

ONTARIO SCIENCE

GRADE

4

pulleys

AND

GEARS

Inquiry Based Unit



giving CREDIT

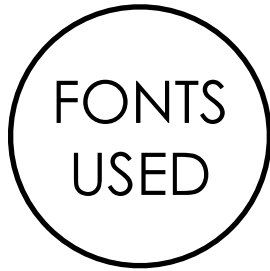
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INTRODUCTION

madly learning inquiry based units

Dear Teacher,

This unit has a lot of hands on experiments that will keep students excited and engaged while learning about flight. Wherever possible, I have tried to ensure that all of the experiments use common and safe materials to accomplish the learning goals. However, an important aspect of these experiments is the ability for students to reflect on their learning because some of the concepts are theoretical and some students may struggle with making these connections without your guidance. This is especially true with understanding concepts of flight that are hard for students to see due to size within the classroom.

This unit uses an inquiry based approach to learning. This means that the role of the teacher is ideally that of a guide to help students learn the concepts in the lessons contained herein. We know that good teaching provides our students with a variety of learning activities. Effective instruction must go beyond the passive consumption of read and respond worksheets or repetitive centres activities. This is the reason that you will find a limited amount of these tasks in Madly Learning units.

We know teachers have a wide variety of experiences with inquiry, and we have worked to make the teaching components flexible and adaptable to your needs as a teacher but also to the wide variety of needs of students in your classroom. Through every Madly Learning unit, we hope to bring you a wider variety fun and engaging lessons that fit it all together to make learning meaningful.

As always, if you have any questions, concerns, or comments you would like to share with me, I am always available to support you. Send me an email and I will get back to you promptly. I appreciate when buyers contact me directly about any issue prior to leaving feedback.

Enjoy the unit!

Sincerely,

Patti

@MadlyLearning

EMAIL : info@MadlyLearning.com

FOCUS ON *inquiry*

Inquiry is an approach to teaching that takes the teacher out of the role of lecturer and transitions the teacher into the guide on the side. By implementing an inquiry approach, you are giving up some of the control in your classroom and over the learning.

Getting Started:

Start your unit getting to know how much your students know and what they are interested in. This is the goal of lesson one. They will review the images of the Wonder Wall to activate prior knowledge and inspire thinking. Their thinking will elicit questions that will serve to guide your exploration through the remaining components of the unit. Capture student questions and post them on a chart as they share their ideas with the class.

At this point, students will ask questions—but don't give them answers; just write the questions down and ask a question back that makes them think more deeply about the topic they are curious about. Get an idea about what they are interested in and what they know. Once you have captured their questions, look at their list and group their questions into topics.

The photos were designed to foster student thinking related to the content of the curriculum. These will serve as questions that will lead into your lessons.

Make a list of themes that students want to know more about. These will generally follow the lessons as they are planned out in this unit, except now you have let them choose why they are learning about them.

FOCUS ON *inquiry*

The Lessons:

The lessons in this resource reflect the typical goals of an initial student inquiry.

You will work through these lessons by always referring to these as being a part of the student goals. They do not have to be done in exactly this order, and you can add in other information based on student interest.

You will notice that many of the pages either activate prior knowledge or are a reflection about a hands-on learning activity to ensure that students are learning what they are supposed to learn from the activities. This is where your guidance becomes an important part of the learning process.

You are no longer just giving information. You are leading discussions through questioning techniques that help students to draw conclusions.

Conferencing and knowledge-building circles will be important activities for this to occur. Assess who is doing most of the talking? It should be the students doing the talking about their learning, not just listening.

This is the goal for learning. However this may be new to many of them as they learn to listen to each other instead of just you. So train them, train them, train them by gradually releasing the control of the conversation away from you and more to them.

Final Inquiry Project:

This is the application piece of all of their learning and should take up the most of your teaching and learning time. During this time, you are not teaching and lecturing. Instead, you are supporting, questioning, and conferencing with students.

FOCUS ON *inquiry*

If this is one of your first inquiry units, you can consider a guided inquiry approach where you walk them through each step and limit their choices. Alternatively, you can allow students to work as a group based on interest and use a guided reading for science model to help guide them through their inquiry.

Assessment

Assessment has three elements along the journey.

Diagnostic - Assess students about their initial knowledge. This is not a formal assessment but will give you a baseline of student understanding. Quickly level student knowledge based on three levels of understanding: limited, developing, and good.

Formative Assessment - Through each lesson, there are guides for how to collect formative assessment of your students. Gather information for your assessment from a balance of your conversations, observations, and the products produced by students.

Summative - At the end of the unit, students will participate in a culminating activity of the inquiry project. This project will have them apply their learning from the smaller parts of the unit to complete this inquiry project. Allow for an open-ended approach to how students present their information. Your assessment will be of the knowledge and skills demonstrated, not on specific methods of how this is demonstrated.

Inquiry is a journey, and wherever you are on your inquiry journey as a teacher is an okay place to be. Start with one inquiry task and with every new experience release a bit more control to students letting them lead. This happens over time, not overnight.

Introduction

Dear Teacher,

Thank you very much for downloading this grade 4 unit on Pulleys and Gears. These lessons have been tried out in my classroom and I can assure you that your students are going to enjoy the activities in this package.

This unit is not designed or intended to be a package of no prep printables. There will be preparation for the units involved however hopefully you will find these as manageable as I do to get ready for your students.

Science instruction is interactive, sometimes messy, and so much fun. I highly recommend that prior to teaching this unit you gather the following materials and have them ready for students to use and explore.

- sponges
- wooden craft sticks
- white glue
- spiral notebooks or scrapbooks
- markers
- gears kits(see the final task for links to examples)
- pulleys kits (either typical pulleys or spools with the thread) removed
- straws
- tape

This unit is easily accomplished without the gears and pulleys kits however (substitute the final demonstration task with an alternate assessment - not included).

If you have any questions, or comments please contact me at info@madlylearning.com

- Patti

Set Up

Use a Student notebook such as the ones shown below. Students will glue their title pages on the front cover of the book.



Page #1 - Sticky Thoughts Page

Students will use this page to write and draw different things that they have learned or found interesting. As students learn about different concepts they can add their sticky thoughts to the front page.

Pages #2 and #3 - Table of Contents

They can add a Table of Contents. As students add new pages to their notebook they can also add the title of that page to their TOC. Use the headings provided at the top of each page

Lessons and Activities

As students work through the unit with you they can add their readings, and reflection notes in their notebooks. For readings that are more than one page use one of the printing options on your printer to print multiple document pages on more than one page. This way students can read a large document but can keep smaller copies easily together on one page in their notebook.



Grade 4 Curriculum Links

Grade 4: Pulleys and Gears	1	2	3	4	5	6	7	F
1.1 assess the impact of pulley systems and gear systems in daily life	X			X			X	X
1.2 Assess the environmental impact of using machines with pulleys and gears, taking different perspectives into account and suggest ways to minimize negative impacts and maximize positive impacts.					X			
2.1 follow established safety procedures for working with machinery				X	X			X
2.2 Use scientific inquiry/experimentation skills to investigate changes in force, distance, speed and direction in pulley and gear systems.				X	X			X
2.3 use technological problem solving skills to design, build, and test a pulley or gear system that performs a specific task					X			X
2.4 use appropriate vocabulary	X	X	X	X	X	X	X	X
2.5 use a variety of forms to communicate with different audiences and for a variety of purposes	X	X	X	X	X	X	X	X
3.1 describe the purposes of pulley systems and gear systems						X	X	
3.2 describe how rotary motion in one system or its components is transferred to another system or component in the same structure						X	X	X
3.3 describe how one type of motion can be transformed into another type of motion using pulleys or gears		X	X		X	X	X	X
3.4 Describe using their observations, how gears operate in one place and in two planes.					X	X	X	X
3.5 distinguish between pulley systems and gear systems that increase force and those that increase speed							X	X
3.6 identify pulley systems that are used in daily life, and explain the purpose and basic operations of each	X	X	X	X				
3.7 explain how the gear system on a bicycle works						X	X	
3.8 Identify the input components that drive a mechanism and the output components that are driven by it.						X	X	X



4th Grade

Common Core and NGSS

Grade 4: Pulleys and Gears	1	2	3	4	5	6	7	F
READING STANDARDS								
CCSS.ELA-LITERACY.RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.			X		X	X	X	X
CCSS.ELA-LITERACY.RI.4.4 Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.	X	X	X	X	X	X	X	X
CCSS.ELA-LITERACY.RI.4.7 Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.	X	X	X	X	X	X	X	X
CCSS.ELA-LITERACY.RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.			X		X	X		X
CCSS.ELA-LITERACY.RI.4.10 By the end of year, read and comprehend informational texts, including history/ social studies, science, and technical texts, in the grades 4-5 text complexity band proficiently, with scaffolding as needed at the high end of the range.			X	X		X		X
WRITING STANDARDS								
CCSS.ELA-LITERACY.W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic.(3-5-ETS1-3)			X					X
CCSS.ELA-LITERACY.W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (3-5-ETS1-3)			X	X		X	X	X
CCSS.ELA-LITERACY.W.4.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (3-5-ETS1-3)	X		X	X		X		X
SCIENCE STANDARDS								
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.				X				X
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.				X				X
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.				X	X			X

PULLEYS AND GEARS

table of contents



ONTARIO

Lesson	Description	Pages
1	<u>Wonder Wall and Diagnostic Assessment</u>	16-29
2	<u>What is Force? What is Work?</u>	28-33
3	<u>What is a pulley? What is their purpose?</u>	34-44
4	<u>What objects in our daily life use a pulley?</u>	45-47
5	<u>How does a pulley work?</u>	48-56
6	<u>How do gears work?</u>	57-61
7	<u>Different types of gears (spur gears, idle gears, worm gears, crown and bevel gears)</u>	62-69
8	<u>Final Task - Mini inquiry product</u>	70-82

SCIENCE

Pulleys and

G E A R S

Name: _____

Room: _____

Grade 4 Pulleys and Gears

LINK TO LIVE BINDER RESEARCH FILES



bit.ly/ML-pulleygear

ACCESS CODE: MLSS&S

LESSON ONE

Wonder Wall and Diagnostic Assessment

4 L1

All pages through this resource are marked similar to above to show the Grade (4) and Lesson number (L1).

grade 4 LESSON ONE

The format for these lessons is structured into two parts. One part is designed as a teacher directed lesson. The second part of the lesson is designed as an independent or small group learning activity. The teacher directed is noted in **PINK** and the small group/independent task is **YELLOW**

Learning Goal

We are gathering information and wonderings about pulleys and gears.

Preparation

- Print and post [Wonder Wall Pictures](#) to your Wonder Wall.
- Print Wonder [Wonder Wall Walking Notes](#) and Wonder Wall Question Page.

Lesson Part A

- Students will begin by looking at the [Wonder Wall Pictures](#) on your Wonder Wall.
- A [Wonder Wall Answer Page](#) has been included.
- Encourage students to think about what the images are, what they have to do with flight, and how they can help us learn more about the topic.
- Provide each student with [Wonder Wall Walking Notes](#) and [Wonder Notes](#). Here, they will record things they observe, know, think, and wonder. They will also come up with questions they have.
- Students can do this independently or with a partner, depending on their readiness to work independently in partnerships while you teach the other group.

Lesson Part B

- Students join the teacher and share their wonderings.
- An [Observation](#) page has been provided to promote discussion.
- Encourage students to share what they are wondering about the unit.
- Ask them what they want to learn and what intrigues them about pulleys and gears.

Assessment

Judge students on their prior knowledge of this topic, interest, and engagement in different pictures.

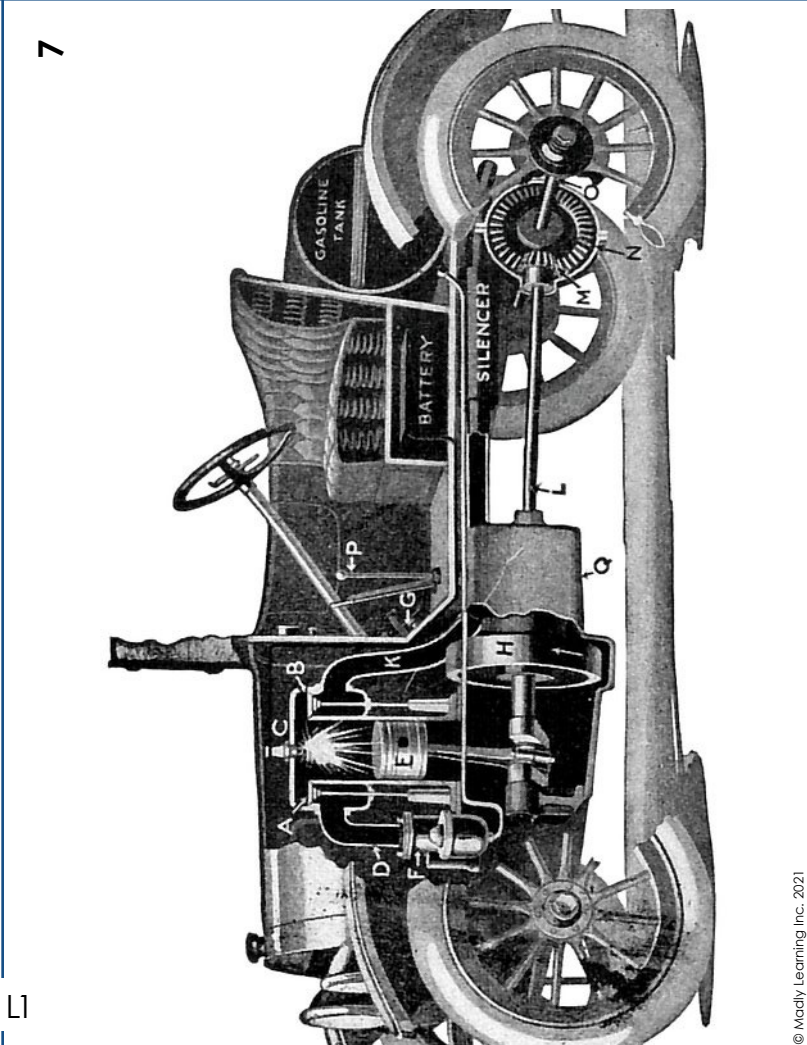
grade 4 LESSON ONE

The format for these lessons is structured into two parts. One part is designed as a teacher directed lesson. The second part of the lesson is designed as an independent or small group learning activity. The teacher directed is noted in **PINK** and the small group/independent task is **YELLOW**

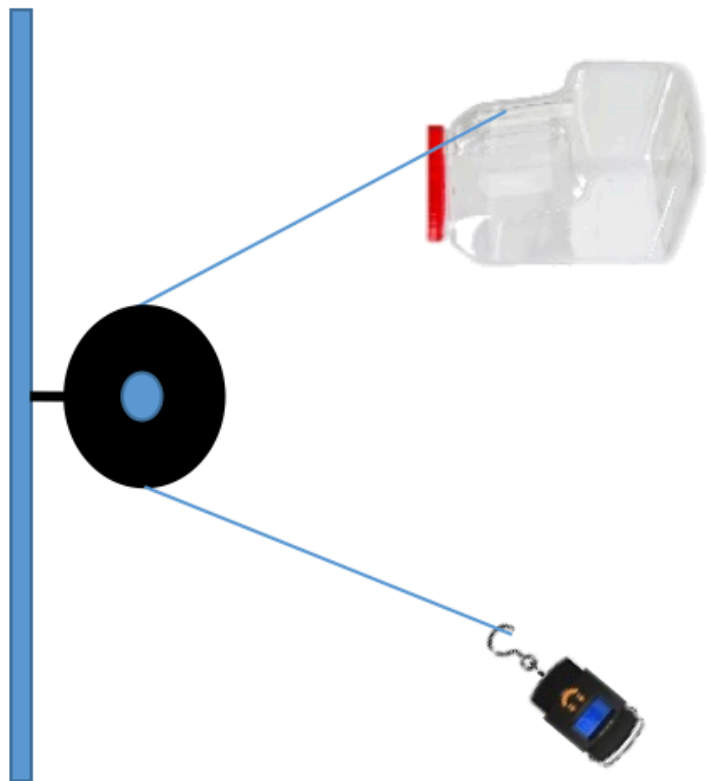
NOTES

Take the [Wonder Wall Picture Cards](#) and place these on a bulletin board. Collect the students some of the students' [observations](#), background knowledge, and questions. Record some of these on the WonderNotes Pages.



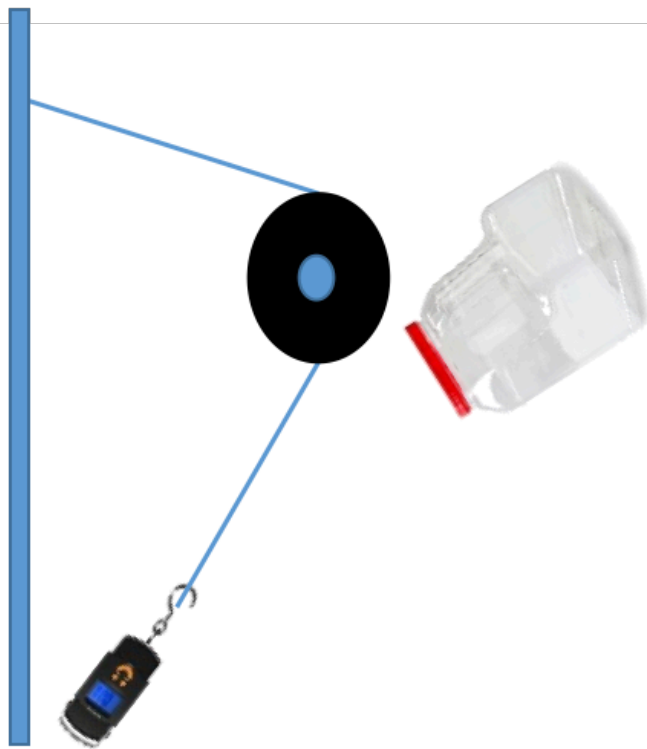


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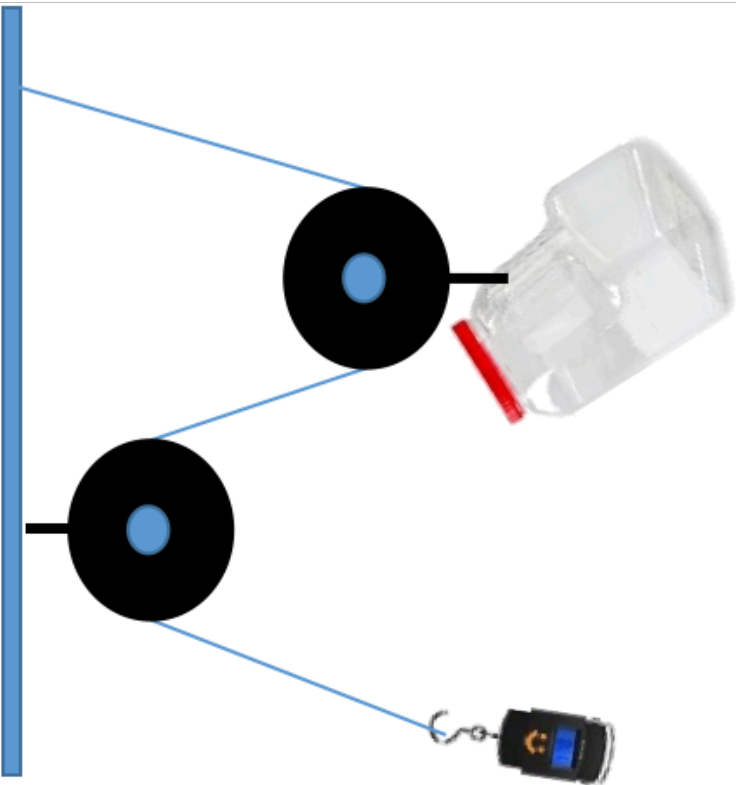
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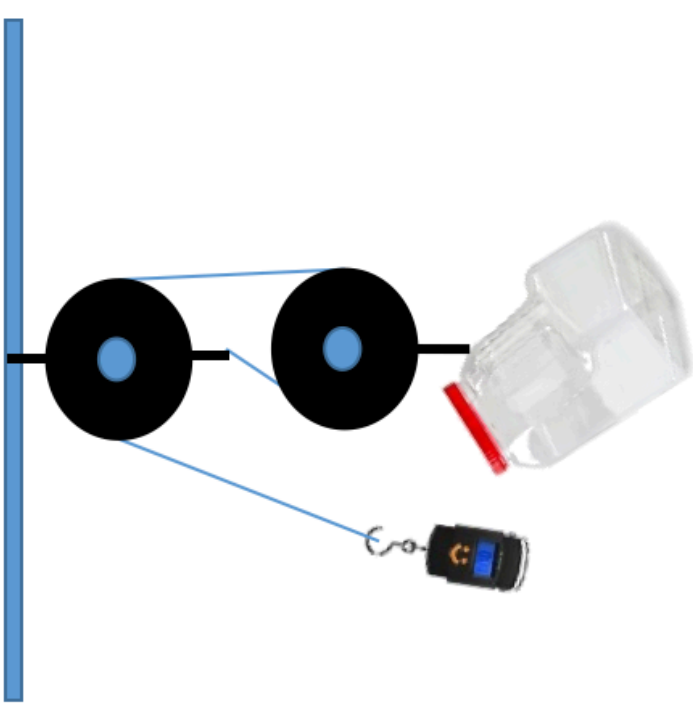
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WONDER WALL ANSWERS

1. Boat Crane
2. Gears
3. Egg Beater
4. Watch movement
5. Boat crane
6. Bicycle gears
7. Car (Transmission)
8. Pencil Sharpener
9. Double pulley - Fixed and moveable
10. Single Pulley - Fixed
11. Double Pulley - Fixed and moveable
12. Single Pulley - Moveable

WONDER WALL WALKING NOTES

i observe...

i know...

i think...

i wonder...

WONDER NOTES

we wonder...

we wonder...

WONDER NOTES

we know...

we know...

WONDER NOTES

we think...

we think...

WONDER NOTES

observations...

observations...

observations...

observations...

LESSON TWO

What is Force?

What is Work?

grade 4 LESSON TWO

The format for these lessons is structured into two parts. One part is designed as a teacher directed lesson. The second part of the lesson is designed as an independent or small group learning activity. The teacher directed is noted in **PINK** and the small group/independent task is **YELLOW**

Learning Goal

Preparation

- Preview their [Wonder Walk pages](#) to determine the students understanding of pulleys and gears.

Lesson Part A

Allow students time to share what they wondered about at the end of the previous lesson.

1. Review some of the [vocabulary cards](#) and ask students what they mean. (See Notes)
2. Have them brainstorm different things in their life that use pulleys and gears. Use the photos from the previous lesson
3. Ask students to:
 - Think about why we need pulleys and gears?
 - How do they help us in our daily lives?
 - What would life be like if we didn't have pulleys and gears?

Lesson Part B

- Students will brainstorm though their interactive notebook activity [Brainstorm Graphic Organizer](#).
- Students will follow the instructions on the [Brainstorming Instruction Page](#) then cut out the items needed and glue in their notebook.

Assessment

NOTES

When reviewing the [photos](#) and especially the [words](#) the tendency is to give students answers. DO NOT DO THIS!! Allow students to discuss this and come up with hypothesis about these concepts. If they don't know turn this into an opportunity to create a question card and allow them to explore these concepts. These will be reviewed as the unit progresses and you will have an opportunity to find the answers to these question organically.

WONDER WALL - VOCABULARY CARDS

**Mechanical
Advantage**

**Fixed
and
Movable**

Force

Work

WONDER WALL - VOCABULARY CARDS

Effort

**Conservation
of
Energy**

**Worm,
Spur,
Bevel,
Helical
Pinion**

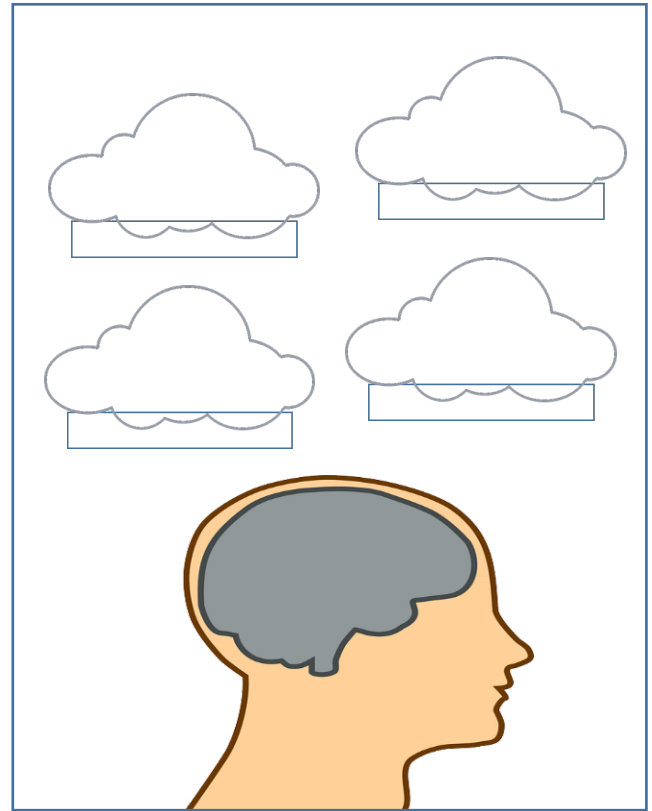
Speed

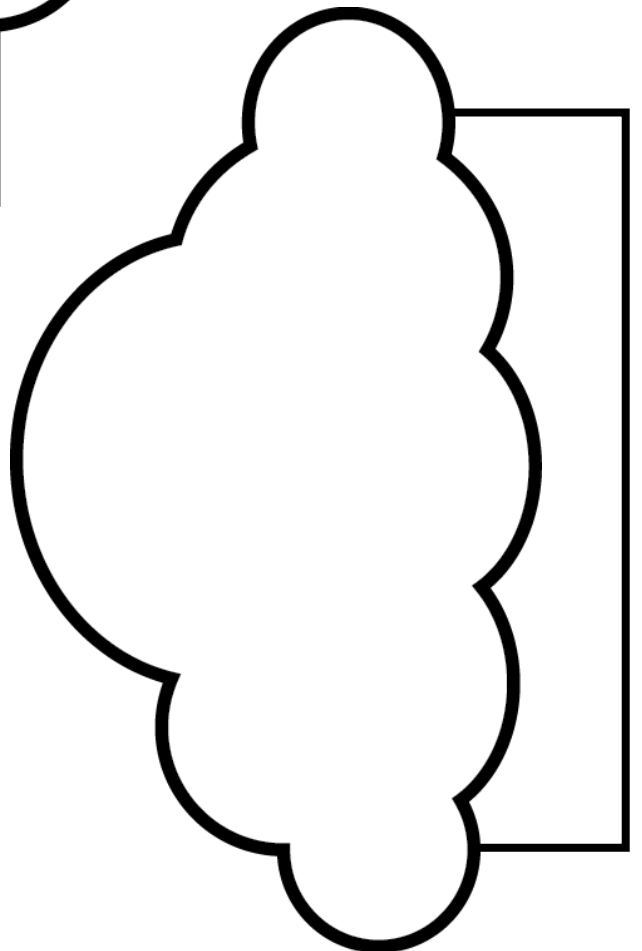
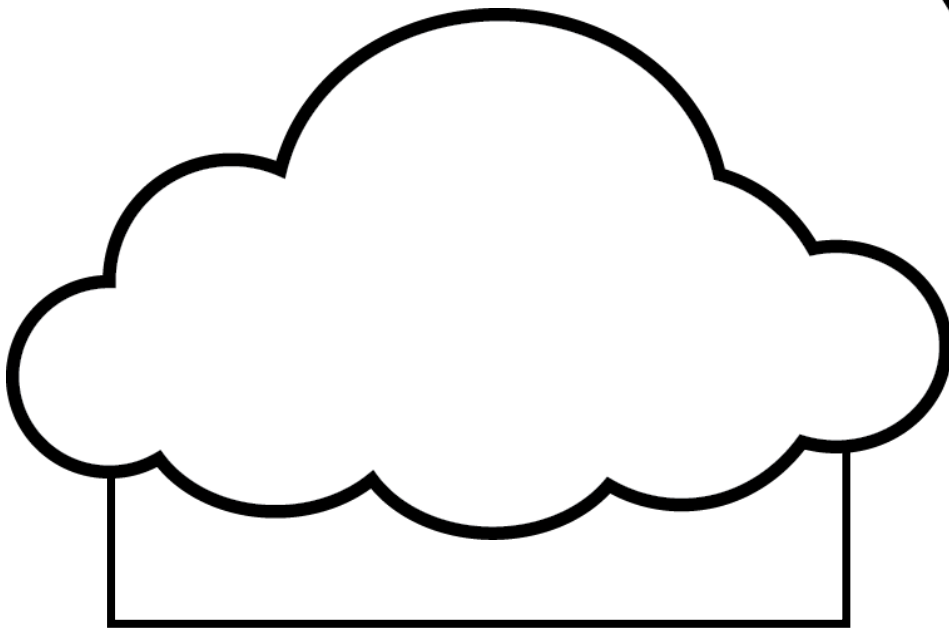
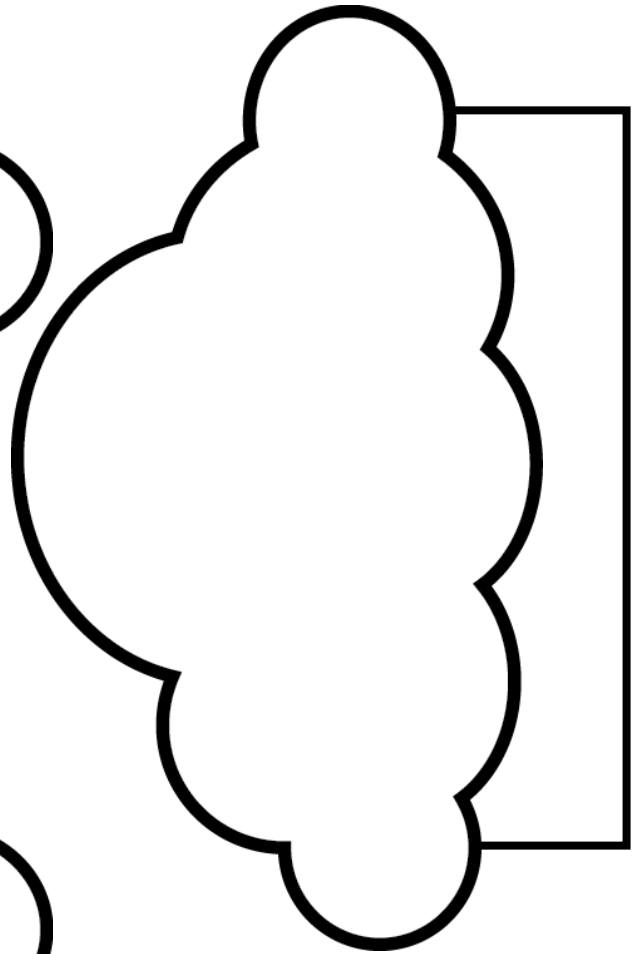
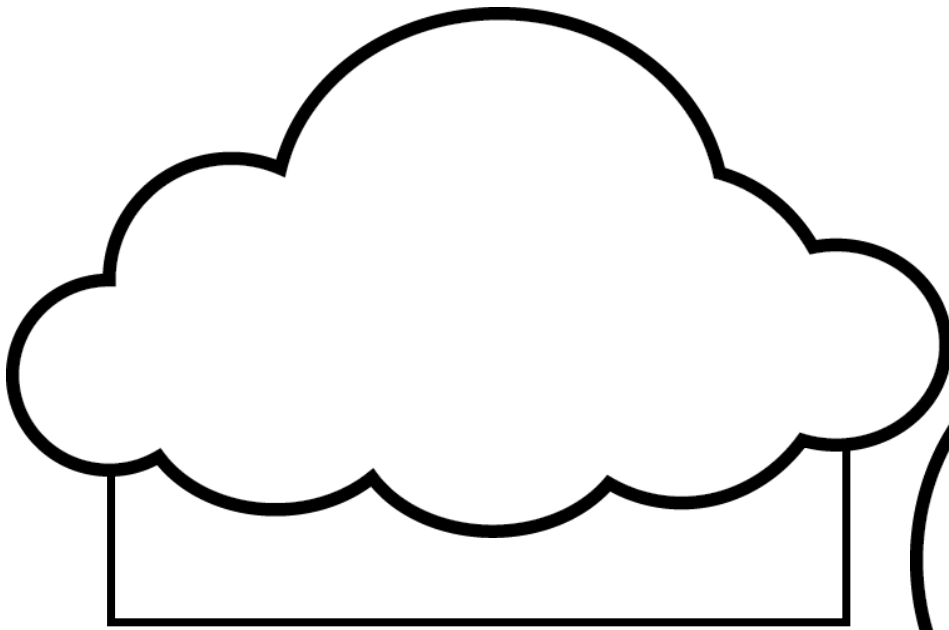
BRAINSTORMING

INSTRUCTIONS

Interactive Notebook Page:

1. Inside the brain: Write the answer to the question. **Why do we need Pulleys and Gears in our lives?**
2. Draw an example of a pulley or gear in your daily life that was discussed in class on the outside of the cloud.
3. Cut out the items and glue it into your interactive notebook. Glue only on the bottom tab so the cloud can be folded down.
4. Under the cloud, identify what picture you drew and explain how this item is used and why we need it.





LESSON THREE

What is a Pulley?
What is their Purpose?

grade 4 LESSON THREE

The format for these lessons is structured into two parts. One part is designed as a teacher directed lesson. The second part of the lesson is designed as an independent or small group learning activity. The teacher directed is noted in **PINK** and the small group/independent task is **YELLOW**

Learning Goal

Preparation

- Print [Student Reading](#) for Pulleys
- Technology for Viewing Video
- Pullin' Your Weight [Game Board](#) and [playing pieces](#).

Lesson Part A

- Depending on the background knowledge of your students, it may be beneficial to review the [Background Information](#) for pulleys.
- Have the students read about [The Pulley](#), how they work and why we use pulleys.
- Students can also watch these videos on pulleys:
 - <https://www.youtube.com/watch?v=9T7tGosXM58>
 - <https://www.youtube.com/watch?v=9T7tGosXM58>
 - <https://www.youtube.com/watch?v=aMx7nllH9ik>

Lesson Part B

- Students will apply what they learned about pulleys to play [Pullin' Your Weight](#).
- Ideally, this game is designed for two players, but can be used up to four.

Assessment

NOTES

Background Information

Pulleys can...

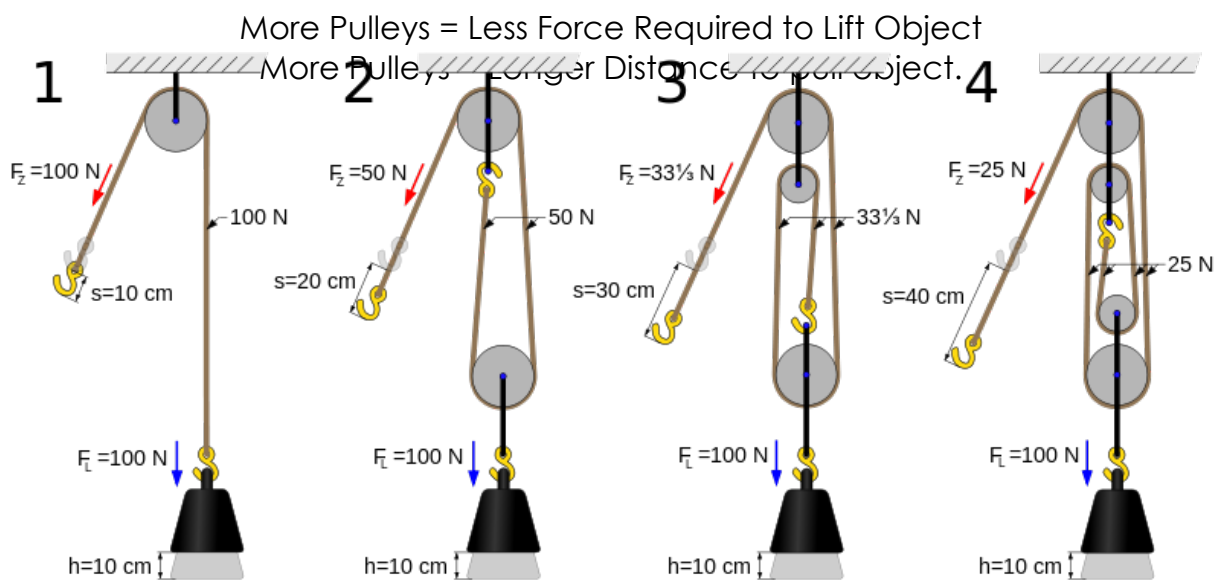
- Transfer motion from one object to another
- Change the amount of force needed to move an object.

What is a Pulley

A pulley is a wheel that has a cable wrapped over it. It is used to help lift an object. We use pulleys to lift objects more effectively. When you use pulleys you can reduce the amount of force that you need to lift heavier objects. But there is a catch. The more pulleys that you use to help you lift heavier objects means that although the load of the object is shared between the pulleys, the distance that you have to pull the cable in order to move the heavy object also increases. So you may have to work less but you need to pull further.

Pulleys and Mechanical Advantage

- One fixed pulley helps us by allowing us to pull down to lift an object. The amount of force needed to lift the object is equal to the weight of the object.
- Two pulleys (or 1 moveable pulley) share the load of the object being lifted between both of the pulleys. The cable you are using to lift the object is doubled up and therefore the amount of force it takes to lift the same object is half but you have to pull the rope further to lift the weight.
- As you add more pulleys the weight of the object is divided by the number of pulleys to give you the force required to lift that object. However the distance that is required to pull that object 3x more.



Pulleys are
so cool

The Pulley

PULLEYS CAN...

- Transfer motion from one object to another
- Change the amount of force needed to move an object.

WHAT IS A PULLEY?

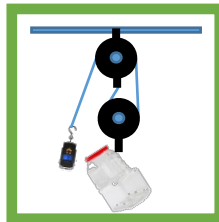
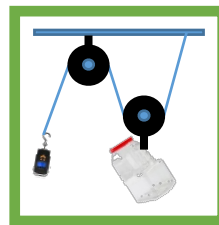
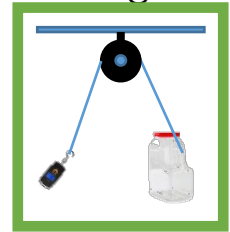
A pulley is a wheel that has a cable wrapped over it. It is used to help lift an object. We use pulleys to easily lift objects. When you use pulleys you can reduce the amount of force or work that you need to lift heavier objects.

Mechanical Advantage

Mechanical advantage means that by using a simple machine you have made your work easier. With pulleys the mechanical advantage describes the amount of force and effort that you save when lifting an object. The more pulleys you use the better your mechanical advantage because you need less effort to lift a heavy object.

TYPES OF PULLEYS

One fixed pulley helps us by allowing us to pull down to lift an object. This pulley system does not make the object feel any lighter but it is easier to lift because you can pull down instead of lifting up. There is no mechanical advantage to a single pulley system.



One Moveable pulley or Two pulleys also share the load of the object being lifted. The cable you are using to lift the object is doubled up and therefore the amount of force it takes to lift the same object is half but you have to pull

the rope further to lift the weight. These pulley systems do give you a mechanical advantage.

As you add more pulleys the weight of the object is divided by the number of pulleys. This increases your mechanical advantage and makes the load easier for you to lift.

PULLIN' YOUR WEIGHT

how to play

Before you Play:

- Cut out the [Game Cards](#) and lay them face down beside the [Game Board](#).
- Assemble either the die or the spinner.
- To assemble the spinner, use a thumb tack to secure a paperclip to the centre of the spinner.
- Cut out the Game pieces

What you need:

2 players

[Die](#) or a [spinner](#)

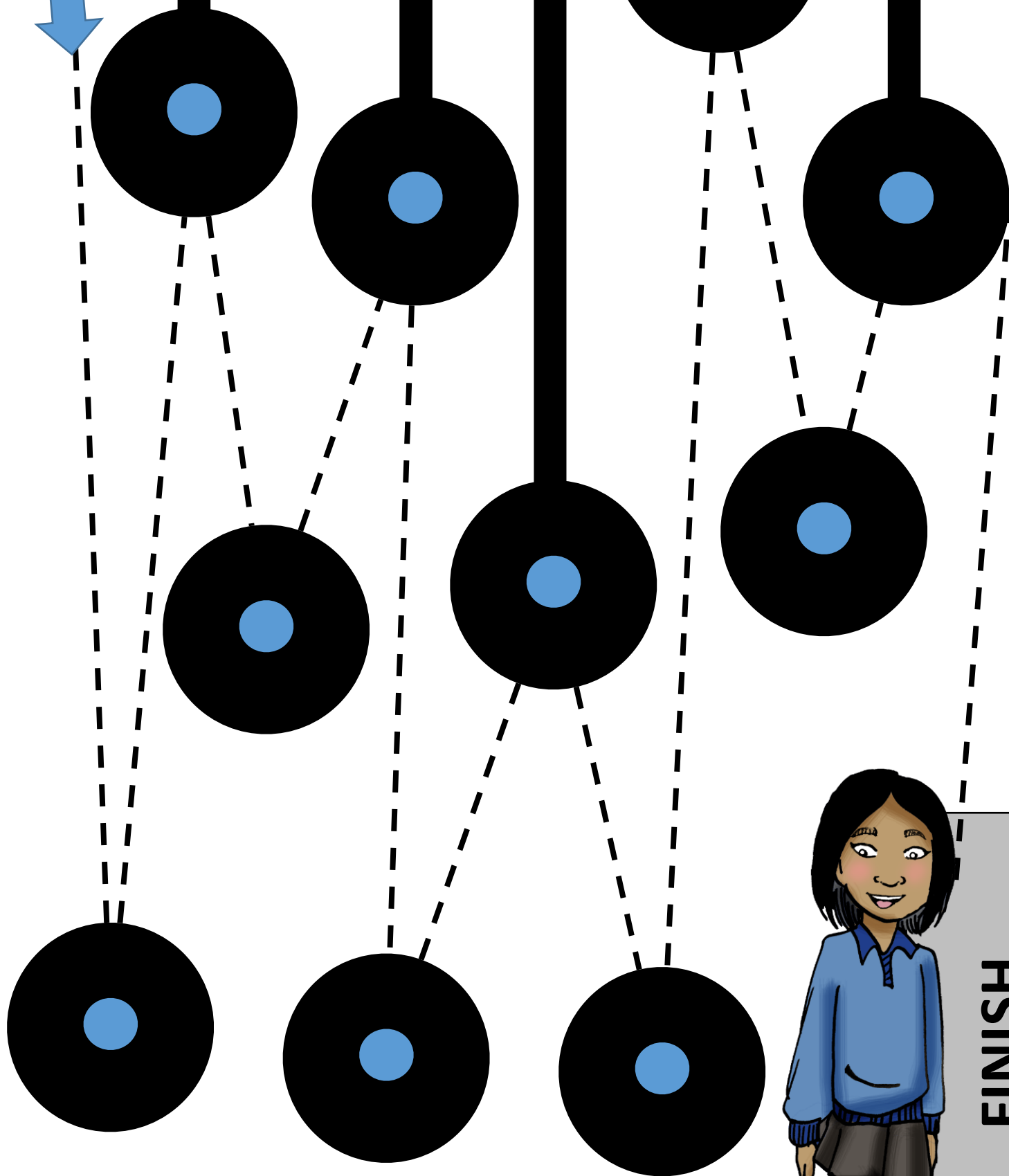
[Game Pieces](#)

Game Cards and Game Board

To Play:

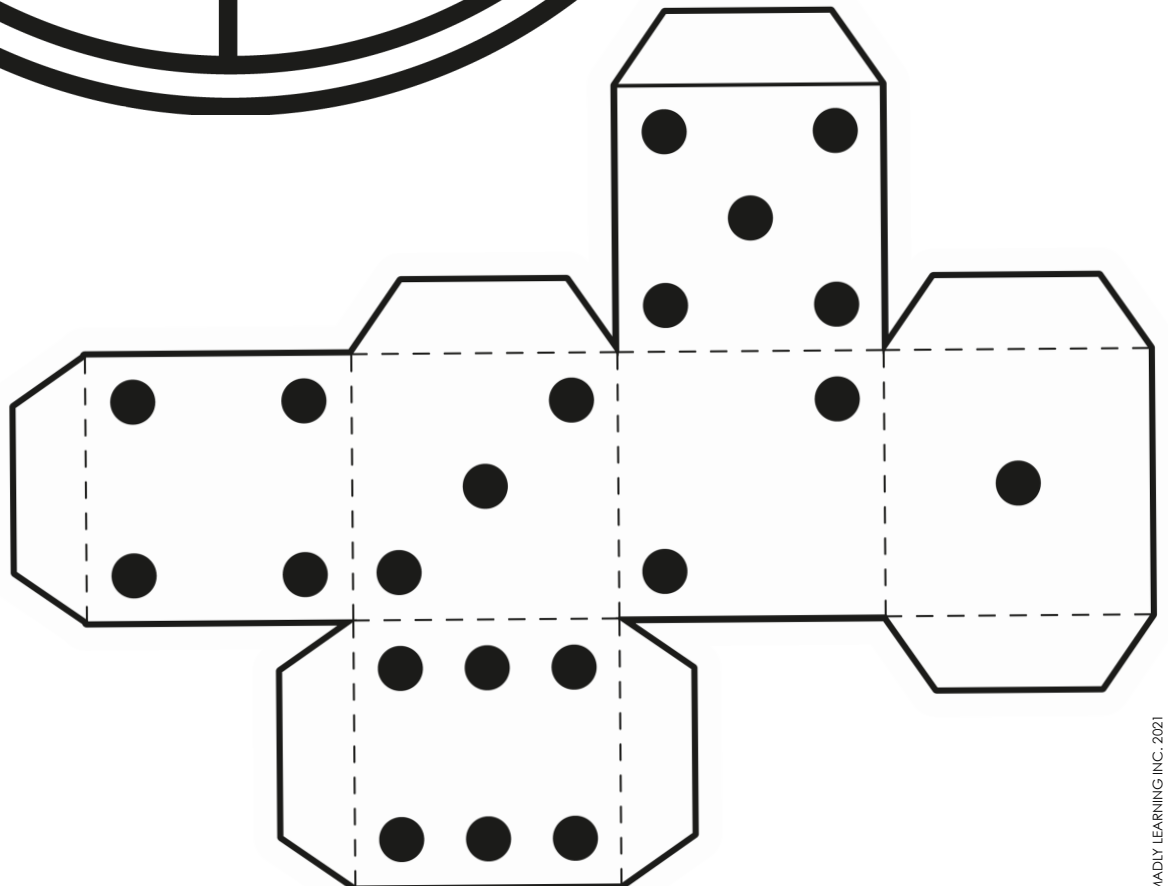
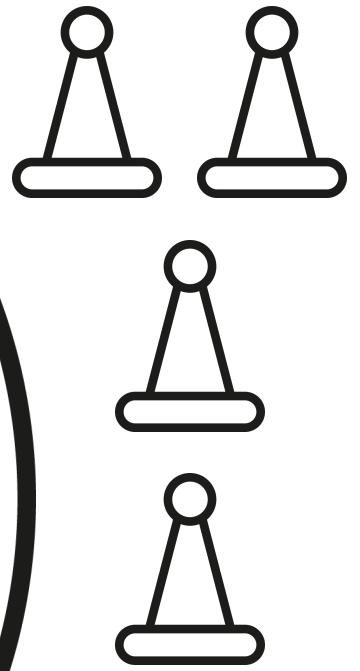
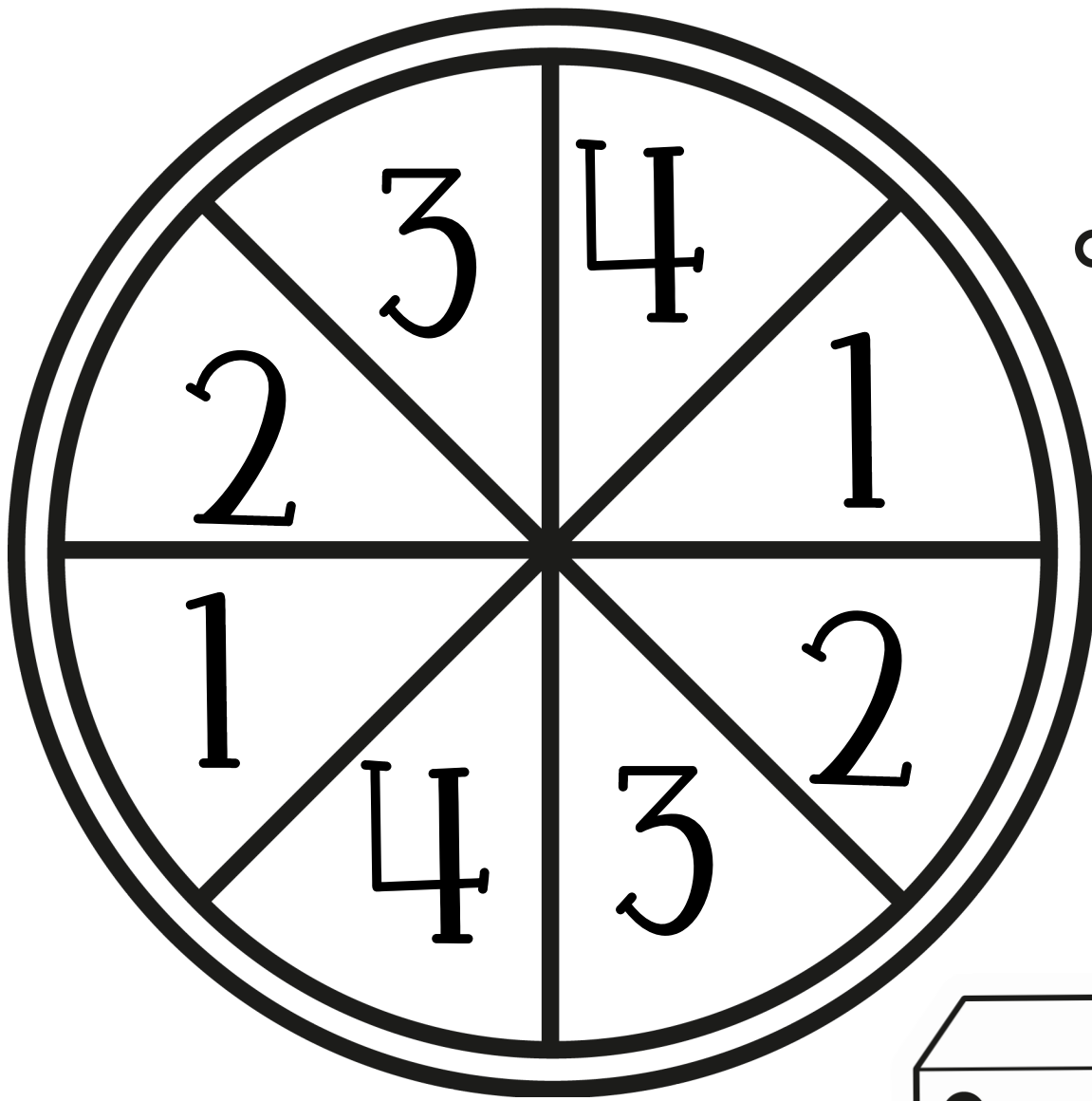
1. The youngest player goes first.
2. Roll the dice (or use the spinner) and pull a [Game Card](#).
3. If the player gets the question correct, move along the game board the number of spaces they rolled.
4. If the player gets the question wrong, move back along the board the number of spaces they rolled.
5. The player who reaches the finish first wins the game.

START



FINISH





Which one of the following objects do not use a pulley system?

- a) An Elevator
- b) A Manual Pencil Sharpener
- c) A Window Blind
- d) A Crane

Answer: B

Mechanical Advantage can be defined as?

- a) What makes it harder to lift or move an object because you need more effort to do the same work.
- b) The help a simple machine gives you so that you use less force to do the same amount of work.

Answer: B

Pulleys can transfer motion from one object to another.

- a) True
- b) False

Answer: A

What is a Pulley?

- a) A Rope that is tied to an object so you can pull it around
- b) A Wheel with teeth
- c) A Wheel and axle
- d) A Wheel that has a cable wrapped over it.

Answer: D

The more pulleys you use to lift an object means...

- a) The more effort you will need to lift the object.
- b) The more rope you will need to use to lift the object
- c) The less efficient you will be at moving the object.

Answer: B

A pulley can...

- a) Change the amount of force needed to lift an object.
- b) Make it easier to turn an object
- c) Make it easier to push an object
- d) Make it easier to break an object.

Answer: A

Using multiple pulleys makes it harder to lift an object

- a) True
- b) False

Answer: A

What is a Pulley?

- a) A Rope that is tied to an object so you can pull it around
- b) A Wheel with teeth
- c) A Wheel and axle
- d) A Wheel that has a cable wrapped over it.

Answer: D

One fixed pulley helps you because

- a) Even though it does not give you a mechanical advantage. You can use it to pull down instead of up on the rope.
- b) It gives you a mechanical advantage and you need half the force needed to lift the object.

Answer: A

One moveable pulley helps you because

- a) Even though it does not give you a mechanical advantage. You can use it to pull down instead of up on the rope.
- b) It gives you a mechanical advantage and you need half the force to lift the object.

Answer: B

One moveable pulley and one fixed pulley helps you because

- a) Even though it does not give you a mechanical advantage. You can use it to pull down instead of up on the rope.
- b) It gives you a mechanical advantage and you need half the force to lift the object.

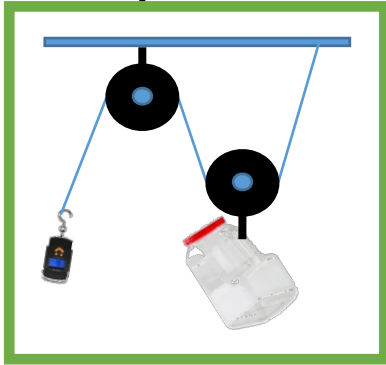
Answer: B

To lift a heavy object with a pulley you can make it easier by...

- a) Using a longer rope
- b) Using a larger pulley
- c) Use lots of moveable pulleys
- d) Use many fixed and moveable pulleys together.

Answer: D

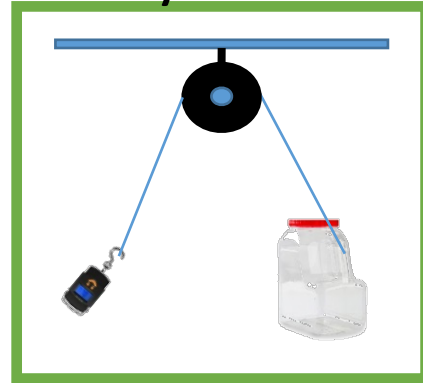
Name this Pulley System



- a) Fixed Pulley System
- b) Moveable Pulley System
- c) Combination Fixed and Moveable pulley system.

Answer: C

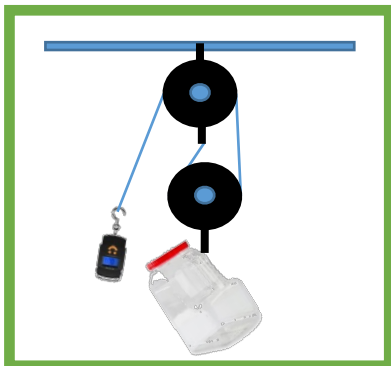
Name this Pulley System



- a) Fixed Pulley System
- b) Moveable Pulley System
- c) Combination Fixed and Moveable pulley system.

Answer: A

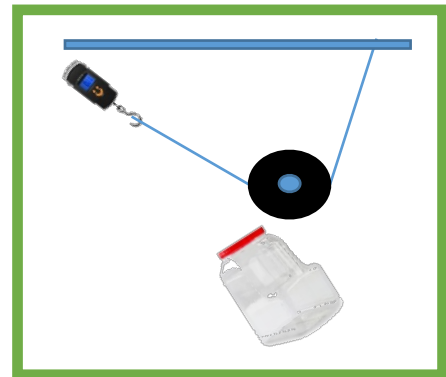
Name this Pulley System



- a) Fixed Pulley System
- b) Moveable Pulley System
- c) Combination Fixed and Moveable pulley system.

Answer: C

Name this Pulley System



- a) Fixed Pulley System
- b) Moveable Pulley System
- c) Combination Fixed and Moveable pulley system.

Answer: B

LESSON FOUR

What objects in our daily life use a pulley?

grade 4 LESSON FOUR

The format for these lessons is structured into two parts. One part is designed as a teacher directed lesson. The second part of the lesson is designed as an independent or small group learning activity. The teacher directed is noted in **PINK** and the small group/independent task is **YELLOW**

Learning Goal

Preparation

- Gather the Following Materials - tape, straws, popsicle sticks, dowel, spool of thread, eraser-weight, cardboard base.

Lesson Part A

- **Students make a simple pulley system. Supply your students with the following materials:**
 - Tape
 - Straws
 - Wooden craft sticks
 - Dowel
 - Spool of thread
 - Eraser (weight)
 - Cardboard base
- Have students create a simple pulley system that will lift their eraser or other small weight.

Lesson Part B

- Students will reflect on their pulley system
- What did they make?
 - How did they make it?
 - What did they have to consider to make their pulley system?
 - Any interesting observations of your pulley system?
 - How could they improve their pulley system?
 - Students will record their findings on the [Research](#) page.

Assessment

NOTES

Help students to see how to lift something heavy by pulling down to lift up. Use some of the cards from the game in the previous lesson or the reading to help students see examples of pulley systems that they can replicate.

*Pulley
System
Reflection*

What materials did you use?

*First Draw
and Write
your answers
to the
questions*

What is the Mechanical Advantage?

Draw your Pulley System?

Explain how your Pulley System Works:

How could you improve your Pulley System?

Finally put glue on the back of the center box. Glue it in your notebook and fold in the tabs

Next Cut out the foldable along the dotted lines on the outside

LESSON FIVE

How does a pulley work?

grade 4 LESSON FIVE

The format for these lessons is structured into two parts. One part is designed as a teacher directed lesson. The second part of the lesson is designed as an independent or small group learning activity. The teacher directed is noted in **PINK** and the small group/independent task is **YELLOW**

Learning Goal

Preparation

Lesson Part A

Lesson Part B

- **Conduct the Experiment Windows Page**
- How do pulleys improve our ability to do work?
- What happens when I increase the amount of pulleys I use to lift an object?
- Why do we need pulleys?
- Students record their hypothesis in their notebooks.
- Complete the three experiments:
 - [5A – Tug of War Pulley Style](#)
 - [5B – Making a Single Pulley System](#)
 - [5C – Making a Double Pulley System](#)
- These should be demonstration task with students observing these events.
- The key understanding is that the force required to lift an object decreases when you increase the amount of pulleys used to help you but the distance that you are required to pull also increases
- Students will each complete a science [Recording Foldable](#).

Assessment

NOTES

Extension activities

Have students develop a mathematical formula that helps them to explain the mechanical advantage of pulley systems.

Allow students to try this in small groups to test and make sure that it is reliable and valid.

EXPERIMENT 5A

Jug of War : Pulley Style

1. Tie the rope on one of the broom sticks.
2. Have two strong students each hold a broom stick about 100 cm
3. Choose a third person and tell them that they need to pull the two strong peers together.
4. Loop the rope that is tied to the one broomstick over the second broomstick 100 cm away.
5. Have the third person stand next to the first broom stick and hold the loose end of the rope. Have them pull on the rope trying to get their two peers to move together.
6. Next Wrap the rope around the broom sticks so that each broom stick now has two loops on the broomstick. Have the third person pull again trying to pull their peers together. They should be able to pull these two student together easier. When this happens ask the student if they found this easier.
7. Continue to loop the rope around the broomstick and have the third student continue to report that he puts forth the same amount of effort to accomplish a goal.

Students should come to the understanding that when they increase the number of pulleys that they are decreasing the amount of force required to pull these two a heavy objects together.

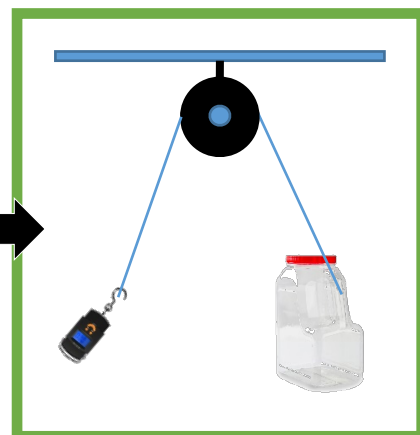
EXPERIMENT 5B

Making a Single Pulley System

Materials:

- Two pulleys (Hardware Store \$2-\$5) or
 - 2 coat hangers
 - Wire cutters
 - Two empty spools of thread
 - Nylon string
 - Small bucket, bag, plastic jug.
 - Fish weight scale (easily found at Walmart for \$5-\$10)
1. Measure the weight of the jug
 2. Using the fish scale have a student sit down and lift the jug with some water in it at least 30 cm off the ground. Ask the student how it felt to lift the jug?
 3. Set up the first pulley system.
 - Put a pulley on a broomstick.
 - Run a broomstick between two objects (desks, chairs, etc).
 - Run the string through the pulley and tie on the handle of the jug.
 - Loop the fish scale on the other end of the string and have the student pull on the fish scale to measure the amount of force that is used to lift the jug.
 - Have a sitting student pull the fish scale until the object is pulled off the ground 30 cm. The more pulleys used the further the student needs to pull back on the rope.
 - Record the amount of force required to lift the object and the distance the rope needed to be pulled to lift this force
 - Ask them to compare these two lifts

Single Pulley
System
Example



EXPERIMENT 5C

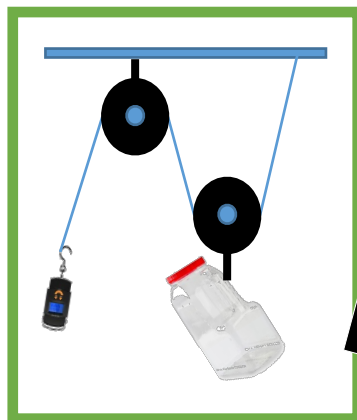
Making a Double Pulley System

Materials:

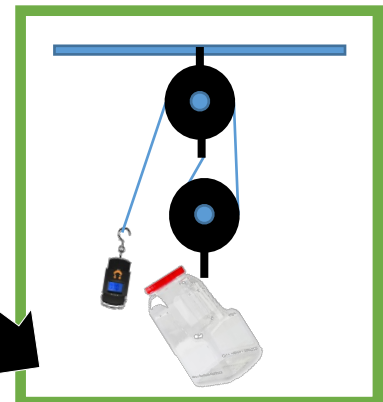
- Two pulleys (Hardware Store \$2-\$5) or
 - 2 coat hangers
 - Wire cutters
 - Two empty spools of thread
- Nylon string
- Small bucket, bag, plastic jug.
- Fish weight scale (easily found at Walmart for \$5-\$10)

1. Set up a double pulley system

- Attach one pulley to the broomstick.
- String the broomstick between two objects
- Tie the one end of the rope to the broomstick.
- Attach one of the pulleys to the jug with a hook or extra rope
- Run the rope through the pulleys as shown below
- Attach the fish scale to the end of the rope where the student pulls. Have the student lift the jug 30 cm off the ground
- Measure the amount of force required to lift the same jug and the distance needed to pull the rope.
- Ask students to explain the difference between the two pulls.
- The amount of force required should be about half as the weight of the jug was spread over two pulleys instead of one.
- Ask student how they felt lifting the jug compared to the other two ways of lifting the jug.



Two Different
Examples of
Double Pulley
Systems



Science Experiment

Recording Foldable

Instructions



Cut out around the outside of each box

Line the boxes up in order. Number 6 is on the bottom and Number 1 is on the top. Make sure to match the top edge of each box

What do I Wonder?

3 I Wonder

Tug of War	Single Pulley	Double Pulley

4 My Hypothesis

Write in 20

- 1 Our Learning Goal
- 2 My Observations
- 3 I Wonder
- 4 My Hypothesis
- 5 Gathering Information
- 6 My Conclusions

Put one staple at the top to hold it together

Write your answers in each section as you complete the experiment.

Glue the back of #6 in your book.



Science Experiment Recording Foldable

What do I see?

2

My Observations

Tug of War

Single Pulley

Double Pulley

5

Gathering Information

Science Experiment Recording Foldable

We are learning to

1

Our Learning Goal

Tug of War

Single Pulley

Double Pulley

6

My Conclusions

Science Experiment Recording Foldable

What do I Wonder?

3

I Wonder

Tug of War

Single Pulley

Double Pulley

4

My Hypothesis

LESSON SIX

How do gears work?

grade 4 LESSON SIX

The format for these lessons is structured into two parts. One part is designed as a teacher directed lesson. The second part of the lesson is designed as an independent or small group learning activity. The teacher directed is noted in **PINK** and the small group/independent task is **YELLOW**

Learning Goal

Preparation

Lesson Part A

What is a Gear?
Have students read [What is a Gear?](#)
Alternately, students can watch the Youtube [video](#) explaining gears, and their role on a bicycle.

Play this game:

- <https://www.engineering.com/gamespuzzles/connectit.aspx>

Lesson Part B

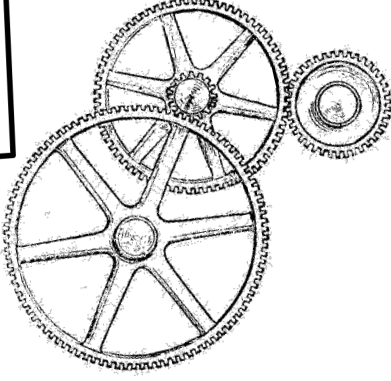
- Use an [Amazon Gear Kit](#), or make some gears out of cardboard using the [Gear Template](#) provided
- Mark the gears with a starting point. Align each gear so that it is lined up on the starting line. Turn the large gear one rotation and count how many rotations the smaller gears makes.

Assessment

NOTES

What is a

GEAR?

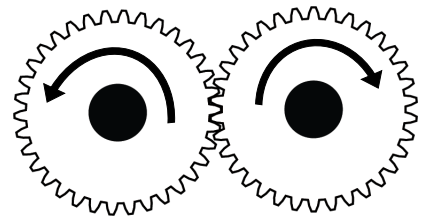


A gear helps us to get things moving. It is a simple machine and looks like a wheel with teeth around the outside. Gears come in many different sizes and many different styles. Each style has different purposes. Gears help us to increase speed, increase force, or change direction. They make doing work easier.

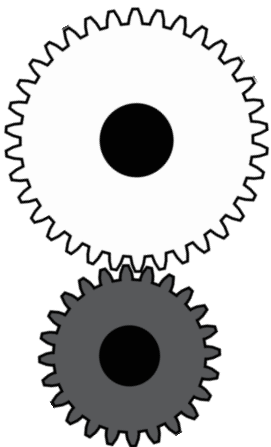
How they Work

The purpose of a gear is to help us do work and transfer energy from one area to another. Gears work together with other gears to change speed, change force or change direction.

Gears can change direction. When you put two gears side by side and turn one of the gears clockwise. The second gear will turn counter clockwise.



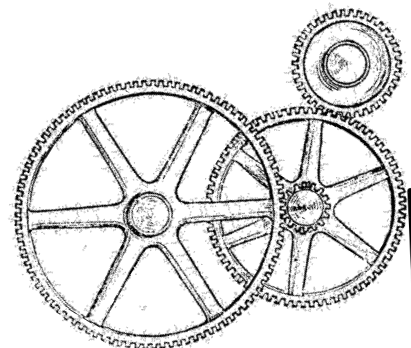
Using force and effort to turn this gear

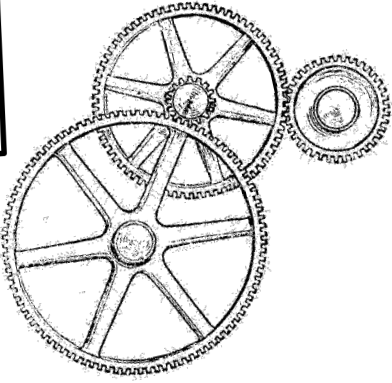


Increases speed of this gear because it will rotate more quickly

Some gears work together to increase speed. The large white gear will turn slower than the grey gear. The white gear has more teeth so it will take longer to do one full rotation. It takes more force from you to turn the white gear but your advantage is that you can increase your speed because the grey gear will turn faster. Think about pedalling your bike.

If you want to go faster you need to choose a large gear in the front and a smaller gear at the wheel. So your wheel turns faster than you pedal. This means you will go faster.



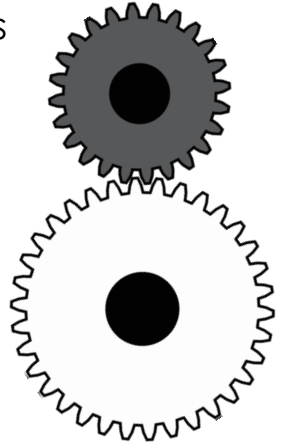


What
is a

GEAR?

Some gears work together to increase force. When you spin the smaller gear you are able to spin it faster. This allows you to increase the amount of force you create. The small grey gear does the work of turning the bigger gear. The bigger white gear would take more force and effort for you to turn it by itself. Think about going up a hill on your bike. You need to put more effort in to get up the hill. You can use gears to help you. If you choose a smaller gear at the front and a larger gear at the back you will need to pedal faster but you will create more force at the back wheel which will allow you to get up the hill easier.

Turning this quickly



*Increases the force
needed to turn the larger
gear.*

With gears you must remember that force and speed work together. You always have the same amount energy. You can have more speed or more force but not both. If you want an increase in force then there will be a decrease in speed between your gears, and if you decrease the force between your gears you increase the speed.

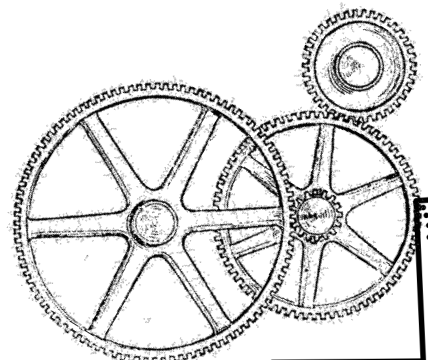
Gears in our World

Gears are used in many machines. Including spinning rides at the carnival, wind turbines, and even your washing machine.

Think about it!

Can you think of other objects in our world that use gears?

How do gears make our ability to do work easier?



Making Gears

Cut the
gears
out

Glue the gears on a
sturdy piece of
cardboard

Cut the gears out of
the cardboard

Line them up so the gear
teeth fit together

Put a pin in the middle to secure
them to a surface below
(bulletin board, or extra
cardboard)

GIVE THEM A SPIN

LESSON SEVEN

Different types of gears (spur gears, idle gears, worm gears, crown and bevel gears)

grade 4 LESSON SEVEN

The format for these lessons is structured into two parts. One part is designed as a teacher directed lesson. The second part of the lesson is designed as an independent or small group learning activity. The teacher directed is noted in **PINK** and the small group/independent task is **YELLOW**

Learning Goal

Preparation

- Print [Types of Gears](#) readings for students (1 per student)
- Print [Gear Cards](#) for students

Lesson Part A

- Have students read the [Types of Gear](#) readings about different types of gears and their application in real life situations.

Lesson Part B

- Match gears with a definition and some pictures of real world applications.

Assessment

NOTES

Types of

GEARS

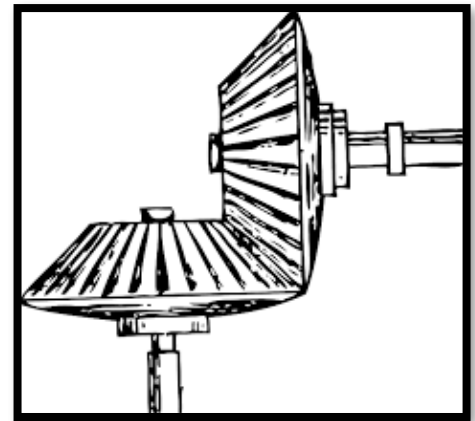
Spur Gears



These gears are the most common gears. They have straight teeth. Gears are joined together side by side. Unlike other gears they do not join together forming a corner. They are parallel. These gears are not often used in cars because they are much louder because the teeth bang together as the gears rotate.

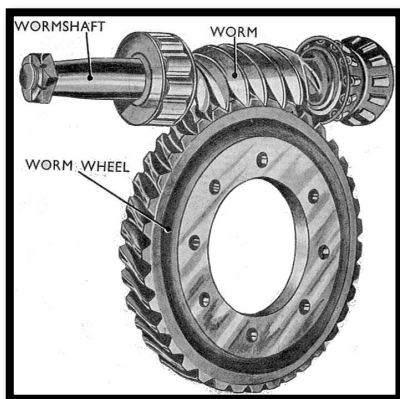
Bevel Gears

These are gears that help you turn a corner. They work at 90° angles. These types of gears are used in an electric screw driver where the power of the trigger needs to be turned to spin the screw driver.



Worm Gears

Worm gears are efficient at decreasing speed and increasing force. The worm part of the worm gear looks like a screw. It spins and turns the gear. In this gear set up the worm cannot be turned by the gear. Only the worm can be the driving gear.



Types of

GEARS

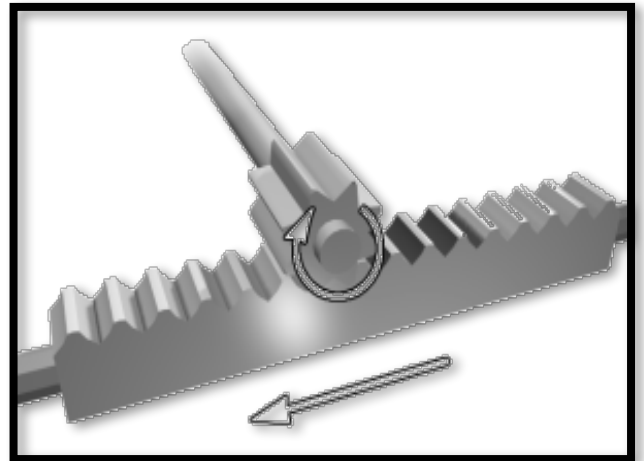


Helical Gears

These gears have teeth that are cut at an angle. The teeth on this type of gear do not bang together but join in a more fluid motion. These gears are much quieter than spur gears and are often used in cars.

Rack and Pinion Gear

In this type of gear the round gear is called the pinion and the straight gear is called the rack. This gear helps to turn a rotating motion from the pinion to a straight or linear motion of the rack. An example of this is used to help trains get up steep hills. The rack is in the middle of the track on a hill and the pinion gear is lowered to help the heavy train make it up a hill. They are also commonly used in steering systems in cars and trucks.



Think About It

Can you find things around you that use gears? What kind of gears do they use?

Name this type of Gear



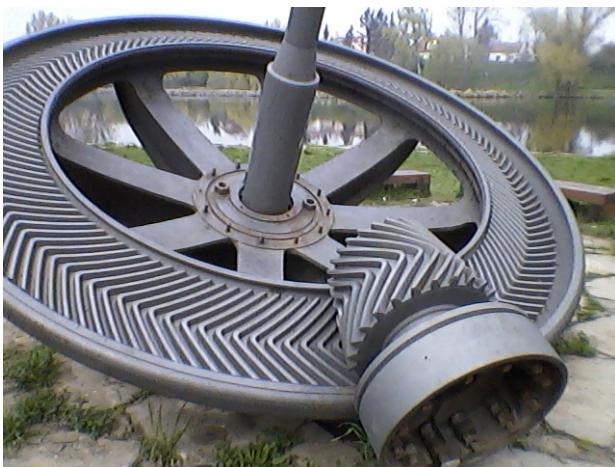
bevel

Name this type of gear.



Bevel Gear

Name this type of gear



Bevel Gear

Name this type of gear



Spur Gear

Name this type of Gear



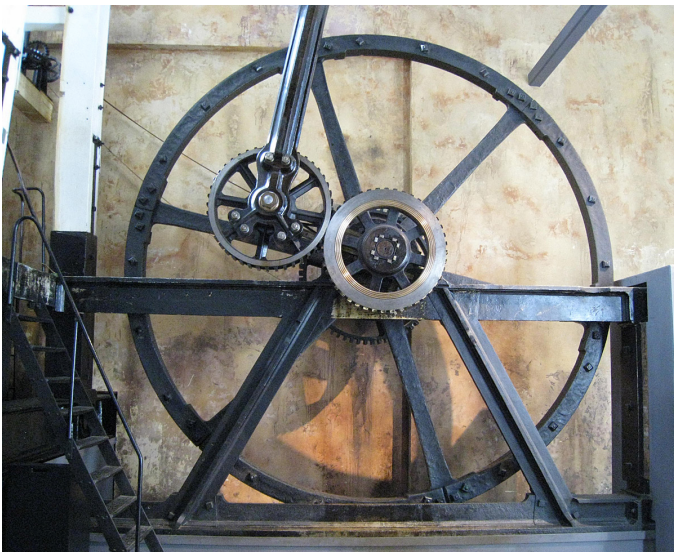
Rack and Pinion

Name this type of gear.



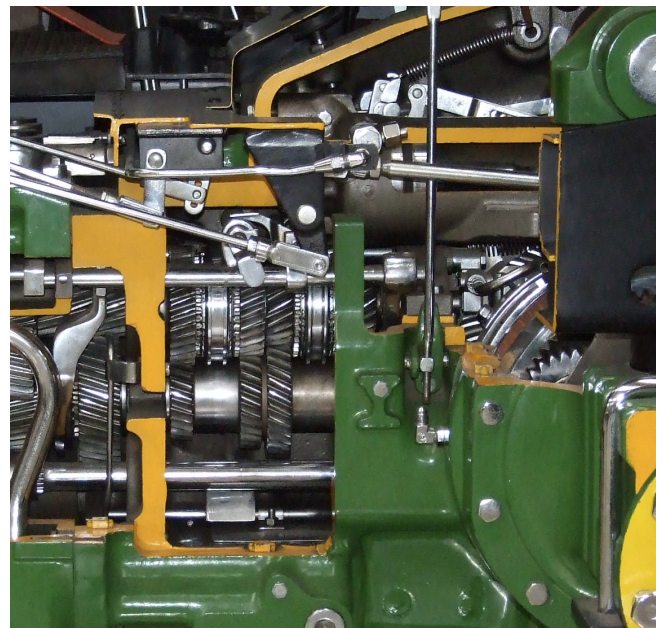
Rack and Pinion

Name this type of gear



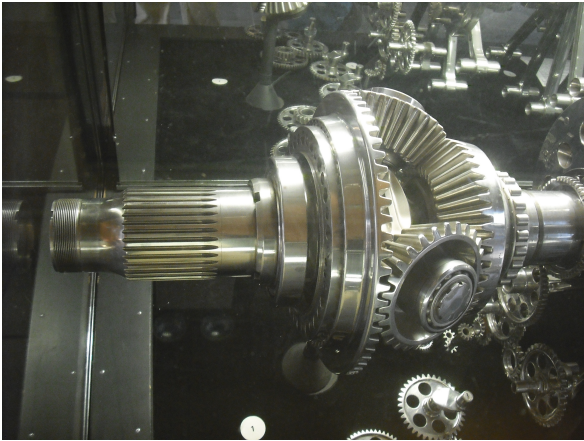
Spur Gear

Name this type of gear



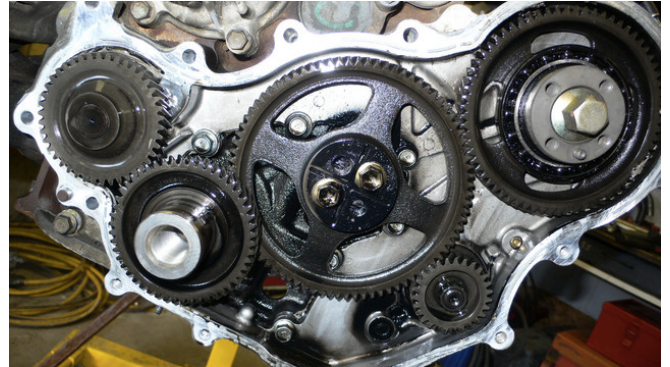
Helical Gears

Name this type of Gear



Bevel Gears

Name this type of gear.



Spur Gears

Name this type of gear



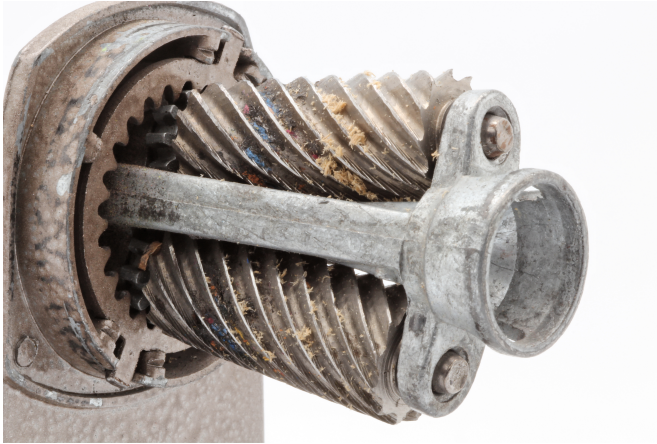
Spur Gear

Name this type of gear



Worm Gear

Name this type of Gear



Helical Gears

Name this type of gear.



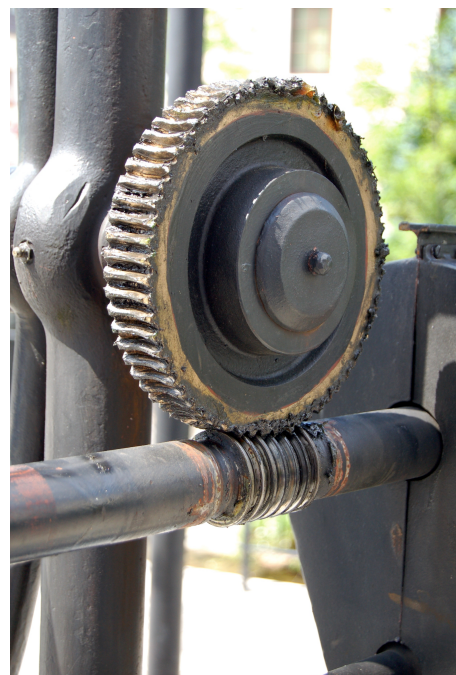
Spur Gears:

Name this type of gear



Rack (Rack and
Pinion)

Name this type of gear



Worm Gear

FINAL TASK

Mini Inquiry Project

grade 4 FINAL TASK

The format for these lessons is structured into two parts. One part is designed as a teacher directed lesson. The second part of the lesson is designed as an independent or small group learning activity. The teacher directed is noted in **PINK** and the small group/independent task is **YELLOW**

Learning Goal

Preparation

Lesson Part A

Lesson Part B

- Students will choose a familiar object or part of an object that uses a pulley or gear
- They will investigate this product and learn how the pulley or gears operate to make this product work.
- (If Available – Highly recommended) students will use gear and pulley manipulatives to recreate this pulley or gear system. Gear manipulatives can be purchased through Amazon
- Students will complete their [Inquiry Booklets](#).
- Depending on the students' level of comfort with inquiry, several [Exemplar](#) pages have been included.

Assessment

- Assessment Students will then demonstrate this to you and explain how it works.
- [Assessment pages](#) have been included.

NOTES

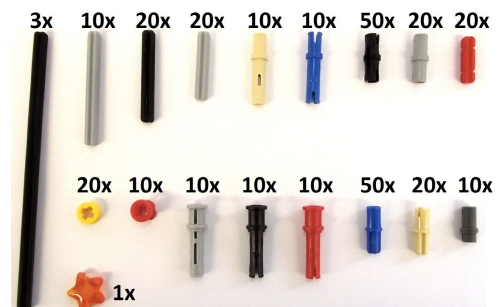
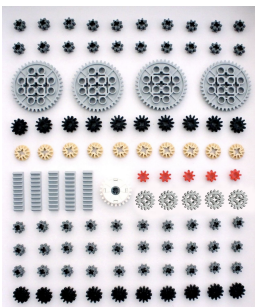
4th Grade

Suggested Resources

If you have a school budget to buy supplies we highly recommend that you consider The LEGO Education – Simple Machines or LEGO TECHNIC kits. If you click on the pictures below you will go to each of the products. You can buy these components separately (like shown below) or full kits. I use the older version of this set called LEGO DACTA



These are the three sets you need for your class to build gear sets. (Gears, Pins and Axles, and Beams with Holes) Make your own Set Below would be about \$88 on Amazon.com



Alternatives

Here are some other products that you might find helpful (and less expensive)



Final project

Pulleys &
Gears

You have learned a lot so far in your unit on Pulleys and Gears. Now it is time to show what you know.

The first step is decide do you want to investigate Pulleys or Gears

Research an object that uses a pulley or a gear.

- What machines use Pulleys and Gears
- What jobs do these machines do?
- What do the pulley and gear systems in this machine look like?
- How do the Pulleys and the Gears work in these machines to make work easier?

Next, develop a prototype blue print. Draw out what you want your machine to look like, Using the materials given. Use the machine you researched to inspire you and help you design your prototype. Get this approved by your teacher before you begin building.

Build your Machine with your materials. Try to follow the plan you made as close a possible. Conference with your teacher about your construction

Pulleys and Gears help to change direction, increase speed or increase force. Can you change your design to modify its ability to change SPEED < FORCE or DIRECTION?



My Research

My Machine is:

What Job or Jobs does my machine do?

How does my machine use pulleys or gears

How do the Pulleys and gears in the machine make 'work' easier?

What do the pulley and gear systems look like?



Ideas and Links

For Student Research

Pulley:

- [Elevators \(2\)](#)
- [Garage Doors](#)
- [Wells](#)
- Exercise Equipment
- Theatre Curtains
- Blinds
- [Flagpoles.](#)
- Clothes lines
- [Crane](#)
- Engines
- Sails
- Rock climbing (belay)
- Escalators

Gears

- [Cars and Trucks \(transmission, steering and engines\)](#)
- [Clocks](#)
- [Drill](#)
- [Bikes](#)
- [Can opener](#)
- Egg beater
- [Pencil Sharpener](#)
- Fans
- Sewing machine
- Trains (for going up hills)
- [Rideau Canal Boat Locks](#)

As you, Research Write down the websites that you visit below.

1

Name: _____

Address: _____

2

Name: _____

Address: _____

3

Name: _____

Address: _____



Blue Print

It is important to draw out your design before you begin building. **NEATLY** draw out **2** different views of your structure. (Big Picture/Overall, closeup)

A large, empty rectangular box with a thin black border, intended for drawing a big picture or overall view of the structure.A second large, empty rectangular box with a thin black border, intended for drawing a closeup view of the structure.



Student Teacher Conference #1

When you have completed and tested your prototype. Please answer these questions and see you teacher to discuss your answers.

1) What Machine inspired your prototype design?

2) Describe how you constructed your prototype?

3) How does your machine help people to do work?

4) Looking closely at the pulley or gears. Explain the following

a) What type of gear or pulley system is being used?

b) What advantages are your gear or pulley creating?

c) Why did you choose this type of gear or pulley system over other types?



Student Teacher Conference #2

Think about ways that you could improve your prototype.

Then Test it out!!

Finally share with your teacher

Think about ways that you could improve your prototype

Pulleys

- How could you lift a heavier object?
- How could you reduce the amount of force needed to lift the object?
- How could you rearrange the pulleys but still be able to lift the same amount of weight?

Gears

- How could you change the direction?
- How could you change the output speed?
- How could you change the output force?

Choose one or two of the questions from above and apply it to your prototype. Write down what you did and your observations of the differences it made to your prototype.

What did you do to change your prototype?

What did you observe change after you made these changes?

Research

SAMPLE

My Machine is:
Can Opener

What Job or Jobs does my machine do?

- opens can lids
- some can open bottle lids
- can be manual or electric

How does my machine use pulleys or gears

- has a crank
- crank attached to one gear
- blade attached to cutter
- spins around can top
- squeeze to keep on can
- turn the crank to open the can
- can be done electrically too

How do the Pulleys and gears in the machine make 'work' easier?

- need more force
- hard for humans to do

What do the pulley and gear systems look like?

- two bevel gears
- on an acute angle



SAMPLE

and Links

Student Research

Pulley:

- [Elevators \(2\)](#)
- [Garage Doors](#)
- [Wells](#)
- Exercise Equipment
- Theatre Curtains
- Blinds
- [Flagpoles.](#)
- Clothes lines
- [Crane](#)
- Engines
- Sails
- Rock climbing (belay)
- Escalators

Gears

- [Cars and Trucks \(transmission, steering and engines\)](#)
- [Clocks](#)
- [Drill](#)
- [Bikes](#)
- [Can opener](#)
- Egg beater
- [Pencil Sharpener](#)
- Fans
- Sewing machine
- Trains (for going up hills)
- [Rideau Canal Boat Locks](#)

As you, Research Write down the websites that you visit below.

1

Name: **EHOW - What type Pulley is on a flagpole?**

Address: _____

http://www.ehow.com/facts_7355522_type-pulley-flagpole_.html

2

Name: _____

Address: _____

3

Name: _____

Address: _____

SAMPLE

EARS

her Conference #1

Completed and tested your prototype. Please answer these questions and see your teacher to discuss your answers.

1) What Machine inspired your prototype design?
A Can Opener

2) Describe how you constructed your prototype?

I made two arms. At the end of each arm I put two gears. I joined the two arms together. When the arms are together the gears mesh and I can turn them with a crank that I attached to the one gear.

3) How does your machine help people to do work?

My machine helps people because it increases the force that you use on the crank to be able to cut and open the can. A person would have a very difficult time cutting through the lid of a can without a can opener.

4) Looking closely at the pulley or gears. Explain the following

a) What type of gear or pulley system is being used?

There are two bevel gears on my can opener

b) What advantages are your gear or pulley creating?

The first gear is small and the second gear is larger to this helps to increase the force that helps you to open the can.

c) Why did you choose this type of gear or pulley system over other types?

I chose this because I have one in my house and I recognized that there was a gear system on it..

SAMPLE

Teacher Conference #2

that you could improve your prototype.

Then Test it out!!

Finally share with your teacher

Think about ways that you could improve your prototype

Pulleys

- How could you lift a heavier object?
- How could you reduce the amount of force needed to lift the object?
- How could you rearrange the pulleys but still be able to lift the same amount of weight?

Gears

- How could you change the direction?
- How could you change the output speed?
- How could you change the output force?

Choose one or two of the questions from above and apply it to your prototype. Write down what you did and your observations of the differences it made to your prototype.

What did you do to change your prototype?

I tried to make the manual can opener into an electric can opener. I added a pulley wheel instead of the crank. I attached this to another pulley at the end of the arm and mounted this to a base. A motor could then turn the pulley system which would turn the crank to operate the gears.

What did you observe change after you made these changes?

The motor would spin the gears too quickly so you would have to reduce the speed of the motor to open the can. It was hard to figure out what to do with both arms so I would need to figure out a better way to mount the arms to open the cans without the arms getting in the way.

Assessment

Final
Project
Pulleys &
Gears

Student Name: _____

Structure: _____

Areas for Concern	Criteria of success	Evidence of Meeting or Exceeding standards
	Student completes good research of a structural design.	
	Student clearly designs a prototype that mimics the machine that they researched	
	Student assembles the structure safely and with good attention to detail	
	Student can justify their design choices and elements.	
	Student can explain the advantages of machines and apply it to their prototype	
	Student can identify ways in which their design decisions contributed to the success and failure of their structure.	

STUDENT INQUIRY PROJECT

assessment

CRITERIA	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Knowledge and Understanding: <ul style="list-style-type: none"> benefits and costs of aviation technology social and economic perspectives into account 	Student has a limited understanding of key concepts learned and with significant support.	Student has a basic understanding of key concepts learned and uses them appropriately some of the time.	Student has a solid understanding of key concepts learned and uses them appropriately most of the time.	Student has a deep understanding of key concepts learned and uses them appropriately all of the time.
Thinking: <ul style="list-style-type: none"> research skills analyze and synthesize information make connections and inferences 	Student requires a high degree of support to research and struggles to analyze and synthesize what they read to answer inquiry questions.	Student demonstrates basic research skills and with some support can analyze and then synthesize what they read to answer questions.	Student demonstrates good research skills by analyzing and synthesizing what they read to answer inquiry questions.	Student demonstrates excellent research skills by analyzing and synthesizing what they read to answer inquiry questions.
Communication: <ul style="list-style-type: none"> appropriate terminology/vocabulary communicate and collaborate with others 	<p>Student rarely uses subject specific vocabulary correctly.</p> <p>Student rarely communicates and collaborates with others to share ideas and insights.</p>	<p>Student uses a few subject specific vocabulary correctly.</p> <p>Student communicates and collaborates some of the time with others to share ideas and insights.</p>	<p>Student uses some subject specific vocabulary correctly.</p> <p>Student communicates and collaborate effectively with others to share ideas and insights.</p>	<p>Students uses most subject specific vocabulary correctly.</p> <p>Student communicates and collaborates effectively with others to share ideas and insights.</p>
Application: <ul style="list-style-type: none"> make connections between research and real life 	Student struggles to use the information from their research to identify a problem and possible solutions.	Student partially uses the information from their research to identify a problem and possible solutions.	Student sufficiently uses the information from their research to identify a problem and possible solutions.	Student comprehensively uses the information from their research to identify a problem and possible solutions.

STUDENT INQUIRY PROJECT

assessment

CRITERIA	Notes
Knowledge and Understanding: <ul style="list-style-type: none"> • benefits and costs of aviation technology • social and economic perspectives into account 	
Thinking: <ul style="list-style-type: none"> • research skills • analyze and synthesize information • make connections and inferences 	
Communication: <ul style="list-style-type: none"> • appropriate terminology/ vocabulary • communicate and collaborate with others 	
Application: <ul style="list-style-type: none"> • make connections between research and real life 	
Overall Grade/ Comments:	