SCIENCE

Forces Acting On STRUCTURES

Junior 3-5

Inquiry Based Unit


Forces
Acting On
STRUCTURES

Introduction

Dear Teacher,

Thank you very much for downloading this unit teaching plan for Forces Acting on Structures. 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 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

Read each grade horizontally.

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

The other black text is independent tasks

Lesson One

	First Half	Second Half
Prep	• Wonder Pictures • Wonder Walk Pages	• Wonder Pictures • Wonder Walk Pages
Grade 4	Wonder Walk • 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 the 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 tnerships while you teach the other oup.	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 WonderNotes Pages. Assessment: Judge students on their prior knowledge of this topic and interest and engagement in different pict s. For instance my students were very interested in bridges and elevat r buildings and bikes.	

Extra information, suggestions or extension activities.

Grade 5
Curriculum Links

Gr. 5 Forces Acting on Structures	1	2	3	4	5	6	7	F
Analyze the effects of forces from natural phenomena on the natural and built environment						x	x	
Evaluate the impact of society and the environment on structures and mechanisms, suggest ways in which structures and mechanisms can be modified	x	x	x					x
Follow safety procedures				x	x			x
Measure and compare quantitatively and qualitatively the force required to move a load using different mechanical systems a				x		x	x	x
Use scientific inquiry/ research skills to investigate how structures are built to withstand forces.			x	x		x	x	x
Use technological problem solving skills.				x				x
Use appropriate vocabulary.	x	x	x	x	x	x	x	x
Identify internal forces acting on a structure				x				x
Identify external forces acting on a structure and describe their effects on the structure using diagrams						x	x	x
Explain the advantages and disadvantages of different types of mechanical systems			x		x			
Describe forces resulting from natural phenomena that can have severe consequences for structures in the environment.			x			x	x	

5th Grade

Common Core and NGSS

Grade 4: Pulleys and Gears	1	2	3	4	5	6	7	F
READING STANDARDS								
CCSS.ELA-LITERACY.RI.5.3 Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.			X	X		X		X
CCSS.ELA-LITERACY.RI.5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.	X	X	X	X	X	X	X	X
CCSS.ELA-LITERACY.RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.			X	X		X		X
CCSS.ELA-LITERACY.RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.			X	X		X		X
CCSS.ELA-LITERACY.RI.5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4-5 text complexity band independently and proficiently.			X	X		X		X
WRITING STANDARDS								
W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-3		X	X	X		X		X
W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (3-5-ETS1-3)	X		X	X	X	X	X	X
W.5.9 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			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			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

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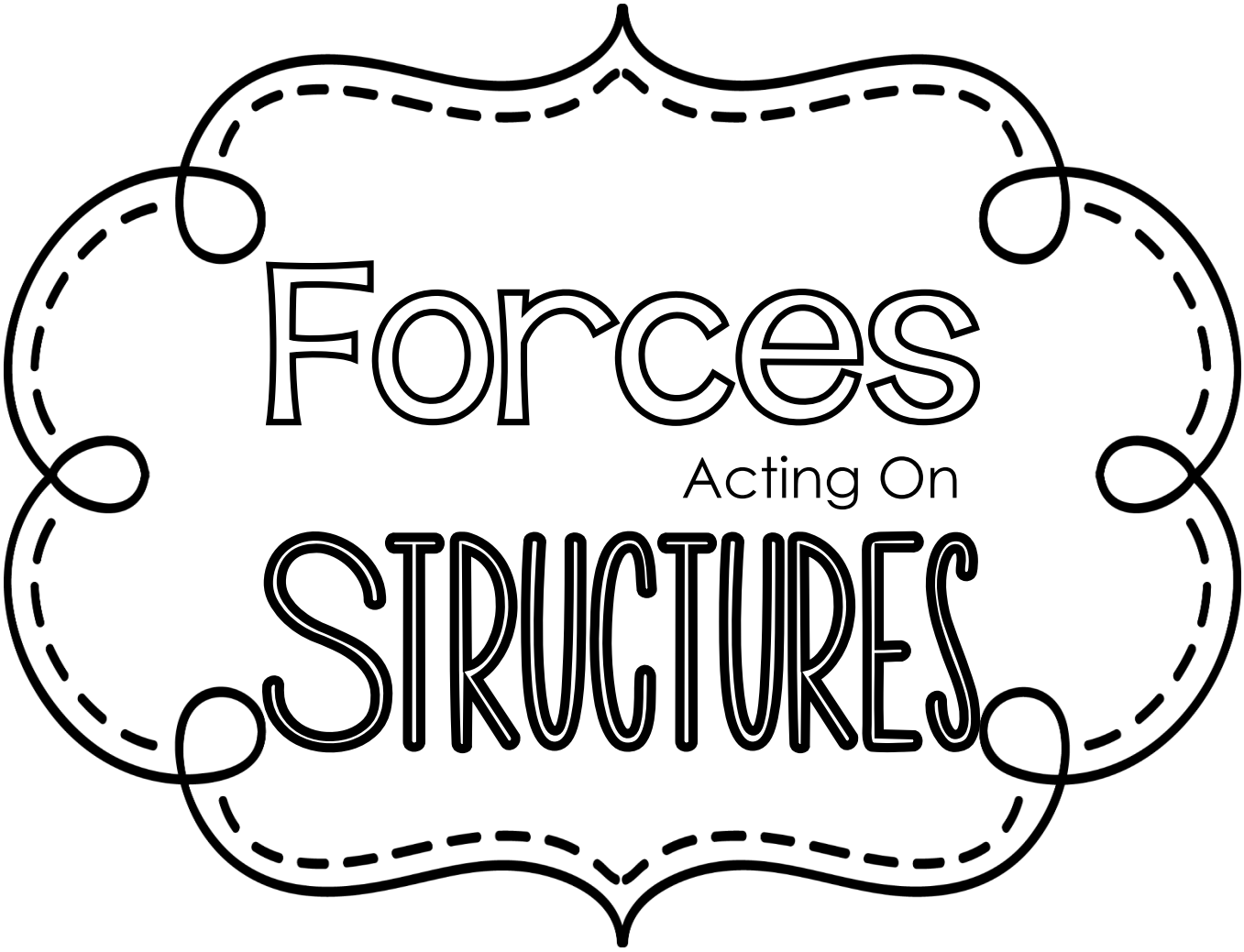

Name: _____

Room: _____

Grade 5
Forces Acting on Structures

LINK TO LIVE BINDER RESEARCH FILES

bit.ly/ML-forces

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

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

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SCIENCE

Lesson Plans and Handouts

Lesson #1

Teaching Plan

Lesson One

	First Half	Second Half
Prep	• Wonder Pictures • Wonder Walk Pages	• Wonder Pictures • Wonder Walk Pages
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 WonderNotes Pages. 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 over buildings.	

WONDER WALL 5

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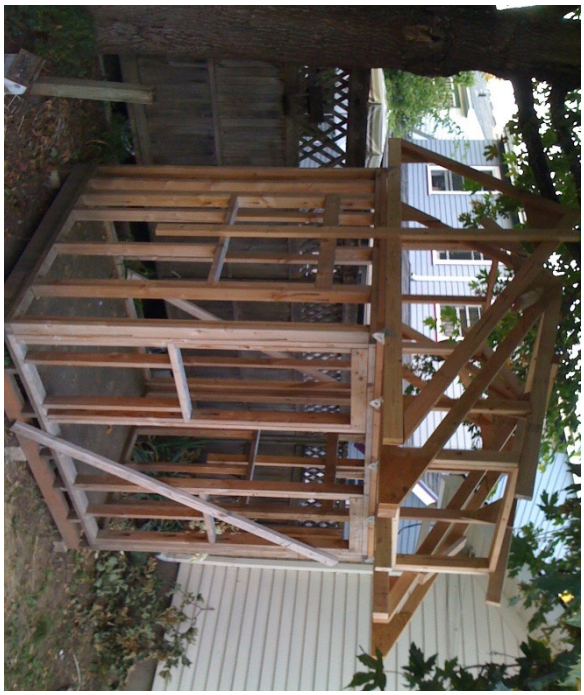
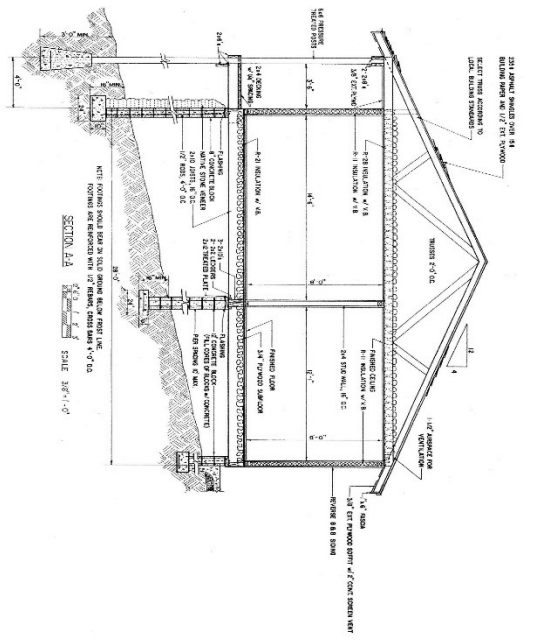
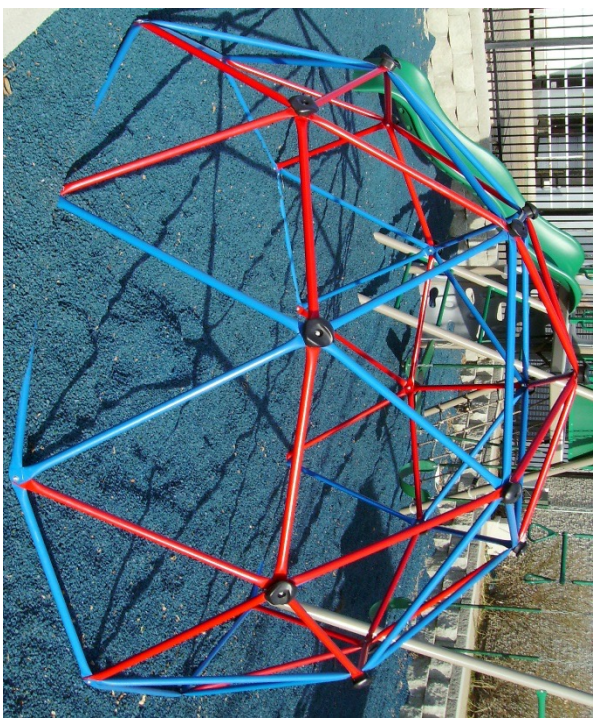
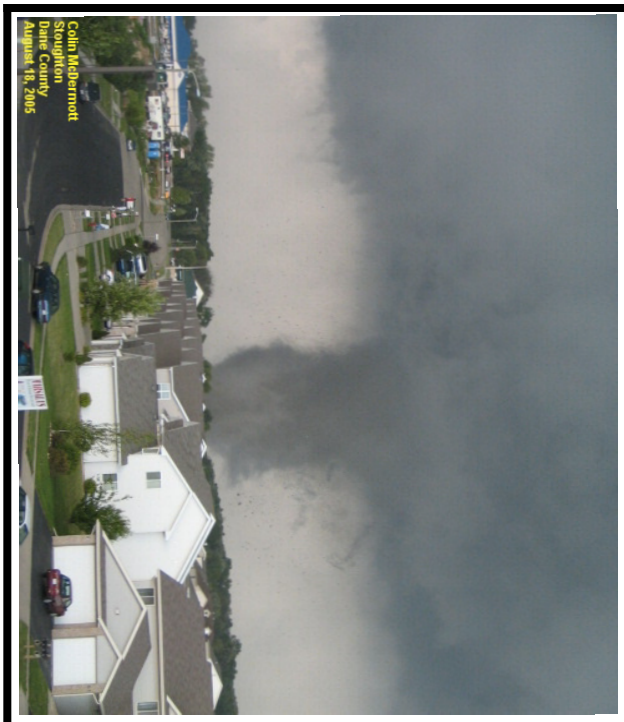
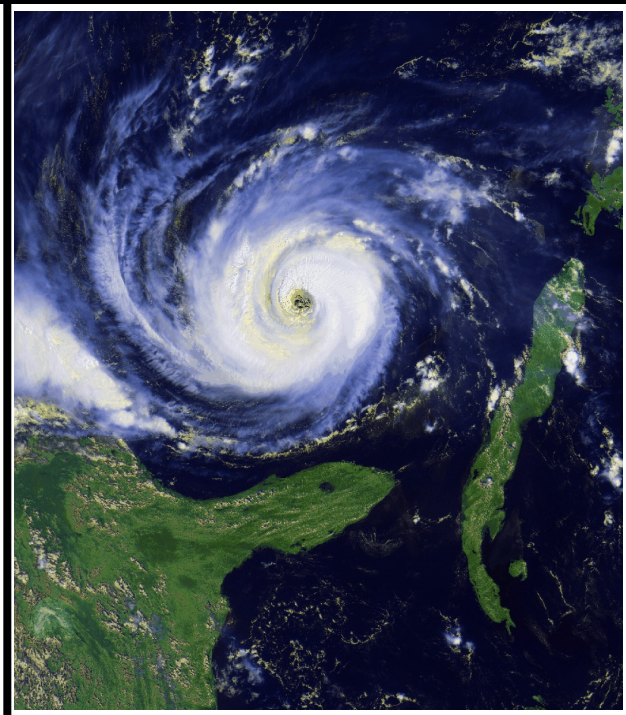






WONDER WALL 5





WONDER WALL 5

Tension and Compression	Loads
Types of Bridges B.A.T.S.	Forces

STRUCTURES

Questions

STRUCTURES

Questions

STRUCTURES

Questions

STRUCTURES

Questions

STRUCTURES

Answers

STRUCTURES

Answers

STRUCTURES

Answers

STRUCTURES

Answers

STRUCTURES

Questions

How many different types of bridges are there?

STRUCTURES

Questions

Why are there different gears on a bike?

SAMPLE

STRUCTURES

Answers

There are many different designs but most bridges are based on FOUR different types. The Beam Bridge, The Arch Bridge, The Truss Bridge, The Suspension Bridge (and the Cable Stayed Bridge)

STRUCTURES

Answers

There are different gears on a bike so that you can be more efficient when you pedal. You need different gear combinations for different jobs like going fast on flat land or saving energy when going up a hill.

WONDER WALK NOTES

I observe...




I know...




I think...




I wonder...



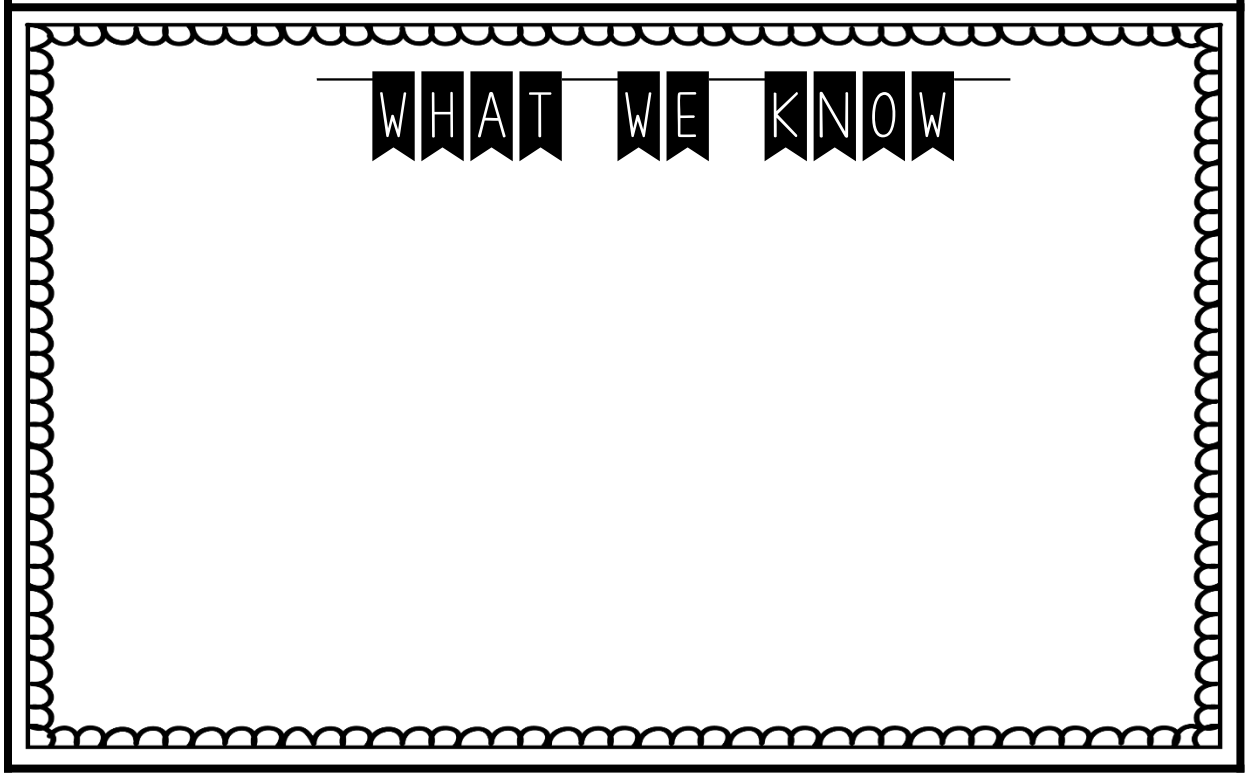

WONDER NOTES

WE ARE WONDERING

WE ARE WONDERING

WONDER NOTES

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

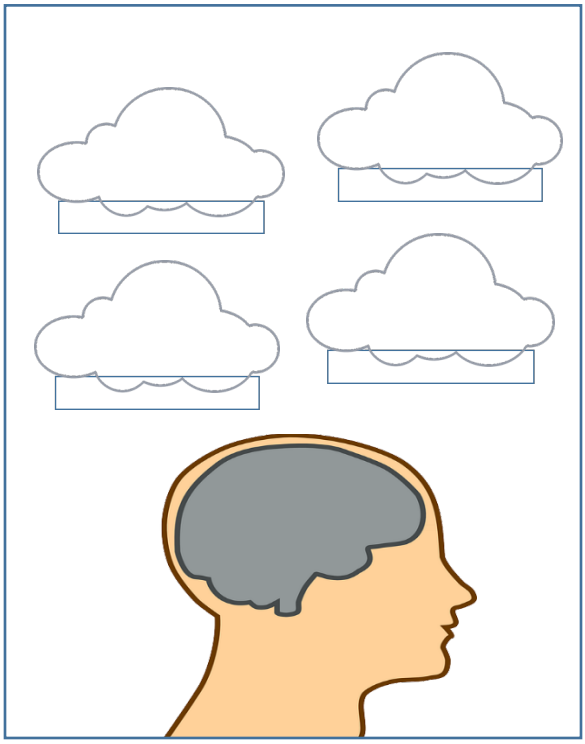
Lesson Two

	First Half	Second Half
	Preview their Wonder Walk pages to determine the students understanding of pulleys and gears.	
Grade 5	Students complete the brainstorm page. Identify strong and stable structures from around the classroom, in their homes and in the communities. Have them think of small, medium and large structures. Have them identify what makes them strong.	• Have students share their structures and review the size, how and why they are structures. • Discuss what makes them strong. • Make a list of the materials that they are made out of that make them strong. • Develop a definition of what is a structure?
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.	

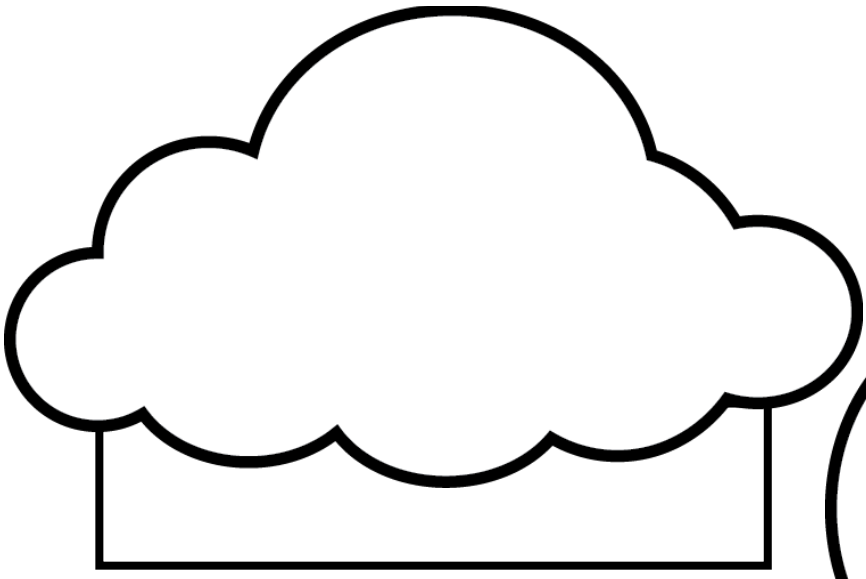
BRAINSTORM 5

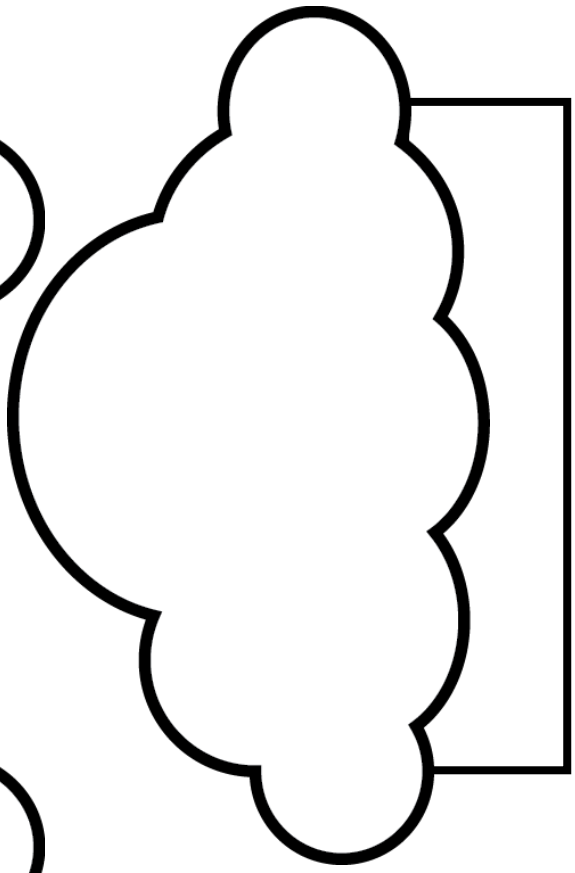
INSTRUCTIONS

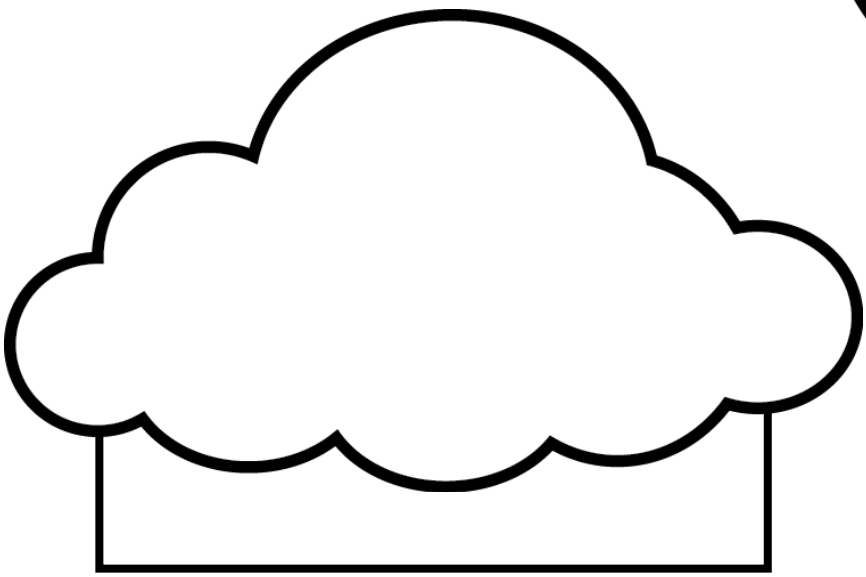
Interactive Notebook Page:

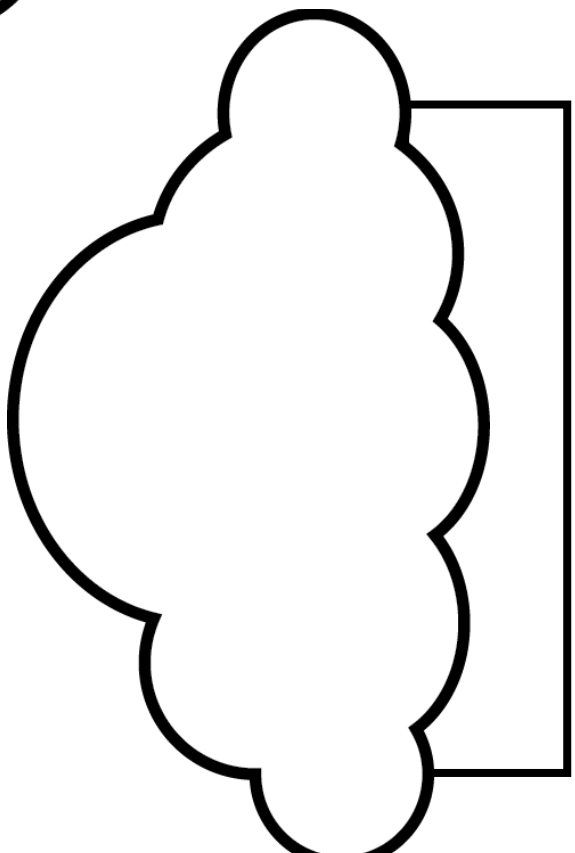


1. Inside the brain write the answer to the question. **<u>What is a structure?</u>**
2. Draw an example of a structure in your daily life that was discussed in class on the outside of the cloud.
3. Cut out the items and glue it into your interactive notebook. Glue only on the bottom tab so the cloud can be folded down.
4. Under the cloud identify what picture you drew and explain
    - What materials are used
    - Size, shape and construction









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Lesson Plans and Handouts

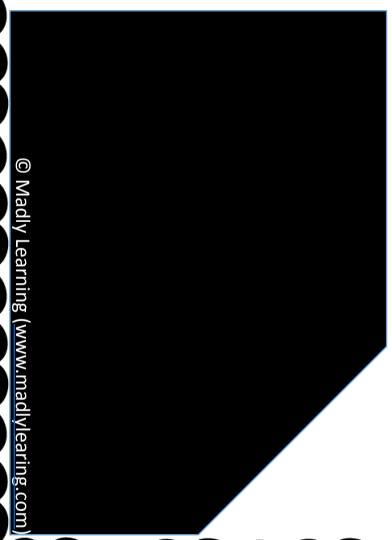
Lesson #3

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. • BATS bridges reading and notebook activity	
Grade 5	Students are introduced to four main types of bridges through the acronym BATS (Beam, Arch, Truss, Suspension) Students will read the article on bridges. Then they will complete the Interactive notebook activity on bridges.	Given the two abutments have students glue these in the their notebook then draw a bridge to connect these together. Students will be encouraged to draw a bridge that connects the two abutments together. Encourage them to draw a bridge that is inspired by bridges from their community or famous bridges that they are aware of. Students can begin to complete their Types of Bridges Reflection. (Will have time next lesson to review these)
Notes	Assess if students understand these concepts before moving on. Ensure they are able to see the difference between the different types of bridges. This is an important key learning that is built on for future lessons. Discourage students from creating lift bridges at this point.	

Draw a Bridge



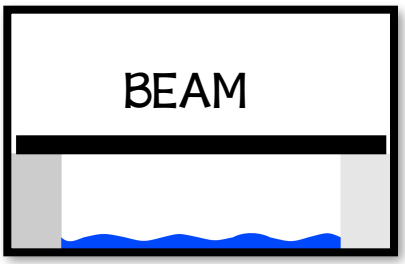
Draw a bridge that spans to each abutment. Use the information that you have learned so far about abutments and what you already know from your own experience to draw a bridge.

Types of Bridges

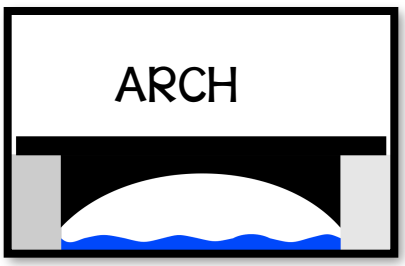
Pg #1

Bridges are an important structure. They help to connect us with each other and make travelling easier. Most bridges are based on 4 common styles. The Beam, The Arch, The Truss, and The Suspension Bridge. To remember these types of bridges we use the short form

B.A.T.S.



A beam bridge is the simplest type of bridge. It can be as simple as a log laid over a stream. However many beam bridges are made by laying multiple beams side by side across the structure then laying a deck on top. A beam bridge is not designed to span a large length however many segments of beam bridges can be combined with piers in the middle. The forces in a beam bridge take the weight of the beams and push straight down through the piers or abutments.



Arch bridges have been used for thousands of years. They were often used by the Romans. An arch bridge structure has a curve that allows forces to be carried all

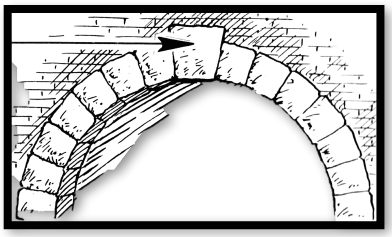
Types of Bridges

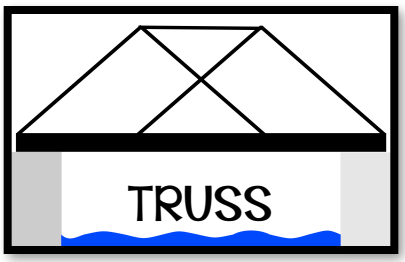
Pg #2

Vocabulary

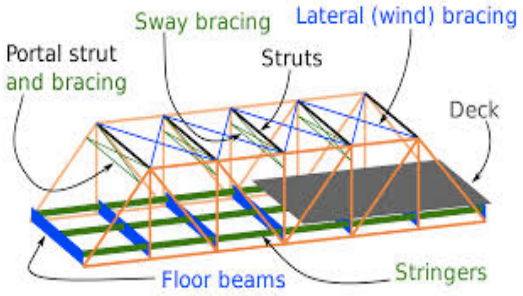
Abutment	Truss
Deck	Keystone
Forces	Cables
Support	Load
Compression	Tension

along the arch. The abutments hold the arch from spreading out by squeezing it together. The Keystone, is the middle piece and the part that keeps the arch strong. When building an arch bridge many supports are needed to hold up the bridge until the keystone is placed. The deck in an arch bridge can be on top of the arch or through the arch.





A truss bridge is like a beam bridge with some added supports. These connected supports are triangular in shape to help carry the load of the bridge. Every bar on a truss bridge is under tension and compression. Trusses can be located either above the deck, below the deck or both. There are many different designs of a truss bridge.

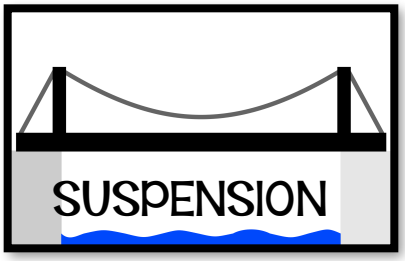


Types of Bridges

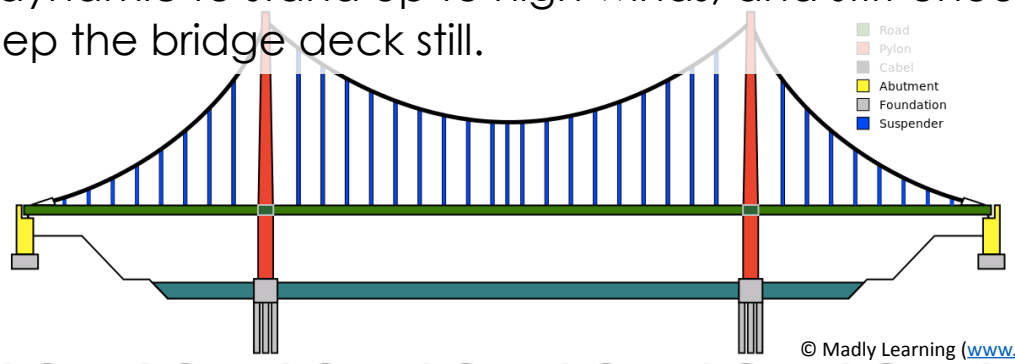
Pg #3

Think About It

1) Can you describe the similarities and difference between each type of bridge?
2) Where might you see each type of bridge
3) What type of bridge is most often used in the area you live? Why?



There are many famous Suspension bridges such as the Golden Gate Bridge in San Francisco. Suspension bridges are designed to span a large distance. They are especially helpful over water when you cannot get to the underside of the bridge. They are also better than other types of bridges in earthquake zones. Suspension bridges are made with a large thick steel cable stretched between towers. More cables called hangers join the suspension cable to the bridge deck. The tension and compression of the cables and the towers are very important to keep the bridge strong. However engineers must be very careful to make the bridge aerodynamic to stand up to high winds, and stiff enough to keep the bridge deck still.

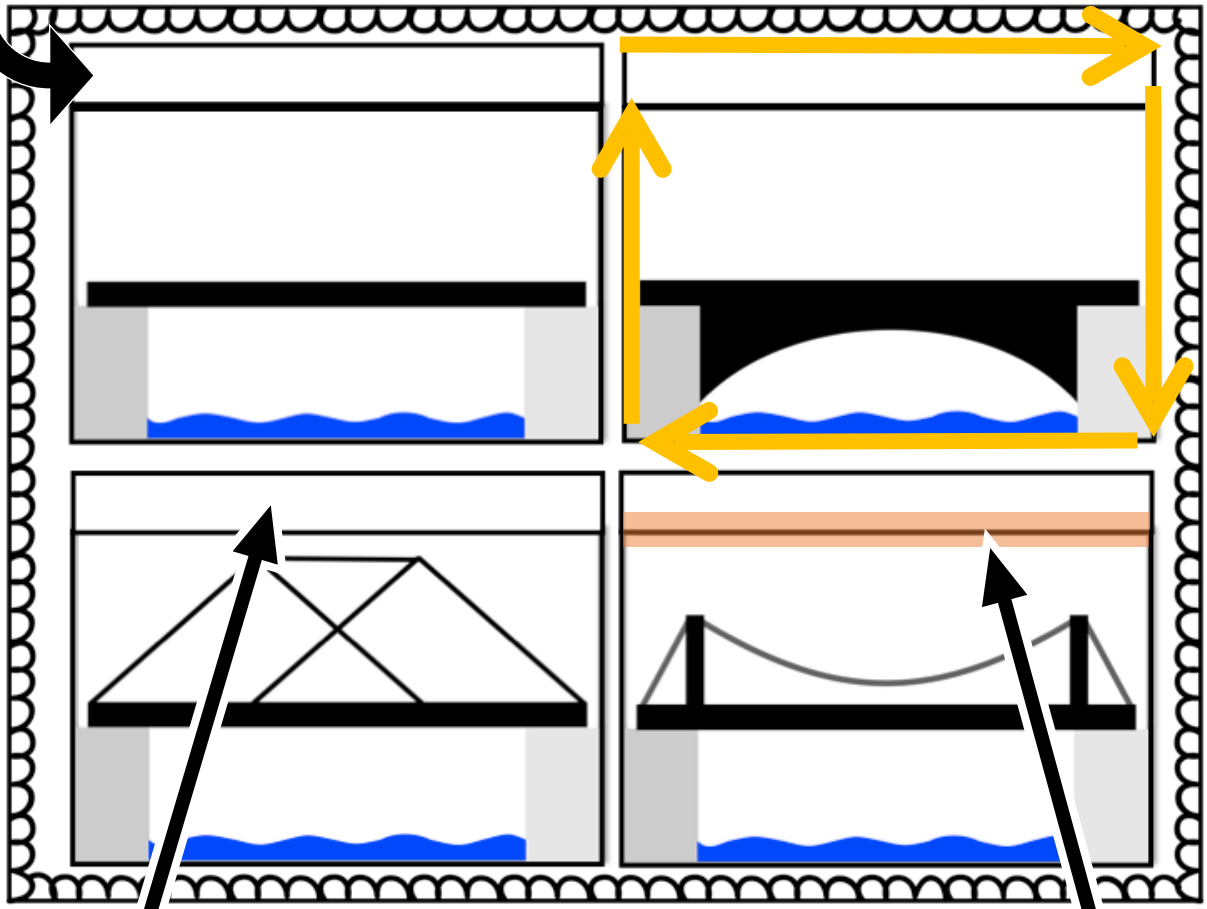


Reflection Instructions

Types of Bridges

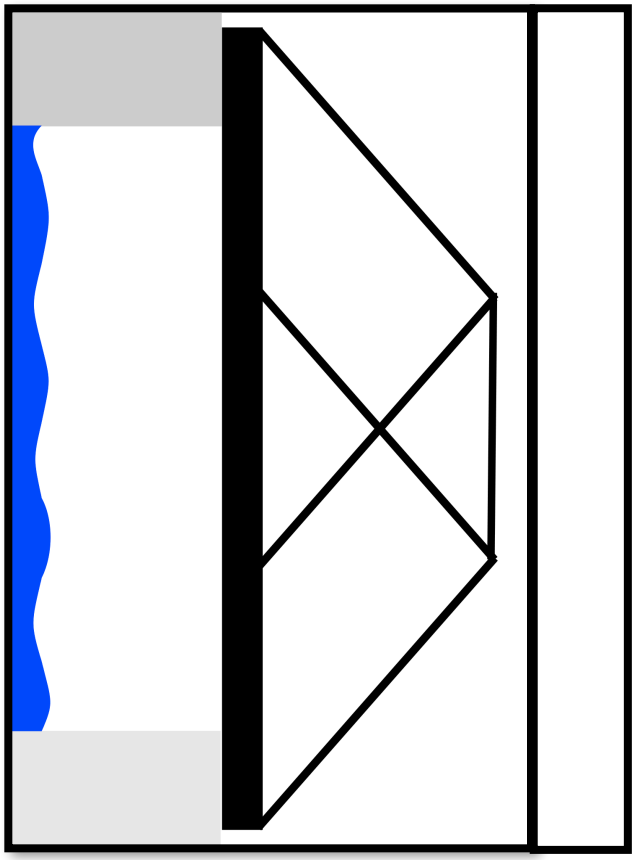
Label each type of Bridge

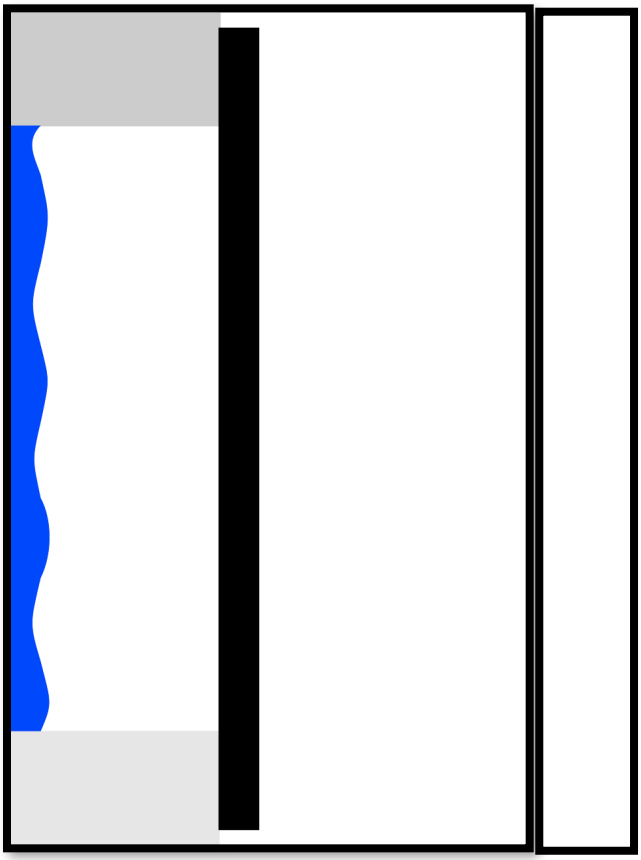
Cut around the outside of each box

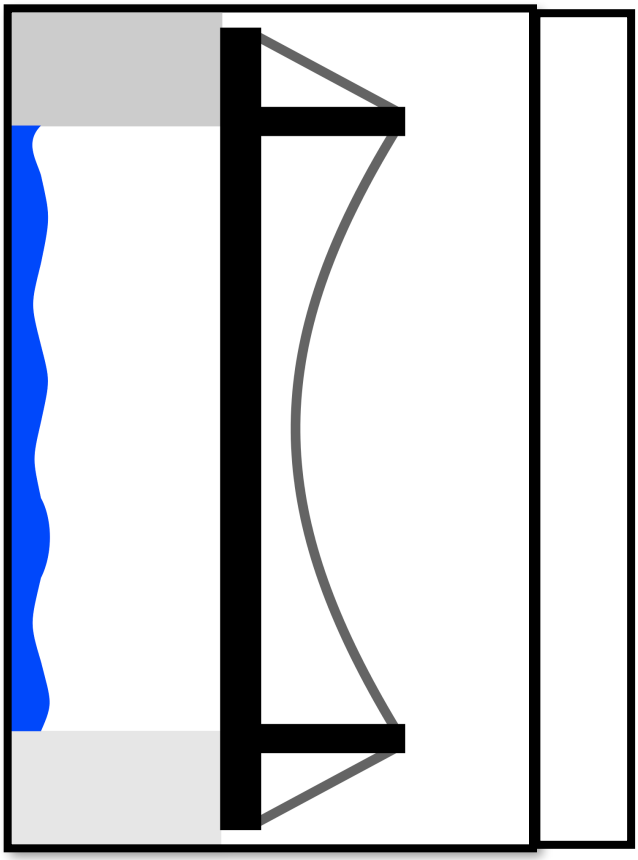


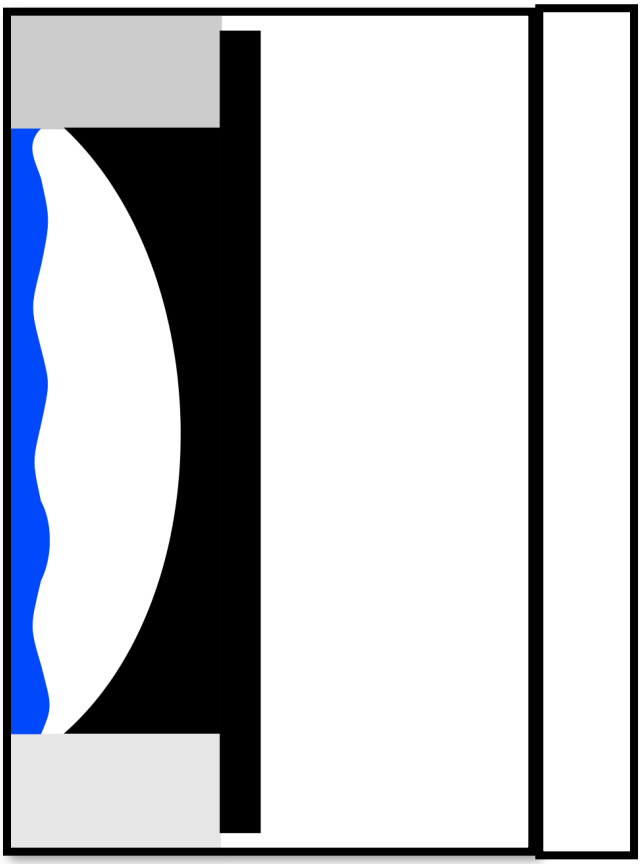
Put glue on the back of the top tab and glue it neatly in your notebook.

Fold the bridge up to the line and under the flap write 3 important facts you learned about each bridge.









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Lesson Plans and Handouts

Lesson #4

Teaching Plan

Lesson Four

	First Half	Second Half
Prep	• Following Materials (tape, straws, popsicle sticks, dowel, spool of thread, eraser-weight, cardboard base)	
Grade 5	Based on the previous lesson students will complete the interactive notebook activity on the four different types of bridges. Students will then read the Tension and Compression Reading before today's lesson begins	Students will investigate the difference between tension and compression. Students will conduct the following three experiments. After each experiment students will complete a reflection page. While students are working you can ask them the following questions. **Some Questions to Ask:** • Where can you see Compression and Tension on the sponge. • How could you make this stronger to withstand the tension and compression.
Notes	Classroom Connections: When discussing how to make the sponge stronger I had a student use his shoes as abutments and discovered that the sponge was stronger when the sponge sat on top of the shoes instead of in-between. Great discussion about the important role of a bridges abutments to withstand the transferred forces of tension and compression. **Additional Link for students to discover the properties of various building materials.** http://www.pbs.org/wgbh/buildingbig/lab/materials.html	

Tension and Compression

Tension and compression are are a type of force that affects structures and bridges. They are a way to describe how something bends. When something bends out of shape part of it stretches out(Tension) and the other part of it squeezes together (Compression).

Think of what your body would feel like if you did a back arch. Your back would feel squished together and your stomach would feel stretched out.

Tension:
A pulling force. The stretching of a structure. Like pulling a rubber band.

Compression
A pushing force. Making something shorter by squeezing. Like squishing a teddy bear.

Engineers need to know how different materials will stand up to these forces when designing structures. Some materials are considered elastic when they can resist both types of tension and compression forces. Steal is an example of an elastic material. However we often think of concrete as being a very strong material. Concrete is not elastic, it is brittle. It can stand up to a compression force but is much weaker when standing up to a tension force. Concrete does not stretch well. This is why it is important for Engineers to spread out (dissipate or transfer) the forces that are acting on structures. So that the structures that they are designing do not buckle (compression) or snap (tension).

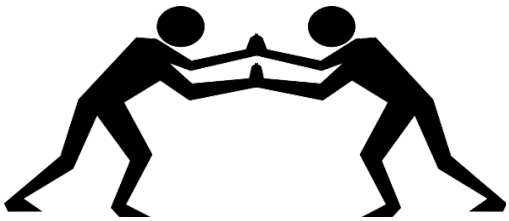
Tension and Compression

Experiment Description

A

Materials

- 2 people
- Space
- Review of safety guidelines



1) Stand facing your partner
2) Put your hands out in front of you at eye level.
3) Join hands with your partner palm to palm
4) Slow and carefully both you and your partner take a few steps back while leaning on your partner for support

Tension and Compression

Think About It

A

1) Describe how it felt while doing this experiment. Where and how did you feel pushing, pulling, weight, and force?

2) Does this experiment show and example of Tension or Compression? Explain.

3) Can you give three examples of this type of force used on objects from your daily life.

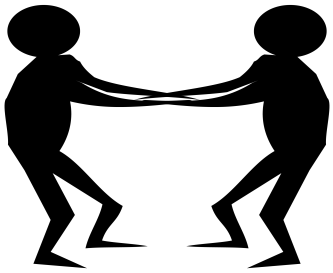
Tension and Compression

Experiment Description

B

Materials

- 2 people
- Space
- Review of safety guidelines



1) Stand facing your partner
2) Put your arms out in front of you at chest level
3) Lock your arms together by holding your partners wrist while they hold yours. Do this with each arm
4) Put your feet together and lean back.

Tension and Compression

Think About It

B

1) Describe how it felt while doing this experiment. Where and how did you feel pushing, pulling, weight, and force?

2) Does this experiment show and example of Tension or Compression? Explain.

3) Can you give three examples of this type of force used on objects from your daily life.

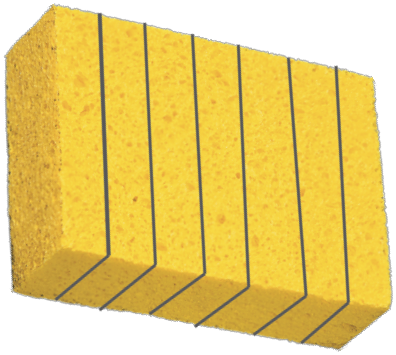
Tension and Compression

Experiment Description

C

Materials

- Sponge
- Marker
- Water



1) Using your Marker, draw a group of parallel lines (5-6) on both sides of the sponge. (see diagram)
2) Add a small amount of water. The squeeze any excess water out
3) Holding the sponge at the ends, bend it into an arch.
4) Look at the lines on the top and bottom

Tension and Compression

Think About It

C

1) Describe what happens to the lines on the top and the bottom of the sponge when you make and arch with it?

2) How is tension and compression affecting the lines on the sponge when you make an arch with the sponge?

3) Explain how this is similar to the tension and compression that affects a bridge or structure?

Tension and Compression Reflection Foldable

Question #1

First Draw and Write your answers to the questions

Question #2

Draw your experiment

Question #2

Reflection?
What did you learn?

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

Answer Key

Tension And Compression

1. Where can you see/feel Compression and Tension
   a) When the two students are pushing on each other this is an example of compression. The force and pressure of the weight of the students is compressed at their hands. Weight is also dissipated to their feet. Students should feel this activity in their feet and their hands. Note that if students are with a peer that is not the same size then the force exerted by the weaker student must compensate for the amount of force needed to equal the stronger partner.
   b) In the Pulling experiment B the students are pulling on each other which is an example of tension. The amount of tension between the partners must be equal to maintain stability.
   c) In the Sponge activity you see examples of both Tension and Compression. Looking at the lines of the arch created by the sponge. The top of the arch is being stretched down so the stretching motion is Tension. Students should see that the lines on the sponge are spreading apart or stretching. On the other side of the arch the opposite is true. The lines on the sponge are squishing together and compressing.

2. What could you change to make this stronger or more stable
   a) Both partners need to be pulling the same amount. Unstable partnerships are a result of one partner exerting more pushing force than another. Arches are only as strong as the support on each side. If the force is not equally distributed then the structure is no longer stable.
   b) Same as above. Both partners need to be pulling the same amount.
   c) If the sponge were the deck of a bridge then it would need to be reinforced. You would have to use materials that are stronger that could withstand more tension and compression forces. In a classroom students may suggest that they could use their ruler, pencils, toothpicks, or paperclips. They may also conclude that sponges are not the best material to make a bridge because they do not withstand the forces of tension and compression.
3. What are some real life examples
   a) Cars going over a bridge, hugging a stuffed animal, squeezing a ketchup bottle, compressed springs,
   b) Stretching and elastic, tug of war, dog pulling on a leash,
   c) What happens when you jump on a bridge, jump on a trampoline, snow sitting on a roof, truck driving over a bridge, balance beam, clothing on a clothesline.

SCIENCE

Lesson Plans and Handouts

Lesson #5

Bonus Lesson on Pulleys to give background knowledge if needed from Grade 4 unit.

Teaching Plan

Background Information

Pulleys can…

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

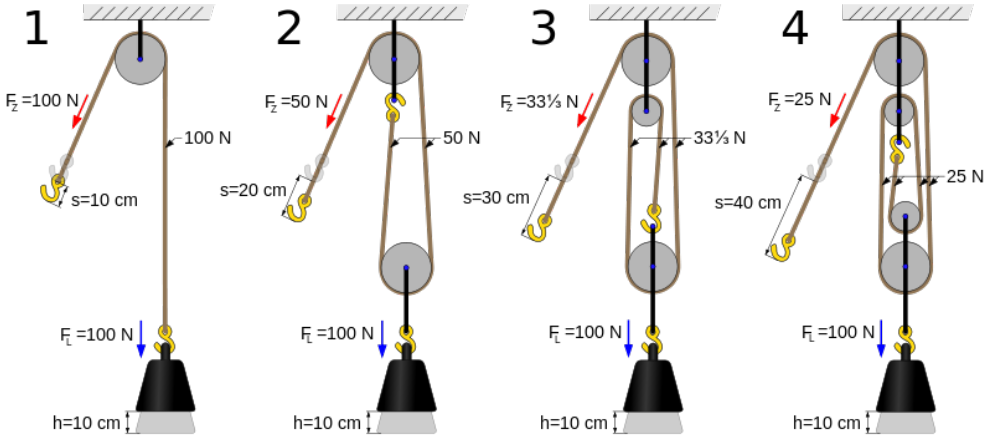
What is a Pulley

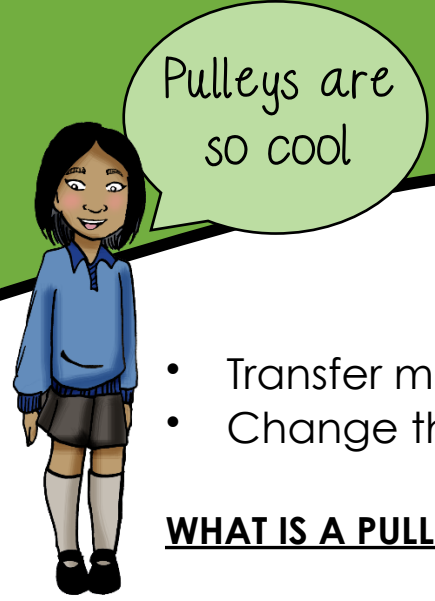
A pulley is a wheel that has a cable wrapped over it. It is used to help lift an object. We use pulleys to lift objects more effectively. When you use pulleys you can reduce the amount of force that you need to lift heavier objects. But there is a catch. The more pulleys that you use to help you lift 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

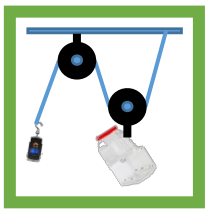
A pulley is a wheel that has a cable wrapped over it. It is used to help lift an object. We use pulleys to easily lift objects. When you use pulleys you can reduce the amount of force or work that you need to lift heavier objects.

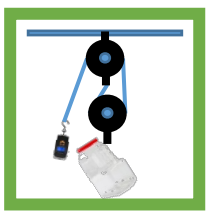
Mechanical Advantage

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.

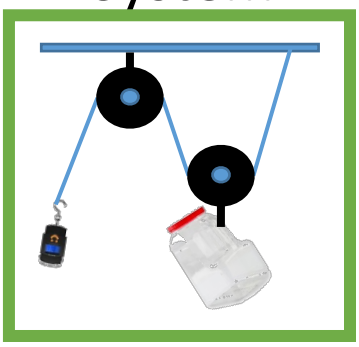
Answer: B

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

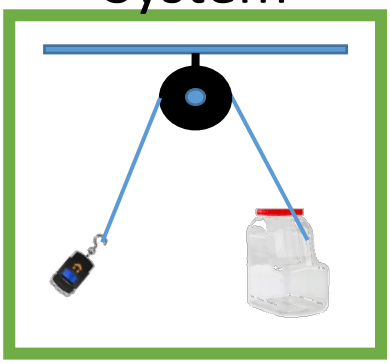
Name this Pulley System



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

Answer: C

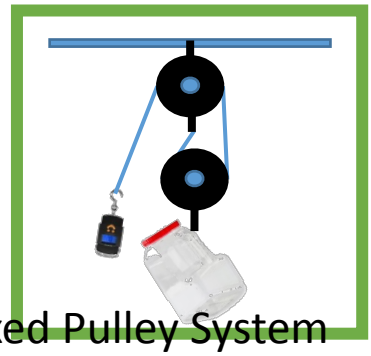
Name this Pulley System



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

Answer: A

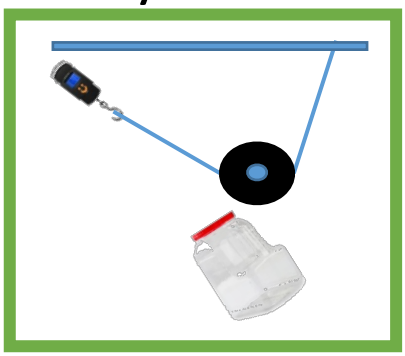
Name this Pulley System



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

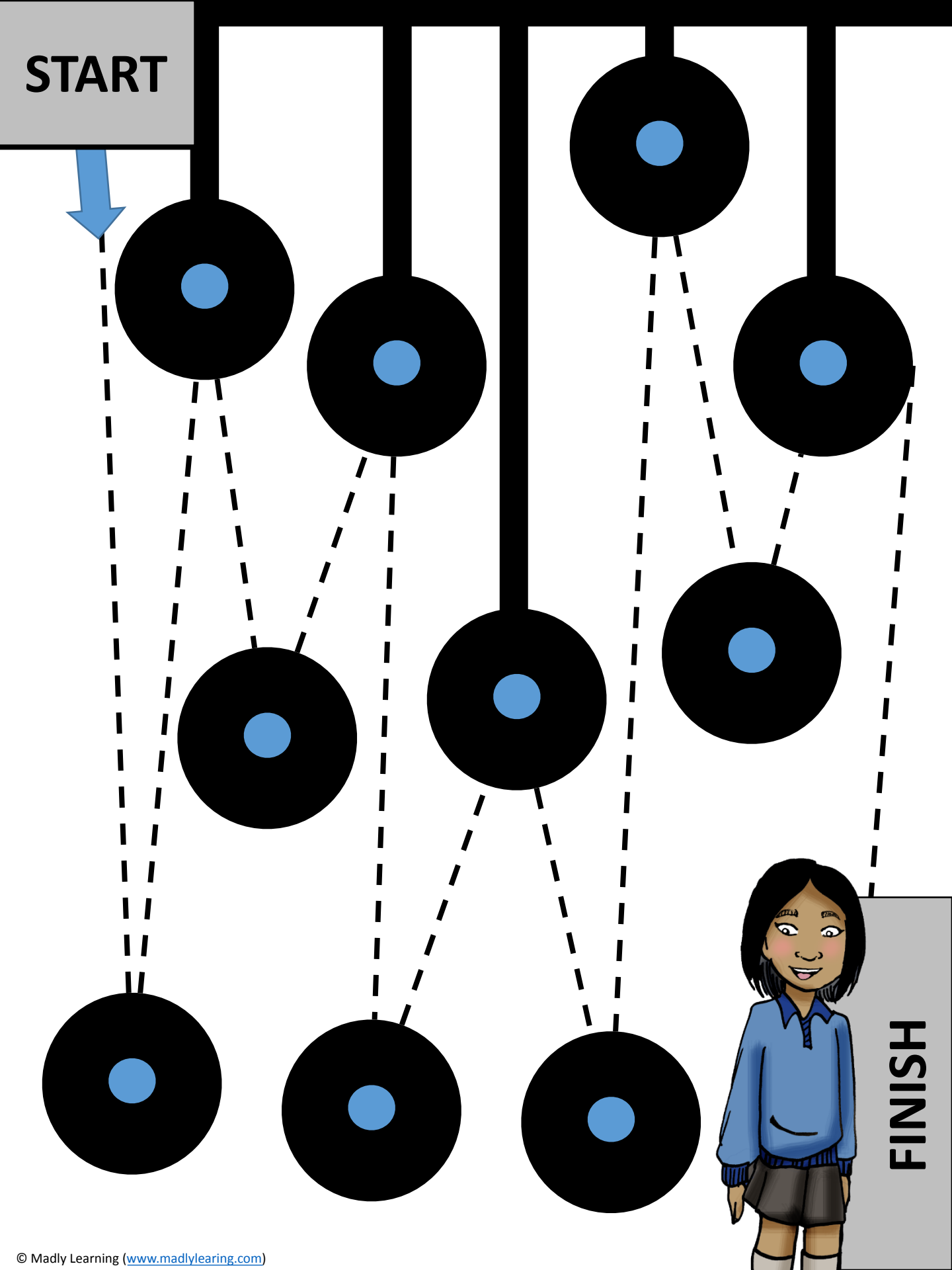
Answer: C

Name this Pulley System



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

Answer: B



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 100cm
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 100cm 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

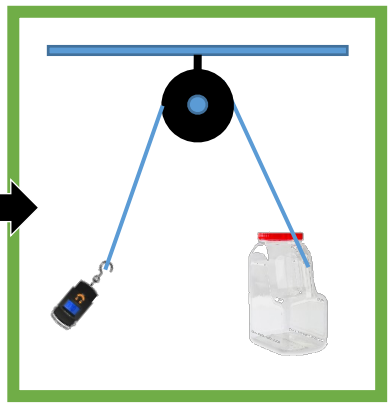
Making a Single Pulley System

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 30cm 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, charis, 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 30cm. 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



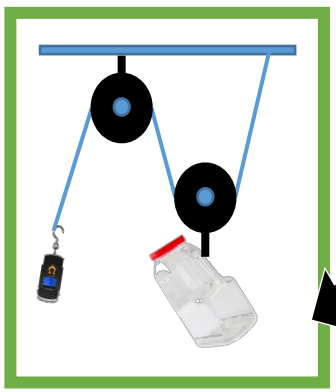
EXPERIMENT 5C

Making a Double Pulley System

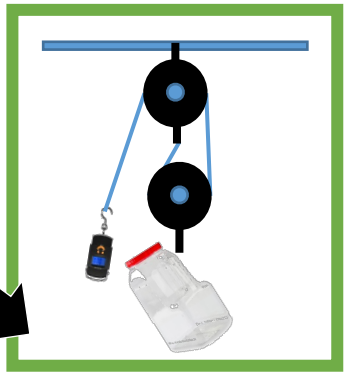
Materials:

- 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 30cm 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

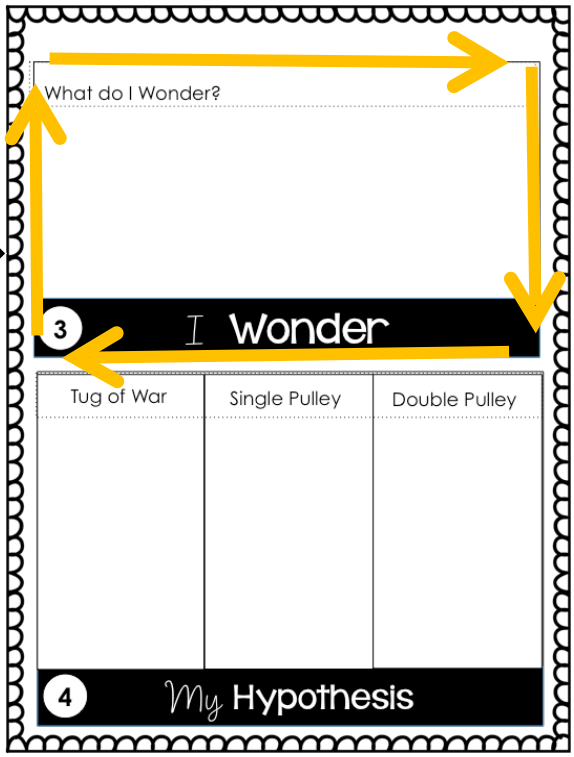


Science Experiment

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

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Lesson Plans and Handouts

Lesson #6

Teaching Plan

Lesson Six

	First Half	Second Half
Prep	• The grade 5 task requires a computer. This task is ideally is best done with students in a computer lab. Or with personal devices. An alternate activity has been included.	
Grade 5	Students can read the article on loads Students Learn about loads that affect bridges. These sites can be used as an alternative or extension to the readings. http://www.pbs.org/wgbh/buildingbig/lab/loads.html http://www.wonderville.ca/asset/DSAstructuralengineering	Students will play the "What a Load" game. Students will use the cards and answer the questions.
Notes		

What a Load

A Load is the weight, pressure or force that a structure takes on. Loads can come from the structure itself, the things moving on it, or from the environment.

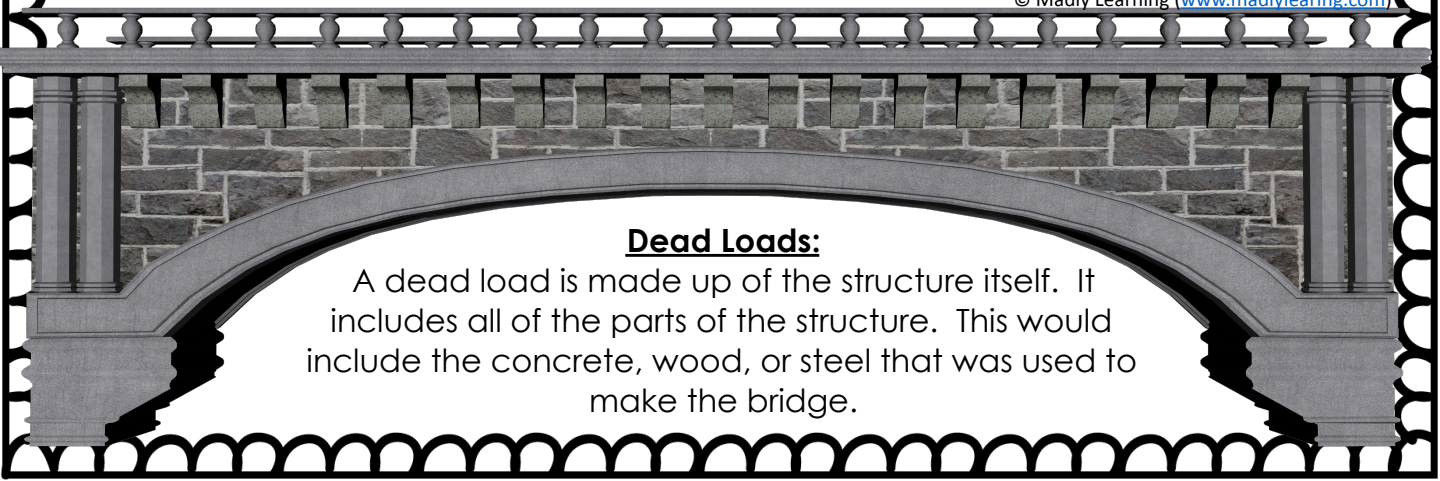
Live Loads:
A live load is the weight added to the structure from things like cars or people. These things are often moving across or within the structure. Engineers must figure out how live loads will affect the structure then thicken up the beams to make them stronger.

Thermal Load
Temperature is an environmental factor that affects structures. Extreme heat and cold affect structures because it causes the materials in the structure to expand and contract (stretch and shrink) Engineers install roller joints and expansion joints to allow for expansion and contraction while still keeping the structure stable.

Wind Load
Wind regularly affects structures especially very tall structures. To prevent damage to a structure by wind engineers use cross bracing most often made by steel.

Earthquake Loads
In an earthquake the ground shakes and moves. This is big problem for many structures. Structures in earthquake zones must be reinforced to withstand these loads. Engineers use Shear walls, a wall that connects beams to prevent twisting.

Settlement Load
Not all soils are able to support heavy structures. That is why **Deep Piles** are added below the structure on hard soil or rock bed to support the weight of the structure.

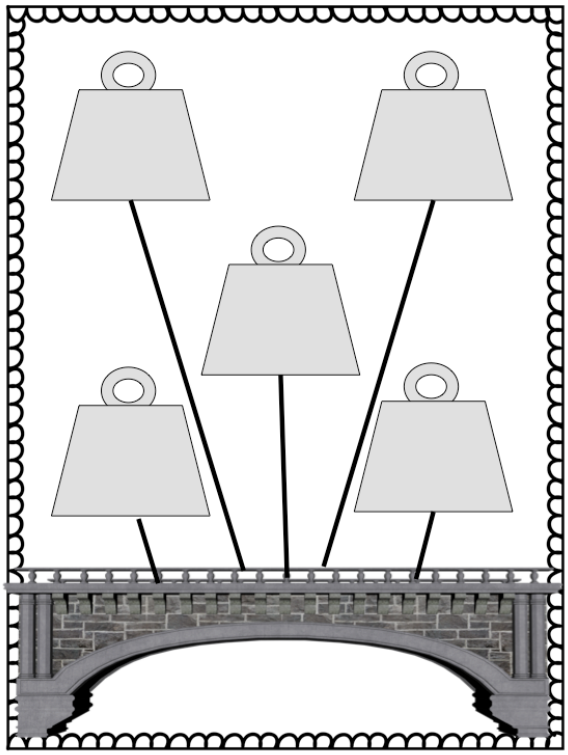


Dead Loads:
A dead load is made up of the structure itself. It includes all of the parts of the structure. This would include the concrete, wood, or steel that was used to make the bridge.

What a Load

The Game

Game Instructions



What you Need

- 2 people
- Load Task Cards (8)
- Pennies (or other markers to mark your space)

Set up

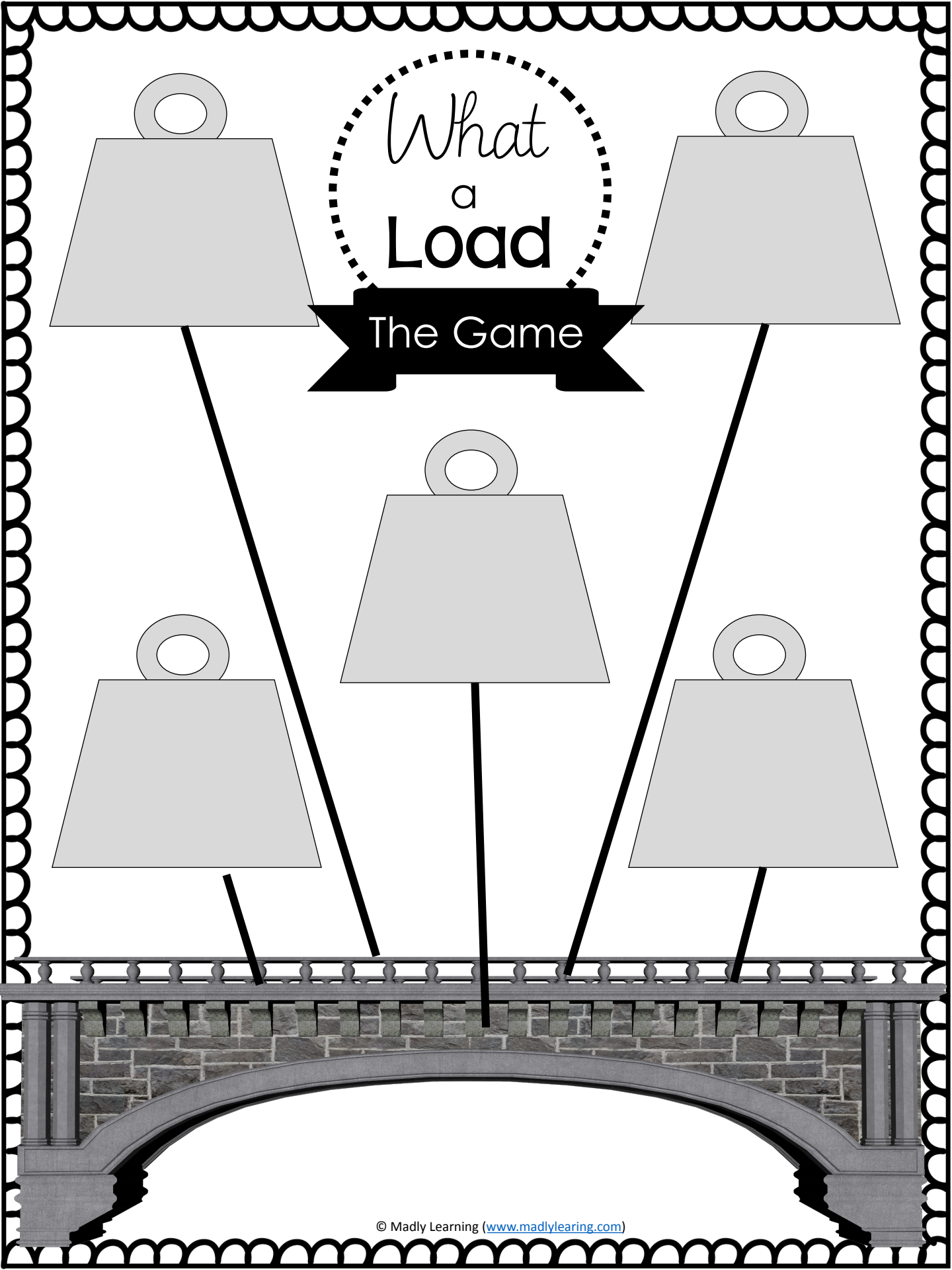
Lay the game board in front of you with the task cards face down.

To Play

- The youngest person goes first
- The other play turns the top card over and reads the question
- If the player gets the question correct then they put a penny on one of the weights on the game board. If you get the question wrong then you need to remove a marker on the game board.
- The person to fill their weights with pennies first will win the game.

What a Load

The Game



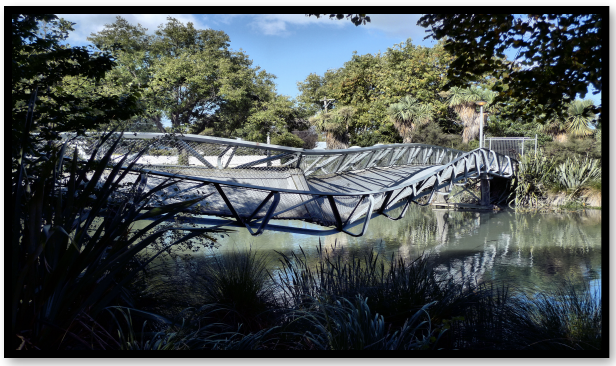
A train moving across a bridge is an example of

Live Load

Driving Deep Piles into the ground helps to protect against

Settlement Load

When an _____ happens the ground shakes and twists structures.



Earthquake

Bridges need to these expansion joints to allow for expansion and contraction from…

Thermal Load

In a tornado the force of the _____ often damage structures, such as ripping off the roof.

Wind

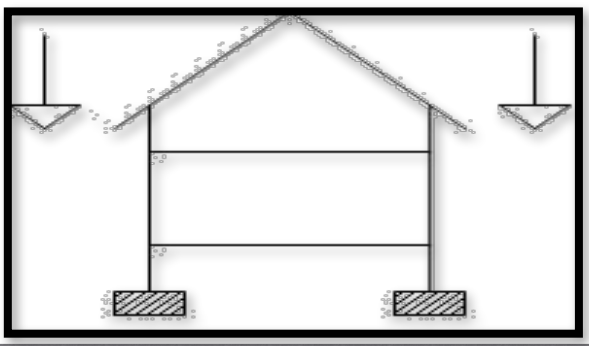
The force of the _____ will often cause trees to uproot. A falling tree often damages the things around it.

Live Load

The leaning tower of Pisa started sinking because the builders didn't consider _____.

Settlement Loads

Every structure has it's own weight that must be supported. This is called…



Dead Load

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Lesson Plans and Handouts

Lesson #7

Combined Teaching Plan

Lesson Seven

	First Half	Second Half
Prep		
Grade 5	Students will apply what they have learned about loads and forces to complete the interactive notebook activity. Students will be using this information to help them design their own bridges or structures out of common materials easily found at the dollar store or in a school supply room.	Students will draw out a "blueprint" of their structure. Students can use the "Blueprint Page" to help them design their bridge or structure.
Notes		

Thermal Load

Dead Load

Live Load

Earthquake Load

Settlement Load

Wind Load

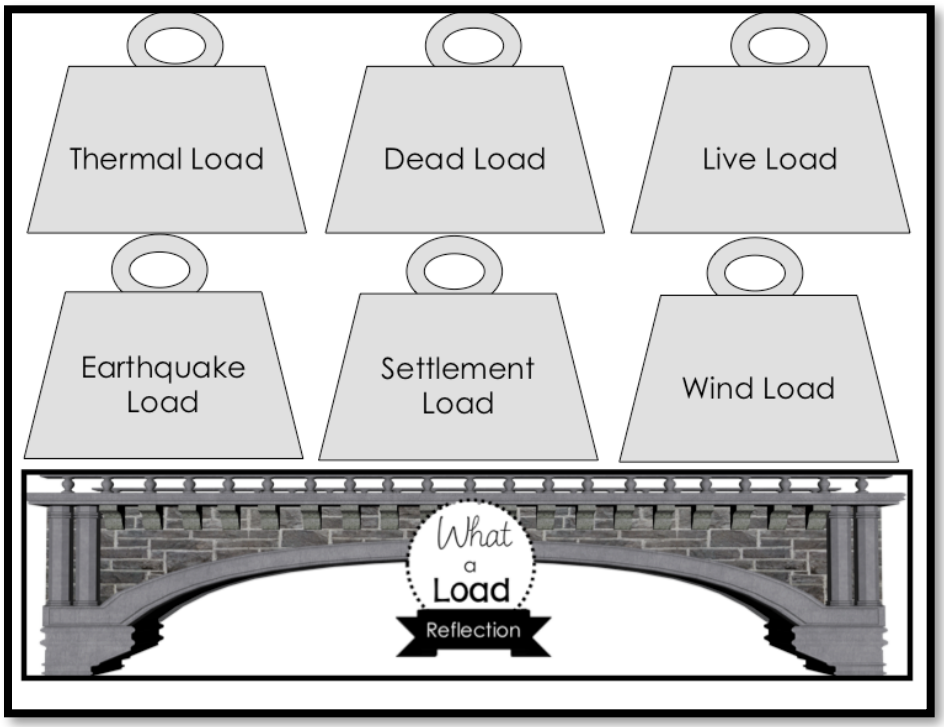
What a Load

Reflection

Hopefully you have learned some things about each type of load. Using the reading and the facts from the game that you have played. Share what you have learned about loads using this Reflection foldable.

Turn your notebook so that the long edge is facing you.

Next cut out the 6 weights and the bridge



Assemble It

Glue the bridge at the bottom of your page. → Cut out the weights. Glue just the circular handle to your notebook → Under the weights write the **definition** of each load and give an **example**

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Lesson Plans and Handouts

Final Task

Teaching Plan

Final Task

	First Half	Second Half
Prep	Final Task - Pulley and Gear Manipulatives (LEGO Education kits are great) - Computer and library resource for research - Popsicle sticks, glue, newspaper and tape for bridge and structure construction - Weights and textbooks to test objects	
Grade 5	Students will begin to build their bridge or structure with a partner using materials found at the dollar store, in the in the school supply room, or at home. Bridge: Use popsicle sticks and glue to create a bridge. (newspapers can also be used instead) Structure: Use paper or newspaper and tape to create a structure that supports textbooks. Assessment: Students will factor in the cost of supplies for their bridge or structure. They will test the strength of the bridge until failure and explain how and why their bridge or structure failed	
Notes		

Final Project

Buildings & Bridges

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

The first step is decide do you want to build a BUILDING or a BRIDGE

Research ways to build your structure. You are not the first to make structure like these. Look for ways that other people have done this before you. Understand the materials that you are using, and how they can be put together to make them strong.

Next develop a blue print. Draw out what you want your structure to look like. Get this approved by your teacher before you begin building.

Structures cost money and so will yours. The goals of most construction companies is to build the best product with the lowest cost. As you require materials you will need to keep track of the cost of each material. The cost of your bridge or structure will need to be handed in at the end of the assignment.

Build your structure.
Try to follow your plan as much as possible.

Final Project
Buildings & Bridges

Research ways to build your structure. You are not the first to make a structure like this. Look for ways that other people have done this before you. Understand the materials that you are using, and how they can be put together to make them strong.

1) My Materials are _____ and _____

1) How will we join our materials together to make them strong? Look for three different ways that others have combined your materials to make them stronger.

3) What shapes will you be using to make your structure? Why?

_____

_____

_____

4) What are some other things I have learned that I will apply to building my own structure.

_____

_____

_____

Final Project
Buildings & Bridges

Research ways to build your structure. You are not the first to make a structure like this. Look for ways that other people have done this before you. Understand the materials that you are using, and how they can be put together to make them strong.

https://goo.gl/KyxBgo

Possible sources for Student Research

NEWSPAPER and TAPE	POPSICLE STICKS AND GLUE
https://www.youtube.com/watch?v=mGMEFgCP2j0 https://www.youtube.com/watch?v=Gxvj9tpiiME https://www.youtube.com/watch?v=MMoHRaVSWnY https://allencentre.wikispaces.com/Rolled+Newspaper+Structures http://beam.berkeley.edu/sites/default/files/Newspaper%20Towers.pdf http://www.pbs.org/parents/crafts-for-kids/forts-for-kids/	https://www.youtube.com/watch?v=_P5ynX7C98M https://www.youtube.com/watch?v=llhSEwUE6cY http://www.instructables.com/id/Teach-Engineering-Truss-Bridges/step2/Advanced-Ideas-Truss-Armor-House-Frame/ http://www.instructables.com/id/Popsicle-Stick-Bridge/

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 **3** different views of your structure. (top, bottom, left, right)

Calculate Costs

Please estimate the amount of materials you will need.

Material Costs

50 craft sticks – $5 000
1 day supply of glue - $1 000

5 pages of paper - $ 1000
1 roll of tape - $ 5 000

Materials Purchased	Cost of Materials	Total Spent

Test and Reflection

Test your structure to see how much weight it will hold. Then answer these questions about your structure.

1) How much weight did your structure hold?

_____

1) How did your structure fail?

_____

_____

_____

2) How did tension and compression affect your structure?

_____

_____

_____

3) How was your structure strong?

_____

_____

_____

4) How could you improve your structure to make it stronger?

_____

_____

_____

Final

ild your structure. You are not
ure like these. Look for ways
ave done this before you.
aterials that you are using, and
y can be put together to make them
strong.

My Material are Wooden Craft Sticks and Glue

1) How will we join our materials together to make them strong? Look for three different ways that others have combined your materials to make them stronger.

3) What shapes will you be using to make your structure? Why?

I will be using triangles for the trusses and rectangles for the base. I will shape my bridge in the form of an arch.

4) What are some other things I have learned that I will apply to building my own structure.

I will make my triangles strong. I will reinforce the joints where my craft sticks are joined. I will make my bridge longer so that more of it rests on the ends. I will carefully put the pieces together so they are stronger.

culate Costs

nate the amount of

rials you will need.

Material Costs

50 craft sticks – $5 000
1 day supply of glue - $1 000

5 pages of paper - $ 1000
1 roll of tape - $ 5 000

Materials Purchased	Cost of Materials	Total Spent
50 Craft Sticks	5 000	5 000
1 day of glue	1 000	6 000

Final Reflection

Now that you have had a chance to see how much weight it can hold, answer these questions about your structure.

1) How much weight did your structure hold?

My Bridge held 6000g

1) How did your structure fail?

My bridge failed in the middle. One of the trusses began to snap as the bridge bent down when more weight was added. Eventually when the last weight was added the truss snapped and the bridge fell

2) How did tension and compression affect your structure?

The bridge began to bend as the weights were added to the bottom it began to stretch out the bottom which is tension. The compression was on the top as it was all squeezing into the centre which is compression.

3) How was your structure strong?

I think I did a good job with my bridge because I took a lot of time to make the trusses strong even though one broke it took a lot of weight. Using triangles and reinforcing my bridge deck made it strong

4) How could you improve your structure to make it stronger?

To make my bridge stronger I would need to reinforce against the tension on the bridge because it did bend too much. I think I would add even more support to the bridge deck to make it thicker

Assessment

Student Name: _____

Structure: _____

Areas for Concern	Criteria of success	Evidence of Meeting or Exceeding standards
	Student makes a solid plan based on research of design.	
	Student assembles the structure safely and with good attention to detail	
	Student can justify their design choices and elements.	
	Student can apply the concepts of tension, compression, and load to analyze their structures failure.	
	Student can identify ways in which their design decisions contributed to the success and failure of their structure.	

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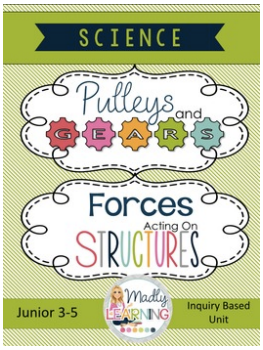

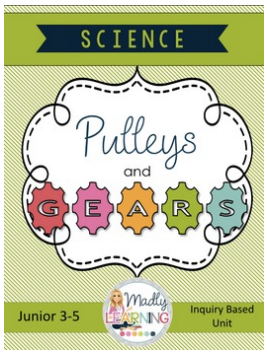

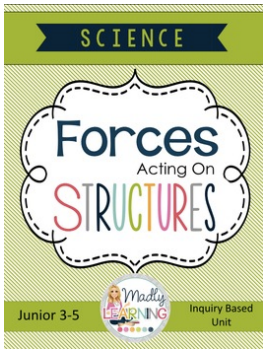

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