

# Simple Machines on a Great Lake

**Grade Level:** 3-5

**Activity Duration:** 1 hour

**Overview:**

Background Information

Classroom Set Up

Procedure

- I. Introduction
- II. Simple Machines
- III. Stations
- IV. Moose Scenario
- V. Conclusion

**Summary:** Simple machines are the most basic type of machines. They either allow us to use less force to move an object or change the direction of the applied force. We use many of these in everyday life. The large ships on Lake Superior are complicated machines made up of many simple machines.

**Topic:** Engineering

**Objectives:**

1. Students will be able to explain how engineered items help people.
2. Students will be able to give examples of simple machines and how they function.
3. Students will be able to explain how man-made things are made of parts.

## MINNESOTA ACADEMIC SCIENCE STANDARDS

### 3<sup>rd</sup> Grade

- 3.1.1.2 Scientific inquiry is a set of interrelated processes incorporating multiple approaches that are used to pose questions about the natural world and investigate phenomena.
- 3.1.3.4 Tools and mathematics help scientists and engineers see more, measure more accurately, and do things that they could not otherwise accomplish.

### 4<sup>th</sup> Grade

- 4.1.2.1 - Engineers design, create and develop structures, processes and systems that are intended to improve society and may make humans more productive.
- 4.1.2.2 – Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the produce.
- 4.1.3.3 - The needs of any society influence the technologies that are developed and how they are used.

### 5<sup>th</sup> Grade

- 5.1.1.2 Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations
- 5.1.3.4 Tools and mathematics help scientists and engineers see more, measure more accurately, and do things that they could not otherwise accomplish.
- 5.2.2.1 An object's motion is affected by forces and can be described by the object's speed and the direction it is moving.

## NEXT GENERATION SCIENCE STANDARDS

### Science and Engineering Practices

- 1. Asking questions (for science) and defining problems (for engineering)**
- 2. Developing and using models**
- 3. Planning and carrying out investigations**
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
- 6. Constructing explanations (for science) and designing solutions (for engineering)**
- 7. Engaging in argument from evidence**
8. Obtaining, evaluating, and communicating information

### Crosscutting Concepts

- 1. Patterns**
- 2. Cause and Effect: Mechanism and explanation**
3. Scale, proportion, and quantity

4. Systems and system models

**5. Energy and matter: Flows, cycles, and conservation**

6. Structure and function

7. Stability and change

**Disciplinary Core Ideas**

PS2.A: Forces and Motion

PS2.B: Types of Interactions

PS3.A: Definitions of Energy

PS3.B: Conservation of Energy and Energy Transfer

PS3.C: Relationships Between Energy and Forces

PS3.D: Energy in Chemical Processes and Everyday Life

**Materials:**

- Lesson Plan
- Master Copies of:
  - o Simple machine station worksheets
  - o Moose drawing worksheets
- 1 set (6) of large simple machine pictures
- 1 set (6) of flip cards (simple machine/part of ship)
- Station Bags
  - o Wedge: : play-doh, 4 wooden shims, \*\*needs a stack of books\*\*
  - o Ramp: the large wooden ramp, weight w/ string, 3 spring scales
  - o Lever: 3 rulers, 3 fulcrums, 3 weights
  - o Pulley: 3 pulleys, 3 weights w/ string, 3 ropes
  - o Wheel: 3 carts, 3 spring scales
  - o Screw: 3 wide thread bolts, 3 wide thread screws, 3 fine thread bolts, 3 fine thread screws
- Simple machine books

**BACKGROUND:**

**INFORMATION FOR SHIPS ON LAKE SUPERIOR**

Lake Superior is part of the Great Lakes St. Lawrence Seaway System (GLSLS), which provides access from the Atlantic Ocean to the Great Lakes region. Transporting cargo by ship is the most fuel efficient mode of transportation that exists today. The GLSLS transports 200 million tons of cargo on average each year, 38 million of which on average is handled by the Port of Duluth-Superior. The Port of Duluth-Superior is located at the westernmost tip of Lake Superior, 2,342 miles from the Atlantic Ocean and the farthest inland seaport in the United States. The Port

supports roughly 11,500 jobs and is seen as the backbone of the region's economy. Its principle outbound cargo includes iron ore, coal, and grain, and the main incoming cargo includes limestone, cement, salt, wood products, and heavy equipment for energy-related projects (i.e. wind turbine parts). Nationally, the Port of Duluth-Superior is ranked #1 by cargo loadings for ore and #4 for coal. The navigation season within the GLSLS runs for 9 months out of the year (from mid-March to mid-January) and the shipping channels are kept open by tugboats and Coast Guard icebreakers ("Duluth Seaway Port Authority", 2015).

Two distinct types of ships visit the Port: "lakers" which are bulk carriers specifically built for the GLSLS and are too large to bypass the locks at Niagara Falls so spend their lives on just 4 of the 5 Great Lakes, and the smaller "salties" which are able to navigate all 16 lock sets along the GLSLS and built to withstand high-seas transport. Lakers are over 1,000 feet long and within the Port of Duluth-Superior they are responsible for 90% of vessel traffic ("Duluth Seaway Port Authority", 2015). These large ships on Lake Superior are made up of many simple machines.

## INFORMATION ON SIMPLE MACHINES

Machines help people do work. Simple machines are the most basic of machines, which are combined in various ways to make more complicated machines. There are 6 of them: ("MIKIDS.com", 2015):

**Lever:** A lever is a stiff bar that rests on a support called a fulcrum which lifts or moves loads. The closer the load is to the fulcrum, the easier it is to move. Examples: Bottle openers, seesaws, crow bars, and wheelbarrows.

**Inclined Plane:** An inclined plane is a slanting surface connecting a lower level to a higher level. Inclined planes make the work of moving things easier. For example, less force is required to move objects up an inclined plane than to lift it vertically. Examples: Ramps, slanted roads, uphill paths, and slides.

**Wheel and Axle:** A wheel with a rod, called an axle, through its center can turn and is used to lift or move loads. Examples: Cars, roller skates, wagons, and door knobs.

**Screw:** A screw is an inclined plane wrapped around a pole. Screws are used to hold things together or lift materials. Examples: Jar lids, light bulbs, key rings, and spiral staircases

**Wedge:** A wedge is an object with at least one slanting side ending in a sharp edge, which cuts material apart. Examples: Knives, axes, forks, and door stops

**Pulley:** A pulley is a simple machine that uses grooved wheels and a rope to raise, lower, or move a load. Pulleys are good for moving objects to hard-to-reach places and they decrease the

force required to move a load. Examples: flag poles, sailboat sails, window blinds, bucket in a well.

## CLASSROOM SET UP

There are 6 different stations. Each station should have a tray, a bag, and a scenario sign. Set up the simple machine stations around the classroom. You can either have these stations at tables, desk groups, or on the floor. Use the trays to help the stations stay organized and place the corresponding station sign at e

## PROCEDURE

### I. INTRODUCTION (5 min)

Ask the students about Lake Superior. What do you see when you look at the lake? (write their answers down on the board). Guide them towards “boats and ships” if they don’t get there themselves

What do you see when you look at the harbor? Boats, ships, a lot of MACHINES!

Explain that a lot of the large boats/ships that they see on Lake Superior are called **lake freighters** or “**lakers**”. These lakers are complicated machines made to carry heavy loads of goods from one spot to another across water. Ask the students the following questions:

- Have you ever seen one of the lakers on Lake Superior?
- Are there machines that carry large loads of goods across land?
  - i.e. semi-trucks and trains
- Where do you think the materials to build your school came from?
- How did it get to this spot?

Parts of your school could have been transported here on one of those large ships! Explain that these large machines are made up of smaller parts. Many of these smaller parts are the **simple machines** that we will study today. Explain to the students that while the class investigates these simple machines, they are learning how to be engineers.

### II. SIMPLE MACHINES INTRODUCTION (15 min)

Introduce the six simple machines 1-by-1 and show large pictures of the simple machines as you talk about them. Make sure you adequately explain what each simple machine is and the parts of the various one (i.e. the fulcrum for the lever).

The six simple machines are:

- 1) Wedge
- 2) Lever
- 3) Ramp
- 4) Pulley
- 5) Screw
- 6) Wheel

A simple machine is the most basic of machines that allows us to do a job easier. It does one of two things. It will either lessen the **force** necessary to move an object, or change the direction of the force that is applied to it. Go over the term **force**- explain that it means the amount of effort required to move an object and that it is measured in units of measurement called **newtons** (N). Write both terms on the board.

Activity: Ask each student to get out a piece of paper and a pencil and take 5 minutes to look around the classroom and write down all the simple machines they find. They can also write down simple machines in the school, the playground, and/or their home. Ask a few of the student to share what they found.

### III. SIMPLE MACHINES STATIONS (20 min)

Now that your class knows what the 6 simple machines are, they are all going to become engineers on one of the lakers! Here is their story:

“Michigan used to have a lot of moose, just like Minnesota, but by the 1890’s there were no longer any moose in the lower peninsula of Michigan and very few in the Upper Peninsula. In the 1980’s, moose were reintroduced to the Upper Peninsula from a park in Ontario, Canada, and have done very well. Now YOU have been hired to transport a moose from Canada by ship through the Port of Duluth-Superior on your way to Michigan. As the ship’s crew, you might encounter problems that you have to solve using simple machines. The following activity will test your preparedness for the journey. ”

Activity:

1. Explain that there are six stations and that each group will get a chance at each one. Each station addresses a problem that the crew might encounter on their journey to the Port of Duluth-Superior
2. Each station addresses a problem that the crew might encounter on their journey to the Port of Duluth-Superior on the station sign
3. Divide the class into 6 group and hand out a worksheets

4. Allow students to spend 3-5 minutes at each station and have them rotate around the room
5. Gather the students back together once everyone has visited all the stations.

Wrap up the station activity by explaining these simple machines are connected together to create compound machines which can do even greater things than the simple machines can do on their own.

How are they combined to create one of the ore boats that carry iron or other materials around Lake Superior?

- Choose six students to come up to the front of the class and hold up the 6 flip cards. Remind them beforehand that they can't give away the answer before a few students get to guess.
- Call on students to guess which machines create which part of the ship. Once they guess how it is used on the ship, have the student holding the card flip it over to show the class that part of the ship.
  - Lever = rudder
  - Screw = propeller, connecting panels
  - Wheel = steering, gears
  - Pulley = anchor, crane
  - Ramp = loading, people
  - Wedge = bow

#### **IV. DRAWING (5 min)**

Now for the final task! You are in charge of loading a ship that will carry one of the moose across the lake. There is a moose on the dock that needs to get onto the deck of the ship 40 feet above. Using the worksheet provided, draw a machine that will move the moose from the dock onto the ship deck. You must include at least 3 of the simple machines in your drawing. Ask some students to share their drawings.

#### **V. CONCLUSION (5 min)**

We have studied the 6 simple machines and ways they can impact our lives and how they are used on the Great Lakes Ships. The things we humans create have an impact on us and the world around us. Write down the students' answers as you ask them the following questions:

- How does using these large machines affect our lives?
- How does using these large machines affect Lake Superior and the Great Lakes?

Review the 6 simple machines. Erase/cover up the various vocab words and quiz the students on them (i.e. fulcrum, force, newtons).