Bay Area Scientists in Schools Presentation Plan

Lesson Name Simple Machines: the Application of Forces
Presenter(s) Taiki Murakami and Sehra Rahmany

Grade Level 2 **Standards Connection(s)** Simple Tools and Machines

Teaser:
This lesson is designed to introduce students to the concept of a force through a demonstration of simple machines. To highlight some practical applications of the Newtonian laws of motion, this lesson will focus on two of the six classical examples of simple machines; the pulley and inclined plane (students are not required to be familiar with Newton's laws). Students will be asked to describe what they believe to be a simple machine before a formal definition is given. For the pulley demonstration, the students will be given time to design their own pulley, before a more efficient design will be introduced. During the inclined plane demonstration, students will determine experimentally if an inclined plane aids in raising a load to higher ground. The class should be broken into groups and each student should have a chance to use each simple machine. At the end, a matching exercise, through means of in class participation or a worksheet, should help students identify different types of simple machines.

Objective: *As a result of your lesson, what will students learn? What will they be able to do?*

Students should be able to recognize the benefit and usefulness of simple machines given an appropriately applied force. They should also be able to place this lesson into a larger context and begin to relate physics to everyday phenomena.

Vocabulary/Definitions: *3 – 6 important (new) words*

- Force: The energy of a push or a pull
- Simple Machine: A machine that has few or no moving parts and makes work easier.
- Pulley: A small wheel with a grooved rim and a rope that makes lifting heavy objects easier.
- Inclined Plane: A flat surface tilted at an angle with one side higher than the other.

Materials:

For each group:

- *Two each broom handles or smooth rods*
- *One each strips of rope of equal length of at least 18 feet*
- *One each weight with handle of 5-10 lbs (e.g. bag with books, capped jug of water, a loaded bucket ect.)*
- *Duct tape*
- *One each rubber band*

- *5 to 6 textbooks*
- *One each baggy of dried beans*

Students should have a ruler, paper and pen/pencil.

Classroom Set-up:
This lesson should be done preferably at a playground that has monkey bars and a slide, where results from demonstrations can be more dramatic and appealing. However this lesson can also be done in-class, but on a smaller scale, in which case desks would need to be re-arranged to allow for rods to be taped between desks. Students should be broken into groups of 5-10.

Classroom Visit

1. Personal Introduction: 5 Minutes

My name is Taiki Murakami and I am a civil engineer major attending Los Medanos College in Pittsburg, CA. My partner Sehra Rhamany is a neurobiology major attending the same school. With her assistance, I would like to show students some fundamental applications of physics through demonstrational use of simple machines. Simple machines are important to understand in all fields of engineering and craftsmanship, and students should be able to recognizing their usefulness. This lesson exploits children's curiosity in technology and shows them the basics of how machines work.

Topic Introduction: 10 Minutes

What questions will you ask to learn from students? Big Idea(s), vocabulary, assessing prior knowledge…

Asking students to describe a force and a machine will indicate students' background knowledge. A prior understanding of Newton's Laws of Motion would be great, but this is not required, and a basic definition of a force is all that is needed for this lesson. I'll next explain to the class what a simple machine is, and what makes it a machine, prior to the pulley demonstration.

2. Learning Experience(s): 30 Minutes
What will you do, what will kids do? Demonstrations, hands-on activities, images, games, discussion, writing, measuring… Describe in order, including instructions to kids.

Pulley: Students should be broken into groups of 5 to 10 with each group receiving some rope and a weighted load (as described under materials). A broom handle should be taped to the top of two desks spaced apart to form an elevated bar. First, give the students 5 to 10 minutes to devise a way of using the rope to pull the weight to the top of the bar. Next, instruct them on

how to use the rope as a pulley. Tie one end of the rope to the load (if not already done so) and throw the second end over the bar. Then loop the end through the handle a second time, and feed the free end over the same bar. If there's enough length of rope, feed the rope through the handle and over the bar a third time. Once each group has done this, instruct them to pull the jug to the top of the bar, and ask them if this method made pulling the weight easier.

Inclined Plane: Have each group do the following:
Stack the books with one book leaning up against the stack. Cut a rubber band and tie one end of it to the bean-bag. Make two marks on the un-stretched band and take an initial measurement between the markings. Record this reading on paper. Next, raise the beanbag strait up to the top of the stacked books, and measure the stretched distance between the markings. Record this final reading. Repeat this step by dragging the bag up the inclined book and taking another reading. Have the students compare the two final readings with the initial and decide which method used less work. This should lead into an explanation of how useful inclined planes are, but that what you gain in effort, you pay in distance.

Both activities can be adapted for an outdoor demonstration on a playground with monkey bars and a slide. The pulley activity is essentially the same as before except that the monkey bars should be used and about 50-ft of rope would be needed. The inclined plane activity should utilize the slide and be set up as a competition. Two teams (no more than three each) would station themselves at the top of a slide, with one team pulling a load up the slide with the other team pulling a load straight up from the ground. Both these activities would more drastically demonstrate the need for simple machines.

3. Wrap-up: Sharing Experiences **10 Minutes**

Putting the pieces together – how will students share learning, interpret experience, build vocabulary?

Discuss with the class their experience with the pulley and inclined plane, and how if used correctly, these simple machines can be used to a great advantage.

4. Connections & Close: **5 Minutes**

What else might kids relate this to from their real-life experience? How can they learn more? Thanks and good-bye! Clean-up.

Have the class think of examples of pulleys and inclined planes they see in their everyday life. The class should be able to identify the different types of simple machines and understand how they work. This can also be achieved by distributing a worksheet.

Total 50 – 60 Minutes

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Follow-up – After Presentation

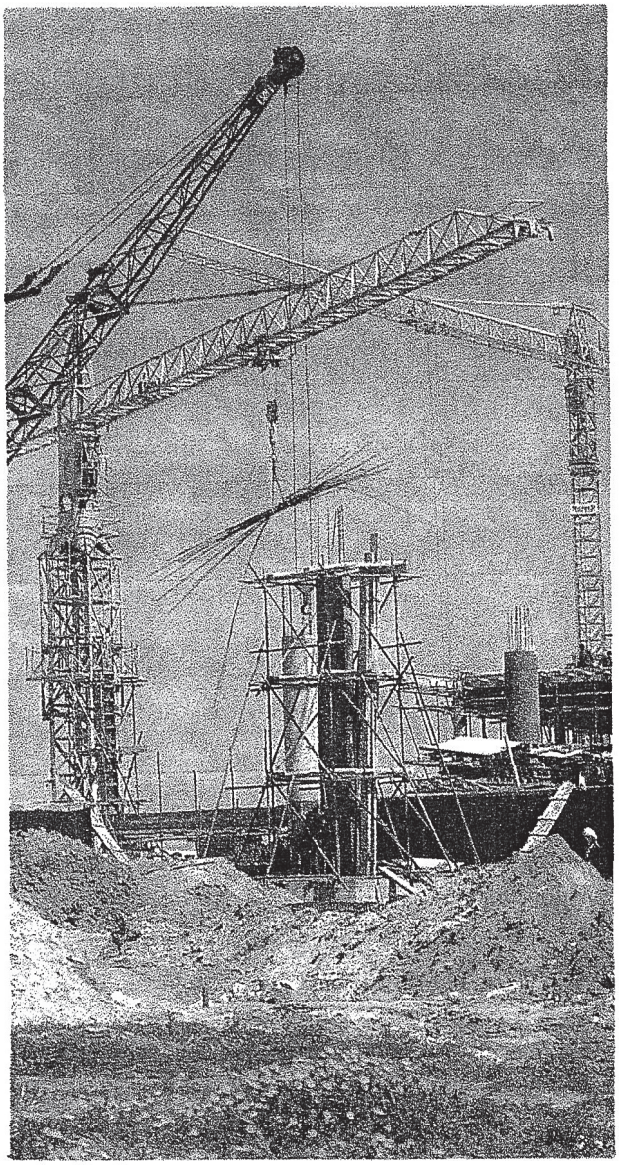
Suggest students write a letter explaining "How we learned about simple machines?"
List or attach examples of activities, websites, connections for additional learning.
Attach worksheets, hand-outs, visuals used in classroom presentation.

Follow-up lessons should cover the four other classical simple machines (the lever, wheel and axle, wedge, and screw) so the students have a well-rounded understanding of these mechanisms. The following website shows some lesson plans on simple machines that teachers can implement with their classrooms.

- http://canadaonline.about.com/gi/o.htm?zi=1/XJ&zTi=1&sdn=canadaonline&cdn=newsissues&tm=1317&f=10&tt=14&bt=1&bts=1&st=38&zu=http%3A//www.grc.nasa.gov/WWW/K-12/Summer_Training/KaeAvenueES/SIMPLE_MACHINES.html

Pulley Power

Pulleys are a special sort of wheel. A pulley wheel has a groove all around the rim for a rope to fit into. If you attach one end of the rope to a heavy load you can lift it more easily.



Cranes use pulleys and levers (see pages 114–115) to help them lift heavy loads. Count the number of pulleys on the cranes you see. The biggest cranes have three or four pulleys. A motor provides the power to pull the cable over the pulley wheels.

Brush and Rope Trick

Amaze your friends with your super strength using this simple trick. Ask two or four friends to hold two brush handles apart. Attach a length of rope to one brush and thread it around the two brushes as shown in the diagram. Take hold of the free end yourself. Ask your friends to try and keep the brushes apart while you try and pull them together. You should find that you are easily able to beat the pulling power of your friends.

Hint: Dust the brushes with talcum powder before you give them to your friends to hold. This will reduce the friction and make it easier for you to pull the brushes together.

Make Your Own Pulleys

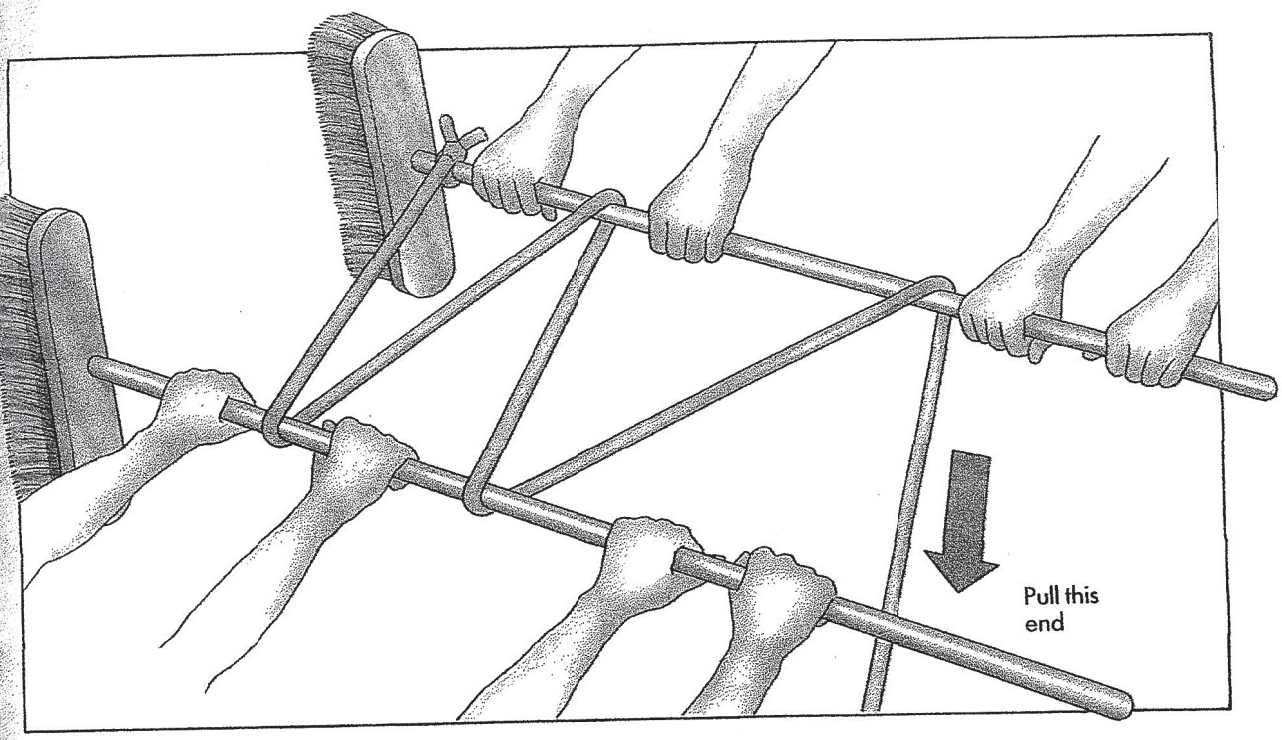
1. Bend about 8 inches (20 cm) of wire into a triangle shape and push the ends into a thread spool. (Ask an adult to help you cut and bend the wire.)
2. Find a suitable place to hang your pulley. A hook in the shed or garage or the hook at the end of a plant hanger wil do.
3. Tie one end of the string to the handle of the load.
4. Wind the string over the thread spool.

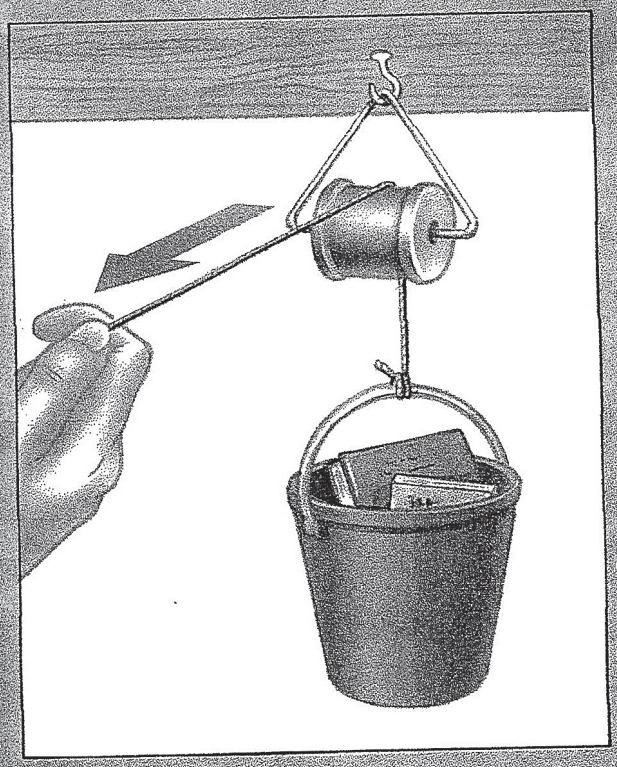
- Is it easier to lift the load with the pulley?
- How much string do you have to use to lift the load 1 foot (30 cm)?

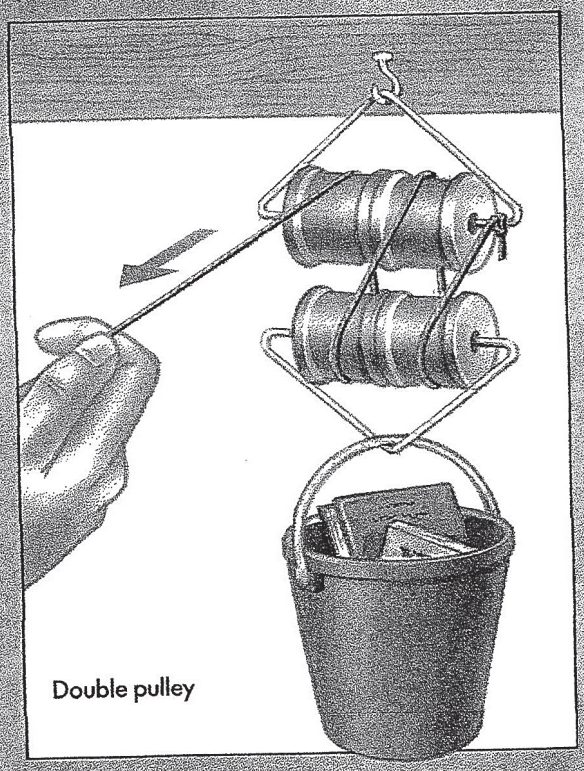
Now try a double pulley . . .

1. Make two wire triangles. Use about 1 foot 2 inches (35 cm) of wire for each one.
2. Attach two spools to each triangle.
3. Thread the string around the pulleys as shown in the diagram. Use about 6½ feet (2 meters) of string.
4. Attach the heavy load to the pulley as before.

Equipment: Wire, thread spools, string, a hook, toy bucket full of heavy objects.





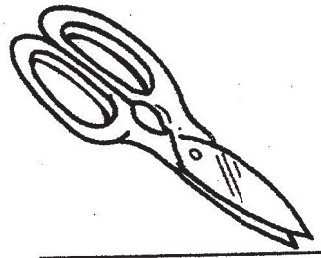


Double pulley

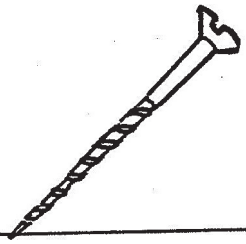
- Is it easier to lift the load with the double pulley?
- How much string do you need to raise the load 1 foot (30 cm)?

How it works
The pulley with one thread spool allows you to lift a heavy load directly underneath the pulley. The double pulley means you have to pull only a quarter as hard, but you have to pull for four times as long.

Continuing intro

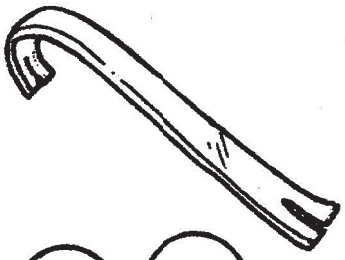


Concept:
Machines with few or no moving parts are called *simple machines.*

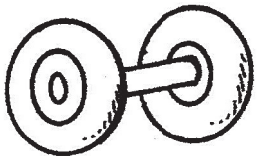


This concept will act as the third step of the learning model **Confirm Their Definitions.** The teacher will introduce each simple machine using a short story about two children, Luke and Brecca, and provide opportunities for the learners to work with those machines.

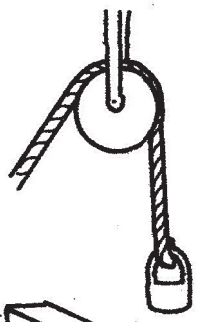
There are six kinds of simple machines presented in this story. Go into as much detail and do as many of the explorations as are appropriate for your students. Here is some general information about each type of simple machine.



Lever
A lever is a bar used for raising or moving a weight at one end by pushing down on the other end. In this unit all three classes of levers are simply referred to as levers. All types of levers have a turning point, a place where an object is moved, and an area where force is applied. A hammer and a crowbar are both examples of levers we use in daily life.



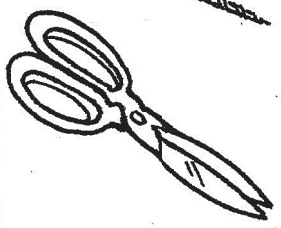
Wheel and Axle
When a wheel is turned, the axle, a bar attached to the center of the wheel, turns too. Objects as simple as a doorknob or as complex as an automobile all use this simple machine.



Pulley
A pulley is a simple machine with one or more grooved wheels connected at their edges by a rope. A pulley makes it easier to move objects up, down, and across a long distance. The more pulleys you combine, the less force you need to move an object.

Inclined Plane
An inclined plane is a flat surface with one end raised higher than the other. It makes the work of moving things up and down easier.

Screw
The screw is actually a special kind of inclined plane that is used to raise and lower things and also to hold things together. It is an inclined plane wrapped around a central pole.



Wedge
A wedge is also a type of inclined plane. It is wide at one end and tapers to a point at the other end. Wedges separate things by cutting, piercing, or splitting.

From: "Learning About Machines" by Jill Norris

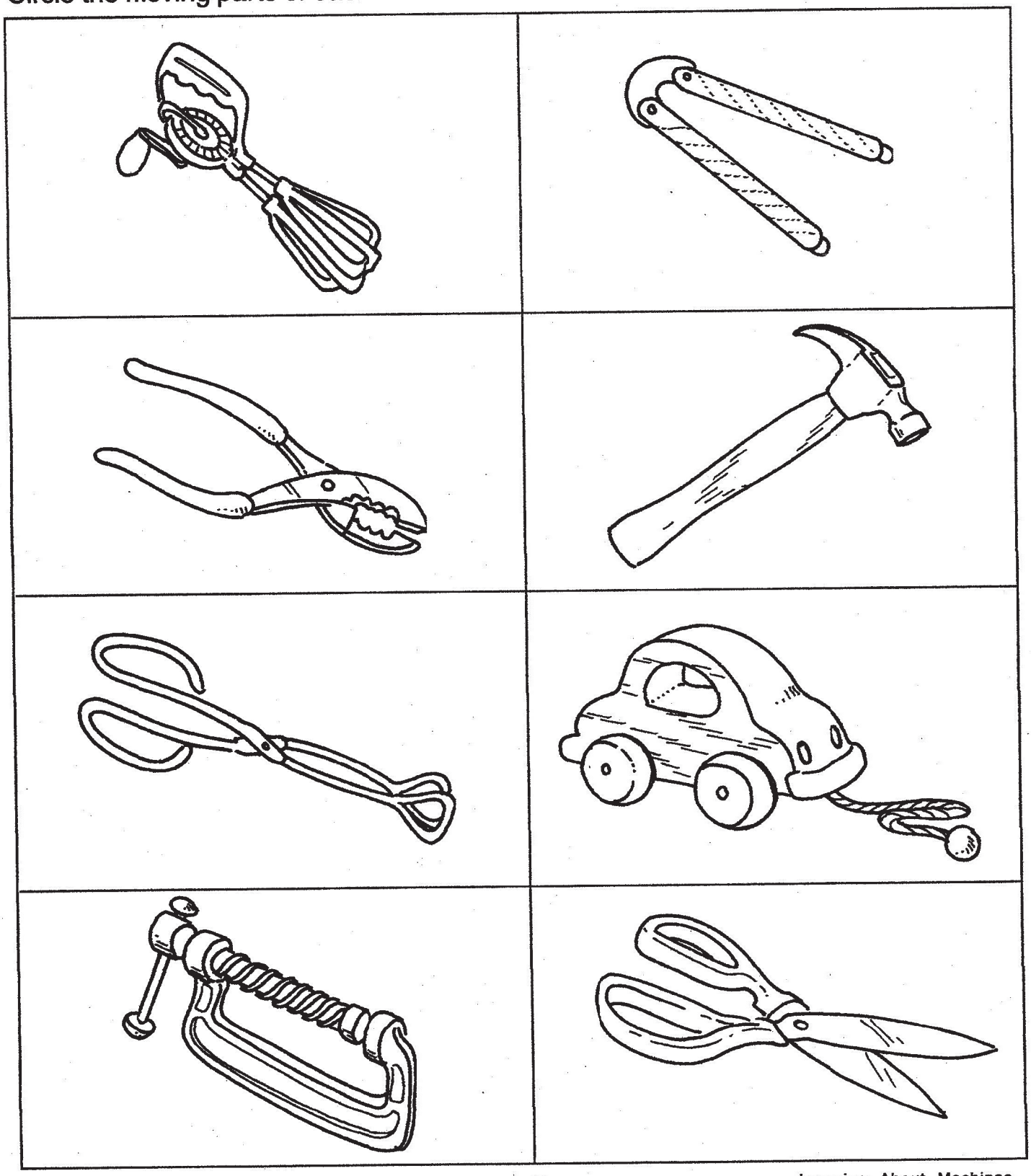
PS2 - motion of objects can be observed or measured
simple tools & machines can apply force, introduction

p1of

Note: Reproduce this form to use with the activity on page 16.

What Parts Move?

Circle the moving parts of each machine.



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