how to read the spring scale in newtons, units of force.
2. Have students fill the baggie with one cup of popcorn kernels or rice. Attach a paper clip to the top of the baggie. This will be the load.
3. Show students how to attach the spring scale to the paper clip on the baggie. Have each group stack 2 books and place the board at an angle to create an inclined plane.
4. Tell students to pull the baggie slowly and evenly up the inclined plane. The spring scale should still be attached. Students should pull the spring scale keeping it parallel to the incline. Remind students to observe the spring scale and record the measurement in newtons on the chart.
5. Instruct students to repeat the process using 4 and then 6 books to increase the angle of the inclined plane. (Use additional books, if the books are not thick enough.) After each pull, students should record the measurement in newtons on the chart.
6. Finally, students will slowly lift the spring scale to raise the attached load straight up as high as the top of the stack of 6 books. This will allow them to compare a straight-up lift to a lift using an inclined plane. Students should read the measurement on the spring scale in newtons and record this amount of force on their chart.
7. Have students measure the length of the ramp in centimeters.
8. Then have students measure the height of the stack of 6 books in centimeters. Compare the two measurements.

EXPLAIN (Part 1)

Which incline required the least amount of pulling force? Why do you think so? (The 2-book incline required the least amount of force because it was not as steep.)
Which incline required the most amount of pulling force? Why do you think so? (The 6-book incline required the most amount of force because it was steeper than the other two.)
How does the angle of an inclined plane affect the amount of force needed? (The steeper the angle, the more force is required.)
What was the reading on the spring scale on the straight up lift with no inclined plane?
How does the amount of force required to lift an object straight up compare to the amount of force required when an inclined plane is used to lift an object to the same height? (Less force is required when an inclined plane is used.)
Which covered a greater distance – lifting the load straight up or pulling the load up the incline? (The load was moved a greater distance when it was pulled up the inclined plane than when it was lifted straight up, but less force was required. An inclined plane enables us to use less force to do about the same amount of work by distributing the force over a greater distance.)
Was any work done when the baggie was pulled up the inclined plane? (Yes, because a pulling force was used to move the baggie.)

EXPLORE (Part 2)

1. Give each group: a half sheet of paper, scissors, tape, and a pencil. Tell students they are going to make a model of another simple machine – the screw.

2. Demonstrate as you instruct students how to make the model of a screw. Tell students to begin by making a small dot in one corner of the paper.
3. Measure 20 cm along one edge from the dot and make an X. Measure 10 cm along the other edge from the dot and make an X.
4. Then have students use a ruler to draw a straight line from X to X so that they have a triangle.
5. Students should trace the line with a marker so that it can be easily seen and then cut just outside the line.
6. Ask: Wh*at simple machine does this triangle look like?* (A screw is a modified inclined plane!)
7. Place one plain edge of the triangle next to a pencil, making sure you can see the colored line.
8. Wrap the triangle tightly around the pencil and tape the end.

EXPLAIN (Part 2)

What does this look like? (a large screw)
How does it resemble a screw? (The colored line looks like lines wrapped around the screw. It looks like more than one line, but it is only one – just like the threads on a screw. You can trace it without lifting your finger.)
How is a screw different from a nail? (A nail has no threads.)
What was it before we wrapped it around the pencil? (an inclined plane)
Where are some places screws are used? (screw-type jar lids, door hinges)
How do screws make our work easier? (Turning a screw with many thread lines is like walking up a long slope. The screw has to be turned more times, but each turn takes less force. That makes your work easier.)

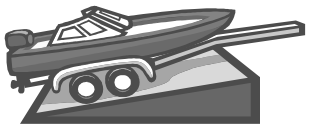
EXTEND AND APPLY

1. Hold up a doorstop or another type of wedge and ask students to describe the object. Students will likely mention that it resembles an inclined plane. Explain that a wedge is really two inclined planes put together. A wedge's pointed end makes it easier to move things apart. It would be very hard to hammer a nail into wood if its tip were not wedge-shaped. The wedge-shaped tip makes it easier because the wedge pushes the wood apart. Ask students if they can think of some other examples of wedges that can be added to the Tree Map.
2. Share the *Early Bird Physics Books*. The titles include: *Work, Inclined Planes, Screws, Wedges, Levers, Pulleys, and Wheels and Axles.*

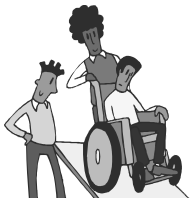
ASSESSMENT

Have students list one or more examples of an inclined plane, a screw, and a wedge and explain how each one helps us to accomplish work.

NAMES _____



ARE YOU SO INCLINED?



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

DEGREE OF INCLINE	AMOUNT OF FORCE REQUIRED (newtons)
2 Books	
4 Books	
6 Books	
Straight Up (Height of 6 books)	

1. Which requires more force – lifting an object straight up to a certain height or using an inclined plane to lift an object to a certain height?

   _____

2. Measure the height of the stack of 6 books in centimeters. _____

3. Measure the length of the ramp in centimeters. _____

4. Which covers a greater distance – lifting the baggie straight up or using the ramp? _____