Discovering Simple Machines: LEVER, WHEEL AND AXLE, PULLEY

Instructor’s Guide
Discovering
Simple Machines:
LEVER, WHEEL AND AXLE, PULLEY

INSTRUCTOR’S GUIDE

Written and Produced by
John Colgren

Published and Distributed by...

united learning
YOUR EDUCATIONAL PARTNER FOR A CHANGING WORLD

United Learning
1560 Sherman Avenue, Suite 100
Evanston, Illinois 60201
(800) 323-9084, Fax (847) 328-6706
http://www.agcunited.com
**Discovering Simple Machines:**
**LEVER, WHEEL AND AXLE, PULLEY**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Instructional Notes</td>
<td>1</td>
</tr>
<tr>
<td>Links to Curriculum Standards</td>
<td>2</td>
</tr>
<tr>
<td>Student Objectives</td>
<td>3</td>
</tr>
<tr>
<td>Assessment Tools</td>
<td>3</td>
</tr>
<tr>
<td>Teacher Preparation</td>
<td>3</td>
</tr>
<tr>
<td>Introducing the Program</td>
<td>3</td>
</tr>
<tr>
<td>View the Program</td>
<td>4</td>
</tr>
<tr>
<td>Discussion Questions</td>
<td>4</td>
</tr>
<tr>
<td>Blackline Master Descriptions</td>
<td>4</td>
</tr>
<tr>
<td>Enrichment Activities</td>
<td>5</td>
</tr>
<tr>
<td>Answer Key</td>
<td>6</td>
</tr>
<tr>
<td>Internet Resources</td>
<td>8</td>
</tr>
<tr>
<td>Script of Video Presentation</td>
<td>9</td>
</tr>
</tbody>
</table>

This video is closed captioned

The purchase of this video program entitles the user to the right to reproduce or duplicate, in whole or in part, this teacher’s guide and the blackline master handouts that accompany it for the purpose of teaching in conjunction with this video, DISCOVERING SIMPLE MACHINES: LEVER, WHEEL AND AXLE, PULLEY. This right is restricted only for use with this program. Any reproduction or duplication in whole or in part of this guide and the blackline master handouts for any purpose other than for use with this program is prohibited.
CLASSROOM/LIBRARY VIEWING CLEARANCE

This program is for instructional use. The cost of each program includes public performance rights as long as no admission charge is made. Public performance rights are defined as viewing of a video in the course of face-to-face teaching activities in a classroom, library, or similar setting devoted to instruction.

Closed Circuit Rights are included as a part of the public performance rights as long as closed-circuit transmission is restricted to a single campus. For multiple locations, call your United Learning representative for details.

Television/Cable/Satellite Rights are available. Call your United Learning representative for details.

Duplication Rights are available if requested in large quantities. Call your United Learning representative for details.

Quantity Discounts are available for large purchases. Call your United Learning representative for information and pricing. Discounts, and some special services, are not applicable outside the United States.

Your suggestions and recommendations are welcome. Feel free at any time to call United Learning at 1-800-323-9084.
Discovering Simple Machines:
LEVER, WHEEL AND AXLE, PULLEY

Grade Levels: 1-4
Viewing Time: 10 minutes with an
optional 10-question Video Quiz

INTRODUCTION

This live-action program is designed for use with the primary grade levels (1-4).

The six simple machines can be grouped into two larger groups based on similarities they contain. One of these groups is made up of the lever, wheel and axle, and pulley. The lever was one of the first and remains one of the most common simple machines in history. The three main parts of the lever are described and identified as the fulcrum, resistance, and effort, or force. The three kinds of levers are also described using common everyday tools or devices. The wheel and axle is presented next and is described as a lever that has been wound up. The large wheel is the effort arm and the axle is the resistance arm. Finally, pulleys are described. The two kinds of pulleys, fixed and moveable, are demonstrated. Block and tackles, which are combinations of many pulleys working together are also presented.

Axle, the 3D animated robot, will help students understand how these three important simple machines have been used to make work easier, faster or to change the direction of effort. Axle will illustrate ideas and demonstrate concepts.

INSTRUCTIONAL NOTES

Before presenting this lesson to your students, we suggest that you preview the program and review this guide and the accompanying blackline master activities in order to familiarize yourself with their content.

As you review the materials presented in this guide, you may find it necessary to make some changes, additions, or deletions to meet the specific needs of your class. We encourage you to do so, for only by tailoring this program to your class will they obtain the maximum instructional benefits afforded by the materials.

It is also suggested that the program presentation take place before the entire group under your supervision. The lesson activities grow out of the context of the program; therefore, the presentation should be a common experience for all students.
LINKS TO CURRICULUM STANDARDS

This Unit of Study addresses the following National Science Education Standards for grades K-4:

Science as Inquiry

Content Standard A:
• Abilities necessary to do scientific inquiry
  Plan and conduct simple investigations
  Employ simple equipment and tools to gather data
  Use data to construct a reasonable explanation
  Communicate investigations and explanations
• Understanding about scientific inquiry

Physical Science

Content Standard B:
• Position and motion of objects
  An object's motion can be described by tracing and measuring its position over time.
  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 and Technology

Content Standard E:
• Abilities of technological design
• Understanding about science and technology
  People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
  People have always had problems and invented tools and techniques to solve problems.
  Scientists and engineers often work in teams.
  Tools help scientists make better observations, measurements, and equipment for investigations.

History and Nature of Science

Content Standard G:
• Science as a human endeavor
  Science and technology have been practiced by people for a long time.
  Men and woman have made a variety of contributions throughout the history of science and technology.
  Although men and women using scientific inquiry have learned much about the objects, events, and phenomena in nature, much more remains to be understood. Science will ever be finished. Many people choose science as a career and devote their entire lives to studying it.
STUDENT OBJECTIVES

After viewing the program and participating in the follow-up activities, students/participants should be able to...

• Identify the six simple machines
• Identify the main parts of a lever
• List example of the three classes of levers
• Describe how a wheel and axle make work easier
• Describe the differences between a fixed and moveable pulley

ASSESSMENT TOOLS

This lesson provides you with three different assessment tools. Together they make it possible to follow closely the progress of your students and to judge their mastery of the subject matter.

The Pre-Test, Blackline Master1, can be used to get some idea of students’ understanding of the topic before the program is presented.

The Post-Test, Blackline Master 10, can be used as a final test for the lesson.

The Video Quiz and its accompanying answer sheet, Blackline Master 2, can be used either as a way to introduce the topic prior to showing the video or to judge student mastery once the program has been presented.

TEACHER PREPARATION

View the program and review the accompanying activities. Duplicate any blackline masters you wish to distribute. If you plan to use the Video Quiz, which immediately follows the program presentation, you may wish to have copies of the quiz ready to distribute at the completion of the program. Also, plan to pause the tape between questions if students require more time.

INTRODUCING THE PROGRAM

Ask the class to name some of the different kinds of tools and machines that are used in our modern world. They may come up with examples such as hammers, huge cranes, shovels, bulldozer, etc. After discussing some of these, tell the students that all the machines are based on six simple machines that were discovered and used thousands of years ago. Ask if any one can name those six simple machines.
The program today is about three of those simple machines. The lever, wheel and axle, and pulley are actually related to each other though they appear to be very different. Ask students to pay attention to how these three machines are related.

**VIEW THE PROGRAM**

Viewing time for this program is 10 minutes. The video quiz that follows the presentation will take about five minutes when you build in pauses for recording answers.

**DISCUSSION QUESTIONS**

You may wish to conduct a discussion after viewing the video based on the following:
1. Ask the students to identify the six simple machines.
2. This video concentrates on the lever, wheel and axle, and pulley. Ask students to think of examples of each of those simple machines. Why were these three simple machines grouped together?

**BLACKLINE MASTER DESCRIPTIONS**

This program contains ten blackline masters that can be used to reinforce ideas and information presented in the video.

- **Blackline Master 1, Pre-Test**, provides a way of finding out how much students know about the material covered in this lesson before you present it. Student scores on the Pre-Test can be compared with their scores on the final Post-Test (**Blackline Master 10**).

- **Blackline Master 2, Video Quiz**, is to be used at the end of the program. At the completion of the program, there is a short quiz. The narrator will read the questions which are displayed on the screen. Students can use **Blackline Master 2, Video Quiz** to record their answers. Answers to the questions are provided in the Answer Key section of this instructor’s guide.

- **Blackline Master 3, Levers**, is a worksheet that describes the three main parts of a lever and then asks students to identify those parts as they pertain to four common objects from around the home.

- **Blackline Master 4, Levers - Two for One**, is an experiment that requires a little bit of patience but shows how levers can be balanced.
• **Blackline Master 5, Levers - Three Classes**, describes the three classes of levers at the top of the page and then at the bottom students are to decide if the examples are first, second, or third class levers. They should write their answer under the picture.

• **Blackline Master 6, Wheel and Axle**, provides information at the top of the page and then asks students to describe how four common objects are examples of wheel and axles.

• **Blackline Master 7, Gears**, is an experiment to demonstrate how gears work. Students will cut out gears A and B and trace them onto construction paper or cardboard, then the gears are cut out and gear B has its teeth folded up as shown with the dotted lines. Using brass fasteners, students can set up the gears so that they can be connected.

• **Blackline Master 8, Kinds of Pulleys**, is an experiment with two parts. In the first part, students are to set up a single fixed pulley. They will lift a book with this pulley arrangement and record findings. In the second part of this experiment, students will set up a moveable pulley. Again, a book will be lifted with this set up and data collected.

• **Blackline Master 9, Pulleys**, is an experiment that could be used as a whole class demonstration. Two students hold broomsticks and face each other. A rope is tied to one broomstick and then wound through the two broomsticks a few times. The end of the rope is held by a third person. When signalled, the two students holding broomsticks will pull apart, then the third person holding the end of the rope will pull on the rope.

• **Blackline Master 10, Post-Test**, is the post-test for the completion of the lesson.

**ENRICHMENT ACTIVITIES**

• Have some students find out about the evolution of the bicycle. How has it changed over the years and why?

• Have students demonstrate various levers in action. For instance, have a student hold a baseball bat and slowly swing as if hitting a ball. Ask the class to identify where the resistance, effort, and fulcrum are located on the bat. Can they see that the fulcrum is below the hands? Most of the bat moves one direction, but the bottom moves the opposite direction, which is what a fulcrum, or turning point, does for a lever. Demonstrate how raking leaves, using a shovel to dig a hole, using a hammer, or using a broom illustrate this concept.
• Blackline Master 1, Pre-Test
1. Fulcrum, resistance, effort, or force.
2. The location of the fulcrum, resistance, and effort determine the type of lever.
3. The distance between the fulcrum and the resistance is the resistance arm.
4. The distance between the fulcrum and the effort is the effort arm.
5. The wheel has made it possible for humans to move loads easily. It is easier to roll something instead of pushing it along.
6. Examples might include: pencil sharpener, vehicles with wheels, steering wheels, doorknobs, screwdriver, etc.
7. A fixed pulley is tied to a support. The fixed pulley changes the direction of effort. A moveable pulley is attached to the object being moved (load or resistance) and the rope that runs through the pulley is attached to a support. The pulley provides an advantage as each supporting line of the rope helps support the load. A single moveable pulley makes lifting an object only half as difficult.
8. fixed
9. block and tackle
10. Answers should include things such as: construction cranes, flag pole, sailboats, exercise equipment, etc.

• Blackline Master 2, Video Quiz
1. c
2. a
3. b
4. c
5. a
6. c
7. b
8. A pulley that is stationary and attached to some support, it changes the direction of the effort.
9. b
10. The moveable pulley is attached to the load. The rope is attached to some support and then it is passed through the pulley wheel. When the other end of the rope is pulled or lifted the pulley and load move up. Because there are two supporting sections of rope, the amount of effort needed to lift the load is only half the weight of the load.

• Blackline Master 3, Levers
1. Baseball bat - resistance top of bat, effort or force hand grips, fulcrum end of bat.
2. Fishing pole - fish resistance, real effort or force, end of pole fulcrum.
3. Hammer - metal part of hammer resistance, handle effort or force, end of hammer fulcrum
4. Pliers - nose of pliers resistance, nut of mid section fulcrum, hand grips force or effort

• Blackline Master 4, Levers - Two for One
  Observations
  1. The pencil should be balanced exactly in the middle
  2. They had to be the same distance from the fulcrum
  3. The two pennies had to be moved closer to the fulcrum.

• Blackline Master 5, Levers - Three Classes
  1. baseball bat - third class
  2. fishing pole - third class
  3. hammer driving nail - third class
  4. hammer pulling nail - first class
  5. pliers - first class

• Blackline Master 6, Wheel and Axle
  Questions
  1. The large steering wheel will make steering easier. A small effort is used.
  2. An ocean liner needs a huge steering wheel to help turn the huge rudder.

  DOOR KNOB - The large door knob is the wheel which can be easily turned. When the doorknob is turned, the axle easily releases the door clasp.
  SCREWDRIVER - A screwdriver handle rotates like a wheel. The narrow screwdriver shaft is like the axle.
  HAND DRILL - A hand drill handle turns in a wide circle which makes work easier.
  PENCIL SHARPENER - A pencil sharpener handle is the wheel part. The axle has cutting edges which shave the wood of the pencil. The large handle provides the advantage.

• Blackline Master 7, Gears
  Part A 3. counterclockwise - opposite direction
  Part B 4. counterclockwise

• Blackline Master 8, Kinds of Pulleys
  Observations Part One
  1. Answers will vary
  2. Will be the same as the weight of the book

  Observations Part Two
  1. Half the weight of the book.
• **Blackline Master 9, Pulleys**

Observations: The third person holding the end of the rope will easily pull the other two people who are holding the broomsticks together.

Conclusions: The rope and broomsticks act like a series of pulleys or like a block and tackle. Each time the rope is wound around a broom handle it provides a mechanical advantage. The third person can easily pull the other two towards each other even though they are pulling against each other.

• **Blackline Master 10, Post-Test**

1. lever, wheel and axle, pulley, incline plane, wedge, screw
2. effort is the push or pull applied to do work
3. resistance is the load or object being moved
4. fulcrum is the turning point of a lever
5. A fixed pulley is attached to a support and provides no mechanical advantage. It qualifies as a simple machine because it changes the direction of the effort. A moveable pulley is attached to the load and actually moves with the load. It provides a great mechanical advantage because the supporting rope helps to support the load.
6. A lever makes work easier. The idea is to have the resistance close to the fulcrum and the effort as far from the fulcrum as possible.
7. Answers might include: pencil sharpener, anything that uses a wheel, door knobs, etc.
8. Answers might include: hammers, shovel, seesaw, scissors, pliers, anything used to pry something else, etc.
9. Answers might include: flagpole, fitness equipment, sailboat rigging, construction cranes, etc.
10. The classes of levers are different from each other based on the location of the fulcrum, effort, and resistance.

**INTERNET RESOURCE**

The following website may be a valuable source of additional information to reinforce the objectives of this lesson:

1. **Discovering Simple Machines at** [http://www.unitedlearning.com](http://www.unitedlearning.com) **will be designed as an electronic learning module specifically correlated to this Unit of Study. It will support and enhance the content and ideas presented in this series of video tapes. Axle the Robot will act as host of the web pages.**
DISCOVERING SIMPLE MACHINES:
LEVER, WHEEL AND AXLE, PULLEY
Script of Narration

Work is accomplished only when an object is moved. A force is needed and to provide the necessary force energy is required. Simple machines are used to change the size or direction of a force. There are six simple machines that have been used throughout history to make work easier.

The six simple machines are the lever, wheel and axle, the pulley, the inclined plane, the wedge, and the screw.

This woman can't lift this car by herself. But when the woman uses a car jack, she is using a lever to increase the amount of force. Now she can lift the car.

The lever has three main parts. The fulcrum is the point where the lever is supported. It is also where the lever changes direction. The resistance or the load is the weight of the object being moved.

The effort is where a person applies a force to lift and move the resistance. Here is Axle the Robot ready to demonstrate how a lever can be used to lift a heavy object. The idea is to have the resistance close to the fulcrum and the effort as far from the fulcrum as possible. The longer the effort arm, the greater the force which means a small effort is used to lift a great weight.

There are three kinds or classes of levers. A seesaw is an example of a first class lever. The resistance on one end and the effort on the other end with the fulcrum somewhere between them.

A nutcracker is a second class lever. In a second class lever the fulcrum is on one end and the effort on the other. The resistance is between the fulcrum and effort.

A third class lever is set up with the effort between the fulcrum and resistance. This shovel is a third class lever. So here are the three classes of levers.

Try to guess what class of lever a fishing pole represents. Where is the resistance? Where is the effort? Where is the fulcrum? The fish is the resistance. The effort is in the person's hands and the fulcrum is at the bottom of the person's hand. So a fishing pole is a third class lever.

What kind of lever is a hammer pulling a nail? It's a first class lever. Here is the fulcrum, the hand is providing the effort and the nail is the resistance. Because the fulcrum is somewhere between the effort and resistance it is a
first class lever.
If a hammer is being used to drive a nail, it is a different kind of lever.
Which is it? The effort is in the person's hand. The resistance is the weight
of the hammer head. The fulcrum is below the hand. So the effort is between
the fulcrum and the resistance. It is a third class lever.

What class of lever is a wheelbarrow? Think of where the resistance is, the
effort and the fulcrum. It is a second class lever. The resistance is between
the fulcrum and effort.

The wheel was one of the most important inventions of all time. No one
knows when the wheel was invented but there is evidence that people were
using the wheel over 6,000 years ago. Everyone knows that it is easier to
move a round object than a flat object. The wheel cuts down the amount of
friction. The wheel and axle work together, they move together. The wheel
and axle is like a lever that has been wound up. The large wheel represents
the effort arm, while the axle represents the resistance arm. A steering wheel
makes it easy to steer the car. A truck or bus has a larger wheel to help steer
the larger vehicle.

A pencil sharpener is a wheel and axle. Turning the crank or handle turns the
axle which has cutting edges in it to shave away the pencil wood.

A door knob is another common example of a wheel and axle. It is easy to
open a door because the door knob is like a wheel with an axle.

A bicycle uses the wheel and axle idea to make pedaling easier. A 10-speed
or mountain bike has wheels that are the same size. However, the pedaling
advantage comes from pedals that move through a larger circle than the rear
tire sprockets.

Another simple machine that is related to the wheel and axle is the pulley.
The pulley has a wheel and axle built into it. There are two kinds of pulleys.
One is called a fixed pulley, which means that the pulley is attached to some-
thing. The object being moved is attached to one end of a rope. The rope is
fed through the pulley and then a force is used to pull on the other end of the
rope. The fixed pulley doesn't make the work easier; what it does do is
change the direction of the effort to lift the object.

The other kind of pulley is called a movable pulley. In this case, the pulley
moves with the object being lifted. The pulley is lifted with the load and
because of the way the rope is used it only takes half the effort to lift some-
thing. For example, this block of wood weighs 240 grams. It only takes 120
grams of effort to lift it.
More than one pulley can be used together to make it very easy to lift something that has a great weight. This is called a block and tackle. This tower crane uses a combination of pulleys to lift heavy buckets of cement to the top of tall buildings. Each supporting cable or rope gives a mechanical advantage making the work easier.

In summary, we have looked at three of the six simple machines. These three, the lever, the wheel and axle, and the pulley were discussed and described together because of how they relate to each other.

The lever is one of the earliest tools. There are three kinds of levers but they are all based on the idea of a short resistance arm, a long effort arm, and a fulcrum, or turning point.

The wheel and axle are related to the lever. The large wheel represents the effort arm and the axle represents the resistance arm. The large wheel turns once while the axle turns many times creating an advantage.

Pulleys use a wheel turning on an axle to help people get work done. With a fixed pulley, the direction of the effort is changed. However, there is no change in the effort required to lift something. If the object weighs ten pounds, it will take ten pounds of effort to lift it.

A movable pulley is organized differently. The pulley is actually attached to the object being moved. When the rope is pulled up, the amount of effort required to lift the object is only half of the object’s weight, so it only takes five pounds of effort to lift the ten pound object.

VIDEO QUIZ

Now it’s time for a video quiz on the material covered in today’s presentation. You can write your answers on the Video Quiz worksheet or on a separate sheet of paper. There will be ten questions. Most questions are multiple choice. Two are designed for a short written answer.

Here’s question number one:
The weight of the object being moved on a lever is called the _______.
a. fulcrum   b. force or effort   c. resistance   or   d. arm

Question number 2:
The pivoting or turning point of a lever is called the ________.
a. fulcrum   b. force or effort   c. resistance   or   d. arm

Question number 3:
The push or pull on a lever is called the ________
Question number 4:
A first class lever has the fulcrum between the resistance and effort. Which of these is a first class lever?
a. broom  b. fishing pole  c. scissors  or  d. baseball bat

Question number 5:
If the fulcrum is at one end of a lever and the resistance is at the other end with the effort or force between them it is a second class lever. Which of these is a second class lever?
a. broom  b. hammer pulling a nail  c. scissors  or  d. pliers

Question number 6:
The wheel and axle is related to the lever because it is like a lever wound up. The large wheel is like what part of the lever?
a. fulcrum  b. resistance arm  c. effort arm  or  d. load

Question number 7:
The axle or smaller wheel of the wheel and axle is like what part of the lever?
a. fulcrum  b. resistance arm  c. effort arm  or  d. none of these

Question number 8 is a short-answer question.
What is a fixed pulley?

Question number 9:
When using a fixed pulley the amount of effort needed to lift a load is equal to the weight of the load. What does the fixed pulley do?
a. make work easier  b. change the direction of the effort  or  c. help support the load

Question 10: How does a movable pulley make work easier?
Discovering Simple Machines: Lever, Wheel and Axle, Pulley

PRE-TEST

DIRECTIONS: Answer the following questions in the space provided.

1. What are the three parts of a lever? ____________ ____________ ____________

2. There are three classes, or kinds, of levers. How are they different from each other?

3. What is the resistance arm of a lever?

4. What is the effort arm of a lever?

5. How has the wheel and axle made work easier for humans?

6. Name three examples of a wheel and axle in operation.

7. There are two kinds of pulley systems. One is called a fixed pulley and the other is called a movable pulley. How are they different?

8. A pulley at the top of a flagpole is used to raise a flag. Of what kind of pulley is that an example? ________________

9. A series of pulleys used together is called a _______ and __________.

10. Give three examples of pulleys in use.
Discovering Simple Machines: Lever, Wheel and Axle, Pulley

VIDEO QUIZ

This is the video quiz for the video called “Lever, Wheel and Axle, Pulley.” Questions will appear at the end of the video. Write your answers on this sheet of paper.

1. The weight of the object being moved on a lever is called the ____________.
   a. fulcrum    b. force or effort    c. resistance    d. arm

2. The pivoting or turning point of a lever is called the ____________.
   a. fulcrum    b. force or effort    c. resistance    d. arm

3. The push or pull on a lever is called the ____________.
   a. fulcrum    b. force or effort    c. resistance    d. arm

4. A first-class lever has the fulcrum between the resistance and effort. Which of these is a first-class lever?
   a. broom    b. fishing pole    c. scissors    d. baseball bat

5. If the fulcrum is at one end of a lever, and the resistance is at the other end with the effort or force between them, it is a third-class lever. Which of these is a third-class lever?
   a. broom    b. hammer pulling a nail    c. scissors    d. pliers

6. The wheel and axle is related to the lever because it is like a lever wound up. The large wheel is like what part of the lever?
   a. fulcrum    b. resistance arm    c. effort arm    d. load

7. The axle or smaller wheel of the wheel and axle is like what part of the lever?
   a. fulcrum    b. resistance arm    c. effort arm    d. none of these

8. What is a fixed pulley?

9. When using a fixed pulley, the amount of effort needed to lift a load is equal to the weight of the load. What does the fixed pulley do?
   a. Make work easier.    b. Change the direction of the effort    c. Help support the load.

10. How does a movable pulley make work easier?
Discovering Simple Machines: Lever, Wheel and Axle, Pulley

LEVERS

Levers were probably one of the very first machines.

There are three parts to every lever. One part is the object or weight being moved. It is called the “resistance.” A push or pull is needed to move the resistance. This push or pull is called the “force or effort.” The third part of the lever is called the “fulcrum.” It is the point on the lever where direction and movement changes.

DIRECTIONS: Label the parts of each lever shown. Each lever will have a fulcrum, a resistance, and a force.
DIRECTIONS: Do the following experiment to find out more about levers. Answer the questions in the Observations section.

Purpose: To demonstrate the principle of a lever.

Materials: 1. A ruler  
           2. three pennies  
           3. a pencil

Procedures: 1. Lay the pencil on the flat surface of your desk.  
              2. Balance the ruler on the pencil so that it resembles a seesaw. The ruler is balanced when both ends are off the table or desk top. Make observations.  
              3. Place a penny on one end of the ruler.  
              4. Place another penny on the other end of the ruler to balance it again. Make observations.  
              5. Place a third penny on top of one of the pennies already on the ruler.  
              6. Try to balance the ruler by moving the pennies. The pennies must stay on their side of the ruler and the double penny set-up must stay as one penny on top of the other.

Observations: 1. When you first balanced your ruler on the pencil, what was the reading on the ruler above the pencil or fulcrum?

2. How did you balance the ruler when there was a penny on each side of the fulcrum?

3. How did you solve the problem of balancing two pennies with one?
There are three classes or kinds of levers. They are called FIRST-CLASS, SECOND-CLASS, and THIRD-CLASS LEVERS. What makes one class of lever different from another is where the force, resistance, and fulcrum are located. Here are some examples:

**First-class lever**
In this case the fulcrum is located between the force and resistance. A seesaw is a good example of a first-class lever.

**Second-class lever**
A second-class lever is set-up so that the resistance is between the force and fulcrum. A wheelbarrow is a second-class lever.

**Third-class lever**
In the case of a third-class lever, the force is between the resistance and the fulcrum. A fishing pole is a good example.

**DIRECTIONS:** Identify the levers below as first-class, second-class, or third-class levers.
A wheel and axle is a simple machine that acts as a lever. The steering wheel on a car is a perfect example of a wheel and axle. The large steering wheel is attached to a smaller rod called the steering column. The force from the steering column is used to turn the wheels so that the car can be driven properly. That force is a great force because the steering column acts like an axle. The steering wheel is large and turns easily in a person’s hands. The steering column, which is the axle part of this simple machine, is much smaller but is attached to the steering wheel, so when the steering wheel is turned, the steering column also turns. The steering column turns with much more force than the steering wheel so that the heavy front tires can be turned and controlled. The larger the steering wheel, the greater the force on the steering column or axle.

**Questions:**

1. Why do trucks have such large steering wheels?

2. Why do ocean liners and other large ships have large steering wheels?

There are examples of wheels and axles all around you. Everyday you use this simple machine.

**Directions:** Tell how each of the things listed below is an example of a wheel and axle. Also tell how it makes work easier or faster.

- **Door Knob**
- **Screwdriver - Used to loosen or tighten a screw**
- **Hand Drill**
- **Pencil Sharpener**
Gears are like wheels with notches or teeth on them. Gears can be used to change the direction of effort, slow or speed things up, or turn many things at once. Gears are used on ten speed bikes and in watches or clocks.

**Purpose:** To demonstrate how gears work.

**Materials:**
1. brass fastener
2. construction paper or cardboard

**Procedures:**
1. Cut out the gear patterns at the bottom of the page.
2. Trace them onto the construction paper or cardboard
3. Gear B has dotted marks to show where you should fold the teeth up.
4. Cut a hole in the center of each gear and pass a brass fastener through these holes.
5. Pass the brass fastener through a second rectangular sheet of construction paper or cardboard.
6. Arrange the gears so their teeth interlock.

**Part A**
1. Set up the gears as shown in diagram A.
2. Turn gear A clockwise.
3. How does gear B turn? ________

**Part B**
1. Make additional gears A and B.
2. Set up as shown in diagram B.
3. Turn gear A clockwise.
4. How does the end gear turn? ________
There are two kinds of pulleys. You can use some simple objects to set up demonstrations of each of these pulley systems.

Materials: 1. Two single pulleys (from hardware store or science supply)  
2. twine  
3. three heavy books  
4. a spring scale  
5. desk  
6. ruler

Part One: FIXED PULLEY
1. Place the ruler on the edge of the desk and lay two of the books on it so that the ruler will stay in place.
2. Take a pulley and attach it to the ruler with twine. The pulley should be hanging freely under the ruler.
3. Tie twine around the remaining book and weigh the book with the spring scale.
4. Feed twine through the pulley wheel. Tie one end of the twine to the book. Tie the other end of the twine to the spring scale.
5. Pull the spring scale to lift the book. Record the reading on the scale.

Part Two: MOVABLE PULLEY
1. Repeat step 1 under Part One.
2. Tie a long piece of twine to the end of the ruler.
3. Feed the twine through the pulley wheel.
4. Attach the book to the pulley and the spring scale to the end of the twine.
5. Lift the book by pulling on the twine. Record the spring scale reading.

Observations: Part One
1. What was the weight of the book to be lifted? ________________
2. What was the reading on the spring scale as you lifted the book with the pulley? ________________

Part Two
1. What was the reading on the spring scale as you lifted the book with this set-up? ________________
Discovering Simple Machines: Lever, Wheel and Axle, Pulley
PULLEYS

DIRECTIONS: You can see the help a pulley provides by performing the following experiment. Answer the questions in the Observation and Conclusion sections.

Purpose: To show the advantage of using a pulley.

Materials:
1. two broomstick handles
2. rope or clothesline at least eight feet long
3. two helpers

Procedure:
1. Ask each of your helpers to face each other holding a broomstick with both hands out in front of them.
2. Tie one end of the rope to one of the broomsticks.
3. Weave the rope around the two broomsticks a number of times and then back away while holding your end of the rope.
4. Pull your end of the rope so that everything tightens.
5. Tell your friends to pull their broom handles apart.
6. While they’re pulling on the broomsticks, you should pull on the rope you’re holding.

Observations: What happened?

Conclusions: Why did things happen the way they did?
DIRECTIONS: Answer these questions in the space provided.

1. Name the six simple machines. __________________    __________________
    __________________    __________________    __________________    _______________

Give a definition for the following terms:

2. effort __________________

3. resistance __________________

4. fulcrum __________________

5. There are two types of pulleys. What are they called and how are they different?

6. How does a lever help people?

7. Name some examples of wheel and axle simple machines found around school and home.

8. Give at least five examples of levers.

9. Give at least five examples of how pulleys are used.

10. There are three classes of levers. What is it that makes the classes of levers different from each other?