Grade 4 Science Unit
Pulleys and Gears

Based on the Ontario Curriculum

This cross-curricular science unit allows teachers to meet the Ontario Science expectations when teaching this complete unit.

Created by Teaching Rocks!

Lisa Papa, Loriana Romano, Elita Saulle

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Topic: Exploring Simple and Compound Machines in Action

Lesson 3 and 4: Wheels in Motion Investigation Activity

Overview: Students will first discuss simple and compound machines as a class before breaking into small groups to explore the motion of a compound machine.

Objectives:
Students will:
- Review the simple machines that they learned about in the last lesson
- Work in small groups to investigate simple machines and motion
- Discuss simple machines and how we use them every day
- Use effective communication skills to share their ideas and listen to the ideas of other group members
- Make connections between the various suggestions posed by group members
- Discuss how simple machines are put together to form a compound machine (e.g. car)
- Set up their materials for their investigation, follow directions for the investigation, and record observations
- Describe the motion of the compound machine using the term “linear motion”
- Observe, record, analyse and explain how the linear motion of the compound machine is affected by adding on weights

Learning Goal:

We are learning to observe, describe, and explain how simple machines can create a compound machine that displays motion.

Materials:
- “Wheels in Motion” booklet (1/group)
- The following materials are needed PER GROUP:
  o small Hot Wheels type car
  o weights (or 3 pennies)
  o masking tape
  o tape measure
  o book
  o ruler
Activities:
1. As a class, review the concepts of simple machine. Complete the first two pages of the student booklet together as a whole class. There is space in the booklet for students to record the definition of a simple machine and draw a picture for each simple machine that was studied.
2. Students are to then draw a picture of how simple machines are used to create mechanisms that we use every day. As you review these every day tools with students, ask students if they have any other examples to share.
3. Discuss how a compound machine is just a combination of a few simple machines. Students are then to draw a picture of a car in the space provided.
4. Depending on student comprehension and class time, the previous discussion and drawing activities can make up lesson number 3. Teachers may then discuss the investigation with their students and inform them that the investigation activity will take place the following class.
5. When your class is ready for the investigation activity, divided them into pairs of small groups (may be heterogeneous grade groupings). The size of the groups is dependent on the amount of materials you have; however, 3 students per group is an ideal number because each student has an active role to play.
6. Have students set up the ramp as indicated in the student booklet. Quickly check that all groups have their materials set up correctly.
7. Have students complete the third page of the booklet in their small groups.
8. Reconvene and show students how to use a piece of masking tape to tape the weight/penny to the roof of the car. Let the car roll down the ramp (without pushing it!) and show students how to measure the distance the car moved once it comes to a complete stop. Show students where to record this information in their chart. Explain how they complete three trials for each investigation.
9. Once students are all done, reconvene and introduce the concept of an average. This may be a bit difficult for students to grasp, but you can use sports or grades to help them understand. Students then complete all sections of the booklet and had it in.

Assessment:
Students complete a short journal entry explaining the lab investigation they completed and what they learned from the experience.
Topic: Gear Design Challenge

Lesson 7: Understanding how gears work together to transfer motion and make work easier

Overview:
Through the introduction of gears via a video, students will create their own gear trains in order understand the different functions of gears.

Learning Goals:
Students will discover the difference between idler, driver, and follower gears as well as understand the concept of gearing up and down. They will also be able to discover how gears transfer motion and help to change direction in motion.

Objectives:
Students will:
- Understand and identify different gears and how they work
- Understand that gears have different functions within a system
- Use effective communication skills to share their ideas and listen to the ideas of other group members

Materials:
Access to view video as a group
Vocabulary cards and images (provided)
Key Word recording sheet (individual)
Gear Design Challenge Sheet (individual)

Per group:
Cardboard (enough to have one board and more to cut out gears)
Brass fasteners (10 per group)
Gear cutouts photocopy
Scissors
Sharpened Pencil
Alternatively: If you have gears sets available, then multi-sized gears for each group.

*Please note: If you prefer you can prepare the gears prior to lesson*

**Activities:**

Explain to students that gears are used to make work easier. They are wheels with teeth (cogs) placed together to transfer motion and force. In any pair of gears the larger one will rotate more slowly than the smaller one, but will have greater force. Two example of how gears are used are:

i) To change the direction of rotation;

ii) To make the rotation go faster or slower

Introduce the vocabulary, use the cards provided and have students record the information on their key word student sheet.

1) **Driver Gear**: the first gear. It “Drives” the other gears in system
2) **Follower Gear**: the last gear. It follows the other gears in the system
3) **Idler Gear**: This gear is used to change the direction of the follower gear. This does not make it go faster or slower. It is placed between two other gears.
4) **Gear Train System**: a combination of gears that mesh and work together
5) **Worm Gear**: A gear consisting of a rod with a screw thread. It is used to change the direction of rotary motion
6) **Spur Gear**: Most common type of gear, a wheel with teeth. It’s the only gear that can be used to drive the system.
7) **Bevel Gear**: They are spur gears that can mesh together at a right angle.

Next, watch the video **Gear Basics** on You Tube by Hila Science Video (note that you only need to watch until time stamp 9:44 as the rest is advertisement)

[http://www.youtube.com/watch?v=odpsm3ybPsA](http://www.youtube.com/watch?v=odpsm3ybPsA)
Once viewed, have students return to their Key Words sheets to make changes to their understanding of the key words and to draw an image for each one to solidify understanding.

Arrange students into groups to continue with the rest of the lesson.

Students will be working in groups to create their own gear train systems according to specifications outlined on the Gear Design Challenge sheet.

*If you have already prepared the gears or if you have a collection of gears, then please skip to step VI. If not proceed with the following:*  

I.  Provide each group with some thick cardboard, scissors, a sharpened pencil and some brass fasteners.

II. Instruct the students to take a large piece of thick cardboard and set it aside as this is the sheet that they will be attaching the gears to.

III. Have the students take the other piece of thick cardboard and trace the gears (copies provided) on the cardboard.

IV. The next step is to cut out each of the circles and to punch a hole with the sharpened pencil in the middle of each.

V. Cut out four small square pieces of cardboard.

VI. Provide students with their Gear Design Challenge sheets: Students are to create systems according to the directions on the student work sheet. Ensure students draw their systems on their sheets and mark with an arrow the rotation of each gear.

*To attach gears in order to create a gear train system:*  

a) Take a gear and attach it to the large piece of cardboard that was set aside at the beginning of the activity with a brass fastener. If necessary students may want to add one of the small pieces of cardboard to the backside of the piece of cardboard before attaching the brass fastener to make a better fit.

b) Next attach the other gears, ensuring that the teeth of the second wheel match up with those in the first wheel and so on.

c) When all of the wheels are attached have the students rotate the driver gear to test their solution. Students make adjustments to their train system to ensure the proper outcome.
Assessment:
Students are to submit their Gear Design Challenge sheets that were completed as a group ensuring that their drawings clearly state how the gears are rotating.
Create a Gear Train Challenge

Use 3 gears to create a system where the follower gear turns clockwise. Draw your system and label the rotation of all gears.

Use more than 3 gears to create a system where the third gear in the train is an idler gear. Draw your system and label the rotation of all gears.
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CENTRE ACTIVITIES FOR PULLEYS AND GEARS

Work with your group only!
Stay on topic!
Respect different opinions!
Contribute to the activities!
You are responsible for YOUR work!
Do no disrupt other groups!
Have fun!

Name: ____________________
A pulley is a simple machine with a cord or a rope moving around it. A pulley is used to lift or pull. How do people move pianos and heavy furniture into tall buildings? It’s easy if these items fit inside an elevator or they can be carried up the stairs. But what happens when they do not fit inside the elevator or it can not be carried up the stairs? The answer is to use a SIMPLE MACHINE! Follow the directions to create your own pulley! Record your observations on your sheet.

STEP 1: Run a piece of string about 1 foot (30 cm) long through the hole in the spool and tie the ends of the string together.

STEP 2: Slide the spool and the string onto the broom handle. Rest the handle across the two chairs with the spool hanging between.

STEP 3: Put one pail on the floor and tie the end of the piece of ribbon to its handle.

STEP 4: Slide the other end of the ribbon over the spool and tie it to the handle of the other pail, which should dangle in the air.

STEP 5: Add a few pennies to the hanging pail. What happens to the pail on the ground?

STEP 6: Return the pail to the ground and add a handful of pennies or marbles. Pull the handle of the hanging pail toward the ground.
Get Into Science

Observations: Explain what happens when you fill the pail with weights.

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As you added pennies to the hanging pail, it started to lift up the pail on the ground. Pulleys let you pull in one direction to move another object in another direction.

Why is this type of system important? Be detailed in your explanation and provide 2 examples of where this type of motion is useful.

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Creative Creations

As a group, create your own gear train. Use the provided gears as models to create a gear train with: 1) an even amount of gears, and 2) an odd amount of gears. Make sure each one uses more than 5 gears of different sizes. Draw and color the gear trains in the provided space.
Rube Goldberg (July 4, 1883 – Dec 7, 1970) was a cartoonist, sculptor, author, engineer and inventor! What he was widely known for was his whacky and elaborate machine drawings that would do a very simple task! Here is an example:

![Creative Creations](image-url)

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As a group come up with a whacky machine of your own! Choose an everyday task and create a whacky machine that uses pulleys and gears. Your machine should have at least 3 pulleys and 3 gears. Draw your machine on the provided paper and label all the parts of your machine!

Once complete ensure you have a description of how the machine works and the purpose of the machine. Try to make your drawing as neat as possible.

In a few sentences, write about how pulleys and gears have made your life easier. Give specific and detailed examples.

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