LESSON TITLE: SIMPLE MACHINES (PART 1)

TOTAL TIME: TWO 45-MINUTE PERIODS

BRIEF DESCRIPTION

In the first part of this *The House That STEM Built* lesson plan, students will discover simple machines by listening, watching, and doing. Students will build a simple demonstration, watch *The House That STEM Built: Simple Machines* video, and then wrap up by noting the simple machines in their own lives. This lesson plan will also touch on forces, as well as mechanical advantage. This lesson plan was created with the New Brunswick Grade 5 curriculum in mind but could be altered to address more advanced topics at middle and high school levels.

CURRICULUM OUTCOMES

Taken from the New Brunswick Grade 5 Science curriculum.

GENERAL CURRICULUM OUTCOMES

GCO 1: Students will develop the skills required for scientific and technological inquiries, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions (scientific literacy).

GCO 2: Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology (STSE).

SPECIFIC CURRICULUM OUTCOMES

SCO 1.1: Students will plan investigations by asking questions, making inferences, and selecting and using equipment or technology needed to solve a specific problem in the natural world.

NEW BRUNSWICK GLOBAL COMPETENCIES ACHIEVED[1]

- Critical Thinking and Problem-Solving
    - Learners engage in an inquiry process to solve problems, as well as acquire, process, interpret, synthesize, and critically analyze information to make informed decisions.
    - Learners construct, relate and apply knowledge to all domains of life, such as school, home, work, friends, and community
    - Learners formulate and express questions to further their understanding, thinking, and problem-solving
- Innovation, Creativity and Entrepreneurship
    - Learners display curiosity, identify opportunities for improvement and learning, and believe in their ability to improve while viewing errors as part of the improvement process.
    - Learners take risks in their thinking and creating; they discover through inquiry research, hypothesizing, and experimenting with new strategies or techniques.

LEARNING OBJECTIVES

Learners will

- identify simple machines in their everyday lives,
- determine forces that impact the movement of objects, and
- be able to describe the term “mechanical advantage”.

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1 https://www2.gnb.ca/content/dam/gnb/Departments/ed/pdf/K12/curric/competencies/NBCompetencies.pdf?fbclid=IwAR1ldrZs1gFgiNm8rC4oz7Fmx6mSn-6t_QJkenev0eD33rZ-foYYn6bmdmc *also available at* https://tinyurl.com/nb-competencies

MATERIALS

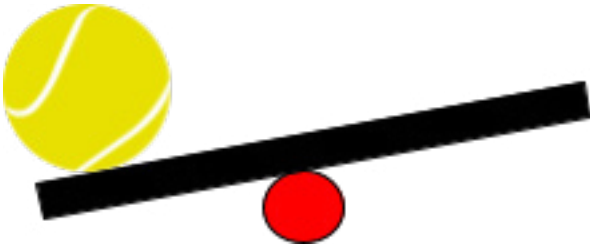
- Video: *The House That STEM Built: Simple Machines*.
- Markers (1 per pair).
- Rulers (1 per pair).
- Masking tape.
- Tennis balls (1 per pair).

WARM UP: 10 MINUTES

GROUPING: PAIRS

Break students into pairs. Give each pair a marker, a ruler, and a tennis ball.

- Tape the marker on the desk in front of each pair and place a looped piece of masking tape on one end of the ruler. Ask students to attach the tennis ball to the tape on the ruler and position the ruler over the marker like a seesaw.



- Let students know that they have just created a simple machine called a lever. With the marker or fulcrum positioned directly in the middle of the ruler, ask students to test the lever by pressing down on the ruler on the opposite end from the tennis ball. By pressing down on the ruler, students should be able to lift the

tennis ball off the desk. After they have tested the lever, ask them to reposition the ruler so that the tennis ball is as close to the marker as possible.

- Does it act differently? Did it feel harder or easier to lift the tennis ball? What would happen if the tennis ball was as far away from the marker as possible?[2]

- Let students know that today we will be learning about simple machines, how they work, and where we find them in our everyday lives.
- Before starting the video, go over some new terms that they will encounter and add them to the board or a word wall if you have one. Some examples include:
  - Fulcrum: the point on which a lever rests and about which it pivots or rotates.
  - Mechanical advantage: the advantage gained by using a tool that transmits force from where it is applied to where it does work.

ACTIVITY: 25 MINUTES

GROUPING: ENTIRE CLASS

Watch *The House That STEM Built* video. Feel free to pause the video and ask some or all of the following open-ended questions to prompt discussions.

- 2:15 – Does this explanation of the lever explain what you experienced in our pairs? Why or why not? Was the tennis ball easier to lift when it was closer to or further from the marker?
- 2:33 – Force is something that can influence the movement of an object. This could be up or down, side to side, or slow or fast.

2 This activity was taken from the National Geographic Simple Machine Challenge which can be found here: https://www.nationalgeographic.org/activity/simple-machine-challenge/

What type of forces do you think are influencing the lever right now?

- 3:30 – Why do you think adding another pulley would make it easier to lift the heavy box?
- 5:10 – In the example of the wheel and the axle, are there any trade-offs that must be made to make it easier to turn the axle?
- 5:52 – Has anyone ever seen an example of the water well that they described? Are there any other examples of wheels and axles that you can think of?
- 7:05 – Let's pretend for a moment that instead of using an axe or a wedge, you were trying to split wood with a rectangle, something like a mallet. How would the energy transfer be different? Where would the energy come from and where would it go (you can use visuals to help with this)?
- 8:18 – What would be an advantage of using a screw over a nail?
- 9:55 – Do you know what sort of simple machine the wheelbarrow is?

CONCLUSION: 10 MINUTES

GROUPING: INDIVIDUAL, PAIRS, ENTIRE CLASS

- Invite students to take a moment and write down as many examples of simple machines that they know of from their own lives.
- After students have had the chance to write down or think of some examples, encourage them to share with a partner.
- While students are talking to their partners, write the 6 types of simple machines on the board. Ask groups to share examples of each which you will write on the board or chart paper. Keep this list handy as it might help with tomorrow's activity.

DIFFERENTIATION

CONTENT

Use *The House That STEM Built* video to spark a conversation about

- simple machines within the classroom or school,
- how simple machines can be used to solve a problem that students might face, and
- how simple machines can be used to make public places more accessible for people with disabilities.

PRACTICE

Are there any professionals in your area who might be a good resource who might be able to bring in materials and resources for your students?

Do you have access to a school shop where you might be able to find materials that can be used to demonstrate all of the simple machines?

Students can watch and host discussions in smaller groups (4–6 students) or as individuals instead of as a full class.

https://gizmos.explorelearning.com/ has many free simulations which include simple machines. These simulations could be used as an alternative format to demonstrate.

PRODUCT

Ask students to create a simple machine using materials that can be found in the classroom.

Have a contest where students are tasked with combining two simple machines to move a weight. Which two work together really well? Can you use more?

Create a bingo card with the simple machines that students can take home. See how many examples they can find.

EXTENSION

National Geographic has a simple machine challenge that introduces students to simple machines, provides examples, and gets them to work hands-on with them. You can find that challenge below.[3]

Ask students to do an audit of their school. Are there any simple machines being used? Is the school accessible? Are there any issues that students spot that could be remedied with a simple machine?

3 https://www.nationalgeographic.org/activity/simple-machine-challenge/ *also available at* https://tinyurl.com/nat-geo-challenge

LESSON TITLE: SIMPLE MACHINES PART 2

TOTAL TIME: TWO 45-MINUTE PERIODS

BRIEF DESCRIPTION

In this second part of *The House That STEM Built* lesson, students in groups will get the chance to create a kinesthetic simulation (a Kinulation) of a simple machine which they will act out for the class. After they have created their Kinulation in groups, they will work together as an entire class to put their simple machines together to create one functioning machine.

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- Innovation, Creativity and Entrepreneurship
    - Learners display curiosity, identify opportunities for improvement and learning, and believe in their ability to improve while viewing errors as part of the improvement process.
    - Learners take risks in their thinking and creating; they discover through inquiry research, hypothesizing, and experimenting with new strategies or techniques.
- Collaboration
    - Learners participate in teams by establishing positive and respectful relationships, developing trust, and acting interdependently and with integrity.
    - Learners learn from and contribute to the learning of others by co-constructing knowledge, meaning, and content.

LEARNING OBJECTIVES

Learners will

- be able to identify the six types of simple machines,
- work together to create a simple machine by acting it out, and
- explain why simple machines are useful in everyday life.

4 https://www2.gnb.ca/content/dam/gnb/Departments/ed/pdf/K12/curric/competencies/NBCompetencies.pdf?fbclid=IwAR1ldrZs1gFgiNm8rC4oz7Fmx6mSn-6t_QJkenev0eD33rZ-foYYn6bmdmc *also available at* https://tinyurl.com/nb-competencies

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MATERIALS

- Video: *The House That STEM Built: Simple Machines*.
- Medium-sized balls or objects that students can move through their Kinulation.
- Printouts of "Kinulation Background Information" (one per team).
- Paper.
- Writing materials.
- Space for students to move around.

BEFORE CLASS

Print out the "Kinulation Background Information" sheets.

For more information about Kinulations, check out https://www.kinulations.com/ where there is a specific video and lesson plan for the Kinulation of simple machines.

WARM UP: 15 MINUTES

GROUPING: 6 EQUAL GROUPS

Remind students of the 6 simple machines that they went over yesterday.

- Split the class into six equally-sized groups. Give each group one of the "Kinulation Background Information" sheets so that each group has a different simple machine to explore.
- Tell students that it is their responsibility to create the simple

machine that they have been assigned, by acting it out with their bodies. Everything else is up to them. They can brainstorm, use the paper and writing materials to plan, and use the ball or object to help them demonstrate their machine.

- They can use examples from yesterday or, if technology permits, they can rewatch relevant parts of *The House That STEM Built* video to help them plan.
- This will require some facilitation. Encourage students to work together, include everyone, and think outside the box. If an aspect of their Kinulation isn't working, encourage your students to pause, rethink, and rework.

ACTIVITY: 20 MINUTES

GROUPING: SIX EQUAL GROUPS, ENTIRE CLASS

- After students have created their own individual Kinulation in their groups, ask each group to demonstrate their simple machine to the class.
- Encourage students in the other groups to kindly and respectfully ask questions, seek clarification, and make suggestions for modifications that might improve the Kinulations presented.
- Once students have demonstrated their simple machines, tell them that the next task is to create one big machine that incorporates all of their simple machines together. The goal of the machine is to pass the ball/object from the start point to the end.
- As a class, students will work together to connect their individual simple machines together to create a Kinulation that includes all of them.
- This will require some facilitation, encourage students to think outside the box, test out the machine, switch around the order of the simple machines, or make alterations as needed.
- Once assembled try, to send the ball/object through the machine to test it out. If it doesn't work the first time, pause, rethink, and

try again.

CONCLUSION: 10 MINUTES

GROUPING: ENTIRE CLASS

As an exit slip, ask students to reflect on their experience today. To do this, ask them to write down 3 things that they learned, 2 questions they have, and 1 thing they would do differently next time.

DIFFERENTIATION

CONTENT

Students can use their knowledge of simple machines to create a plan to solve an issue that they have seen in their school.

The building and construction industry uses many simple machines. Are there any other careers that make use of them? Explore different career paths that make regular use of simple machines.

Does the human body make use of any simple machines? Investigate whether or not there are any examples.

PRACTICE

Are there any professionals in your area who might be a good resource who might be able to bring in materials and resources for your students?

Students can use technology or simulations to help provide them with inspiration for their Kinulation.

Ask your school shop to provide you with some materials that students could use in their Kinulation.

PRODUCT

Ask students to design a Rube Goldberg machine using more than one simple machine. There are many videos on YouTube that can be used as inspiration.

Ask students to create their Kinulation on paper in a storyboard format.

Ask students to design a brand-new invention that includes a simple machine.

EXTENSION

Ask students in groups to build a project using simple machines. These projects must have at least 2 machines and create mechanical advantage. Students will get the chance to explain their projects and how they work in a classwide science fair format.

Kinulation Background Information
Lever

Definition:
A lever is made up of a stiff rod that pivots around a fixed (unmoving) point or fulcrum.

What does it do:
Levers can be used to lift heavy objects. By moving the pivot point (fulcrum) you can increase or decrease the amount of force needed to lift the object.

What does it look like:

Examples:

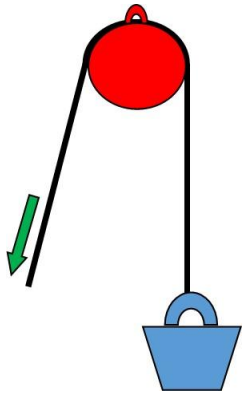
- Seesaws
- Wheelbarrows
- Scissors
- Staplers
- Hammers

Kinulation Background Information
Pulley

Definition:
A pulley is a simple machine that is made up of a wheel with a groove and a rope. Pulleys reduce the amount of force needed to lift an object.

What does it do:
Pulleys are used to lift heavy objects vertically. They change the direction of applied force and can make it easier to lift heavier objects.

What does it look like:



Examples:

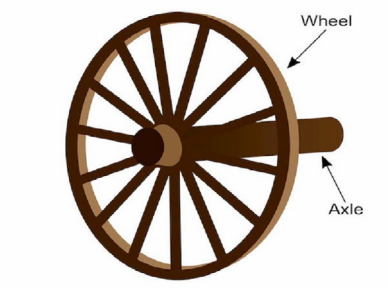
- Elevators
- Water wells with a bucket
- Exercise equipment
- Flagpoles

Kinulation Background Information
Wheel and Axle

Definition:
A simple machine that is made up of a larger wheel attached to a smaller rigidly attached axle.

What does it do:
Both the wheel and the axle travel together in the same direction which transfers the energy from the movement of the larger wheel onto the axle or vice versa.

What does it look like:



Examples:

- **Car tires**
- **Ferris wheel**
- **Revolving doors**
- **Windmills and Watermills**

Kinulation Background Information
Inclined Plane

Definition:
A flat surface that is tilted at an angle with one end higher than the other.

What does it do:
Inclined planes are used to move heavy objects up and down. The force required to move something up or down on an inclined plane is less than what is required to vertically lift the object.

What does it look like:

Examples:

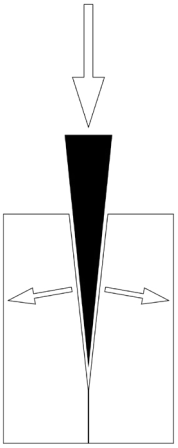
- **Slides**
- **Ramps**
- **Pyramids**
- **Waterslides**

Kinulation Background Information
Wedge

Definition:
An object that has one thick end that tapers into a thin end which is driven between two objects or into one, with the intent to separate it.

What does it do:
Wedges can be used to hold objects in place (wheels, doors etc…) or they can be used to separate an object (slicing, chopping, etc…)

What does it look like:



Examples:

- **Shovels**
- **Axes**
- **Knives**
- **Chisels**
- **Door stops**
- **Sewing needles**

Kinulation Background Information
Screw

Definition:
A screw is a cylinder with a head at one end and a point on the other end. Over the length of the cylinder, it has ridges winding around it.

What does it do:
Screws are used to hold things together. They can push or pull objects together or they can be used to lift or tighten objects.

What does it look like:

Examples:

- Guitar tuners
- Light bulbs
- Bottle caps
- Bolts
- Spiral Staircase