Mighty Mining Machines

Lesson Plan

Description

Students will learn about mining machinery and about the people who design, build, and use these machines. They will then design and build a piece of mining machinery using concepts of simple machines.

Learning Outcomes

- Associate careers with the design and use of mining technology
- Understand what a simple machine is and how they appear in complex technologies
- Apply knowledge of simple machines and mining technology in a design challenge

Introduction

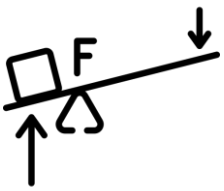
What is a simple machine?

A simple machine is a mechanism which changes a force in either direction or amount.

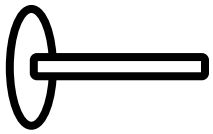
What are the types of simple machines?

There are 6 simple machines.

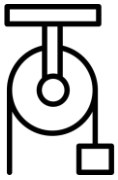
Lever – a lever is a rigid beam on a fulcrum. A seesaw in a playground is an example. While a child probably couldn't lift another child their own size, the lever reduces the force needed to perform that work. Indigenous people in Canada have used paddles as levers to move in canoes for a very long time. The closer the fulcrum is to the load, the more it reduces the work needed to move that load.



Wheel and Axle – When the wheel is turned, the force is transferred to the axle. Because the wheel rotates more per turn than the axle does, it requires less work to move a load. The bigger the wheel, and the smaller the axle, the less work is needed. A doorknob is an example of a wheel and axle, as are the wheels on our vehicles. In the Yukon, the Gwich'in people invented a wheel and axle system for fishing salmon. Paddles turn a wheel, which rotates baskets through the river to collect salmon.



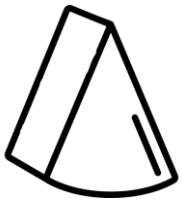
Pulley – A pulley is a wheel which has a flexible cord on its rim which reduces the work needed to move a load. It is related to the wheel and axle. The wheel needs less effort to turn than the load needs to move, but because the wheel is larger and moves more per rotation than the load, it reduces the work needed to move the load directly. The more pulleys you have in sequence, the less work is required. Anishinaabe people used bows to create a pulley system which let them spin their firestarter more quickly, a method which is still popular for starting fires quickly today without matches or a lighter.



Inclined Plane – An inclined plane is a very simple machine with no moving parts. It is a flat plane which creates a slope. Simply put, it is a ramp. It takes less force to push a load up an incline than it does to lift it to that same height. The less steep the ramp, the less force is required. Earth ramps are sometimes used in the traditional building of plank houses by the Indigenous people of the Northwest, such as the Coast Salish, to raise the planks needed for the roof.

Screw – A screw is an inclined plane around a cylinder. It converts cyclical motion into directional motion, using the inclined plane to reduce the amount of force needed for drilling.

Wedge – A wedge is a small, inclined plane which is tapered at one end and thick at the other. An axe is an example of a wedge. It takes less work to use a wedge to separate two parts than to do so manually. Indigenous people across Turtle Island used and continue to use wedges as carving tools for building canoes and kayaks, and more.



How Efficient is a Simple Machine?

The force of an object is its mass times its acceleration. This is Newton's second law. We use simple machines to augment the force we put in, in order to counter the force of the load we are trying to move.

Mechanical advantage = load / effort. It is a practical measurement of how much a machine reduces the work needed to complete a task. The velocity ratio is the theoretical version of this, which does not take friction into account.

The efficiency of a machine is measured by dividing the mechanical advantage by the velocity ratio. A perfect machine will have an efficiency of 1, but since all machines lose some energy to friction, the input will always be greater than the output, and the efficiency less than 1.

Simple Machines in Mining

Simple machines are everywhere in mining. In an open pit mine, the ramps used to let machines up and down safely are inclined planes. Drills use screws on the drill bits to make drilling easier. Picks are examples of a wedge, and shovels are examples of both a wedge and a lever. A lot of modern mining uses hydraulics, which works on the same principles as a lever.

Complex machines are made up of multiple simple machines working in tandem.

Mining Machines

Bucketwheel excavators are used in open pit mining. There is a wheel and axle on the front of the machine which turns. On the edge of the wheel are toothed buckets. The teeth are wedges, which help the buckets loosen and pick up material.

The continuous miner is a piece of machinery which works in a similar way but for underground mining. A toothed wheel turns to loosen material and deepen drifts.

Auger drills are drills which have a giant screw which makes drilling easier. They are used in both above and below ground mining.

Mining technology is always evolving. The use of unmanned vehicles, drones, and hydraulic machines are making mining safer, greener, and more effective.

Engineers are needed to design new technology, as are computer scientists, coders, and more. Technicians and mechanics are needed to operate and repair mining technology too!

Action

Part 1: Research (Worksheets)

There are 5 base machines which can be bought and upgraded in the game. Hand out the one-pagers to students and have them choose one to learn more about.

Hand out the worksheets. Ensure you have chosen the one for your appropriate grade level. Students will be asked to do some research. A one-pager on each of the mining technologies in the game are provided to help guide their research, but they may use other sources if you allow.

Part 2: Design

Put students into small groups, and issue them the following challenge:

Your task is to design a new kind of technology to use in an underground or open pit mine. Consider how automation, AI, remote control, and other new technologies can be used to make a mine site safer, greener, and more effective.

As a group, have students brainstorm as many ideas as they can for 15 minutes.

Have students choose their favourite 4 ideas and build them out in more detail. Have them describe what task it will accomplish, how it will make the mine site safer, and how it will make the mine site greener.

Have students narrow their choice down to one idea and give them a blank sheet of paper on which to draw their design. Their drawing should be labelled with any simple machines or technological innovations used.

Part 3: Prototype

Using materials such as cardboard, tape, glue, and markers, have students create a model of their invention. If it relies on simple machines, it should work at least enough to demonstrate what it should do. If it relies on coding and computer technology, each part should be labelled to describe what purpose it serves.

Part 4: Pitch

As the final part of this task, students should present their invention as if to sell it to a mining company. Their pitch should include details on:

- How it works to make mining easier, safer, and greener
- What its key features are
- How it can be used alongside existing mine technology

Part 5: Game Play

Play the Mine Evolution "Mine Race" mini game and see mining machinery in action and cutting-edge technological upgrades.

Materials:

- 1 device for each student

Procedure:

- Each student will need a device (laptop, tablet, or mobile phone).
- Each student will need to go to mineevolution.ca on their device. Click "Get the Game".
- Students can download either the Google Play (Android devices and Chromebooks), App Store (Apple devices), or PC versions of the game depending on what type of device they are using.
- Once the game is downloaded, select "Challenges".
- Select "Mine Race" and begin playing! The tutorial will show students how to play. There is also a tutorial video and a "How to Play" document with tips and tricks on the Science North educator resources website (https://schools.sciencenorth.ca/educator-resources).

Consolidation/Extension

Grade 10: Who makes, uses, maintains, and repairs mine equipment? Research three jobs related to mine technology, and find the salary, the education needed, and some daily tasks.

Mine to Table: What is your invention made of? Research where those materials come from, and what the lifecycle of that product would be. What is the environmental impact of producing this product? How can it be made to last for a long time, or be repurposed, in order to lessen its footprint?

Accommodations/Modifications

Worksheets are provided as a word document so that you can change the font size or type as needed for students with visual impairments, dyslexia, or other needs.
Ensure you are using the worksheets which most closely matches what your students have learned.

Assessment

The worksheet answers can be used as an evaluation tool.
Are students communicating clearly verbally and in writing about science concepts?
Are students applying knowledge about simple machines, force, and work in order to solve a problem?

Additional Resources

https://www.hrparts.com/blog/post/parts-bulldozer-undercarriage-diagram -> explore an animated description of a tracked vehicle and its simple machines.

Books: The Inuit Thought of It by Allootook Ipellie and A Native American Thought of It by Rocky Landon and David Macdonald for more Indigenous innovations