PUTTING THE "SIMPLE" IN SIMPLE MACHINES

Grade Level: Second
Presented by: Lou Tucker, Donna Cueto, Ridge View Elementary, Kennewick, WA
Length of Unit: Seven Lessons

I ABSTRACT

We live in the machine age and depend on machines in almost every activity of our daily lives. This unit introduces students to simple machines that make our lives easier by helping us do our work. Background information is provided about: levers, pulleys, wedges, inclined planes, screws, gears, wheels and axles. Through observation and hands on activities, the lessons identify six simple tools that are combined and used in everyday machines to help make-work easier. The principles of force and friction that make tools and machines work, are also explored through experimentation and demonstrations. Basic vocabulary and science concepts are presented in activities and designed to engage student's imaginations. Ideas for assessment and evaluation are also discussed.

II OVERVIEW

A. Concept Objectives
   1. A machine is a device that does work.
   2. Specific tools are made to perform a specific job.
   3. Simple machines help make work easier.
   4. Machines change one kind of work into another.
   5. There are six simple, or basic machines:
      a. inclined plane: a sloping surface that makes lifting or moving an object easier
      b. wedge: a small inclined plane used to raise an object or split it apart
      c. screw: an inclined plane wrapped around a cylinder used to hold things together
      d. lever: a strong board or rod that rests on a support (a fulcrum), used to help lift a weight with less effort
      e. wheel-and-axle: a large wheel and cylinder that are fastened together and turn together. It is used to help lift a heavy load with less effort. A gear is a wheel with teeth.
      f. pulley: a wheel with a grooved rim in which a rope or belt moves, used for lifting heavy objects
   6. Force: a push or pull action that makes an object move.
   7. Friction: a force that slows down motion between two objects that touch.

B. Core Knowledge Content:
   1. Simple Machines:
      a. Specific tools are made to perform specific jobs.
      b. Simple machines help make our work easier.
      c. Simple machines are combined and used in familiar tools and machines.
      d. Simple machines examined: lever, pulley, wheel-and-axle, inclinedd plane, wedge, and screw.
      e. Gears: wheels with teeth and notches.
      f. Friction and ways to reduce friction (lubricants, etc.)

C. Specific Skills Addressed
   1. Science processing skills: observing, making and testing hypothesis, classifying, sorting, collecting data, recording data, interpreting data, identifying and controlling variables
   2. Math processing skills: using spatial sense, ordering data, graphing, linear measurement, using a spring scale, predicting, and estimating.

III BACKGROUND KNOWLEDGE

A. For Teachers:
   1. Hirsch Jr. E.D., *What Your 2nd Grader Needs To Know.*
   2. Carratello, John and Patty. *Simple Machines*. Teacher Created Materials, Inc. 1988.
   3. Grove, Sandra Ford; Hechtman, Judi. *Simple Machines.* Creative Teaching Press, 1997.
   4. *Simple Machines.* Delta Science Moeul3, Delta EDU. Inc. 1988.
   5. Carson-Dellosa. *Simple Machines*. 1994.

B. For Students:
   1. Machines are introduced in second grade. Students may have varying degrees of background knowledge, thus defining machines and their specific jobs will be necessary.
   2. Students are introduced to the scientific method in first grade and should review the process.

IV RESOURCES

Carson -Dellosa, *Simple Machines*. 1994.
Simple Machines. Delta Science Module, Delta Education Inc. 1998.
Simple Machines. Teacher Created Materials, Inc. 1988.

V LESSONS

Lesson One: What is a Machine?

A. Objectives:
   1. Students will identify familiar machines and tools.
   2. Students will be introduced to six simple machines.

B. Materials:
   1. Pictures or real examples of six simple machines.
   2. Activity sheet (Appendix A) one per student.

C. Key Vocabulary:
   Machines, wheel-and-axle, wedge, pulley, lever, inclined plane, screw

D. Procedures/Activities:
   1. Show students a pair of scissors and a hammer. Ask what they have in common (both are simple machines/tools).
   2. Ask students to brainstorm machines/tools they know or use at home.
   3. Provide students with definitions and background:
      a. Machines help us do work faster and more easily.
      b. Machines are made up of one or more simple machines.
      c. There are six simple machines: lever, pulley, wheel-and axle, inclinedd plane, wedge, and the screw.
      d. Show students examples of each tool from illustration or actual machines.

E. Assessment:
   1. Give each student a copy of Appendix A.
   2. Ask students to identify the six simple tools and label each tool using the vocabulary introduced in the lesson.

Lesson Two: Inclined Planes Ease Lifting

A. Objectives:
   1. Students learn how inclined planes ease lifting heavy objects.
   2. Students will apply the scientific methods of investigating, observing, experimenting, and drawing conclusions to explore friction.
   3. Students will learn to read a spring scale.

B. Materials:
   Overhead of Appendix B -spring scale

- board
- string
- sandpaper
- vegetable oil
- copies of Appendix B
- books
- cookie sheets
- tape
- paper towels
- small objects (erasers, checker pieces, paper clips, etc.)

C. Key Vocabulary

inclined plane, spring scale, weight, force, friction, ramp

D. Procedures/Activities:

1. Ask students which is the easier way to lift three books-straight up or by using a ramp? Record their responses.
2. Explain to the students that they will be using the scientific method to test their "hypothesis," or what they think will happen.
3. Put Appendix B on the overhead; complete the scientific process filling in the form as the steps are completed by the teacher and one or two of the student assistants. (Optional: student copies for each to fill out)
4. Title of Experiment: The inclinedd plane. Explain that an inclinedd plane is a flat surface with one end higher than the other. Sometimes called a ramp. Show an example.
5. What we want to know? Which is the easier way to lift three books – straight up or by using a ramp? Students write their answer on individual forms or as a group on the overhead.
6. Hypothesis: What do you think will happen (individual or group responses)? Record response. Procedure: How I will find out (step by step)?
   a. Introduce the spring scale- reading and recording weights.
   b. Tie three books together. Stack seven books in a pile.
   c. Lift the three books to the top of the seven-book pile with a spring scale. Record the weight as I lift the books straight up.
   d. Use the board and seven books to make an inclinedd plane.
   e. Pull the three books up the ramp with a spring scale. Record the weight as I lift the books up the ramp.
7. Results: What actually happened?
   a. Which way was easier?
   b. Is that what you thought?
8. Conclusions. What did I learn?
   a. The inclined plane /ramp made lifting the books easier.
   b. An inclined plane/ramp makes it easier to lift heavy objects.
9. Ask students: what if we pulled the book up a carpeted inclined, a metal inclined, etc.
10. Test the hypothesis.
11. Explain that a force called "friction" makes it harder to move something across something else. When two things rub against each other, friction slows them down. How can we reduce the friction between a ramp and the weight being moved on it?

F. Assessment

1. Students test hypothesis about friction and inclinedd planes through the scientific method.
2. Using cookie sheets half covered with sand paper and secured with tape, students will: lift sheet, release objects down both sides, observe and record which object reaches the bottom first.
3. Teacher and student conference as they perform tests and record results.

Lesson Three: Easy Lift Lever

A. Objectives:

1. Students will learn how levers decrease the effort needed to lift heavy objects.

2. Students will create models of levers with fulcrums.
3. Students will investigate different ways to lift pennies (or other objects) using rulers as levers and a rectangular eraser as the fulcrum.
4. Students will observe how weight affects the use of a lever.
5. Students will discover that by moving the heavier objects towards the center of the ruler (or fulcrum), less force is needed.

B. Materials

- rulers - rectangular erasers -pennies or other objects such as weights.

C. Key Vocabulary

Lever, fulcrum, force, first class levers, Point of Balance (Background), Second class levers: wheelbarrows, nutcracker

D. Procedures/activities

1. Have students balance their ruler on the eraser and then stack four pennies on one end. Challenge students to raise the pennies without touching them.
2. Explain how levers are used to lift heavy objects in a similar fashion.
3. Have students stack four more pennies on the opposite end. Note observations.
4. Have students determine the minimum amount of pennies needed on the opposite stack to lift the 8 pennies off the ground.
5. Challenge: Ask students to place seven pennies on one end and four pennies on the other. Ask students to lift the seven pennies without adding more pennies (or other objects) to the four on the opposite end. (Clue: Have students reposition one stack of pennies on the ruler.
6. Discuss that by moving the heavier object towards the center of the ruler (the point of balance or fulcrum) less force is required to balance the stack.

E. Assessment

Observe students as they test and explore levers.

Ask- What happens when there are more pennies on one end of the ruler?

- How did you lift the pennies on the ruler without touching them?
- How did you lift the pennies on the ruler without adding more pennies to the other side?

Lesson Four: Pulleys, Wheels, and Axles

A. Objectives

1. Students learn how wheels, axles, and pulleys are used to lift heavy objects.
2. Students will construct models of pulleys and wheel-and-axle machines
4. Students will observe how rotating wheels can help lift heavy objects.
5. Students will communicate their results through discussion and or drawings.

B. Materials

- small paper cups - hole punch - unsharpened pencils
- large spools - masking tape - small objects (paper clips, erasers, pebbles) - 6”, 12” and 36” pieces of string

C. Key Vocabulary

wheels, pulley, axles

D. Procedure/Activities

1. In advance, make small buckets with handles using paper cups, whole punch, and 6” piece of string. (Appendix C)
2. To construct model students will need: 1 bucket, one 12” string, two 36” strings, an unsharpened pencil, a thread spool, masking tape and assorted small objects. (See Appendix C for an example.)
3. Explain how spinning “wheels” and string can help lift heavy objects.
4. Have students tie one end of the short string to their bucket handle and tape the other end around the middle of a pencil.

5. One student places small objects inside the bucket and holds one end of the pencil so the bucket hangs freely. Have partners spin the ends of the pencil. Ask students to observe the pencil rotating and the bucket moving upward.
6. Students create a second "lifting device" by making a pulley system using spools.
7. Students pull a 36" piece of string through the center of the spool. Next they tape the string and spool between two desks.
8. Students remove the pencil from the first model and attach a 36" piece of string to the one already attached to the bucket handle.
9. Make a pulley system by placing their bucket on the floor and looping the string over the spool. Students lift their bucket off the floor by pulling the string downward against the spool.
10. Ask students which needs less force to be moved: a roller skate on its side or on its wheels?
    a. Materials
        1. Roller skate
        2. Rubber bands
        3. Ruler
    b. Attach rubber bands to roller skates and measure their rubber bands before you pull.
    c. Pull the skate on its side and measure rubber bands during the pull.
    d. Students would conclude that the wheel and axle used less force to move.

E. Assessment

Observation and discussion of students testing results.

Lesson Five: Get into Gears

A. Objectives

1. Students will learn how gears are used to do work.
2. Students will construct models of gears.
3. Students will observe how gears work.
4. Students predict how moving one gear will affect the movement and direction of another.
5. Students observe that connected gears move in opposite directions.

C. Materials

- glue - pushpins - scissors - file folders - Appendix D, one per student
- 8½" X 11" pieces of thick cardboard

Optional: eggbeater, hand-drill, clock or other examples of gears.

D. Procedures/Activities

1. Show students an example of a machine with gear (clock, hand-drill, eggbeater etc.), and ask students if all the gears will move in the same direction.
2. Explain to students that they will construct a model of gears, then test their hypotheses about the direction that the gears will move.
3. Give each student a copy of Appendix D, a file folder, glue, scissors, 3 pushpins, and a piece of cardboard.
4. Students glue Appendix D to file-folder and carefully cut out illustrated gears.
5. Place largest gear on cardboard and put a pushpin through the center. Pin the smallest gear next to it so the "teeth" (cogs) interlock.
6. Instruct students to rotate the big gear clockwise a full turn and observe the direction and number of times the small gear turns.
7. Invite students to add a third gear on the other side of the small gear and repeat testing.

E. Assessment

Through observation and discussion the students will explain what happens to the small gear when the big gear turns. Did they move in the same direction?

Student Conference: What did you learn about gears?

Lesson Six: Wonderful Wedges

A. Objective

1. Students learn how wedges are simple machines that are used to split, cut, go through or move an object.
2. Students will observe how wedges are used to raise heavy objects from flat surfaces.
3. Students will compare wedges to inclined planes.

B. Materials

- thick cardboard - hardback books - yarn - scissors - tape -hammers
- board - nails, with and without points

C. Vocabulary

wedge, split, blunt

D. Procedures/Activities

1. Teacher cuts different sized cardboard wedges (triangles).
2. Students are given 3 wedges, a book, yarn, scissors, and tape.
3. Discuss how wedges are like moveable inclined planes. They reduce the amount of effort needed to move objects.
4. Students test and compare their wedges on books lying flat on desktop. One student pushes a wedge under the book's spine while another keeps it from sliding. One student measures and cuts string to match the height the book was raised. Students repeat testing with other wedges and books.
5. Ask students to compare the string lengths and the force needed to move each book. Which wedge worked best? How are wedges different from inclined planes?
6. Discuss how wedges can also be used to split or pierce material. Knives, chisels, axes, pins, needles, and nails are wedges.
7. Ask students what is easier to pound into a board: a nail with a point (wedge) or a blunt nail (without wedge)?
8. Measure nails. Record the measurements . Student hammers the nail with the wedge end 5 times. Measure the part you see. Record measurement. Then hammer the nail with the blunt end 5 times. Record measurements. Students compare measurements.

E. Assessment

Observation and discussion of experiments.

Student Conference • Which wedge worked best?

• How are wedges different from inclined planes?

• Which nail was easier to pound?

Lesson Seven: Screws

A. Objective

1. Students will discover that a screw is an inclinedd plane.
2. Students will feel and observe a screw in motion.
3. Students will create a curved inclined plane and compare the threads of a screw to a winding mountain road.
4. Students will compare a screw and a nail.

B. Materials

- pencils -Appendix E, one per student - screw drivers (optional) - nails
- variety of large screws same size but different threads -firm modeling clay or a bar of soap

C. Vocabulary

screw, nail, screwdriver, spiral, nail, curved inclined plane

D. Procedure/Activities

1. Pass out screws to students. Ask them to examine the threads of different screws, noting the number of spirals.

2. Have each student place two fingers at the base of a screw and turn the screw clockwise with the other hand to feel the screw move downward.
3. Have students compare the spiraling screw to a winding mountain road (the spiraling path takes more time to travel but less effort).
4. Provide each student with a copy of Appendix E, scissors, a marker, and a pencil. Students construct a curved inclined plane and compare it to the screw.
5. Ask students to predict which will use less effort and less force to insert into a bar of soap (or firm clay): a screw or a nail? Record predictions. Which will take less time?
6. Students use their hands to insert a nail and a screw into a bar of soap and determine which effort requires less force. Students will try to remove both items by pulling them out of the soap. Which was harder to remove?
7. Students should discover that it takes less effort to insert the screw into the soap because the force is applied over a greater distance.
8. Explain to students that, as the force is applied, along the spiral of the screw, the screw cuts straight into the soap.

E. Assessment

Observation and discussion of student test results.

VI CULMINATING ACTIVITY

There are many ideas for extending this unit. It is fun and student interest is high. One culminating activity that we have used is a student created pop-up tool book. Using Appendices F, G, and construction paper, students create a book that demonstrates learning objectives they have mastered.

VIII BIBLIOGRAPHY

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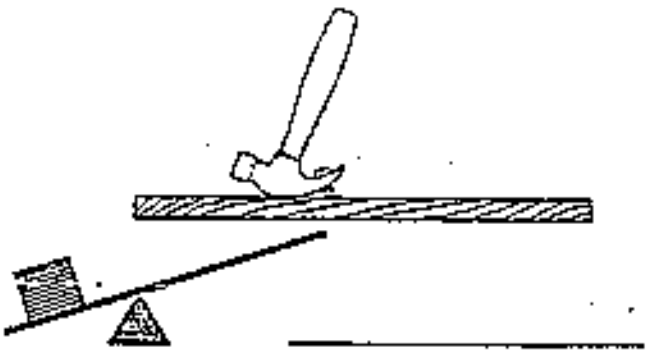
Schaffer, Frank. *Simple Machine Concepts.* Frank Schaffer Publishing. ISBN 0-86734-732-5.

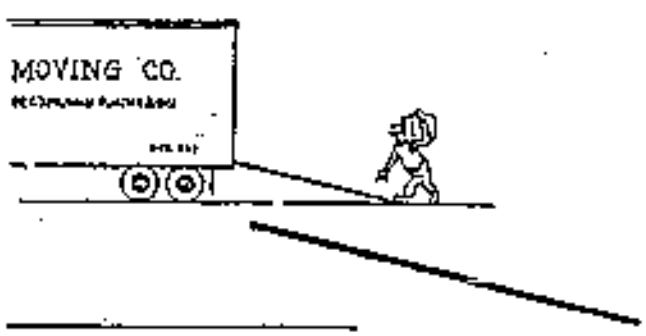
Trend. *Simple Machines*. Poster Set.

APPENDIX A

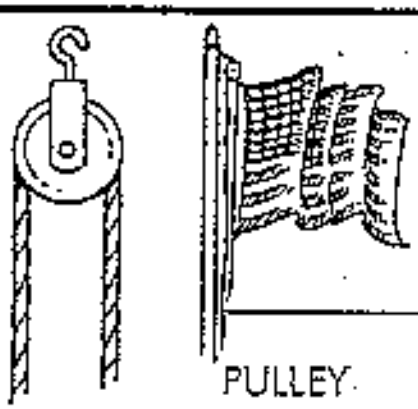
SIMPLE MACHINES



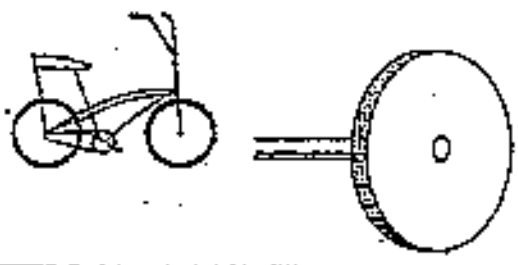
LEVER



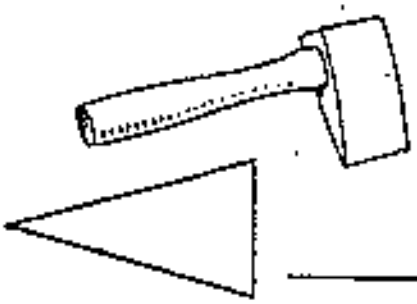
INCLINED PLANE



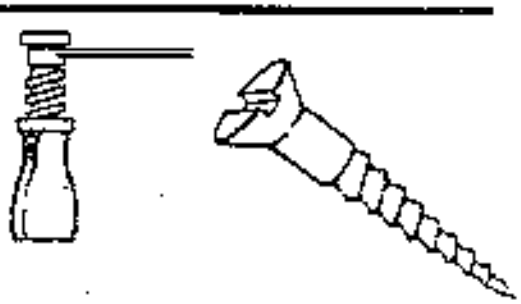
PULLEY



WHEEL AND AXLE



WEDGE



SCREW

APPENDIX B

Science Experiment Form

Name: _____

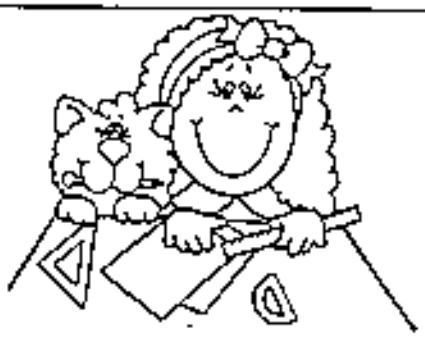
Title Of My Experiment _____

Question → What do I want to find out?

Hypothesis → What do I think? _____

Procedure → How will I find out?
(step by step)

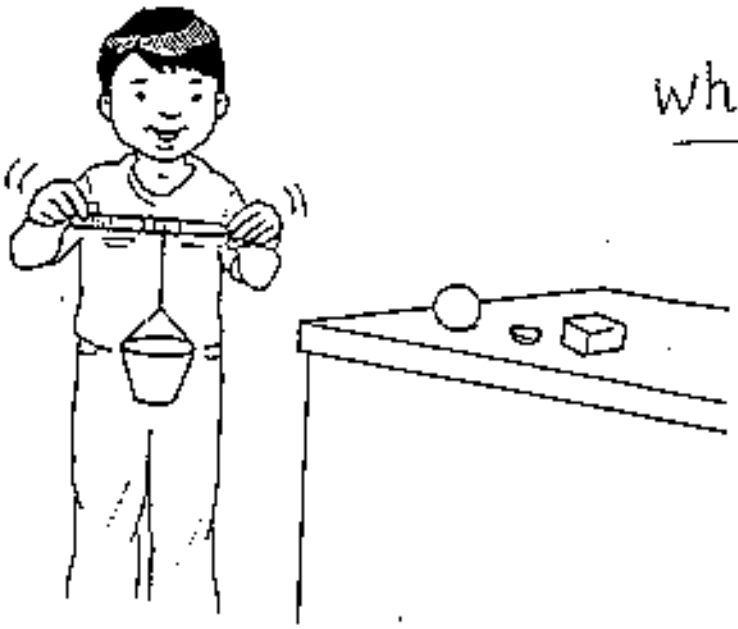
1. _____
2. _____
3. _____
4. _____
5. _____



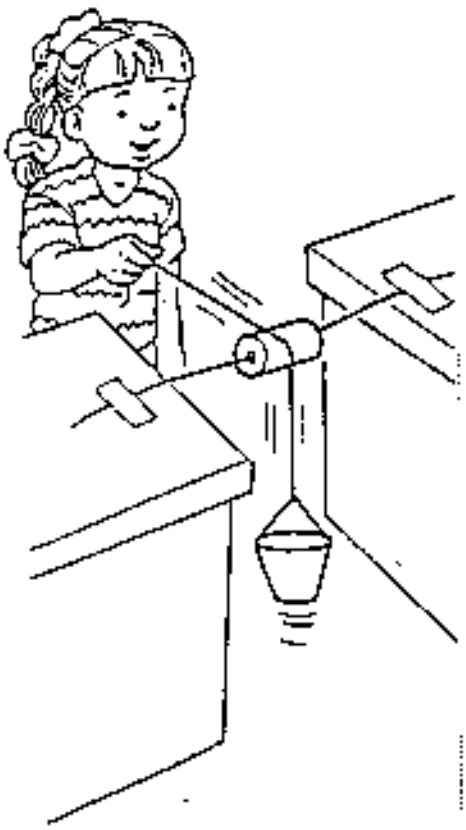
Results → What actually happened?

Conclusions → What did I learn?

APPENDIX C-1



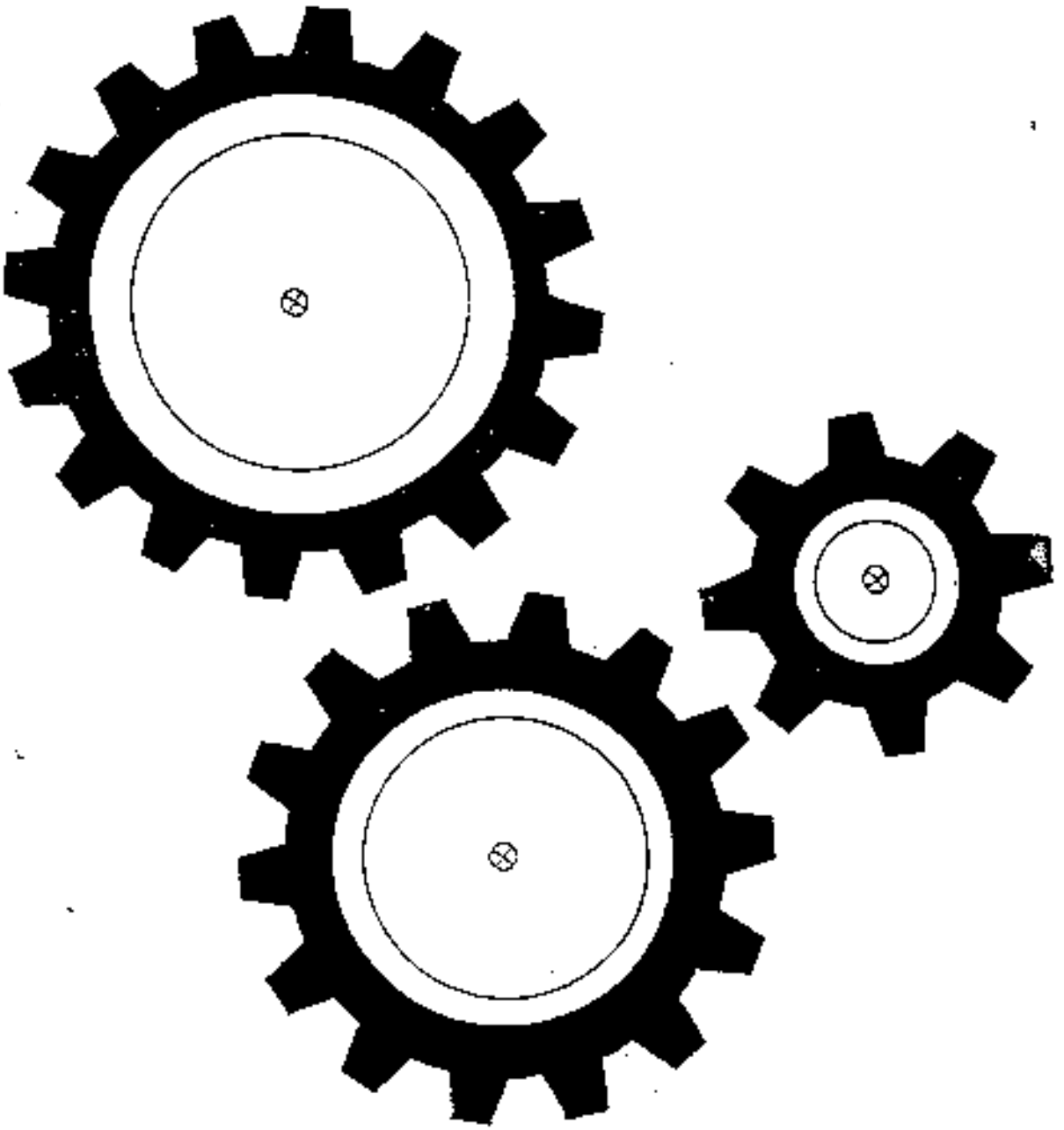
wheel-and-axle



pulley

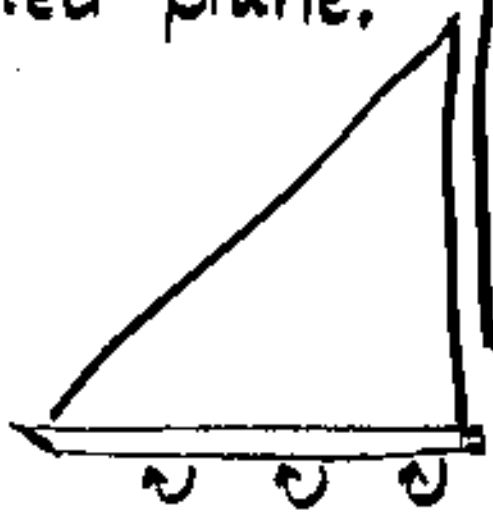
APPENDIX
D

Get into Gear



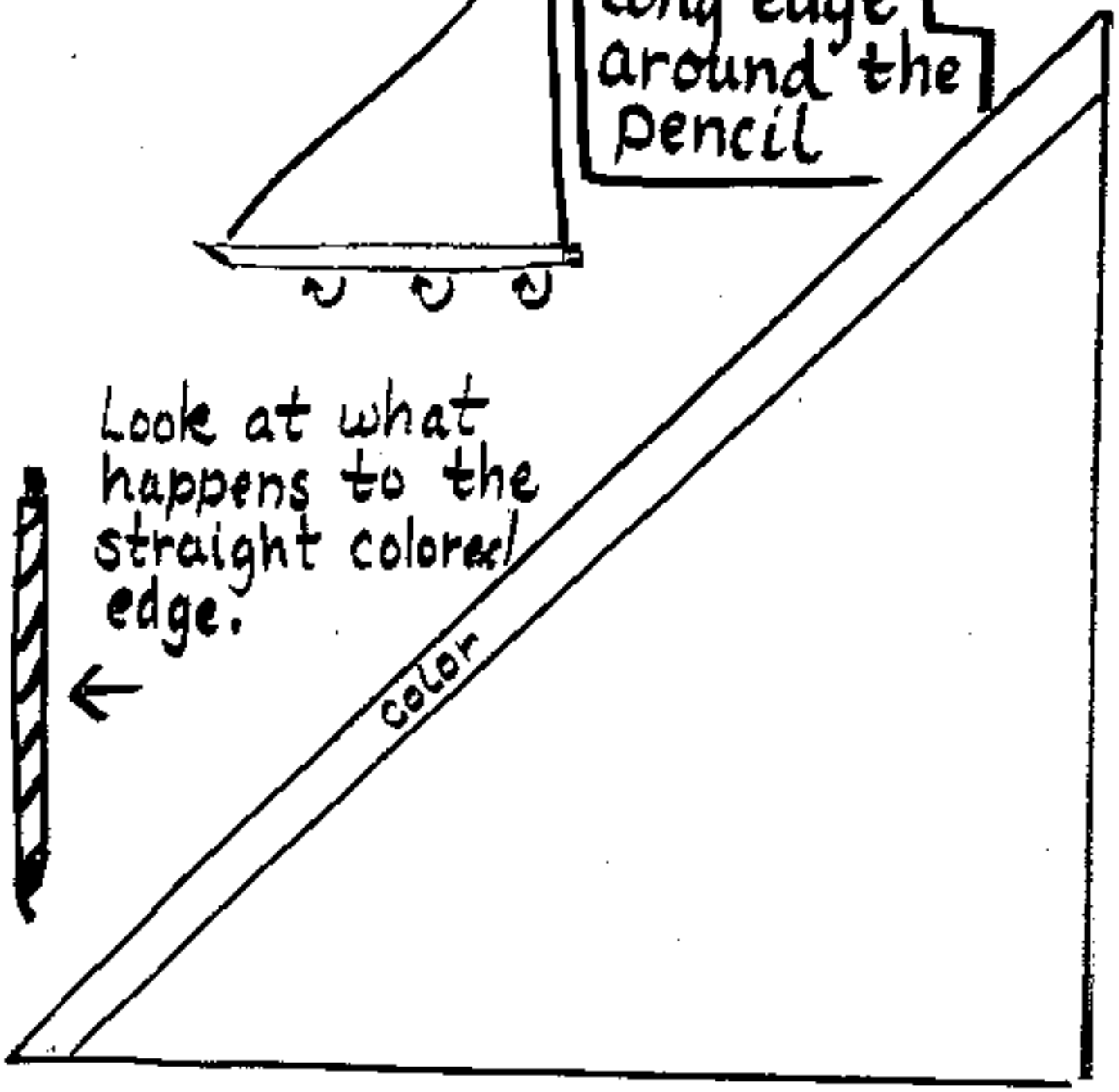
Appendix E

A screw is a simple machine. It is really a curved inclined plane.



Roll the long edge around the pencil

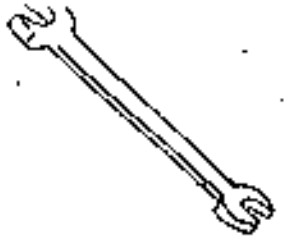
Look at what happens to the straight colored edge.

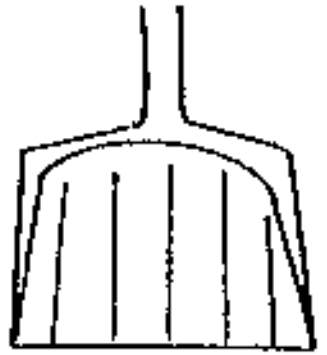


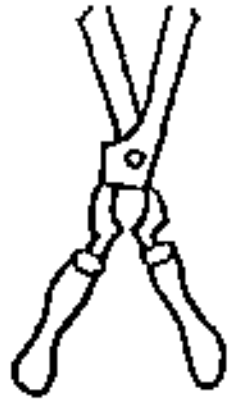
APPENDIX F


drill

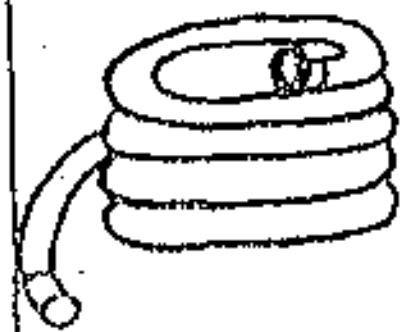
screws


wrench


dust pan

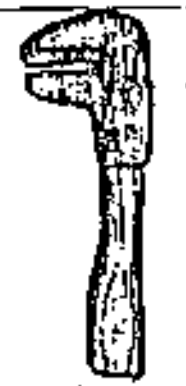

clippers

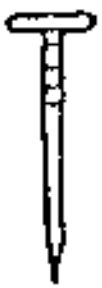

saw


hose

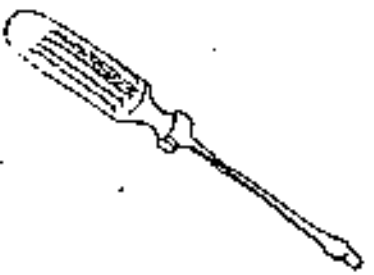

hammer


screwdriver


monkey wrench




shovel


screwdriver

This is a _____.
What can it do?

It can _____
_____ for you.

This is a _____.
What can it do?

It can _____
_____ for you.

APPENDIX G