SCIENCE

Pulleys and GEARS

Junior 3-5

Inquiry Based Unit

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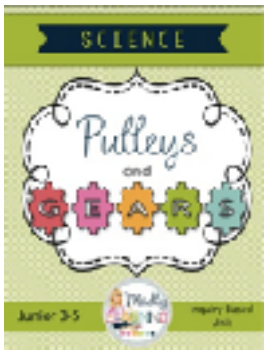

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Introduction

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

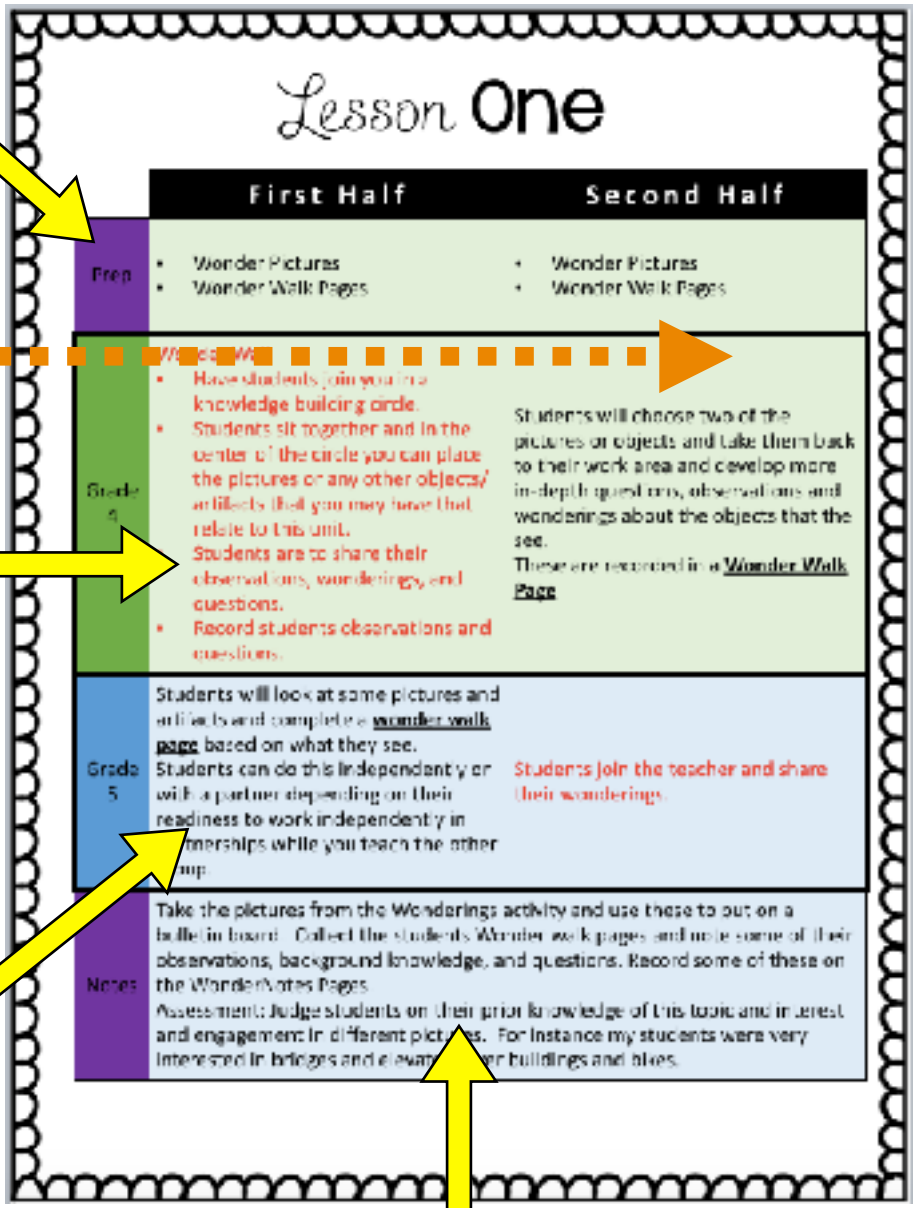
They can add a Table of Contents. As students add new pages to their notebook they can also add the title of that page to their TOC. Use the headings provided at the top of each page

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.

How to read
The Lesson Plans

Prep: Suggestions to help you prepare for the lesson



Lesson One

	First Half	Second Half
Prep	• Wonder Pictures • Wonder Walk Pages	• Wonder Pictures • Wonder Walk Pages
Grade 4	• Have students join you in a knowledge building circle. • Students sit together and in the center of the circle you can place the pictures or any other objects/ artifacts that you may have that relate to this unit. • Students are to share their observations, wonderings, and questions. • Record students observations and questions.	Students will choose two of the pictures or objects and take them back to their work area and develop more in-depth questions, observations and wonderings about the objects that they see. These are recorded in a Wonder Walk Page
Grade 5	Students will look at some pictures and artifacts and complete a wonder walk page based on what they see. Students can do this independently or with a partner depending on their readiness to work independently in partnerships while you teach the other group.	Students join the teacher and share their wonderings.
Notes	Take the pictures from the Wonderings activity and use these to put on a bulletin board. Collect the students Wonder walk pages and note some of their observations, background knowledge, and questions. Record some of these on the Wonder Notes Page. Assessment: Judge students on their prior knowledge of this topic and interest and engagement in different pictures. For instance my students were very interested in bridges and elevator buildings and skies.	

Read each grade horizontally.

The text highlighted in Red (lighter) text is teacher led time.

The other black text is independent tasks

Extra information, suggestions or extension activities.

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
ICCSS.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

Combined Lesson Plans

	Grade 4
1	I Wonder - Introduction to Inquiry Provocation Inquiry Board
2	What is force? What is Work?
3	What is a pulley? What is their purposes?
4	What objects in our daily life use a pulley. Make a simple pulley system out of found objects
5	How does a pulley work? How can pulleys help us work (mechanical advantage) Experiment with Pulleys
6	How do gears work?
7	Different types of gears (spur gears, idle gears, worm gears, crown and bevel gears)
F	Final Task: Conduct research on Pulleys and gears used in our daily life. Design a Pulley or gear system using either found materials or class manipulative kits

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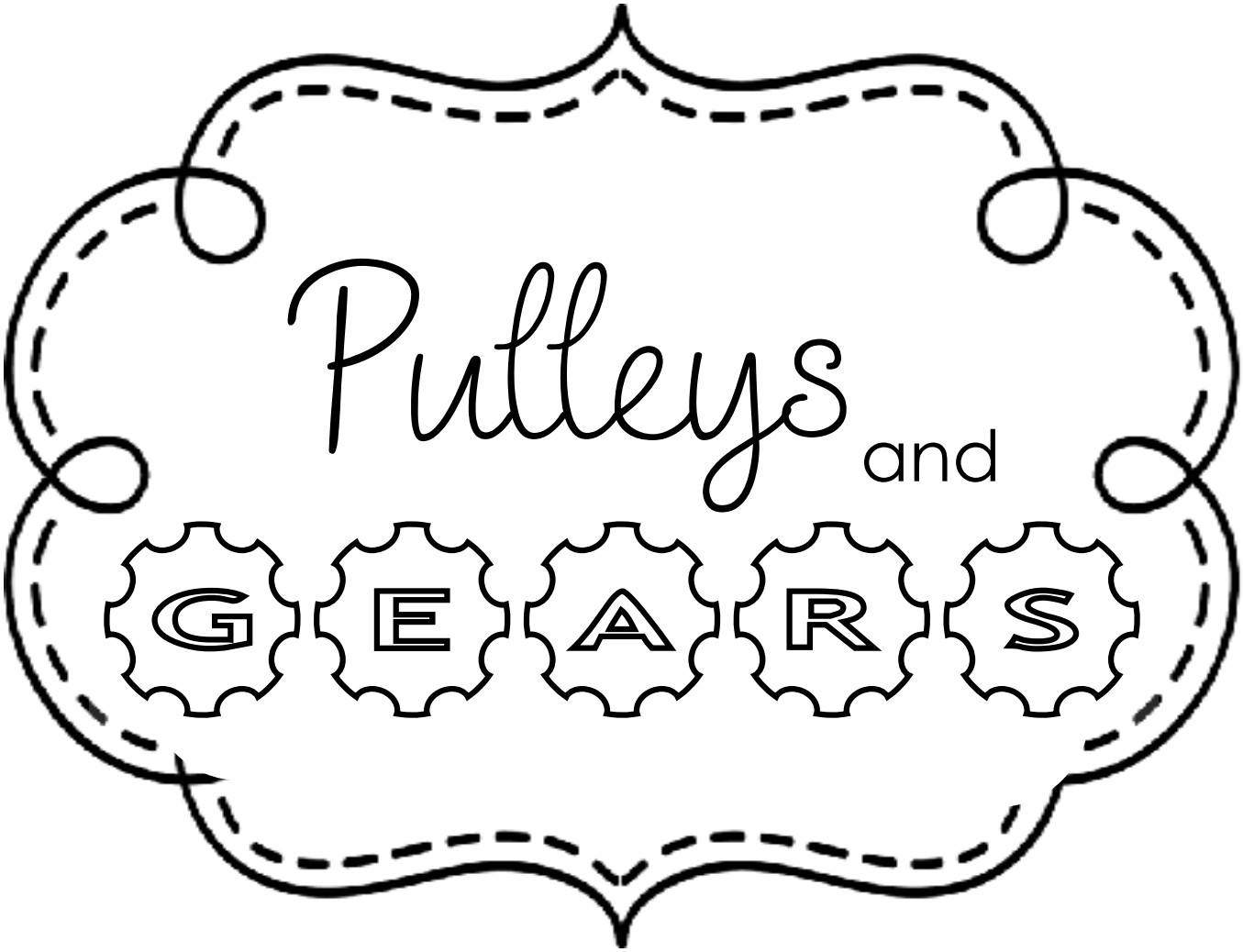


Name: _____

Room: _____

Grade 4
Pulleys and Gears

LINK TO LIVE BINDER RESEARCH FILES

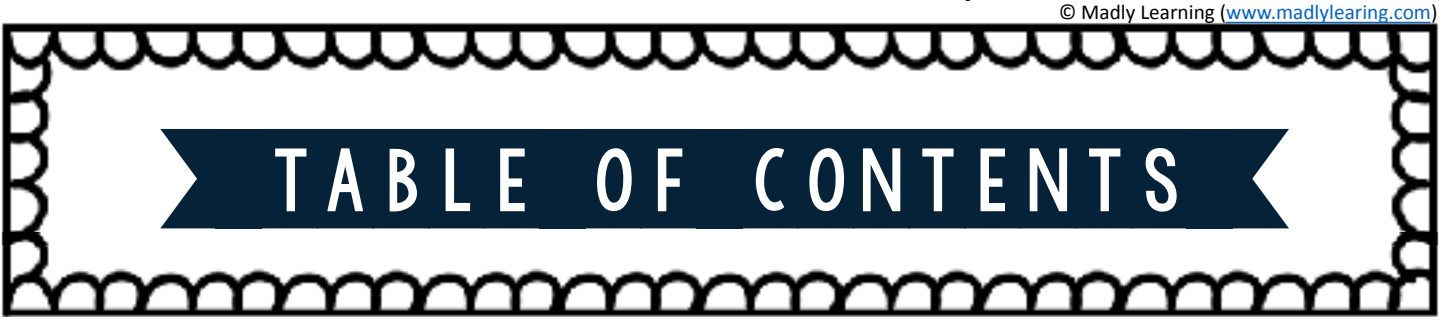
bit.ly/ML-pulleygear

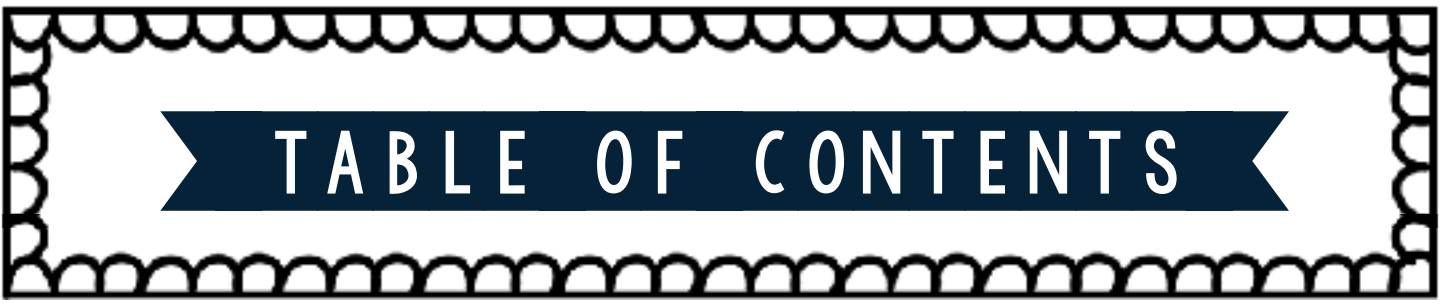
ACCESS CODE: MLSS&S

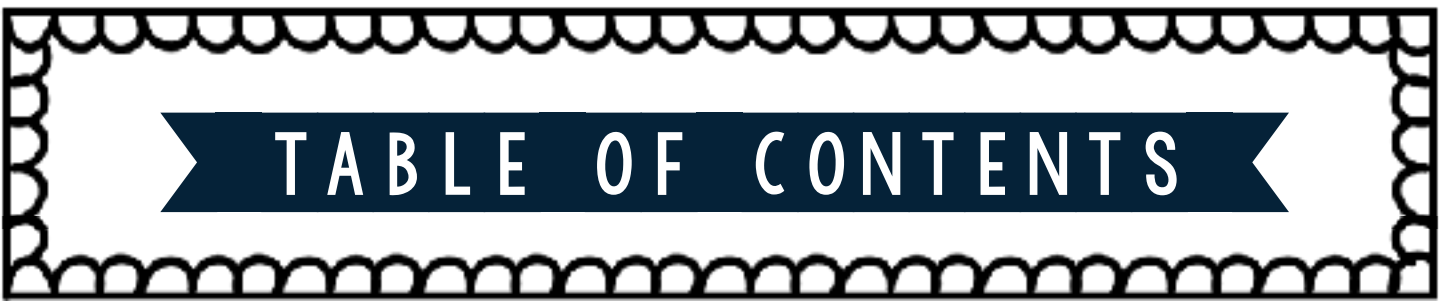
MY STICKY THOUGHTS

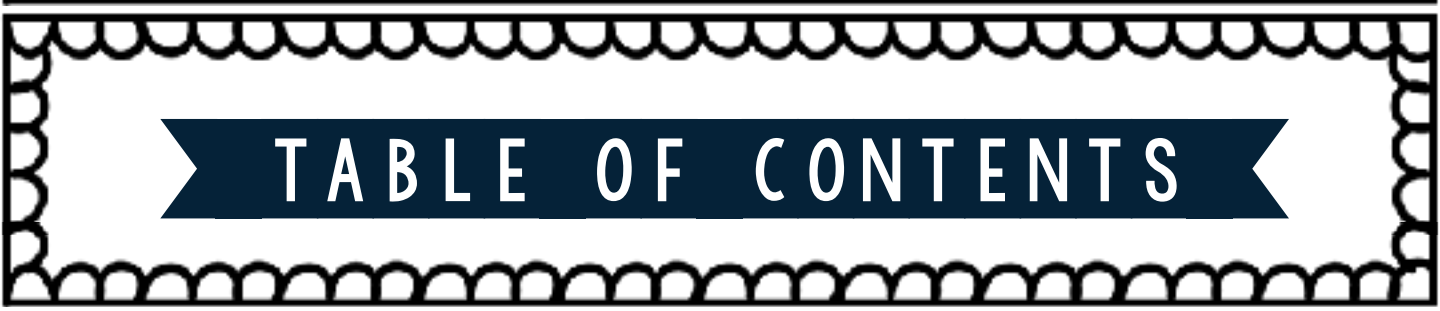
What stuck with me today...

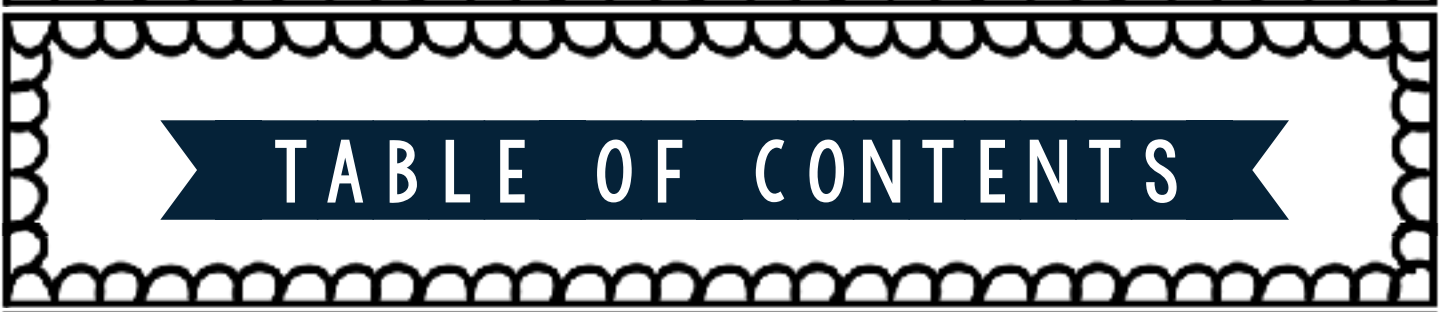
Cut these labels out and use as the headers for your Table of Contents

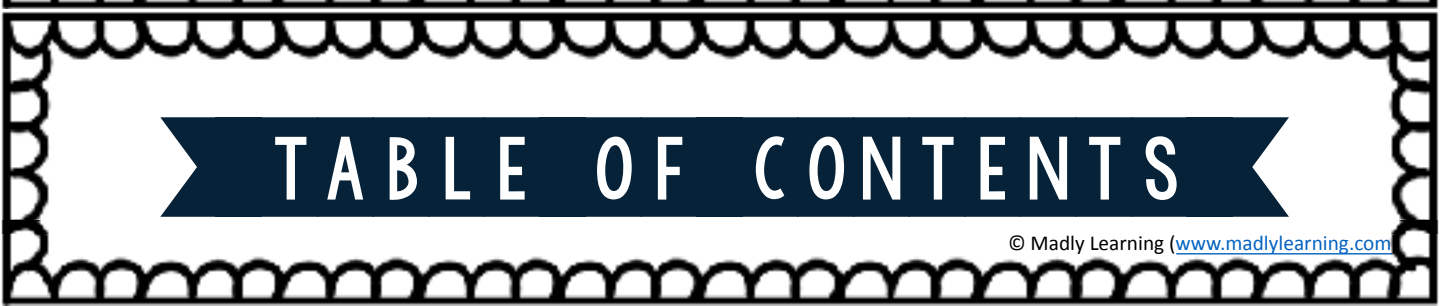












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Lesson Plans and Handouts

Lesson #1

Combined Teaching Plan

Lesson One

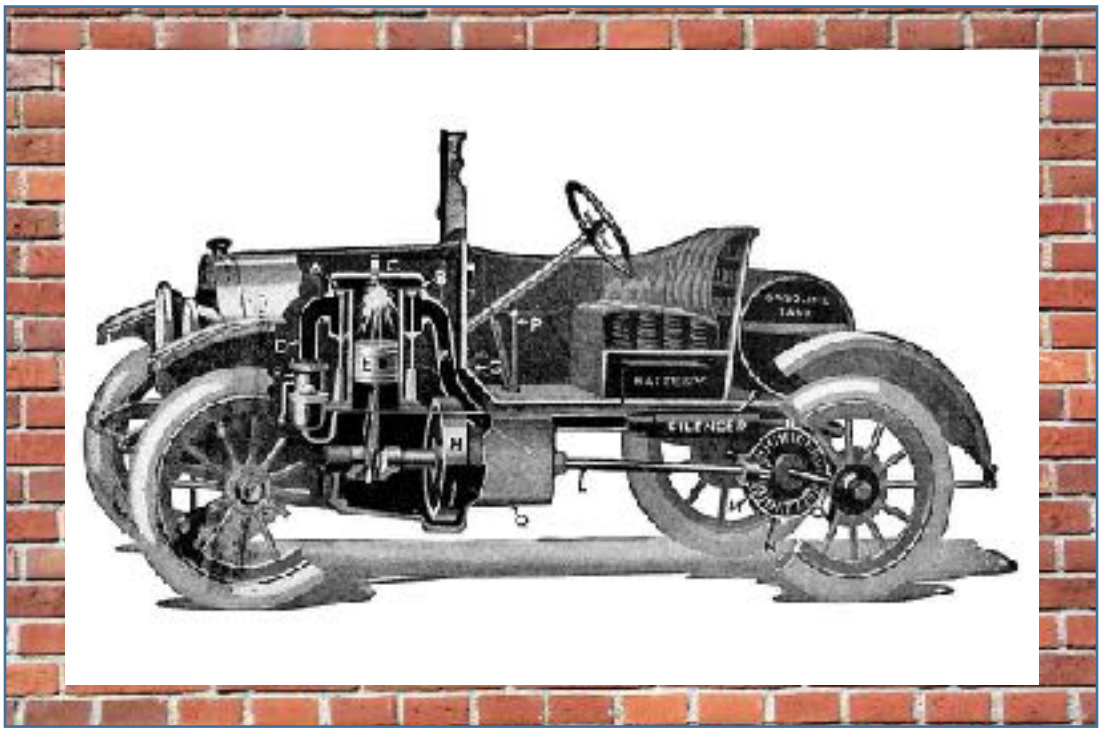
	First Half	Second Half
Prep	• Wonder Pictures • Wonder Walk Pages	• Wonder Pictures • Wonder Walk Pages
Grade 4	Wonder Wall • Have students join you in a knowledge building circle. • Students sit together and in the center of the circle you can place the pictures or any other objects/ artifacts that you may have that relate to this unit. • Students are to share their observations, wonderings, and questions. • Record students observations and questions.	Students will choose two of the pictures or objects and take them back to their work area and develop more in-depth questions, observations and wonderings about the objects that they see. These are recorded in a **Wonder Walk Page**
Notes	Take the pictures from the Wonderings activity and use these to put on a bulletin board. Collect the students Wonder walk pages and note some of their observations, background knowledge, and questions. Record some of these on the WonderNotes Pages.	

WONDER WALL 4

WONDER WALL 4

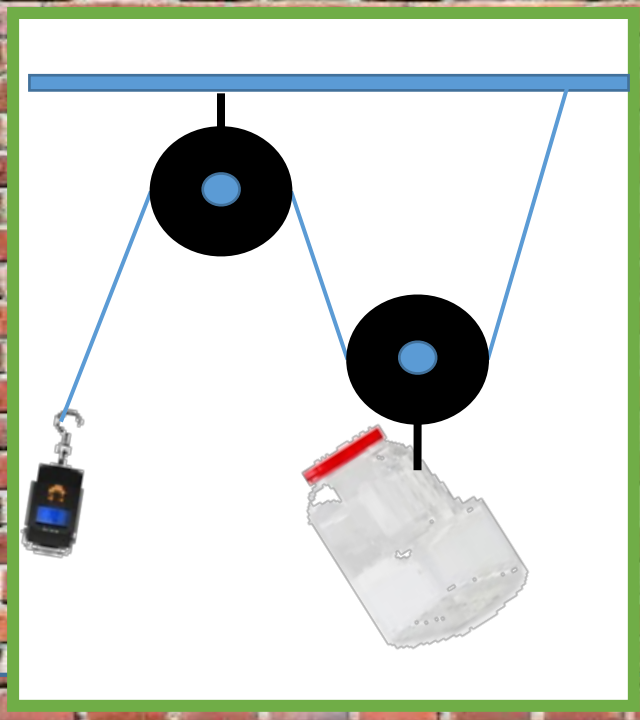
WONDER WALL 4

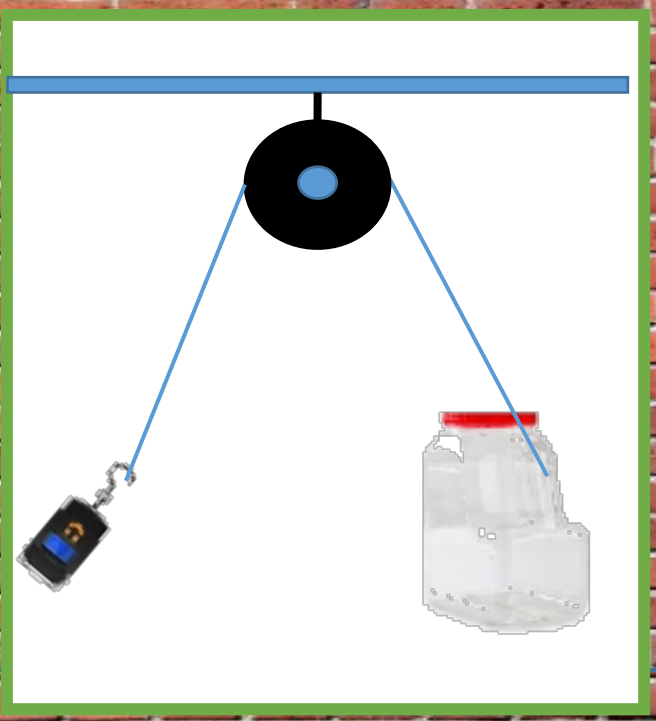
WONDER WALL 4

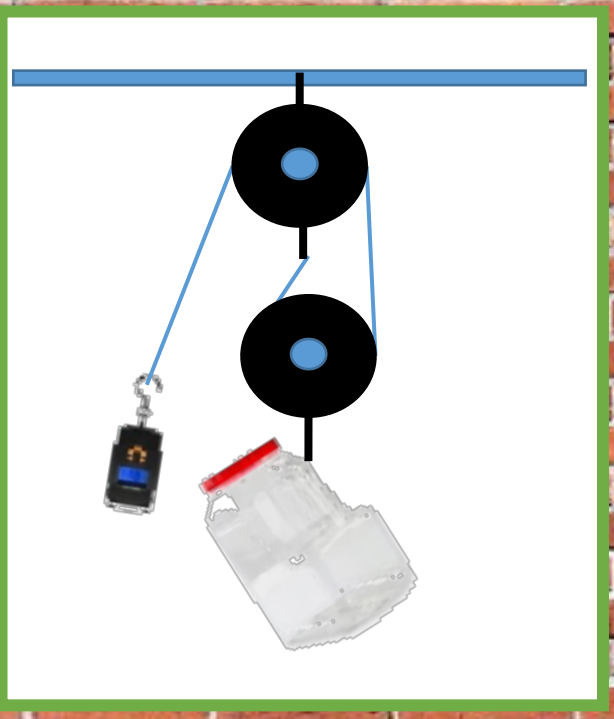


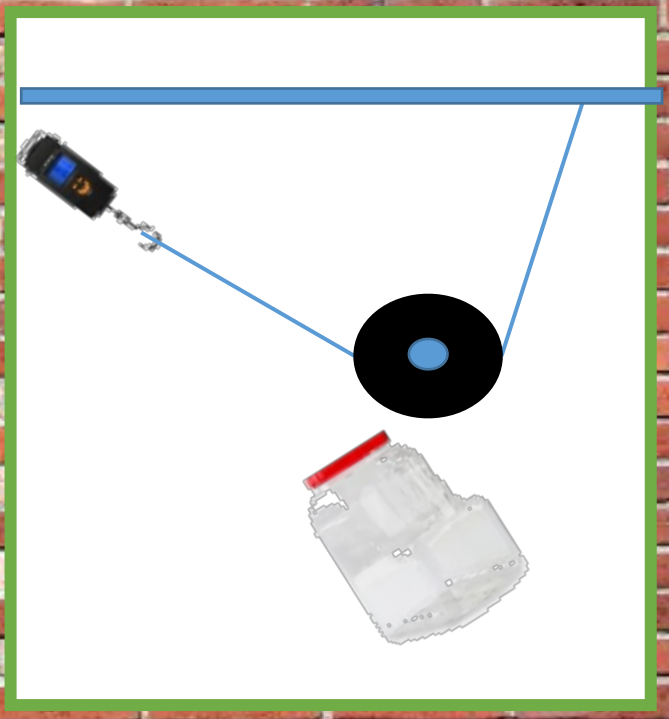
WONDER WALL 4

WONDER WALL 4









WONDER WALL 4

Mechanical Advantage	**Fixed and Movable**
Force	**Work**

WONDER WALL 4

Effort	**Conservation of Energy**
Worm, Spur, Bevel, Helical Pinion	**Speed**

WONDER WALK NOTES

I observe...




I know...




I think...




I wonder...




WONDER NOTES

WE ARE WONDERING

WE ARE WONDERING

WONDER NOTES

WHAT WE KNOW

WHAT WE KNOW

WONDER NOTES

WHAT WE THINK

WHAT WE THINK

WONDER NOTES

OBSERVATIONS

OBSERVATIONS

OBSERVATIONS

OBSERVATIONS

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Lesson Plans and Handouts

Lesson #2

Combined Teaching Plan

Lesson Two

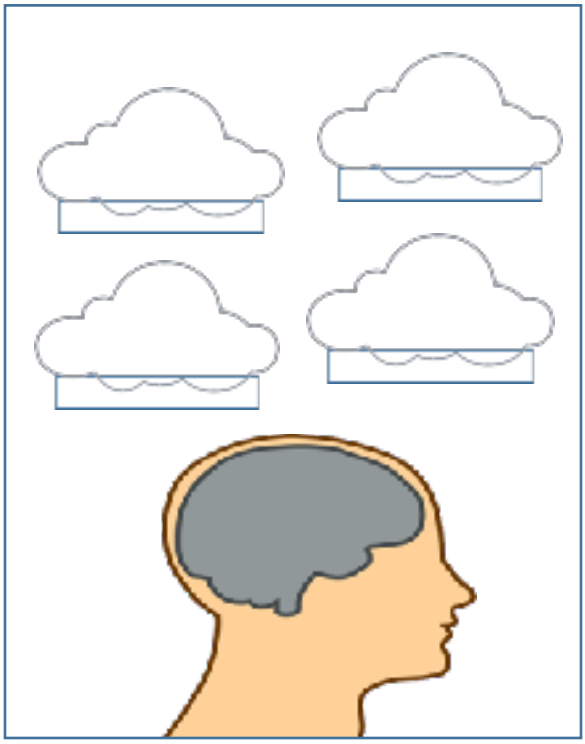
	First Half	Second Half
	Preview their Wonder Walk pages to determine the students understanding of pulleys and gears.	
Grade 4	Allow students time to share what they wondered about at the end of the previous lesson. 1. Review some of the vocabulary cards and ask students what they mean. (See Notes) 2. 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?	Students will brainstorm though their interactive notebook activity (Think About It – Brainstorm) Students will follow the instructions on the instruction page then cut out the items needed and glue in their notebook.
Notes	When reviewing the photos and especially the words the tendency is to give students the 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.	

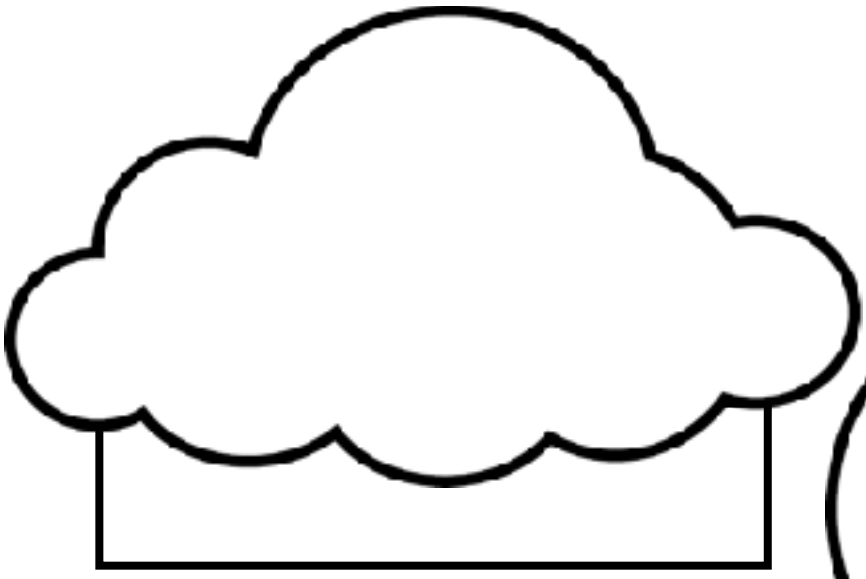
BRAINSTORM 4

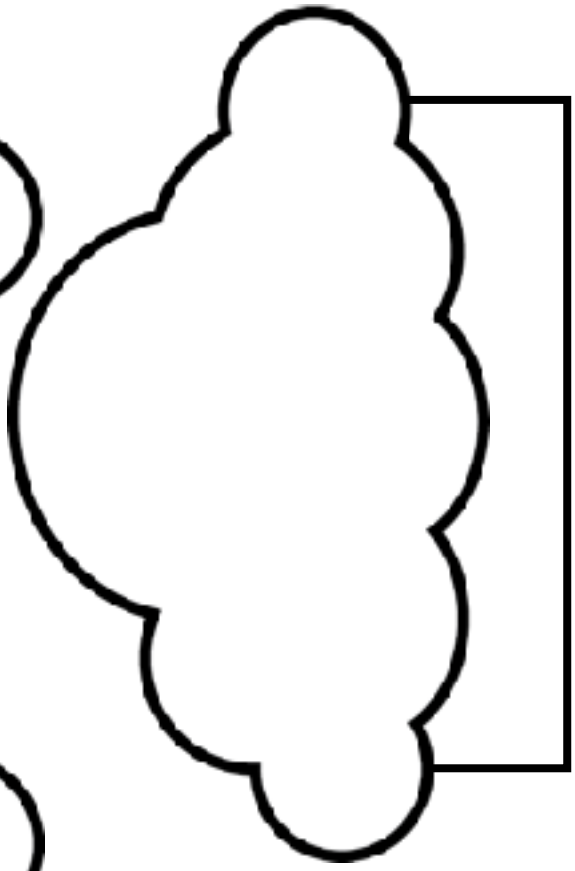
INSTRUCTIONS

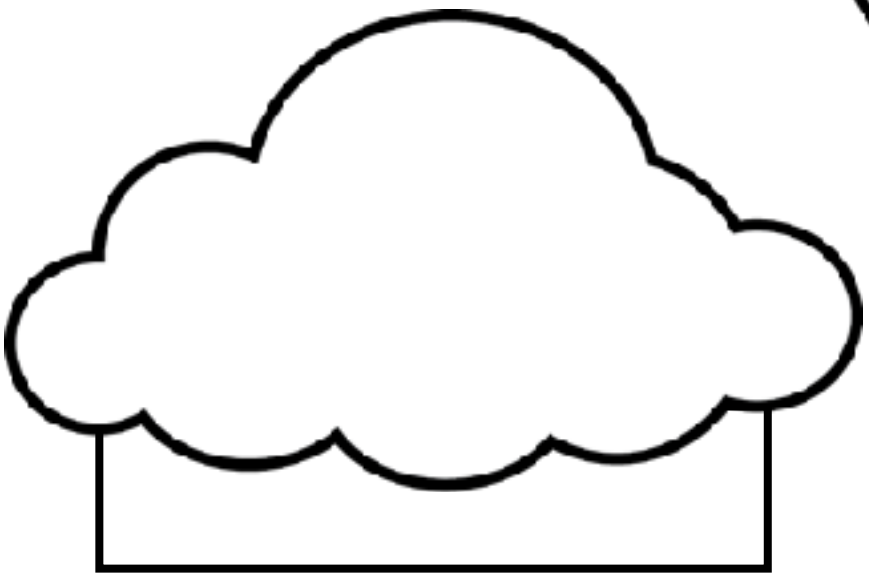
Interactive Notebook Page:

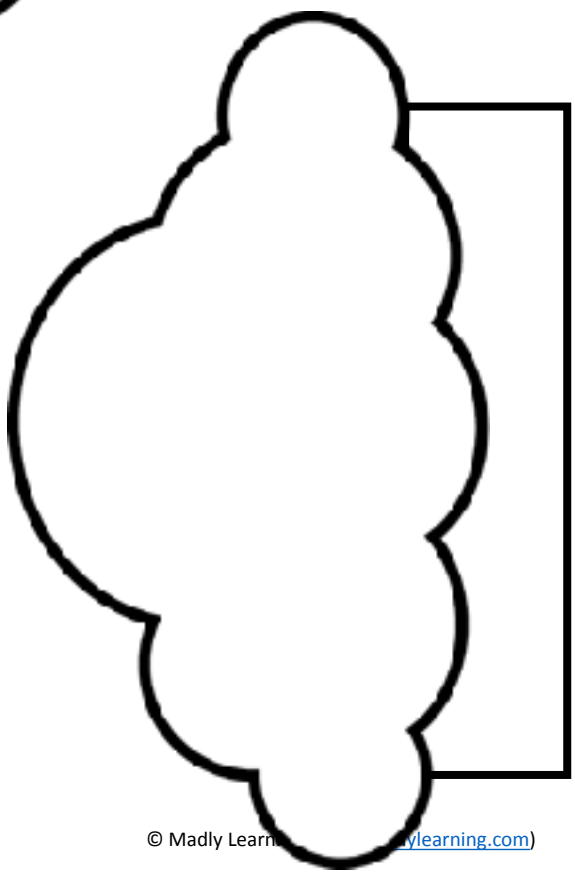
1. Inside the brain: Write the answer to the question. **Why do we need Pulleys and Gears in our lives?**
2. Draw an example of a pulley or gear in your daily life that was discussed in class on the outside of the cloud.
3. Cut out the items and glue it into your interactive notebook. Glue only on the 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.











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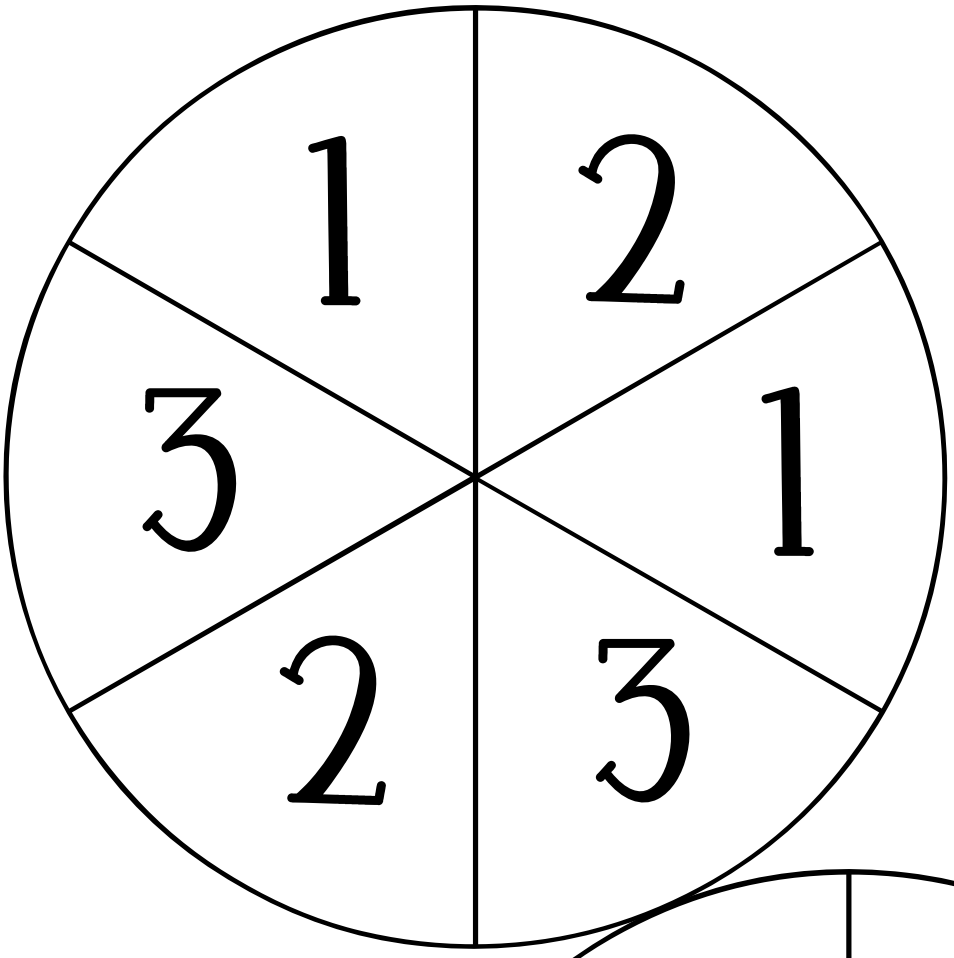
Lesson Plans and Handouts

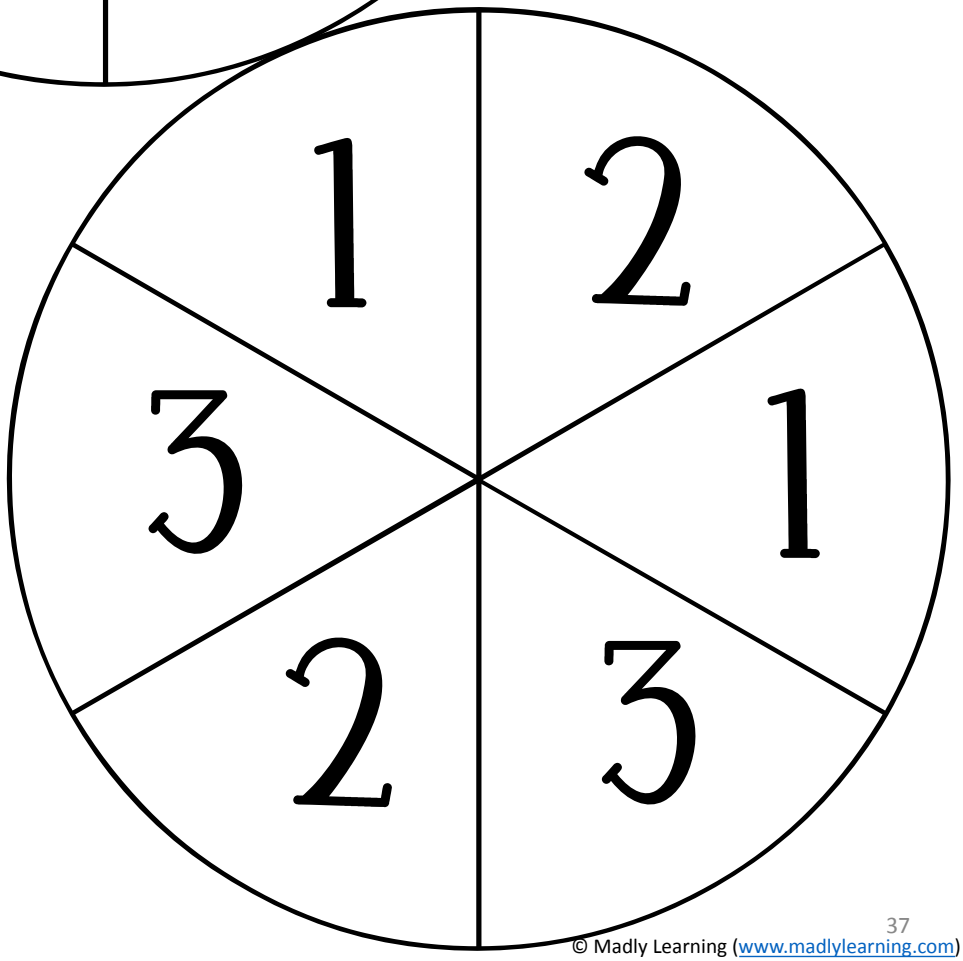
Lesson #3

Combined Teaching Plan

Lesson Three

	First 20 min	Second 20 min
Prep	• Student Reading for Pulleys • Technology for Viewing Video • Pulleys game board and playing pieces.	
Lesson	Students will read about pulleys and 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=aMx7nIlH9ik	Students will apply what they learned about pulleys to complete the pulley game. Students can either work in small groups or as a large group.
Notes	Game Instructions: Students will each have a marker. They will start with their marker on the start box. Students will spin the spinner. If they answer the question correctly they will move forward the number of spaces. If they answer the question wrong they move back the number of spaces that they spun.	





Background Information

Pulleys can…

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

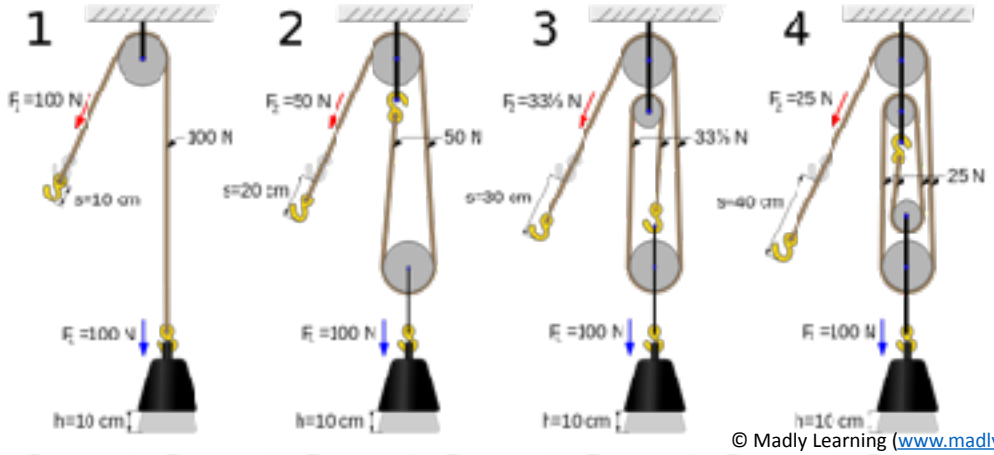
What is a Pulley

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.

More Pulleys = Less Force Required to Lift Object
More Pulleys = Longer Distance to pull object.



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

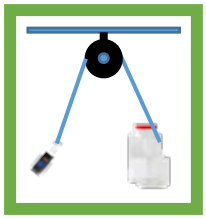
A pulley is a wheel that has a cable wrapped over it. It is used to help lift an object. We use pulleys to easily lift objects. When you use pulleys you can reduce the amount of force or work that you need to lift heavier objects.

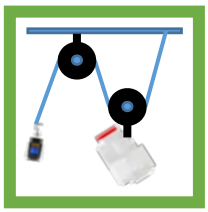
Mechanical Advantage

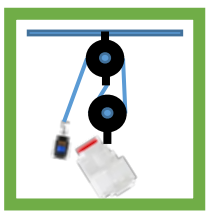
Mechanical advantage means that by using a simple machine you have made your work easier. With pulleys the mechanical advantage describes the amount of force and effort that you save when lifting an object. The more pulleys you use the better your mechanical advantage because you need less effort to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

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.

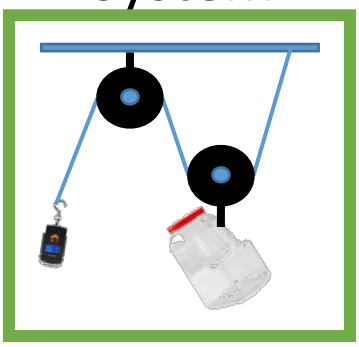
Answer: B

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

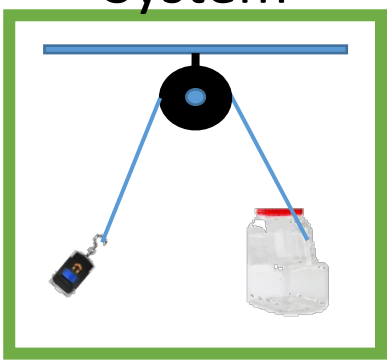
Name this Pulley System



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

Answer: C

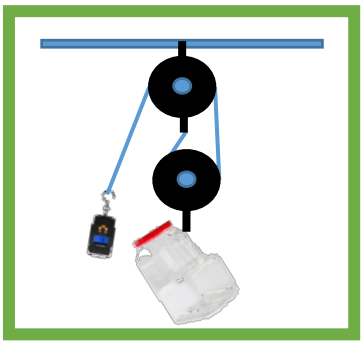
Name this Pulley System



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

Answer: A

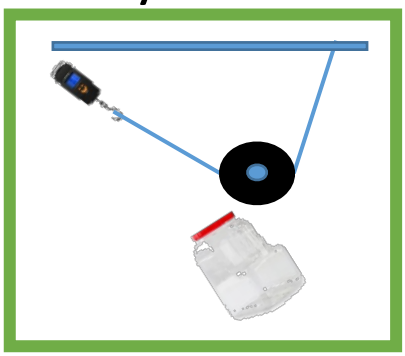
Name this Pulley System



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

START

FINISH

SCIENCE

Lesson Plans and Handouts

Lesson #4

Combined Teaching Plan

Lesson Four

	First Half	Second Half
Prep	• Following Materials (tape, straws, popsicle sticks, dowel, spool of thread, eraser-weight, cardboard base)	
Grade 4	Students make a simple pulley system. Give students 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.	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?
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 Foldable

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

SCIENCE

Lesson Plans and Handouts

Lesson #5

Combined Teaching Plan

Lesson Five

	First Half Second Half
Prep	This Lesson can be combined as both groups of students need to investigate the load and mechanical advantage of different mechanisms.
Every one	**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 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 complete a science experiment page.
Notes	**<u>Extension activities</u>** 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

Tug 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

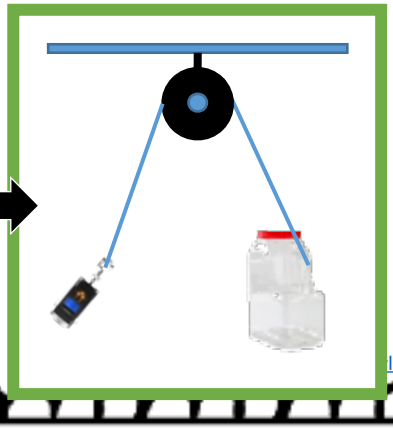
Making a Single Pulley System

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 to 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 students 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



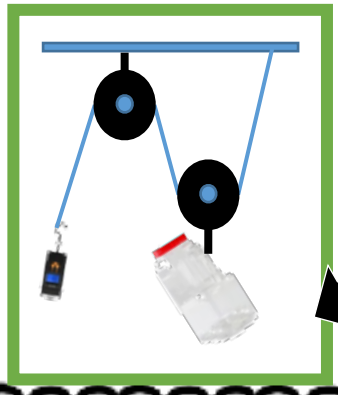
EXPERIMENT 5C

Making a Double Pulley System

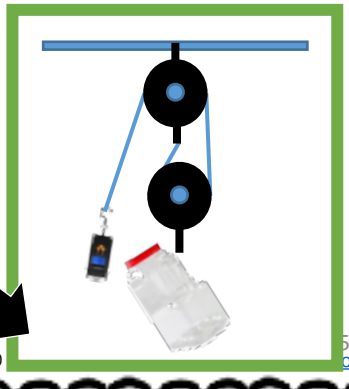
Materials:

- 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 different 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

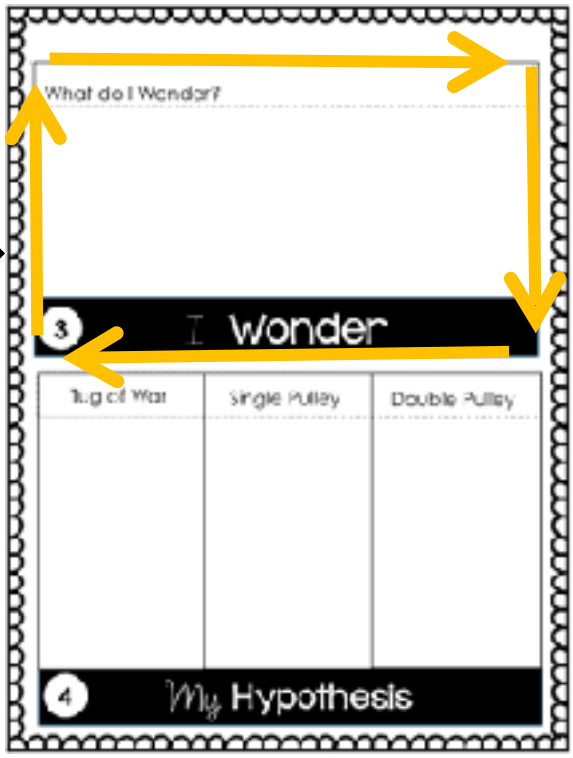


Science Experiment

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

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

SCIENCE

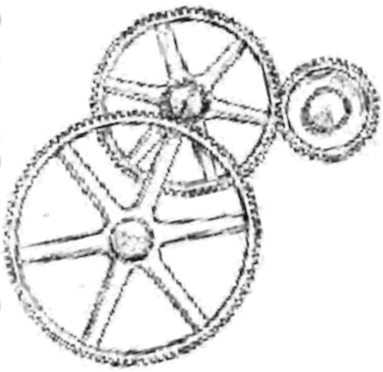
Lesson Plans and Handouts

Lesson #6

Combined Teaching Plan

Lesson Six

	First Half	Second Half
Prep		
Grade 4	What is a Gear Students can read the article provided or watch the video links below. • Students watch the video • https://www.youtube.com/watch?v=cPG15KqbtII&index=4&list=PL6srG0mlmRVS86KJ38msNPljcED9r4Ff7 Play this game • http://www.smart-kit.com/s5042/connect-it-gear-game/	Use a kit of gears such as this one found on Amazon or make some gears out of cardboard using the template provided http://www.amazon.com/Kinds-Plastic-Shaft-Single-Double/dp/B00SKD8Q1Y/ref=zg_bs_166103011_13 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.
Notes		



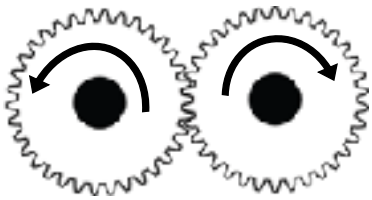
What is a GEAR

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.

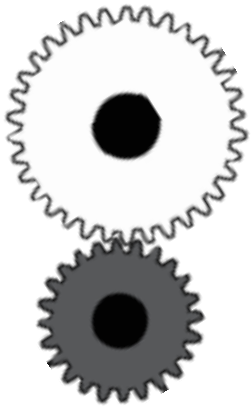
How they work

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.



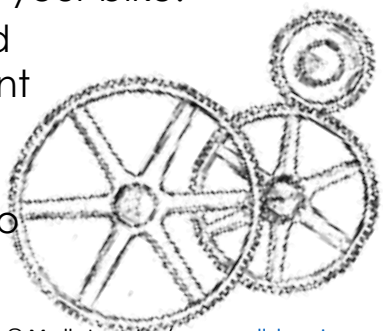
Using force and effort to turn this gear

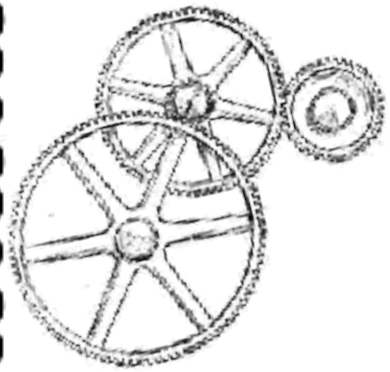


Increases speed of this gear because it will rotate more quickly

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.

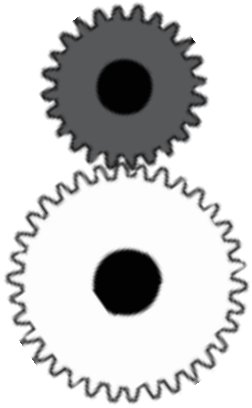




What is a GEAR

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



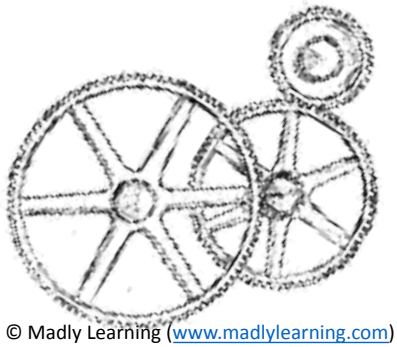
Increases the force needed to turn the larger gear.

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

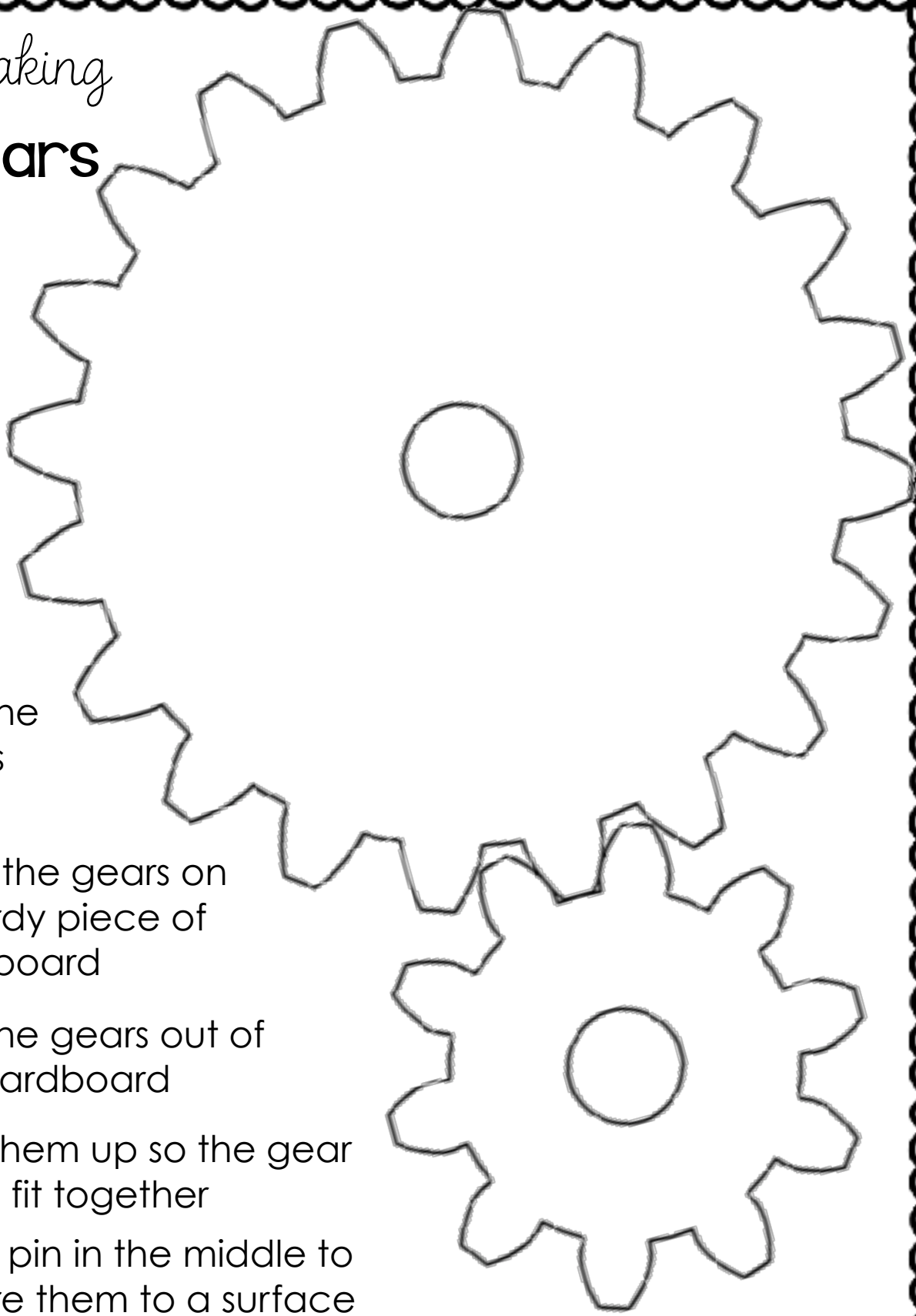
Gears are used in many machines. Including spinning rides at the carnival, wind turbines, and even your washing machine.

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

SCIENCE

Lesson Plans and Handouts

Lesson #7

Combined Teaching Plan

Lesson Seven

	First Half	Second Half
Prep	• Print pages for students to read • print cards for students	
Grade 4	Learn about different types of gears and their application in real life situations.	Match gears with a definition and some pictures of real world applications.
Notes		

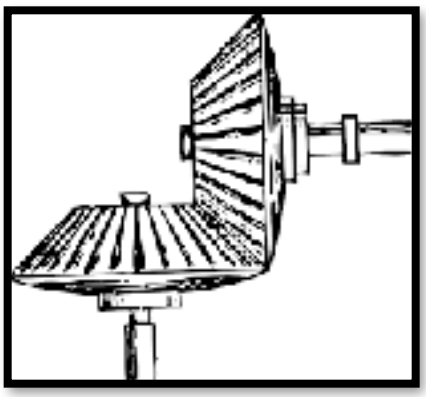
Types of GEARS

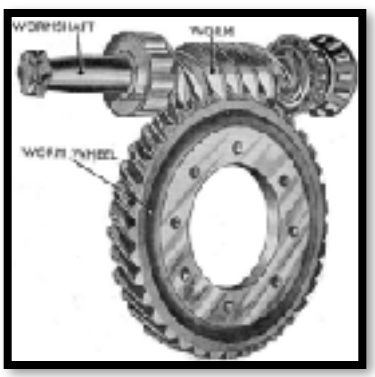
Spur Gears

These gears 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 a 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.

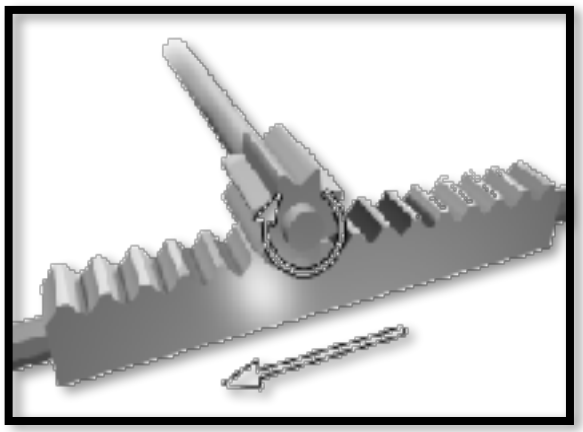
Types of GEARS

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

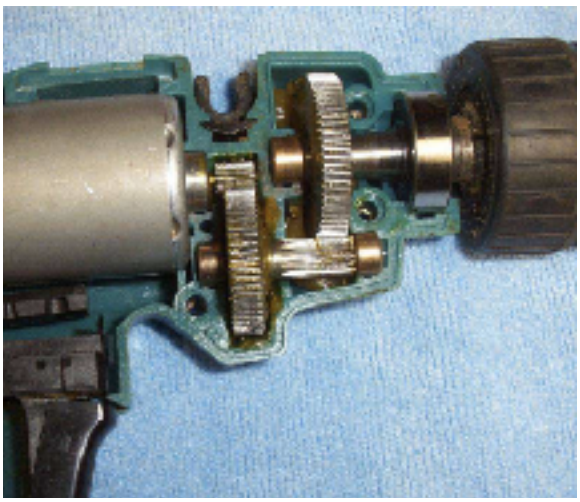
Name this type of gear.

Bevel Gear

Name this type of gear

Bevel Gear

Name this type of gear



Spur Gear

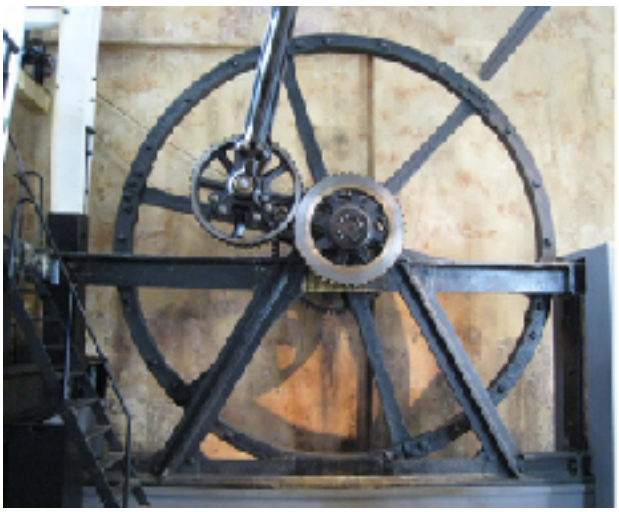
Name this type of Gear

Rack and Pinion

Name this type of gear.

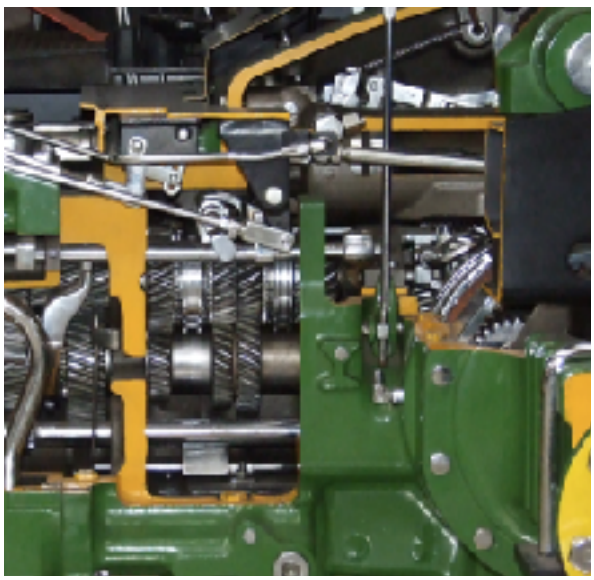
Rack and Pinion

Name this type of gear



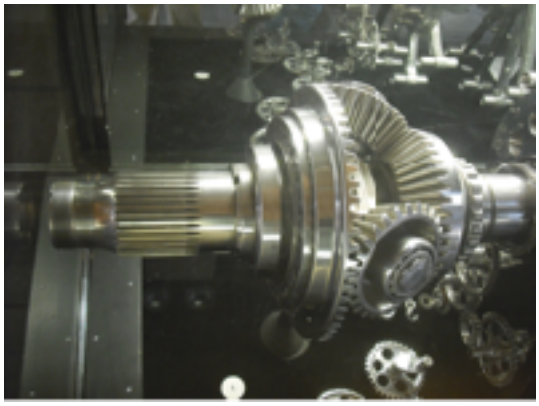
Spur Gear

Name this type of gear



Helical Gears

Name this type of Gear

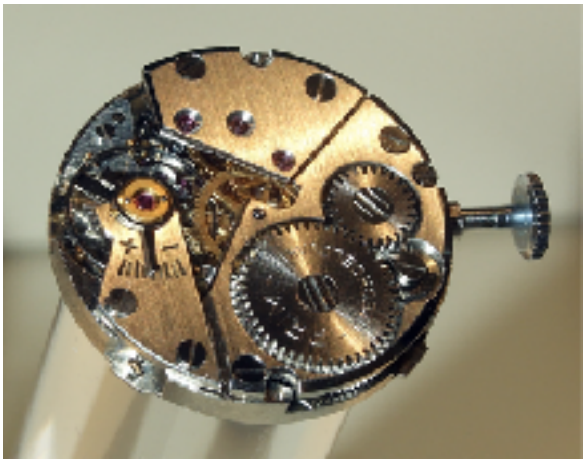


Bevel Gears

Name this type of gear.

Spur Gears

Name this type of gear

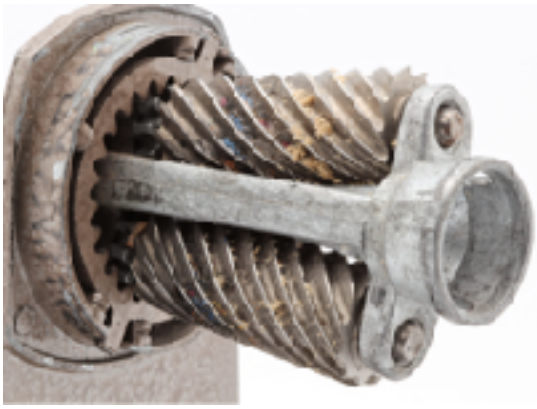


Spur Gear

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

SCIENCE

Lesson Plans and Handouts

Final Task

Combined Teaching Plan

Final Task

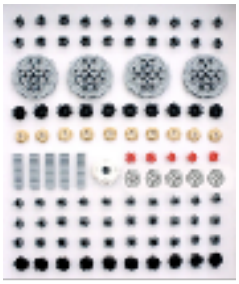
	First Half	Second Half
Prep		
Grade 4	Students will choose a familiar object or part of an object that uses a pulley or gear They will investigate this product and learn how the pulley or gears operate to make this product work. (If Available – Highly recommended) students will use gear and pulley manipulatives to recreate this pulley or gear system. Gear manipulatives can be purchased through Amazon Assessment Students will then demonstrate this to you and explain how it works.	
Notes		

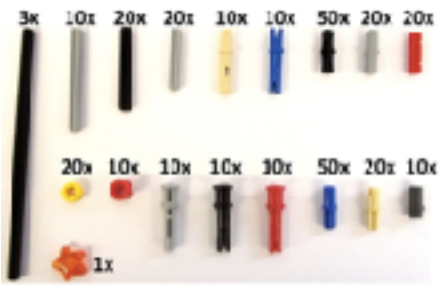
4th Grade

Suggested Resources

If you have a school budget to buy supplies I 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

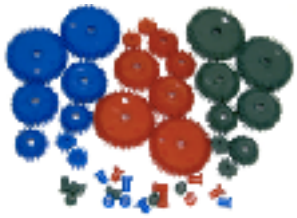
These are the three kit components you would need for your class to build gear sets. (Gears, Pins and Axles, and Beams with Holes) Make your own Set Below would be about $88 on Amazon.com





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?

Final Project
Pulleys & Gears

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?

Final Project
Pulleys & Gears

Ideas and Links For Student Research

https://goo.gl/4RM7qg

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)

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

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

s 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: 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: _____

her Conference # 1

ompleted and tested
pe. Please answer these
ions and see you teacher to
discuss your answers.

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.. .

her Conference #2

ays that you could
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.