Toying With a Wheel and Axle

Topic
Simple machines: wheel and axle

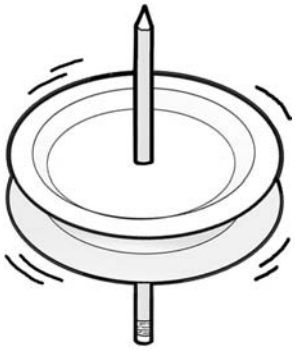
Key Question
How is a top a simple machine?

Learning Goals
Students will:
- make a top,
- identify the wheel and axle,
- observe the speed at which the wheel turns, and
- model the speed of the wheel and axle system.

Guiding Documents
Project 2061 Benchmarks
- *Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. Investigations can focus on physical, biological, and social questions.*
- *In something that consists of many parts, the parts usually influence one another.*

NRC Standard
- *The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.*

Science
Physical science
force and motion
simple machines
wheel and axle



Integrated Processes
Observing
Comparing and contrasting
Applying

Materials
For each student:
2 small paper plates (see *Management 1)*
white glue
craft stick
pencil (see *Management 2)*
masking tape
circle template
pushpin
student page

Background Information
The wheel and axle is a simple machine composed of two wheels. The larger wheel is called the wheel; the smaller wheel is called the axle. In order for these two wheels to function as a simple machine, they must be attached and move together.

Wheels and axles are found in doorknobs; screwdrivers; bicycle mechanisms; steering wheels; faucets; and the wheels on luggage, cars, hand trucks, etc.

Like all simple machines, there is a trade off of force for distance, or distance for force. With the screwdriver, the force is applied to the wheel. It turns the axle, increasing force but sacrificing distance and speed. When the force is applied to the axle, as with a bicycle, force is decreased and distance and speed are increased.

In this experience, students will discover that the little force applied to the axle of a top is translated into a great distance (and greater speed) at the wheel.

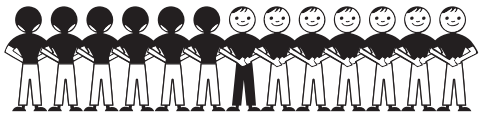
Management
1. Use stiff cardboard paper plates. Plates with 7-inch diameters work well. These are usually found in the party section of grocery and department stores.
2. Pencils that are about 15 cm (6 inches) long work best. Make sure there is an eraser on each one as this provides friction for the spinning top.
3. Students can each make a wheel and axle top. The construction is fairly simple and the experience helps them understand the components of the wheel and axle system.
4. A large cleared area is needed when students model the wheel and axle. This can be done in the classroom if desks/tables are moved out of the way, or it can be done outdoors or in an all-purpose room.

Procedure
Making the Wheel
1. Ask the *Key Question*.
2. Distribute the paper plates, white glue, and craft sticks.
3. Direct students to put a quarter-sized pool of glue on the back side of one of their paper plates. Have them use the craft sticks to spread the glue on the bottom, not including the curved lip of the plate. There should be a very thin coat of glue. Too much glue takes too long to dry.

4. Have students put the back side of the other paper plate on the glued one. Tell them to set the plates aside so the glue has a chance to dry.
5. Inform them that while the glue is drying, they are going to see what happens when the axle of a wheel and axle system is turned. Make sure that students realize that the wheel is the larger of the two parts.

Modeling

1. Take the students to the area chosen in which they can model a wheel and axle.
2. Invite one student to the center of the area. Tell the others that this student represents the axle. Have this students bend his or her arms with fists on the hips. Tell the class that the axle and wheel must be connected. Looping arms will connect the two.
3. Have six students line up on each side of the "axle," interlocking their arms. Direct those on the right arm of the axle to face toward his/her back and those on the left arm to face toward his/her front.



4. Tell the students that as the axle starts turning, they are to keep their lines straight and turn at the same time. Help them get started.
5. As they are turning, discuss how the axle is only moving a little, but the wheel is moving a lot—and at a greater speed.
6. Let the other students in the class model the wheel and axle.

Making and Using the Top

1. In the classroom, distribute a pushpin, the circle template, and a pencil to each student.
2. Direct students to place the circle templates on their paper plates. Have them use the pushpin to poke a hole at the midpoint of the circle. Tell students to hand in the pushpins and remove the circle templates.
3. Have students gently push the points of their pencils through the holes made by the pushpins. Tell them to push the pencils through until there are about 5 or 6 centimeters left on the eraser end.
4. Show them how to hold the pencil, pointed-end up, and flick it with the fingers to make the top spin. Discuss how the pencil is the axle and the paper plate is the wheel.
5. If the hole is too big for the pencil to turn the top, wrap a length (6-10 centimeters) of masking tape above and below the pencil so the plates don't slip.
6. Distribute the student page. Have students record their observations and label the parts of the system.

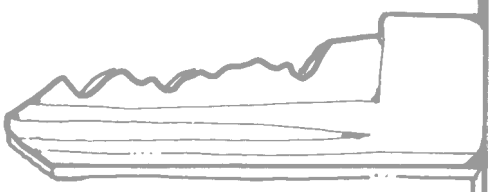
Connecting Learning

1. What is a wheel and axle? [It is a simple machine made of two different-sized wheels that are attached to each other.]
2. What part of the top was the wheel? [the paper plate] What was the axle? [the pencil]
3. To which part did you apply a force? [to the axle]
4. What happened to the wheel when you turned the axle? [It turned too. It turned faster than the axle.]
5. Explain how our linking arms and turning modeled the motion of our wheel and axle top.
6. What did you notice about the speed of the people on the ends?
7. How do you think the speed of the people on the ends compared to the speed of the people in the third positions? [The end people went faster than the third people. The third people went faster than the axle.]
8. What would happen to the speed of the wheel if we put 10 students in a row from the axle?
9. What would happen to the speed of the wheel if we used a larger paper plate on our wheel and axle top?
10. How is our top like a merry-go-round?
11. What are you wondering now?

Extension

1. Have students count the number of steps they took to make a complete circle when they were modeling the motion of a wheel and axle.
2. Have the entire class link arms, half on one side and half on the other, and turn like a wheel and axle.

Toying With a Wheel and Axle



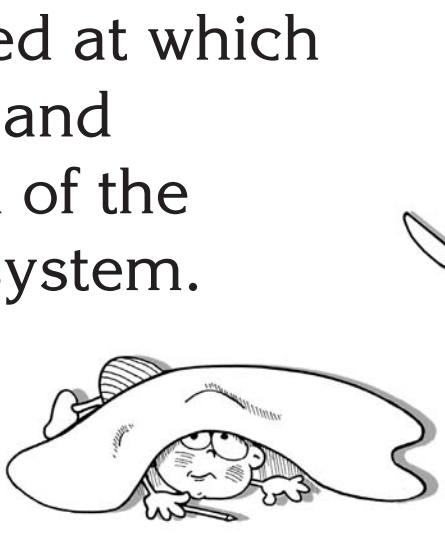
Key Question

How is a top a simple machine?

Learning Goals

Students will:

- make a top,
- identify the wheel and axle,
- observe the speed at which the wheel turns, and
- model the speed of the wheel and axle system.



Toying With a Wheel and Axle

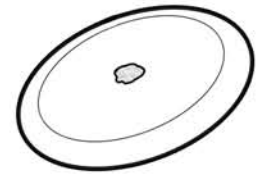
Making the Top

You will need:

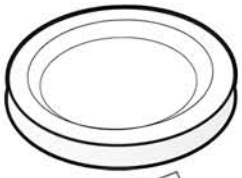
2 small paper plates	pencil
white glue	circle template
craft stick	pushpin

Do this:

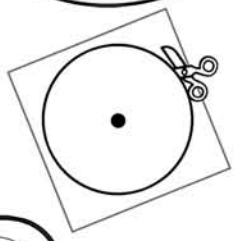
1. Put a quarter-sized puddle of white glue on the back side of one of the plates. Spread it over the bottom of the plate with the craft stick. Don't put glue on the lip of the plate.



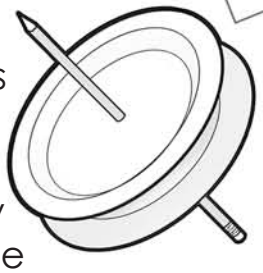
2. Put the back side of the other paper plate on the glued one. Set them aside to dry.

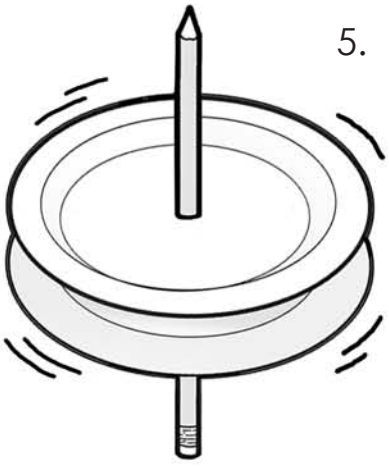


3. Cut out the circle template. Put it on the top of one of the paper plates. Use the pushpin to poke a hole at the midpoint of the circle.



4. Gently push your pencil through the hole until there are only 5-6 centimeters left on the eraser end.

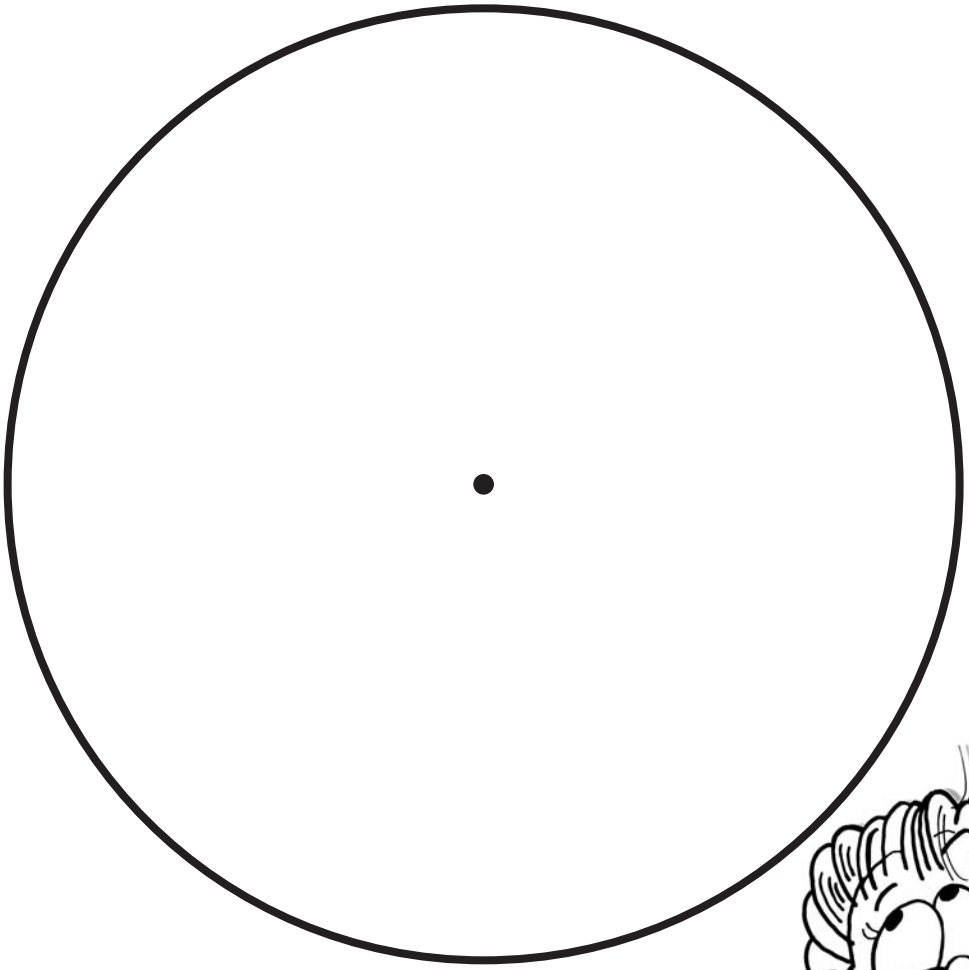




5. Your top is now ready to spin. Hold it with the pencil-point up. Flick it with your fingers to make it spin.

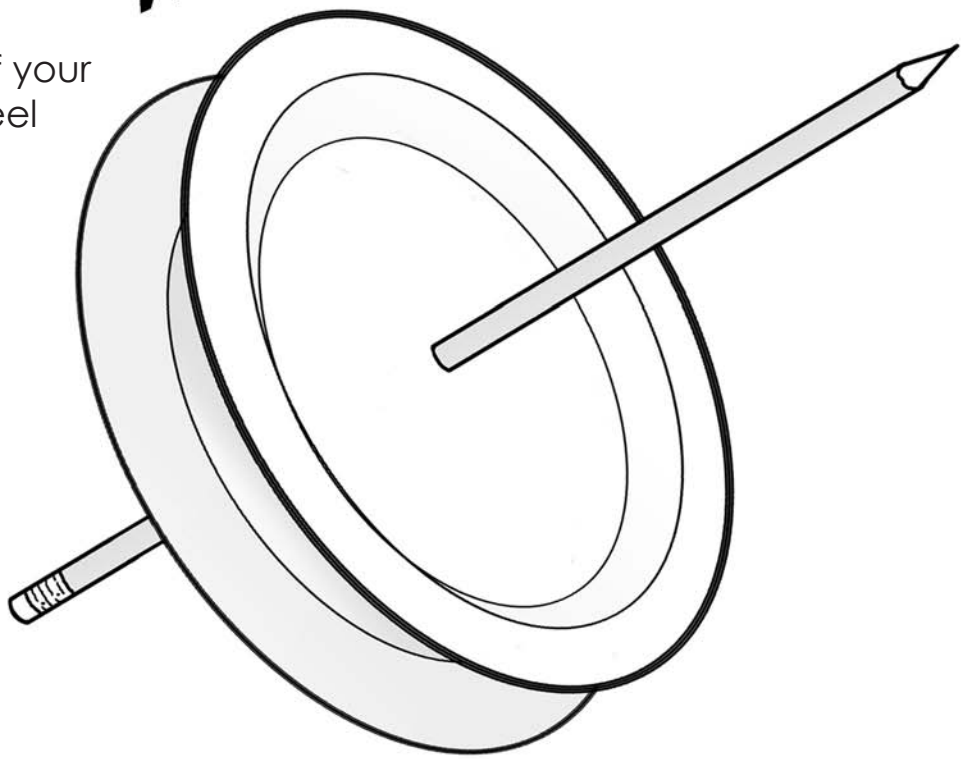
Toying With a Wheel and Axle

Circle Template

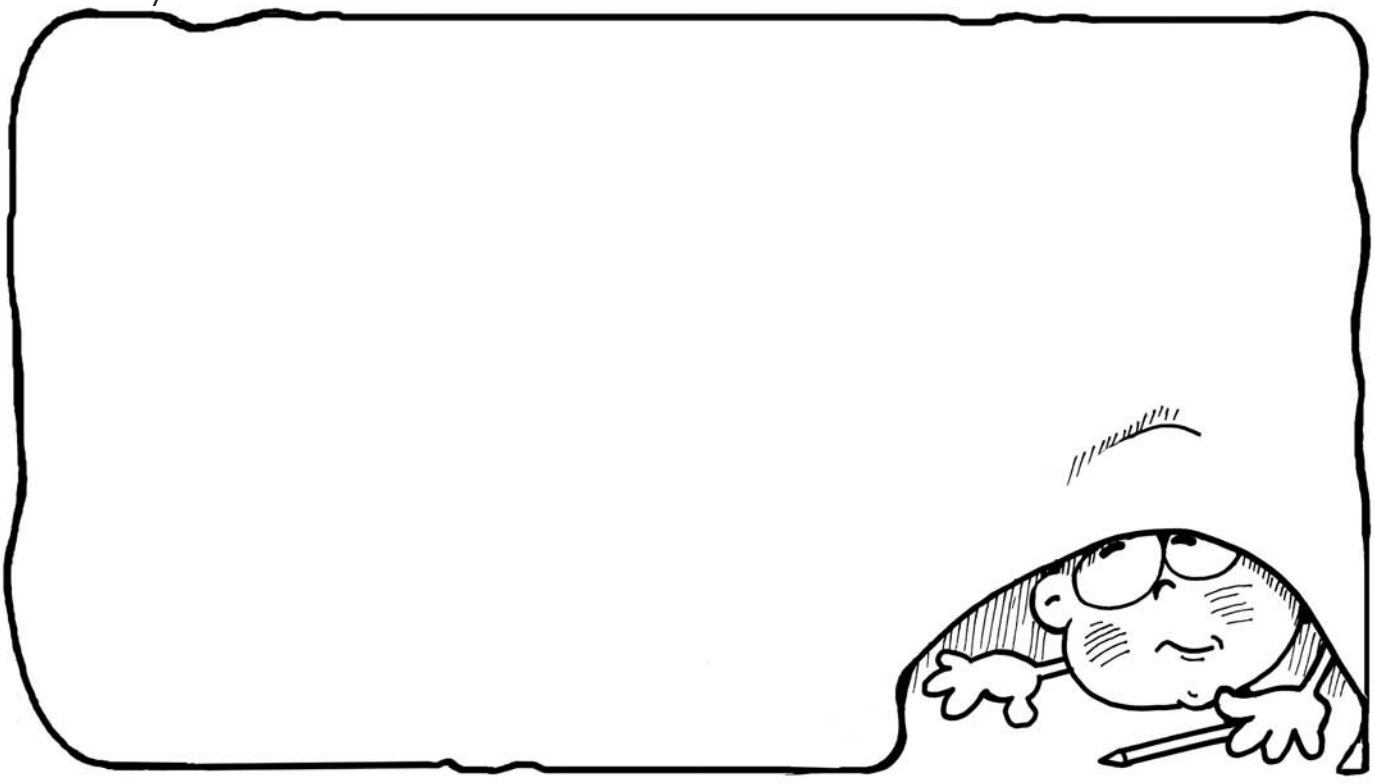


Toying With a Wheel and Axle

Here is a picture of your top. Label the wheel and axle parts.



Record your observations.



Toying With a Wheel and Axle

Connecting Learning

1. What is a wheel and axle?

2. What part of the top was the wheel? What was the axle?

3. To which part did you apply a force?

4. What happened to the wheel when you turned the axle?

5. Explain how our linking arms and turning modeled the motion of our wheel and axle top.

6. What did you notice about the speed of the people on the ends?

Toying With a Wheel and Axle

Connecting Learning

7. How do you think the speed of the people on the ends compared to the speed of the people in the third positions?

8. What would happen to the speed of the wheel if we put 10 students in a row from the axle?

9. What would happen to the speed of the wheel if we used a larger paper plate on our wheel and axle top?

10. How is our top like a merry-go-round?

11. What are you wondering now?

Thank you for your purchase!

Please be sure to save a copy of this file to your local computer.

This file contains materials developed by the AIMS Education Foundation. **AIMS** (**A**ctivities **I**ntegrating **M**athematics and **S**cience) began in 1981 with a grant from the National Science Foundation. The non-profit AIMS Education Foundation publishes hands-on instructional materials that build conceptual understanding. The foundation also sponsors a national program of professional development through which educators may gain expertise in teaching math and science.

AIMS Education Foundation
1595 S. Chestnut Ave., Fresno, CA 93702-4706
permissions@aimsedu.org
888.733.2467 • aimsedu.org