Simple and Compound Machines

Strand Force, Motion, and Energy
Topic Simple and compound machines
Primary SOL 3.2 The student will investigate and understand simple machines and their uses. Key concepts include
a) purpose and function of simple machines;
b) types of simple machines;
c) compound machines;
d) examples of simple and compound machines found in the school, home, and work environments.
Related SOL 3.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
b) predictions are formulated using a variety of sources of information;
h) data are gathered, charted, graphed, and analyzed;
j) inferences are made and conclusions are drawn.

Background Information

Simple machines are used to make work easier. They are used in various places and times in our lives. They include: the pulley, screw, wheel and axle, wedge, lever, and the inclined plane. Compound machines are made up of two or more simple machines.

Materials

Activity 1: Discovering Simple Machines

- Parents bring simple machines that they will demonstrate for students such as pliers, hammers, screwdrivers, wrenches, wire cutters, small crowbars, scissors, saws, garden tools, carrot peelers, C clamps, bottle openers, wood planes, cheese cutters, and pizza cutters.
- If possible, have parents bring some mystery tools or even obsolete ones - old fashioned curling iron, shoe button hook.
- Parent letter
- Simple Machines Task Cards
- Simple Machines Task Recording Sheet
- Simple Machines Homework Task

*** It is essential to prepare ahead of time to have other adults present for this activity.

Activity 2: Wheel and Axle Investigation

- Toy cars with removable wheels
- Spring scales
- Wooden board
- Metric rulers
- “Wheel and Axle Investigation” handout
- Tape
- Stack of books

Activity 3: Simple Machines: Wedge

- Plastic tools such as a knife (many schools will not allow this in school; check your school board policy)
- Clay
- Saw to demonstrate
- Pictures of other wedges such as an ax
- Piece of wood (approximately two feet long)

Activity 4: Simple Machines: Pulley

- Spring scale
- Broom
- Three sets of textbooks - all the same size
- Two chairs
- Two pieces of strong string, each about four feet long
- Pulley
- Three plastic shopping bags or baskets

Activity 5: Simple Machines: Lever

- Rulers
- Pennies
- Pencils
- Plastic hammer, shovel, and screwdriver

Activity 6: Simple Machines: Inclined Plane

- Spring scale
- Wooden board
- Chair
- Spiral notebook
- Metric ruler
- Inclined Plane Investigation handout

Activity 7: Simple Machines: Screw

For each pair:

- Two screws with different amounts of threads
- Screwdriver
- Block of wood
- Screw Recording sheet
- 8 ½ X 11 piece of construction paper
- Marker

Activity 8: Compound Machines

- Pictures of scissors, wheelbarrow, pencil sharpener, and can opener for each student
- Glue
- Scissors
- Compound Machine Scavenger Hunt

Vocabulary

simple machine, compound machine, pulley, wheel and axle, lever, wedge, inclined plane, screw

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction Activity 1: Discovering Simple Machines

1. Read a trade book with concepts about simple machines and discuss the basic science concepts from the story.
   a. Machines make work easier for people.
   b. Machines need energy to produce movement.
   c. It is possible for one machine to perform a variety of tasks.
   d. People power machines.
   e. Simple machines combine to become compound machines.

Procedure – Activity 1

Be sure to have plenty of adults present for this activity.

1. Send home the letter to the parents at least two weeks before you conduct this activity. The letter is found at the end of this lesson. The letter requests their assistance with this activity.
2. Students will work with a partner for this activity. Set up tasks in clear plastic bags. Display the machines to be used and hand out the task cards to partners.
3. Have parents stationed with each tool that has been brought in for the parents to demonstrate. Allow students to select the parent stations to visit. Have the student teams determine which of the machines being demonstrated is the machine they will use for the task they have. They may choose a machine that is unusual for their task but this is acceptable because this lesson is simply meant to be a chance for students to see a wide variety of machines.
4. Include pliers, hammers, screwdrivers, wrenches, wire cutters, small crowbars, scissors, saws, garden tools, carrot peelers, C-clamps, bottle openers, wood planes, cheese cutters, and pizza cutters. It would also be interesting to include some mystery tools, even obsolete ones - old fashioned curling iron, shoe button hook.

Conclusion – Activity 1

1. Using a bulletin board display, ask students to identify and label simple machines used on the task cards.
   a. pliers – lever
   b. hammers/nail – wedge
   c. screwdrivers – screw/wedge
2. Homework – have students discuss the use of machines at home. The Simple Machines Homework Task page is at the end of the lesson.
3. Students should complete the Machine Scavenger Hunt to find tools that are simple or compound machines and explain their use. The Machine Scavenger Hunt page is at the end of the lesson.

Introduction– Activity 2: Simple Machines: Wheel and Axle

1. Ask the students to explain how a bicycle works. Ask, *"What do you have to do to make the wheels turn?"* (Apply force to the pedals.) Ask the students, *"Have you ever noticed exactly what makes it possible for a bike wheel to revolve?"* (A rod, called an axle, goes through the

center hole of the wheel, and the wheel is free to turn around the axle.) A wheel and axle is a simple machine that makes it easier to move objects.

Procedure– Activity 2

1. Begin the lesson with a class KWL chart. Ask, *"What do you Know about wheels and axles? What do you Want to know about them?"* Write the students' responses in the K and W columns.
2. Have the students experiment to find out whether wheels and axles make it easier to move objects. Hand out the Wheel and Axle Investigation sheet, and have the students make their predictions about how far a toy car will go with wheels and without wheels.
3. Mark a place on the floor with tape. Put the toy car without wheels on the line. Push it from the back and measure from the tape to the back of the car with a metric ruler. Record the actual length. Have the students compare their predictions with the actual length.
4. Repeat with the toy car with wheels.
5. Discuss the results. *"Which car went farther? Why? What made it easier for the car to move?"*
6. Have students make predictions about how much force is needed to pull each toy car up a ramp.
7. Place a stack of books on the floor and lean the wooden board against it to make a ramp. Hook the spring scale to the car without wheels. Place the car at the bottom of the ramp. Slowly pull the car up the ramp. At the top of the ramp, read the force needed to pull the car up the ramp. Record the actual force. Have the students compare their prediction with the actual force.
8. Repeat with the toy car with wheels.
9. Discuss the results. *"Which car took more force to 'tow' it up the ramp? Why? What made it harder to pull that car?"* Have the students write their conclusions on their handouts. They should conclude that wheels and axles make it easier for an object to move.

Conclusion – Activity 2

1. Have students brainstorm about as many objects they can think of that use wheels and axles. As one student names an object, ask another student to explain how its wheels and axles make work easier.
2. Complete the L section of the KWL chart as a lesson wrap-up.

Introduction – Activity 3: Simple Machines: Wedge

1. Ask the students whether they have ever enjoyed eating cake at a birthday party, and if so, what was used to cut the cake. Explain to the students that a knife is generally used to separate cake into individual pieces.
2. A knife is an example of a simple machine called a wedge. It is used to separate or push objects apart.

Procedure – Activity 3

1. Show the students the plastic tools, one at a time. Ask the students to name the items and tell you what each one can do. Ask the students what the items have in common.
2. Give students clay and ask them to roll it into a cylinder shape. Ask them to divide it into halves, thirds, or fourths using the plastic knife.

3. Demonstrate the use of a saw on a piece of wood.
4. Discuss that each of the tools used cut, separated, or divided an object.

Conclusion – Activity 3

1. Have the students label a piece of paper "Simple Machines: Wedge" and draw pictures of the wedge objects that you have shown. Have them label each item and write a sentence about its function. For example, "A saw is a wedge because it cuts wood into pieces." Have a few students share their pictures and sentences with the class.
2. Have students think again about the birthday cake. Ask, *"How do you eat a piece of cake — swallow it whole or chew it? What simple machine do you carry around with you all the time that you use to cut, split, or separate things?"* (teeth)

Introduction – Activity 4: Simple Machines: Pulley

1. Ask the students if they have ever noticed how the flag on a flagpole gets to the top of the pole. Explain that the flag is raised and lowered by a simple machine called a pulley. A pulley is a rope and a wheel that work together. Pulling on the rope makes the wheel turn. This helps to move objects up, down, or across long distances without using much force.
2. Show students an example of pulleys in the classroom by raising and lowering the blinds and pointing out that there are several pulleys in the mechanism.

Procedure – Activity 4

1. Have the students experiment with pulleys. Set up the demonstration by placing a broom across the tops of the backs of two chairs. Hang a pulley from the broom. Tie a plastic bag to one end of each of the two pieces of string, and make a small loop in the other end. Then, put equal amounts of weight in each bag (3 textbooks). Place the bags side by side on the floor under the broom and between the chairs. Put one of the pieces of string through the pulley, and drape the other one over the top of the broom.
2. Have the students predict which bags will be easier to lift — the one that is lifted by hand, the one whose string goes through the pulley, or the one whose string goes over the broom.
3. Have a student volunteer come up, hook the spring scale to the bag to be lifted by hand and measure the force. Another student will hook the spring scale through the small loop of the string draped over the broom, and lift the weight to the top of the broom by pulling down on the string. Have the student read the force indicated on the scale, and have the other students record it in their journals. Then have another student repeat the experiment with the string that goes through the pulley. Repeat the experiment with several other students pulling the weight.
4. Have the students compare the forces required to lift the three weights. *"Why was the force less for the weight that used the pulley?"*

Conclusion – Activity 4

1. Have the students label a piece of paper "Simple Machines: Pulley" and draw a picture of a pulley with a wheel and a rope.
2. Also, have them write down examples of pulleys, such as that at the top of a flagpole, the reel on a fishing rod, and those in blinds.
3. Then, have them write a sentence about the function of a pulley.

Introduction Activity 5: Simple Machines: Lever

1. Ask the students whether they have been on a see-saw or teeter-totter, and ask those who have to explain how it works. Tell the students that this ride is an example of a simple machine called a lever. The bar in the middle of the see-saw (lever) is called the fulcrum. All levers have fulcrums. The object at the end that is being lifted is called the load. Levers help to lift loads.
2. Show students other examples of levers, such as a hammer, shovel, and screwdriver. Ask them what the objects are used for, and then demonstrate how they act as levers (hammer pulling nails out of a wall, shovel lifting dirt, screwdriver lifting up a lid).

Procedure – Activity 5

1. Have the students experiment with levers and fulcrums to discover that the position of the fulcrum makes it easier or harder for the load to be lifted. Give each group one ruler (lever), one pencil (fulcrum), and five pennies (load). Have the students center the ruler on the pencil and put all of the pennies on one end of the ruler.
2. Have them draw a picture of this arrangement on paper labeled "3.2 Simple Machine: Lever."
3. Have each student take a turn using his/her index finger to lift the load. Make sure the students notice how hard or easy it is to lift the load with the fulcrum in the center of the lever.
4. Have the students move the pencil (fulcrum) two inches from the end of the ruler (lever) without the pennies (load). Have them draw this arrangement in their journals and then take turns lifting the load with their fingers, noticing how hard or easy it is.
5. Have them move the pencil two inches from the pennies, draw this arrangement, lift the load, and notice the degree of difficulty.
6. Have the students rate each lift by labeling each picture "easy," "medium," or "hard." (easy = fulcrum close to the load; medium = fulcrum in the middle; hard = fulcrum on the opposite end of the load)

Conclusion – Activity 5

1. In summary, have the students write sentences describing what levers do and how the fulcrum helps levers function.

Introduction Activity 6: Simple Machines: Inclined Plane

1. Ask the students whether they have ever wondered how people in wheelchairs get into buildings. Direct the discussion to ramps.
2. Ask the students whether they have ever thought of stairs as a ramp to get from one level to another. Explain that these examples are simple machines called inclined planes.

Procedure – Activity 6

1. Begin the lesson with a class a KWL chart. Ask, *"What do you <u>K</u>now about inclined planes? What do you <u>W</u>ant to know about them?"* Write the students' responses in the K and W columns.
2. Have students experiment to find out whether inclined planes make it easier to move objects. Distribute the Inclined Plane Investigation handout, and have the students predict the distance a spiral notebook will travel from the floor to the seat of a chair. Have them record their predicted distance on their handout.

3. Place the notebook on the floor beside the chair. Then, lift the notebook so that it sits on the chair's seat but overhangs the edge. Have one student measure the distance from the floor to the bottom of the notebook, using a metric ruler. Have the students record this actual distance and compare their predicted distance with the actual distance.
4. Have students predict how much force will be needed to pull the spiral notebook from the floor to the seat of the chair and record their predicted force on their handout.
5. Place the notebook on the floor beside the chair. Hook the spring scale to the spiral edge, and pull the notebook up until it meets the edge of the chair's seat. Have a student read the spring scale. Have the students record the actual force needed and compare their predicted force with the actual force.
6. Discuss the data collected thus far. *"What do they think will happen when a ramp is used? Why?"*
7. Lean the wooden board against the chair to make a ramp. Have the students predict the distance the notebook will travel from the floor at the bottom of the ramp to the seat of a chair. Have them record the predicted distance on their handout.
8. Place the notebook on the floor at the foot of the ramp. Then slide the notebook up the ramp so that it rests on the chair's seat in the same position it did in step three. Have a student measure the distance it traveled, using a metric ruler. Have the students record this actual distance and compare the predicted distance with the actual distance.
9. Have students predict how much force will be needed to pull the spiral notebook up the ramp to the seat of the chair and record the predicted force on their handouts.
10. Place the notebook on the floor at the foot of the ramp. Hook the spring scale to the spiral edge, and pull the notebook up the ramp until it meets the edge of the chair's seat. Have a student read the spring scale. Have the students record the actual force needed and compare their predicted force with the actual force.
11. Discuss the data collected. *"Which way took more force to move the notebook? Why? Which way caused the notebook to travel a greater distance? Why?"* Have the students write their conclusions on the handout. (Ramps make it easier for an object to move from one place to another, but the object has to travel further to get there.)

Conclusion – Activity 6

1. Complete the L section of the KWL chart as a lesson wrap-up.

Introduction – Activity 7: Simple Machines: Screw

1. Ask the students if they have wondered how objects in the classroom, such as desks, chairs, bookshelves, and doors, were put together.
2. Direct the class discussion to possible answers, including glue, nails, and screws.
3. A screw is a simple machine made of an inclined plane that has been wrapped around a rod. The spiral-shaped edge around the rod that makes the screw is primarily used to hold objects together. (Make sure you have placed a mark (tape) on the screwdrivers before giving to pairs.)

Procedure – Activity 7

1. Divide the class into pairs and give each pair a small block of wood, a marked screwdriver, and two screws (with different space between threads).

2. Explain that students will investigate which screw takes fewer turns to drive into the wood. Ask students to make a prediction.
3. One student should count the turns it takes to drive the screw into the wood while the other student drives the screw into the wood completely.
4. Make sure students record their results.
5. Have the teammates switch roles and drive the other screw into the wood completely.
6. Record the results on the Screw Recording Sheet.

Conclusion – Activity 7

1. Share results and make inferences.
   a. *Which screw took fewer turns? Which took more turns to drive into the wood?*
   b. *If you were a worker who constructed houses, which type of screw would you prefer to use? Why?*
   c. *Did your prediction match what actually happened? Why do you think so or why do you think it did not match?*
2. Draw a picture on a piece of paper labeled "Simple Machines: Screw" of the two screws. Have students draw a circle around the one that took less turns.
3. On the same sheet of paper, have students write an e-mail pretending to be a worker of a construction company. The e-mail should be directed to their boss explaining how the screw worked and which of the two they would like for him/her to order for the company.

Introduction – Activity 8: Compound Machines

1. Ask the students to explain how a pair of scissors works. Discuss the simple machines that make the scissors work.
2. Have students label a journal page "Compound Machines." Have them cut out pictures of compound machines, glue them in their journal, and label each of the compound machines with the simple machines that make it work.
3. Have volunteers share the simple machines they found for each compound machine.

Procedure – Activity 8

1. Have students work in cooperative groups or teams to complete the "Machine Scavenger Hunt" worksheet.
2. After the students locate simple and compound machines in the classroom, around the school building, and outside, have them interpret the information collected by classifying each machine as simple or compound.
3. For each compound machine, have them name at least two simple machines that make up the compound machine.

Conclusion – Activity 8

1. Use the information collected about various compound machines to discuss with the students the importance of each simple machine working together to make a compound machine work.

Assessment

- **Questions**
  - Name the six simple machines.
  - Pick one simple machine and describe how it works.
- **Journal/writing prompts**
  - Give students a writing prompt to describe five ways they use simple machines in their everyday lives.
- **Other**
  - Assess the data sheets that go along with the students' investigations.
  - Have students create their own compound machine that will accomplish a simple task.
  - Observe students investigating machines.
  - Discuss which simple machine names match the tool used in tasks.

Extensions and Connections (for all students)

- Have students create a class picture diary with pictures and descriptions of themselves using various simple and compound machines around the home, work, or in the classroom (e.g., using a hammer or a can opener). They should explain in each description how a simple or compound machine is being used.

Strategies for Differentiation

- Make pictures that show what you want the end result to be.
- Limit the selection of tools.
- Prior to the lesson, allow students to practice using common tools.
- Take pictures of students working with different tools to associate the use of the tool with the machine.
- The homework task could be adapted so the student can draw a picture of tools in the home, check the location of the tool (kitchen, bathroom, etc.), and draw how it was used.
- Activity 2: Wheel and Axle
  - match the cards with machines that have a wheel and axle with the item that can be carried by those machines (i.e., a wheelbarrow and dirt)
- Activity 3: Wedge
  - supply pictures cards that show halves, thirds, and fourths
- Activity 4: Pulley
  - allow students to be flag raisers for one week for the school
  - allow students to use an actual fishing rod with a magnet (instead of a hook) to pick up magnetic objects
- Activity 5: Lever
  - Provide picture matching cards with examples of the uses of a lever (a hammer and bent nail to be pulled out, a shovel and a pile of dirt, a screwdriver and a paint can to open, etc.). Two students on one side would mean one student on the opposite side would need to move out.
- General Differentiations
- Give students a "rube goldberg" device – machines work in sequence to produce a desired outcome. Students use several objects or simple machines to accomplish a task.
  - Students match machine pictures with their uses.

- Create a chart. Headings include: “Machines” and “Machine Uses.”
- Classify machines as “Simple vs. Compound” and explain why.

Dear Parents,

I am so excited to tell you that next week we will begin a simple machines unit in science!

I have worked on a hands-on unit and I will need your help. If you have any of the items listed below that you would be willing to share with us and demonstrate its use for us, will you please let me know? We will be having an "Introduction to Simple and Compound Machines Faire" on _____ _____. If you could come to demonstrate your tool for us that day, it would be wonderful.

The items that we would like to have demonstrated are: pliers, hammers, screwdrivers, wrenches, wire cutters, small crowbars, scissors, saws, garden tools, carrot peelers, C clamps, bottle openers, wood planes, cheese cutters, and pizza cutters.
It would also be interesting to include some mystery tools, even obsolete ones: old fashioned curling iron, shoe button hook, anything you can think of.

Thank you so much! I appreciate your participation!!!!

I can bring and demonstrate the following item(s): _____

_____

_____

_____

Student name: _____

Parent name: _____

E-mail: _____

Simple Machines Task Cards

You have a nail in a piece of wood hammered in at an angle. Your task is to remove the nail and place it back in the wood straight.	You have a piece of wood with a screw in it. Your task is to remove the screw.
You have a rough piece of wood. Your task is to make it smooth.	You have an egg white. Your task is to make the egg white foamy.
You have a carrot. Your task is to peel the carrot into shreds.	You have a dressmaker's pattern and cloth. Your task is to make the pattern out of the cloth.
You have a can of vegetables. Your task is to remove the top from the can.	You have been given a piece of wire and a ruler. Your task is to make the wire into 5 cm. pieces.
You have a piece of cheese. Your task is to cut pieces of cheese in thin slices.	You have a board. Your task is to divide the board in half.

Simple Machines Task Recording Sheet

Name: _____ Date: _____

1. Which machine did you use? _____

2. Why did you choose this machine? _____

_____

_____

Draw a picture of the machine you used and you using it.

3. Explain how you used your machine.

_____

_____

_____

Simple Machines Homework Task

Name: _____ Date: _____

This week at home, discuss with your family the use of machines.
Here are some questions that can start your discussion. Write answers to the questions in the spaces.

1. How do machines help us do work? _____

2. How have machines changed in your parents and grandparents lifetime? _____

3. Are there old machines around the house or the garage? What are they? _____

4. Do machines ever cause problems? _____

Wheel and Axle Investigation

Name: _____ Date: _____

If an object has a wheel and axle, then it will be easier to move.

OBJECT	**Predicted distance it will travel**	**Actual distance it traveled**	**Predicted force it will need to get up the ramp**	**Actual force it needed to get up the ramp**
Toy car without wheel and axle	____ cm	____ cm	____ g	____ g
Toy car with wheel and axle	____ cm	____ cm	____ g	____ g

Conclusion:

_____

_____

_____

_____

Inclined Plane Investigation

Name: _____ Date: _____

If an inclined plane is used to move an object, then it will be easier to move, and the distance it travels will increase.

OBJECT	**Predicted distance it will travel**	**Actual distance it traveled**	**Predicted force it will need**	**Actual force it needed**
Spiral notebook without ramp	_____ cm	_____ cm	_____ g	_____ g
Spiral notebook with ramp	_____ cm	_____ cm	_____ g	_____ g

Conclusion:

_____

_____

_____

_____

Screw Recording Sheet

Names: _____ Date: _____

You and your partner will investigate how two screws go into a piece of wood. Notice that each of your screws is different.

Make a prediction. Which screw do you think will go into the wood in less turns?

_____

Draw each screw in the boxes below.

Screw #1	Screw #2

Record your results in the chart below.

Type of Screw	Number of turns to drive the screw in completely

If you were assembling a chair in your kitchen, which screw would you rather use? Why?

_____

_____

_____

_____

Machine Scavenger Hunt

Name: _____ Date: _____

Directions: Locate as many machines as you can. Classify each machine as either simple or compound.

Simple Machines	**Compound Machines**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

Choose one compound machine from your list above. Tell where you found it. Name two or more simple machines that make it work. Explain its use.

Compound machine:_____

Where it was found:_____

Simple machines it uses to work:_____

_____

Its use:_____