Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Activity 1

Development of Curiosity and Wonder:
Introducing a design challenge.

Scientific and Technological Concepts:
Structure and Function: This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes.

Learning Goal:
Students will

- investigate how pulley and gear systems can be used to make changes in speed, force, and/or direction.
- Observe how different pulley and gear systems have different characteristics, and can be improved to move a load more easily or more quickly.

Expectations:
Overall

- ***D1. Relating Science and Technology to Our Changing World***
  - evaluate the impacts of various machines and their mechanisms on society and the environment
- ***D2. Exploring and Understanding Concepts***
  - demonstrate an understanding of the basic principles and functions of machines and their mechanisms

Specific Expectations
Machines and Their Mechanisms

- D1.1 assess the impacts of machines and their mechanisms on the daily lives of people in various communities
- D2.2 identify the parts of various mechanisms and describe the purpose of each part

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

- D2.3 describe how different mechanisms transmit various types of motion, including rotary motion, from one system to another
- D2.4 describe how mechanisms transform motion, including how they can change the geometric plane in which the motion occurs and the speed and/or direction of motion

Equipment & Materials	Personal Protective Equipment (PPE)
• Commercial pulley and gear kits (e.g., Lego Dacta Basic Simple Mechanisms Set [89630] or Motorized Simple Machines Set [89645]) • Commercial pulleys (including those with metal frames) • Support structure for pulleys • Standard weights • Spring/Newton scales	• Safety glasses

Safety Considerations:

- Teachers should be circulating around classroom to ensure all students are on task and using material properly

What does the teacher do?	What do the students do?
Minds On: Teachers introduce the design challenge; “You are the owner of a car recycling business. You are going to hire an engineer to improve an existing pulley and gear system that moves cars, on sleds, from the area where they are dropped off to a platform where reusable parts can be removed from	Initiating and Planning What do you notice? What do you wonder? What do you think? Performing and Recording Students will record their observations of the commercial pulley and gear kits, students explore

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

the car, prior to dropping it into the crusher below. The engineering company that comes up with the best working model will be chosen to re-design the system for the recycling plant." Explain they will be working through a variety of Skill Builders that will enable them to work successfully on the Design Challenge. Discuss and record responses: What do you notice? What do you wonder? What do you think? Action: Using the commercial pulley and gear kits, students explore how different mechanisms transmit various types of motion. Students will record this information (science, notebook, lined paper, MLS) Consolidation: As a class, students share their notices and wonderings. Teacher records responses. This will be a growing resource throughout this unit. Sample accommodations: Students work in small groups. Use random groupings to ensure transparency in this process. Students can use a digital tool to record their observations (e.g. Flip, Jamboard, Padlet).	how different mechanisms transmit various types of motion. Students will record this information. Analyzing and Interpreting Encourage students to make connections to their own lived experience. WHen have they seen something similar? What previous knowledge do they have to make exploring the pulley and gear kits easier? Communicating Students communicate their initial understandings they have gained from their exploration. Highlight any key vocabulary that comes up making note of this on the consolidation chart.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Opportunities for assessment (Links to assessment pieces, organizers):
Assessment for Learning Conversations: Asking students questions to check their understanding of the design challenge. What questions do they still have?

To Differentiate: Continuously evaluate and adjust lesson content to meet student needs.

Parallel tasks: Students explore youtube videos of different pulleys and gears at work.

Assessment as Learning Observations: Observe students and their ability to explain the reasoning behind the choices they make.

- Observe students and check how they express themselves and organize themselves during their work.

Cross Curricular Opportunities:
Students can use this opportunity to apply their understanding of metric units of mass using the standard weights and spring/Newton scales they were exploring.

Give students time to explore resources that help to answer the question: How do the use of pulleys and gears make certain machines possible? If no one invented pulleys and gears, what would the world be like?

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Tool Identification and Safety

Structured to develop technological problem solving skills

Scientific and Technological Concepts:

Structure and Function: This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes.

Learning Goal:

Students will

- identify and demonstrate how to use tools safely
- follow established safety procedures and identify possible safety concerns
- suggest and implement appropriate safety procedures
- consistently show care and concern for their own safety and that of others

Expectations (Overall & specific):

Overall Expectations

A1. STEM Investigation and Communication Skills

- use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

Specific Expectations

A1. STEM Investigation and Communication Skills

- A1.4 follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials
- A1.5 communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes

Equipment & Materials	Personal Protective Equipment (PPE)

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

• hacksaw and bench hook/mitre box • hand drill • hammer • screwdriver • pliers • glue guns • hand cutters (e.g., Jinx/Kidder Cutters, safety snips)	• Safety glasses • Individual school/board safety policy ○ Starting point can be OCTE Elementary SAFEdoc and Tool Safety Teacher Resource

Safety Considerations:

- ensure that a first aid kit is available in each Technology area

What does the teacher do?	What do the students do?
Minds on: Lay out tools for students to do a gallery walk of the tools that will be needed to complete the design challenge. hacksaw and bench hook/mitre box, hand drill, hammer, screwdriver, pliers, glue guns, and hand cutters (e.g., Jinx/Kidder Cutters, safety snips). At this point students should not touch any of the tools. Have students turn and talk to share what they notice, wonder and think about each of the tools. Before moving to the action portion of this lesson, the teacher should demonstrate the safe use of safety goggles when using tools. It is very important to stress this!	Initiating and Planning Gallery walk, What do you notice? What do you wonder? What do you think? Performing and Recording Students will record and create posters that show their understanding of the safety procedures when using their assigned tool. Analyzing and Interpreting Encourage students to make connections to their own lived experience. When have they seen something similar? What previous knowledge do they have to make exploring safety procedures easier?

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Action: Divide students in small groups, assigning each group a tool. Group 1- hacksaw and bench hook/mitre box Group 2- hand drill Group 3- hammer Group 4- screwdriver and pliers Group 5- glue gun, Group 6- hand cutters (e.g., Jinx/Kidder Cutters, safety snips) Students will create a safety poster for the tool they have been assigned using this resource as a starting point. Teachers should circulate and demonstrate safe practice and safety rules for each piece of equipment that individual groups have been assigned. Consolidation: Consolidate learning during and after this activity. DURING - Engage individual groups in conversations around their tool and the safety requirements their peers need to know. Provide descriptive feedback as students work through each part of the activity. Provide students with the opportunity to participate in gallery walks to share their ideas in a creative and engaging way.	Communicating Students communicate their understandings and how to use their tool properly to the class.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

AFTER - As students share their ideas throughout the learning process provide them with the time to present their final products. This can be done in front of the class or in a science fair format. Sample accommodations: Provide a layout for the poster portion of the activity. Students may create something other than a poster (eg play, comic strip, youtube video). Provide a space with minimal distractions. Allow students to choose their own group. Provide on-task/focusing prompts. Sample Troubleshooting: Students could create posters and teacher does tool demonstrations for all instead of students doing demonstrations.	

Opportunities for assessment (Links to assessment pieces, organizers):
Students should demonstrate knowledge of safety rules and safe machine usage by creating a safety passport and/or contract signed by student, parent(s), and teacher.

Cross Curricular Opportunities:
In the creation of their safety posters, students will describe in detail the topic, purpose, and audience for their media texts they plan to create.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Characteristics of Pulleys

Guided development of technological problem solving skills

Scientific and Technological Concepts:
Structure and Function: This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes.

Learning Goal:
Students will

- identify of characteristics of pulleys (e.g., make lifting load easier, take longer to move load)
- explain how pulley system requires less effort than single fixed pulley to lift load
- identify characteristics that contribute to making load easier to lift

Expectations (Overall & specific):
Overall

- ***D1. Relating Science and Technology to Our Changing World***
    - evaluate the impacts of various machines and their mechanisms on society and the environment

- ***D2. Exploring and Understanding Concepts***
    - demonstrate an understanding of the basic principles and functions of machines and their mechanisms

Specific Expectations
Machines and Their Mechanisms

- D1.1 assess the impacts of machines and their mechanisms on the daily lives of people in various communities
- D2.2 identify the parts of various mechanisms and describe the purpose of each part
- D2.3 describe how different mechanisms transmit various types of motion, including rotary motion, from one system to another
- D2.4 describe how mechanisms transform motion, including how they can change the geometric plane in which the motion occurs and the speed and/or direction of motion

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Equipment & Materials	Personal Protective Equipment (PPE)
• Commercial pulley and gear kits (e.g., Lego Dacta Basic Simple Mechanisms Set [89630] or Motorized Simple Machines Set [89645]) • Commercial pulleys (including those with metal frames) • Support structure for pulleys • Standard weights • Spring/Newton scales • Grade 4 text books and other information books (e.g., Harcourt Canada, Pearson/Addison-Wesley, Scholastic, GTK Press) • Simple machines web sites (e.g., Pulley Facts for Kids - https://kids.kiddle.co/Pulley and Simple Machines – https://www.dkfindout.com/uk/science/simple-machines/pulleys/	• Safety glasses

Safety Considerations: Teachers should be circulating around classroom to ensure all students are on task and using material properly

What does the teacher do?	What do the students do?
Minds-On Create a class KWL chart. Students start by adding	Initiating and Planning Students add their understandings to K-W-L chart.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

ideas to post-it notes. Each student needs to add at least one idea. What do you know or want to know about pulleys. This can be done on chart paper, white board or digitally using a tool like Jamborad. Action Students will use their commercial pulley manipulatives and print resources listed to explore the characteristics of pulleys (including large and small pulleys, single pulleys, moveable pulleys, combined pulleys), and how they change speed, direction, and force. Students to add their new learnings to post-it notes as they go. Consolidation: Students will share their understanding of pulleys. They can then add these learnings to the L (learned) section of K-W-L chart. Students will then go on a pulley hunt! Students will walk around the class and the school and find examples of how pulleys are used in daily life and/or share other places that pulleys are used in real life (e.g., window blinds and curtains, clothes lines, fishing rod, flag pole, block and tackle, cranes). Students will then share their discoveries with class	Initially adding to K(Know) and W(Want to know). Performing and Recording Students explore pulley systems, then add their new learnings to their post-it notes. Analysing and Interpreting Students will share their understanding of pulleys. They can then add these learnings to the L (learned) section of K-W-L chart. Communicating As students explore real world examples of pulley systems, they will orally share their discoveries and add to class anchor chart.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

and add to anchor chart. Sample accommodations: Provide video resources. Provide handout with question prompts based on individual needs of students. Provide a space with minimal distractions. Allow students to choose their own group. Provide on-task/focusing prompts.	

Opportunities for assessment:
Assessment for Learning Conversations: Asking students questions to check their understanding of the design challenge. What questions do they still have?

To Differentiate: Continuously evaluate and adjust lesson content to meet student needs.

Parallel tasks: Students explore youtube videos of different pulleys at work.

Assessment as Learning Observations: Observe students and their ability to explain the reasoning behind the choices they make.

- Observe students and check how they express themselves and organize themselves during their work.

Cross Curricular Opportunities:
Students can use this opportunity to apply their understanding of metric units of mass using the standard weights and spring/Newton scales they were exploring.

Give students time to explore resources that help to answer the question: How do the use of pulleys make certain machines possible? If no one invented pulleys, what would the world be like?

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Using Pulleys and Pulley Systems

Structured to develop technological problem solving skills

Scientific and Technological Concepts:
Structure and Function: This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes.

Learning Goal:
Students will

- identify of characteristics of pulleys (e.g., make lifting load easier, take longer to move load)
- explain how pulley system requires less effort than single fixed pulley to lift load
- identify characteristics that contribute to making load easier to lift

Expectations (Overall & specific):
Overall

- ***D1. Relating Science and Technology to Our Changing World***
    - evaluate the impacts of various machines and their mechanisms on society and the environment

- ***D2. Exploring and Understanding Concepts***
    - demonstrate an understanding of the basic principles and functions of machines and their mechanisms

Specific Expectations
Machines and Their Mechanisms

- D1.1 assess the impacts of machines and their mechanisms on the daily lives of people in various communities
- D2.2 identify the parts of various mechanisms and describe the purpose of each part
- D2.3 describe how different mechanisms transmit various types of motion, including rotary motion, from one system to another

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

- D2.4 describe how mechanisms transform motion, including how they can change the geometric plane in which the motion occurs and the speed and/or direction of motion

Equipment & Materials	Personal Protective Equipment (PPE)
• Commercial pulley and gear kits (e.g., Lego Dacta Basic Simple Mechanisms Set [89630] or Motorized Simple Machines Set [89645]) • Commercial pulleys (including those with metal frames) • Support structure for pulleys • Standard weights • Spring/Newton scales • Grade 4 text books and other information books (e.g., Harcourt Canada, Pearson/Addison-Wesley, Scholastic, GTK Press) • Simple machines web sites (e.g., Pulley Facts for Kids - https://kids.kiddle.co/Pulley and Simple Machines – • https://www.dkfindout.com/uk/science/simple-machines/pulleys/	• Safety glasses

Safety Considerations:

- Teachers should be circulating around classroom to ensure all students are on task and using material properly

What does the teacher do?	What do the students do?

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Minds-On Students will review the class KWL chart and discuss some of the new learnings from the previous lesson. Introduce weights and how to measure weight using a Newton scale. Students make predictions. How will using pulley systems change the weight on the scale? Action Using commercial pulleys, students lift a load of about 1 kg using a single fixed pulley (Grade 4 Science and Technology textbooks will have illustrations of pulleys and pulley systems, and suggestions for activities). Students then lift the same load with a moveable pulley (see textbook illustration). Students compare: the force used to lift the load (measured with a spring/Newton scale) the distance the load travels compared to the distance the hand (effort force) travels the speed at which the load travels compared to the speed at which the hand (effort force) travels Note: The force used to lift the load with a single fixed pulley will seem to be less because pulling down (with the force of gravity, using your own weight) is easier than pulling up. The force used to lift the load with a moveable pulley will be about half the force required to lift the load with a fixed pulley	Initiating and Planning Students add their understandings to K-W-L chart. Initially adding to K(Know) and W(Want to know). Performing and Recording Students explore pulley systems, then add their new learnings to their post-it notes. Analysing and Interpreting Students will share their understanding of pulleys. They can then add these learnings to the L (learned) section of K-W-L chart. Communicating As students explore how pulley systems make work more efficient, they will orally share their discoveries and add to class anchor chart.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

because two strings/ropes (instead of just one with the fixed pulley) are supporting the load. Students then add a fixed pulley to the moveable pulley (thereby changing the direction of the effort force), and determine that this makes it easier to move the load because of the effect of gravitational force; this combination of a fixed and moveable pulley is a simple block and tackle. Students predict what will happen when more pulleys are added to the system and test their predictions (see illustrations of various pulley combinations). After several tests, students determine that the more strings they have supporting the load, the less effort force is required to lift the load, and the greater the distance that the effort force travels. This is a beginning awareness of the concept of mechanical advantage (the ratio of the force produced by a machine [output force] to the force applied to the machine [input force]). Students to add their new learnings to post-it notes as they go. Consolidation: Students will share their understanding of pulleys. They can then add these learnings to the L (learned) section of K-W-L chart.	

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Students will then share their discoveries with class and add to anchor chart. Sample accommodations: Provide video resources. Provide handout with question prompts based on individual needs of students. Provide a space with minimal distractions. Allow students to choose their own group. Provide on-task/focusing prompts.	

Opportunities for assessment:
Assessment for Learning Conversations: Asking students questions to check their understanding of the design challenge. What questions do they still have?

To Differentiate: Continuously evaluate and adjust lesson content to meet student needs.

Parallel tasks: Students explore youtube videos of different pulleys at work.

Assessment as Learning Observations: Observe students and their ability to explain the reasoning behind the choices they make.

- Observe students and check how they express themselves and organize themselves during their work.

Cross Curricular Opportunities:
Students can use this opportunity to apply their understanding of metric units of mass using the standard weights and spring/Newton scales they were exploring.

Give students time to explore resources that help to answer the question: How do the use of pulleys make certain machines possible? If no one invented pulleys, what would the world be like?

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Characteristics of Gears

Structured to develop technological problem solving skills

Scientific and Technological Concepts:
Structure and Function: This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes.

Learning Goal:
Students will

- identify characteristics of gears (change speed, direction, and force of movement)
- explain how gear teeth mesh; gears turn each other

Expectations (Overall & specific):
Overall

- ***D1. Relating Science and Technology to Our Changing World***
  - evaluate the impacts of various machines and their mechanisms on society and the environment

- ***D2. Exploring and Understanding Concepts***
  - demonstrate an understanding of the basic principles and functions of machines and their mechanisms

Specific Expectations
Machines and Their Mechanisms

- D1.1 assess the impacts of machines and their mechanisms on the daily lives of people in various communities
- D2.2 identify the parts of various mechanisms and describe the purpose of each part
- D2.3 describe how different mechanisms transmit various types of motion, including rotary motion, from one system to another
- D2.4 describe how mechanisms transform motion, including how they can change the geometric plane in which the motion occurs and the speed and/or direction of motion

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Equipment & Materials	Personal Protective Equipment (PPE)
• Commercial pulley and gear kits (e.g., Lego Dacta Basic Simple Mechanisms Set [89630] or Motorized Simple Machines Set [89645]) • Commercial gears (including those with metal frames) • Grade 4 text books and other information books (e.g., Harcourt Canada, Pearson/Addison-Wesley, Scholastic, GTK Press) • Simple machines web sites (e.g., Gears Facts for Kids - https://kids.kiddle.co/Gear	• Safety glasses

Safety Considerations:

- Teachers should be circulating around classroom to ensure all students are on task and using material properly

What does the teacher do?	What do the students do?
Minds-On Create a class KWL chart. Students start by adding ideas to post-it notes. Each student needs to add at least one idea. What do you know or want to know about gears. This can be done on chart paper, white board or digitally using a tool like Jamborad. Action	Initiating and Planning Students add their understandings to K-W-L chart. Initially adding to K(Know) and W(Want to know). Performing and Recording Students explore pulley systems, then add their new learnings to their post-it notes. Analysing and Interpreting

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Students will use their commercial gear manipulatives and print resources listed to explore the characteristics of gears (including large and small gears, driver gears, follower gears, and idler gears), and how they change speed, direction, and force. Discuss and demonstrate how gears are used in daily life (e.g., can opener, hand egg beater, toys, bicycle, clock). Students to add their new learnings to post-it notes as they go. Consolidation: Students will share their understanding of gears. They can then add these learnings to the L (learned) section of K-W-L chart. Students will then go on a gear hunt! Students will walk around the class and the school and find examples of how gears are used in daily life and/or share other places that gears are used in real life. Students will then share their discoveries with class and add to anchor chart. Sample accommodations: Provide video resources. Provide handout with question prompts based on	Students will share their understanding of gears. They can then add these learnings to the L (learned) section of K-W-L chart. Communicating As students explore real world examples of gear systems, they will orally share their discoveries and add to class anchor chart.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

individual needs of students. Provide a space with minimal distractions. Allow students to choose their own group. Provide on-task/focusing prompts.	

Opportunities for assessment:
Assessment for Learning Conversations: Asking students questions to check their understanding of the design challenge. What questions do they still have?

To Differentiate: Continuously evaluate and adjust lesson content to meet student needs.

Parallel tasks: Students explore youtube videos of different pulleys at work.

Assessment as Learning Observations: Observe students and their ability to explain the reasoning behind the choices they make.

- Observe students and check how they express themselves and organize themselves during their work.

Cross Curricular Opportunities:
Students can use this opportunity to apply their understanding of metric units of mass using the standard weights and spring/Newton scales they were exploring.

Give students time to explore resources that help to answer the question: How do the use of pulleys make certain machines possible? If no one invented pulleys, what would the world be like?

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Using Gears and Gear Systems

Structured to develop technological problem solving skills

Scientific and Technological Concepts:
Structure and Function: This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes.

Learning Goal:
Students will

- identify characteristics of gears (change speed, direction, and force of movement)
- explain how gear teeth mesh; gears turn each other

Expectations (Overall & specific):
Overall

- ***D1. Relating Science and Technology to Our Changing World***
  - evaluate the impacts of various machines and their mechanisms on society and the environment
- ***D2. Exploring and Understanding Concepts***
  - demonstrate an understanding of the basic principles and functions of machines and their mechanisms

Specific Expectations
Machines and Their Mechanisms

- D1.1 assess the impacts of machines and their mechanisms on the daily lives of people in various communities
- D2.2 identify the parts of various mechanisms and describe the purpose of each part
- D2.3 describe how different mechanisms transmit various types of motion, including rotary motion, from one system to another
- D2.4 describe how mechanisms transform motion, including how they can change the geometric plane in which the motion occurs and the speed and/or direction of motion

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Equipment & Materials	Personal Protective Equipment (PPE)

• 2 pieces of 1 cm x 1 cm bass wood 10 cm in length
• 2 pieces of 1 cm x 1 cm basswood 5 cm in length
• 1 piece os 1 cm x 1 cm bass wood 3 cm
• 1 piece of 3/16th dowel 14 cm long
• 2 pieces of 3/16th dowel 9 cm long
• 8 gussets
• 3 pieces of plastic straw cut to 5 cm in length
• 4 different sized gears
• glue / low temperature glue gun
• Equipment:
  ○ Ruler
  ○ Saw
  ○ drill - 3/16th drill bit
	• Safety glasses
	• Protective Heat Resistant Gloves

Safety Considerations:

- secured, behind, feet, draw, one, hold, saw
- Check to make sure that the glue gun cord or plug is not damaged or frayed. If it is, the glue gun should be discarded.
- Check to make sure the stand is functioning. If not, you will need to use a glue gun stand to keep the tool upright went being used, heating up or cooling down before storage
- Excess glue should be removed from the tool while still hot, using a large piece of tinfoil in a ball shape, so that you can both wipe the nozzle as well as the body.

What does the teacher do?	What do the students do?

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Minds-On Create a class KWL chart. Students start by adding ideas to post-it notes. Each student needs to add at least one idea. What do you know or want to know about gears. This can be done on chart paper, white board or digitally using a tool like Jamborad. Action Steps 1. Using the 1 cm x 1 cm bass wood construct a wooden rectangular frame which measures 12 cm x 5 cm (see Figure 1) * strengthen the corners by gluing cardboard gussets to each corner (top and bottom) Note: The frames from this activity should be kept intact to be used for the Grade 4 Design Challenge. 2. Glue the first plastic straw (axle holder) across the width and parallel to the end of the frame 3 cm from one end. (see Figure 2) 3. Glue (low temperature glue gun) one commercially made gear (small or medium in size) to the 12 cm wooden dowel (axle) and slide the axle into the axle holder. 4. Make a crank, and glue it onto the end of the first axle: * Cut 5 cm piece of 1 cm x 1 cm bass wood * Drill .5 (3/16th) diameter hole 1 cm from each end * Cut 3 cm piece of wooden dowel, and push	Initiating and Planning Students add their understandings to K-W-L chart. Initially adding to K(Know) and W(Want to know). Performing and Recording Students explore gear systems, then add their new learnings to their post-it notes. Analysing and Interpreting Students will share their understanding of gears. They can then add these learnings to the L (learned) section of K-W-L chart. Communicating As students explore real world examples of gear systems, they will orally share their discoveries and add to class anchor chart.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

and glue it into one of the holes * Slide the other hole onto the other end of the first axle attached to the frame; glue if it is loose (see Figure 3) 5. Glue another commercially made gear (larger size) to a second wooden dowel axle (9 cm) that extends 2 cm (on each side) beyond the width of the rectangular frame * Slide axle through another plastic straw (axle holder). This becomes the gear/axle assembly. - Position and glue gear/axle assembly onto the frame so that the two gears mesh as well as possible making sure that the axle holders are parallel to each other and the frame; when one gear is turned the other gear should turn in the opposite direction with the smaller gear rotating more quickly than the larger gear * Glue smaller gear onto the opposite end of the axle 5. Glue another commercially made gear (larger size) to t third wooden dowel axle that extends 2 cm (on each side) beyond the width of the rectangular frame *Slide the 9 cm dowel (axle) through another plastic straw (axle holder) * Position and glue gear/axle assembly onto the frame so that the smaller gear from the second axle meshes as well as possible (making sure axle holders are parallel to each other and the frame) with	

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

the gear attached to the third axle; when the first axle's gear is turned the second axle's gears should turn in the opposite direction with he smaller gear rotating more quickly than the larger gear, and the third axle's gear turning in the same direction as the first axle's gear but much more slowly (see Figure 4). Note: The ratio of the number of teeth from one gear to another is the same as the ratio of the number of rotations for each gear when connected and turning together, and also corresponds to the mechanical advantage of the gears. For example the speed of a 50 tooth follower gear driven by a 10 tooth driver gear will be 5 times slower than the driver gear; similarly, the effort force needed to turn the driver gear will be 5 times less than the output force produced by the follower gear (thereby providing a mechanical advantage of 5). This is the idea behind gearing down (smaller gear drives larger gear resulting in less speed but more power) and gearing up (larger gear drives smaller gear resulting in more speed but less power). Students to add their new learnings to post-it notes as they go. Consolidation: Students will share their understanding of gears. They can then add these learnings to the L (learned)	

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

section of K-W-L chart. Students will then share their discoveries with class and add to anchor chart. Sample accommodations: Provide video resources. Provide handout with question prompts based on individual needs of students. Provide a space with minimal distractions. Allow students to choose their own group. Provide on-task/focusing prompts.	

Opportunities for assessment:
Assessment for Learning Conversations: Asking students questions to check their understanding of the design challenge. What questions do they still have?

To Differentiate: Continuously evaluate and adjust lesson content to meet student needs.

Parallel tasks: Students explore youtube videos of different gears at work.

Assessment as Learning Observations: Observe students and their ability to explain the reasoning behind the choices they make.

- Observe students and check how they express themselves and organize themselves during their work.

Cross Curricular Opportunities:
Students can use this opportunity to apply their understanding of metric units of measure when creating their gear system.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Give students time to explore resources that help to answer the question: How do the use of gears make certain machines possible? If no one invented gears, what would the world be like?

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Using Pulleys and Gears Together

Structured to develop technological problem solving skills

Scientific and Technological Concepts:
Structure and Function: This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes.

Learning Goal:
Students will

- demonstrate how mechanism works (e.g., lifts load)
- demonstrate how pulleys and gears are interconnected and work together to accomplish work (e.g., lift load)

Expectations (Overall & specific):
Overall

- ***D1. Relating Science and Technology to Our Changing World***
  - evaluate the impacts of various machines and their mechanisms on society and the environment

- ***D2. Exploring and Understanding Concepts***
  - demonstrate an understanding of the basic principles and functions of machines and their mechanisms

Specific Expectations
Machines and Their Mechanisms

- D1.1 assess the impacts of machines and their mechanisms on the daily lives of people in various communities
- D2.2 identify the parts of various mechanisms and describe the purpose of each part
- D2.3 describe how different mechanisms transmit various types of motion, including rotary motion, from one system to another
- D2.4 describe how mechanisms transform motion, including how they can change the geometric plane in which the motion occurs and the speed and/or direction of motion

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Equipment & Materials	Personal Protective Equipment (PPE)
• Commercial pulley and gear kits (e.g., Lego Dacta Basic Simple Mechanisms Set [89630] or Motorized Simple Machines Set [89645]) • Commercial gears (including those with metal frames) • Support structure for pulleys • Standard weights • Spring/Newton scales	• Safety glasses

Safety Considerations:

-

What does the teacher do?	What do the students do?
Minds on: Students will review their KWL Charts, both for pulleys and gears. Students will discuss all of their new learnings from this unit. Action: Students use pulleys and gears they have made (or from commercial kits) to make a device that lifts a load. For example: using a 1 or 2 litre milk carton (or 1 cm x 1 cm wooden frame structure) poke (or drill and push) two wooden skewers (or small round dowels) through	Initiating and Planning Students add their understandings to K-W-L chart. Initially adding to K(Know) and W(Want to know). Performing and Recording Students create pulley and gear systems, then add their new learnings to their post-it notes. Analysing and Interpreting Students will share their understanding of pulleys and gears and how working together can reduce a load. They can then add these learnings to the L (learned) section of K-W-L chart.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

two opposite sides (one towards the top and one towards the bottom) attach one end of a string to the middle of the lower skewer (dowel) and loop that over the top skewer (dowel) so that it hangs towards the bottom of the milk carton attach a paper clip hook to this end so that it can hold a load attach a larger gear to the top skewer attach a smaller gear onto another skewer (dowel) and poke it through the sides of the carton so that it meshes with the larger gear glue a small (wooden dowel) handle onto the smaller (driver) gear students can now attach a weight to the paper clip hook and use the driver gear handle to operate the entire mechanism Students experiment with smaller driver gears and larger follower gears; record observations and conclusions (e.g., smaller driver gears turn more quickly than larger follower gears – therefore, there is more force delivered to the pulley) Consolidation: Review the design challenge. Discuss and create anchor chart, how can we use what we have learned to help us create our machine. Sample accommodations: Students can use tinkercad to create simulations for their pulley and gear systems. Provide video resources.	Communicating As students explore real world examples of pulley systems, they will orally share their discoveries and add to class anchor chart.

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Provide handout with question prompts based on individual needs of students. Provide a space with minimal distractions. Allow students to choose their own group. Provide on-task/focusing prompts.	

Opportunities for assessment:
Assessment for Learning Conversations: Asking students questions to check their understanding of the design challenge. What questions do they still have?

To Differentiate: Continuously evaluate and adjust lesson content to meet student needs.

Parallel tasks: Students explore youtube videos of different pulleys at work.

Assessment as Learning Observations: Observe students and their ability to explain the reasoning behind the choices they make.

- Observe students and check how they express themselves and organize themselves during their work.

Assessment of Learning: Students will share their understanding from the unit by completing the following table.
Fill out the table below.

Simple Machine	What is it? How does it make work easier?	Diagram/Picture	Examples
Gear	• A gear is...		•

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Pulley	• A pulley is		•

Focus on the following criteria:

- Knowledge and understanding: Student shows considerable knowledge of content (e.g., facts, terminology, definitions).
- Communication: Use of conventions, vocabulary, and terminology (single pulley, moveable pulley, combined pulley, fixed pulley, effort force, gravity, force, driver gear, follower gears, idler gear) of the discipline in written forms.
- Application: Making connections within and between various contexts (connections to everyday and real-life situations).

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Design Challenge

Structured to develop technological problem solving skills

Scientific and Technological Concepts:
Structure and Function: This concept focuses on the interrelationship between the function or use of a natural or human-made object and the form that the object takes.

Learning Goal:
Students will

-

Expectations (Overall & specific):
Overall

- ***D1. Relating Science and Technology to Our Changing World***
  - evaluate the impacts of various machines and their mechanisms on society and the environment

- ***D2. Exploring and Understanding Concepts***
  - demonstrate an understanding of the basic principles and functions of machines and their mechanisms

Specific Expectations
Machines and Their Mechanisms

- D1.1 assess the impacts of machines and their mechanisms on the daily lives of people in various communities
- D2.2 identify the parts of various mechanisms and describe the purpose of each part
- D2.3 describe how different mechanisms transmit various types of motion, including rotary motion, from one system to another
- D2.4 describe how mechanisms transform motion, including how they can change the geometric plane in which the motion occurs and the speed and/or direction of motion

Expectations (Overall & specific):

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Overall Expectations

A1. STEM Investigation and Communication Skills

- use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

Specific Expectations

A1. STEM Investigation and Communication Skills

- A1.4 follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials
- A1.5 communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes

Equipment & Materials	Personal Protective Equipment (PPE)
• Commercial pulley and gear kits (e.g., Lego Dacta Basic Simple Mechanisms Set [89630] or Motorized Simple Machines Set [89645]) • Commercial pulleys (including those with metal frames) • Support structure for pulleys • Standard weights • Spring/Newton scales • hacksaw and bench hook/mitre box • hand drill • hammer • screwdriver • pliers • glue guns • hand cutters (e.g., Jinx/Kidder Cutters, safety snips)	• Safety glasses • Individual school/board safety policy ○ Starting point can be OCTE Elementary SAFEdoc and Tool Safety Teacher Resource

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

Safety Considerations:

- ensure that a first aid kit is available in each Technology area
- display safety posters created by students
- ensure safety contract has been signed and completed by both students and parents

What does the teacher do?	What do the students do?
Minds on: Review the design challenge; "You are the owner of a car recycling business. You are going to hire an engineer to improve an existing pulley and gear system that moves cars, on sleds, from the area where they are dropped off to a platform where reusable parts can be removed from the car, prior to dropping it into the crusher below. The engineering company that comes up with the best working model will be chosen to re-design the system for the recycling plant." Discuss the Skill Builder activities that students have completed. How will this help them with the Design Challenge? Action: This project will guide students through the engineering design process. Step 1: Develop a deep understanding of the challenge/problem: • identify and review resources related to a	Initiating and Planning Performing and Recording Analysing and Interpreting Communicating

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

problem • identify the users affected by the problem • review related problems and solutions to these problems • Research to develop a deeper understanding challenges that would occur when someone needs to lift a large load. This can be a review of the knowledge gained in the skill builder activities. • Make connections to what you have seen in your community or the skill builder activities you participated in. Step 2: Brainstorm • brainstorm several ideas and potential solutions • consider the end-users and those impacted by potential solutions, taking into consideration their experiences, perspectives, and concerns • consider applying related and existing solutions (or some aspects of them) to the identified problem • consider developing new solutions that are different from existing solutions refine or combine potential solutions Step 3: Ideate Get realistic, choose the best solution, and then plan how it will be built. • plan the design of the solution, considering	

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

the required stages as well as available materials, equipment, and time • consider the economic, environmental, ethical, and health and safety concerns related to the potential design • consider the key components of the design, and ensure that they can be effectively produced construct a prototype of the design Step 4: Build, Test, Evaluate, Redesign Design a prototype to test all or part of the solution. Redesign when necessary. • develop tests to evaluate the solution • conduct tests in a variety of contexts, including in controlled and in real-world environments • record observations and data • obtain feedback on the prototype from others, including teachers, classmates, friends, family members, and/or community members • refine the prototype to develop a finished product Step 5: Test and Share Engage in a continuous short-cycle innovations improve the design. • test your prototype: What does it need, collect feedback from others,(peers and educators) • identify the important information and components of the solution and/or project to	

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

share, and develop a draft or plan for the presentation or demonstration, using appropriate vocabulary • present and finalize the design or solution • Does your solution work as intended? • Do you need to make any iterations to the design? • What would you change next time? Consolidation: Consolidate learning during and after this activity. DURING - Engage individual groups in conversations around their designs, construction, and the visual appeal of the creation. Provide descriptive feedback as students work through each part of the challenge. Provide students with the opportunity to participate in gallery walks to share their ideas in a creative and engaging way. AFTER - As students share their ideas throughout the learning process provide them with the time to present their final products. Sample accommodations: Chunk this activity and guide students through each phase of the engineer design process. Allow students to work in small groups or individually. Students can share their final learnings in the form that is best for their learning. This does not have to	

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

be done in a presentation. Sample Troubleshooting: It is best to use commercial pulleys and gears in order to have pulleys and gears that work reliably, and have less friction than those made by students; students should be reminded that there is some friction in every pulley or gear system.	

Opportunities for assessment (Links to assessment pieces, organizers):

Let's Make This a Goal…	Success Criteria	WOW!
	Science: • I can develop and design a plan (Engineering Design Process) using a variety of resources to create • I can use my critical and creative thinking skills to solve problems • I can express and organize my ideas to explain my creative design • I can apply what I have learned to build a functional model from my sketch.	

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

	Mathematics: • I can compare, estimate, and determine measurements to adjust and improve my creation Social-Emotional Learning • I can express and manage my feelings and show understanding of the feelings of others in my group and members of the community • I can work collaboratively on math problems share my thinking and listen to my group members	
	Language: • I can listen in order to understand and respond appropriately to my group members and other groups to provide meaningful feedback. • I can develop ideas and create a detailed plan by asking questions of my class/group members and using my prior knowledge. • I can share my learning in a presentation with my class	

Unit/Strand: D. Structures and Mechanisms

Machines and Their Mechanisms

Grade: Grade 4

	Transferable Skills ● Collaboration - I cooperate well with the members of my team to construct original ideas that are applicable in the real world ● Critical Thinking - I look at this topic from different points of view and incorporate feedback to consider solutions in new and exciting ways ● Citizenship - I care about social issues and can generate solutions that affect my community ● Creativity - When faced with a challenge, I use innovation to effectively build on existing ideas or to create new ideas that improve the way a problem is solved ● Communication - I bring ideas to life in an organized and logical way in order to compose, produce, and communicate a solution that is relevant and meaningful for my audience	