Catapults

Major Topic: Catapult Contraptions

Length of Unit: 2-90 minute class periods

Unit Summary: Present students with the following problem: *You are in the process of cleaning up your fenced backyard so that you can plant a vegetable garden. The yard is filled with heavy, large rocks. You need to move the rocks over the fence into the creek. Your job is to create a catapult that will allow you to propel the rocks over the fence into the creek.* Students will work in teams to design a catapult that will propel their "rock" into a "pond" using knowledge of levers.

Interdisciplinary Connections: Students will begin by reading about levers and forces. Next, students will outline three strategies that will be important in designing a catapult. As a conclusion, students will write a summary describing how they created their catapult and the results of their design and redesign. Students will use a graphic organizer to list variables in their experiment. Students will also use science, math and engineering skills to complete the activity.

Understanding Goals: Students will record data using a frequency table and correctly represent data using a bar graph. Additionally, they will calculate the theoretical and experimental probability of their "rock" landing in the pond, meadow or forest. Students will represent probability as a ratio in simplest form, as a decimal and a percent and identify variables in their experiment.

Essential Questions:

- What are some ways to move the rocks to the pond?
- What are the benefits of using a catapult vs. other methods of clearing the rocks?
- What can your team do to redesign your catapult to make it more effective, hitting the *target* 100% of the time?
- What other items might be used in creating your catapult?
- What could be done to the farmer's "playing field" to increase the probability of hitting the target?
- What happens to the experimental probability if you increase the number of trials to 50 or 100?
- From the design task, what were the constants, independent variable and the dependent variable in our experiment?

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Student Objectives:

Students will be able to:

PS.1

i) investigate and understand scientific principles and technological applications of work, force, and motion frequency distributions, scattergrams, line plots, and histograms are constructed and interpreted.

PS.10

c) investigate and understand scientific principles and technological applications of work, force, and motion work, force, mechanical advantage, efficiency, and power;

d) and applications (simple machines, compound machines, powered vehicles, rockets, and restraining devices).

LS.1:

a) demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which data are organized into tables showing repeated trial and means.

LS.1:

f) demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which dependent variables, independent variables, and constants are identified.

h) demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which data are organized, communicated through graphical representation, interpreted, and used to make predictions.

Math7.3:

b) add, subtract, multiply and divide integers.

Math7.9:

investigate and describe the difference between experimental and theoretical probability of an event.

Math7.11:

construct and analyze histograms.

Differentiation:

Students with disabilities may be partnered with a high achieving student. Students can also use a calculator to assist in making calculations involving probability and fraction/decimal/percent conversions.

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Blooms Taxonomy	21st Century Skills
Creating Evaluating Analyzing Applying Understanding	Critical Thinking Problem Solving Communication Creativity & Innovation Collaboration

Performance Tasks:

Students will:

- Students will write a summary describing their catapult contraption idea and design.
- Students will work in groups of 3 using materials provided to create a catapult contraption prototype.
- Demonstrate knowledge of theoretical and experimental probability- students will calculate the theoretical and experimental probability of launching a “rock” into a pond, meadow, forest, out of bounds, or not over the fence.
- Students demonstrate knowledge in a frequency table and bar graph by recording and analyzing data.
- Identify the constants, independent variable and dependent variable in their design task using a graphic organizer.
- Write a catapult contraption reflection- students will write a paragraph which reflects on their data, prototype and design process.

Evidence of formative assessment:

The teacher will use whole group discussion, completion of a research outline, a probability chart, design description, and frequency table as formative assessment.

Evidence of Summative Assessment:

Students will be assessed through their completion of their bar graph, variable graphic organizer and reflection paragraph. A rubric will be provided outlining grading criteria. The Catapult Contraption Recording Sheet will be collected and graded.

Technology

Hardware	Software
Computers Projection System Design Materials	PowerPoint

Resources from the web:

- Levers and Force
- See-saw image
- Simple machines images
- Parts of a lever images
- Pros/cons image
- Constant, dependent, and independent variable slide
- Mad Scientist image

Supplies:

- 2 3 x 5 index cards
- 5 coffee stirrers
- 3 large paper clips
- 2 straws
- 10 popsicle sticks
- 1 plastic spoon
- 10 rubber bands
- 1 long piece of string
- 20 jumbo marshmallows
- 20 craft pompoms
- Catapult Presentation
- 30 gallon size zip lock bags
- glue bottles/glue sticks
- masking tape -
calculator
- scissors
- "Levers are Simple Machines" packet
- Catapult Contraption Directions
- Catapult Contraption Recording Sheet
- colored pencils
- 5 1-in pieces of tape

Vocabulary: theoretical probability, experimental probability, frequency table, cumulative frequency, bar graph, histogram, lever, simple machine, catapult, fulcrum, force, constant, dependent variable, independent variable

Lesson 1: (1 90-minute class)

- Teacher needs to prepare materials bags (1 for each group of three students) and must set up "playing field" on classroom floor. Do so by taping off a 64 square foot area and divided the square into sections of pond, meadow, and forest (see diagram in PowerPoint).

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- Using PowerPoint lesson, introduce Catapult Contraptions.
- Discuss levers(machines used to increase force, they are simple machines because they have only a few moving parts, made up of arms and a fulcrum).
- Discuss other simple machines and where they are found in our everyday life (lever, wheel and axle, screw, wedge, inclined plane, pulley).
- Discuss parts of a lever (fulcrum is the point on which the lever turns or balances, an arm is the part of the lever in which you push or pull).
- In groups of three, students will read the article, “Levers are Simple Machines” and discuss the parts of a lever, the three classes of a lever, and the uses of a lever. Students will have 8 minutes to read the article.
- Introduce the problem. (You, the farmer, are in the process of cleaning up your fenced backyard so that you can plant a vegetable garden. The yard is filled with 20 heavy, large rocks. You need to move the rocks over the fence into the pond. Your job is to create a catapult that will allow you to propel the rocks over the 20 inch high fence into the pond.)
- Discuss ways that the farmer can get the rocks to the pond as a whole group.
- Introduce catapults and show pictures of different catapults. Tell students that catapults were used in Medieval times for protection and to break through gates and walls surrounding cities.
- Discuss the pros and cons of using a catapult (pros: lift heavy objects, can be disassembled, anyone can use them; cons: large, not accurate, expensive to make, etc)
- Now refer back to the problem and share the rules: The pond is surrounded by a beautiful meadow of wildflowers and lush green grass. This area is mowed twice a year, so large rocks will be a hazard to the person mowing the meadow. Therefore, you should not shoot any boulders into the meadow. If you do, you will lose 5 points for each boulder landing in the meadow. It is permissible to throw the rocks into the forest. However, you will only earn 10 points for rocks that land in that area. Your goal is to propel the rocks into the pond where you will earn 20 points each time you hit the target. The team with the most points after 20 trials will be declared the winner of the contest. Each rock catapulted outside of the farmer’s land will deduct 15 points from your team’s score. Rocks that do not make it over the fence will score your team no points. You may only use the supplies provided in your bag. You may not get any new supplies. You do not have to use all of your supplies. You may test your prototype during the design process. However, you may not get additional supplies. You may redesign/recreate your prototype.
- Show students a picture of the “playing field”.
- Show scale drawing of playing field and discuss. The area of the square is 64 cubic centimeters/feet. What do we know about the number 64? It is a perfect square.

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What does the area of the square tell us about the length of each side? In a square, all sides are congruent; the square root of 64 is 8, so each side of the square is 8 cm/ft long.

- Discuss the area of the pond, how the meadow surrounds the pond, and how the forest is the edge of the "playing field".
- Discuss the variables in the Scientific Process: Variables in mathematics represent values that change. Just as in mathematics, the scientific process contains variables. Constant- things that remain the same throughout the experiment; Dependent Variable- what is measured or observed in the experiment; Independent Variable- the one thing changed by the scientist in the experiment. Tell students to look for the variables as they create and test their catapult contraptions.
- Review key vocabulary for math review. THEORETICAL PROBABILITY- what should happen; EXPERIMENTAL PROBABILITY- what does happen when conducting the experiment; FREQUENCY TABLE- a table used to record trials using tally marks; CUMULATIVE FREQUENCY- a running total of trials which should equal the total number of times you completed the experiment; HISTOGRAM- a bar graph that uses INTERVALS; DiaPeR- Decimal to Percent RIGHT; PuDdLe- Percent to Decimal LEFT; Fraction to a Decimal- LONG DIVIDE in/out; Integer rules for adding/subtracting- SAME SIGNS ADD… DIFFERENT SIGNS SUBTRACT…Keep the sign of the BIGGEST NUMBER
- Students will complete the "Let's Research" outline portion of the Catapult Contraption directions. Instruct students to use the recording packet to record all answers, paragraphs, data, etc. Set timer for 5 minutes.
- Finally, for day 1, complete the "Let's Start" portion of the Catapult Contraptions directions packet. Allow 15 minutes for students to complete this activity.
- To close, lead a discussion with the group about ways to move the rocks to the pond. Discuss levers and the parts of a lever and how a lever will benefit each team in the designing of a catapult. Discuss each group's calculations of theoretical probability. Have groups share their "playing field" scale drawings. Some groups may have used a scale factor to dilate their scale drawings, which would be an excellent time to review dilations and scale factors.

Lesson 2: (1 -90 minute class, plus 1-45 minute class if needed)

- Begin day 2 by reviewing the *Problem Task*.
- Go over the theoretical probabilities found from the previous lesson.
- Have students brainstorm for 5 minutes the possible designs for building a catapult using the supplies from the bag. Tell the students that they may not begin building.
- Set the timer for 5 minutes. Students will write a paragraph describing how their group will use the supplies to build their catapult contraption.

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- Set the timer for 25 minutes. Students will now work in their groups to create a catapult contraption. Teacher will move about the room observing how the children are working together, use of lesson vocabulary, design strategies, materials used and adapted, etc. Periodically, remind students of the timer, making sure students are working to finish within the time limit. Also encourage groups to test their prototype and redesign if needed.
- After 25 minutes announce that students must stop working and take hands off of their catapult.
- Now it is time for each group to compete. Each group sits around playing field. Groups will take turns completing their 20 trials. Have one team member record results on the frequency table on the Catapult Contraption Recording Sheet.
- After all groups have completed their trials, students will again go back to their tables to complete final calculations and reflections. Instruct students to begin at #13 on the Catapult Contraption Directions.
- Students will compute their total points earned from their trials, calculate the cumulative frequency, and the experimental probability of landing in the pond, meadow, forest, out of bounds, and not over fence.
- Once students are finished calculations, discuss as a group the variables in the experiment. (constants: supplies, time limits, the rock; dependent variable: the targets; and independent variable: catapults).
- Students will then complete the variable graphic organizer on the Catapult Contraption Recording Sheet.
- Finally, read and discuss the “Let’s Reflect” portion of the directions packet. Allow the students 10 minutes to complete this task.
- Students should turn in their packet when completed.
- Close the lesson by reviewing key concepts, what worked, what didn’t work, etc. Discuss what improvements could be made to our catapults to make them more effective. How did the experimental probability compare to the experimental probability? What other supplies could we have used to make our catapult more efficient? Why wouldn’t the jumbo marshmallow work for us? (it was too heavy) What could we do to the target so that the probability of landing the pond was increased?

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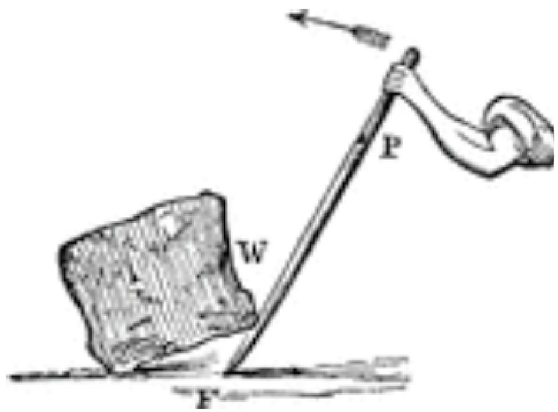
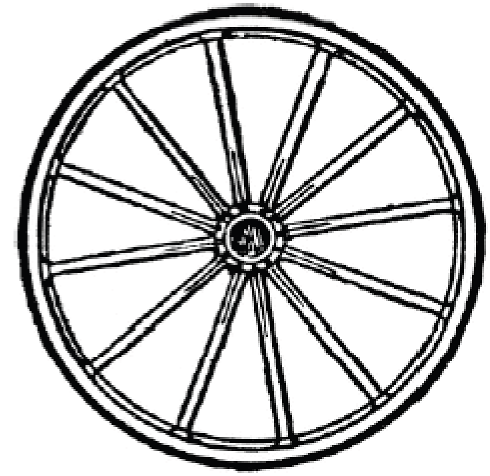
Catapult Contraptions

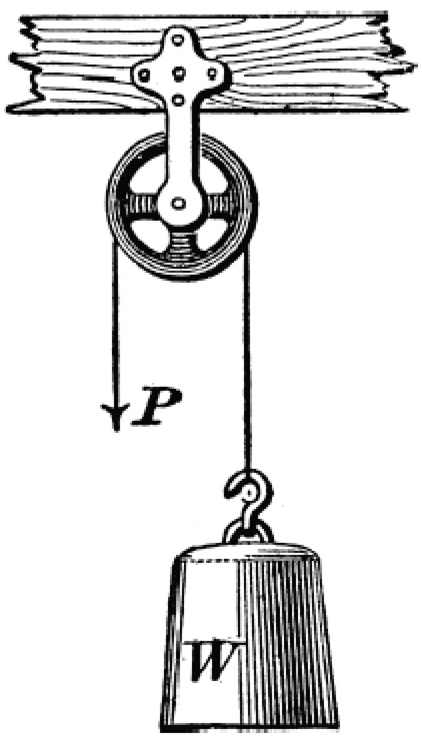
What is a LEVER?

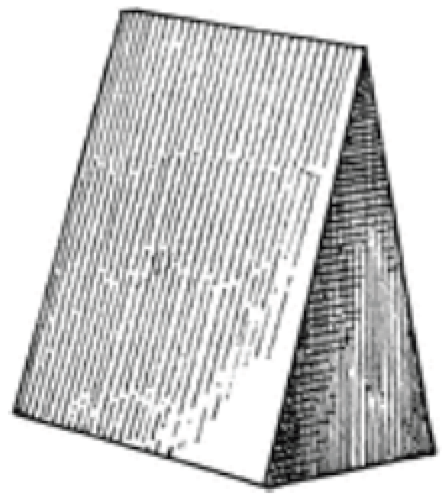
- LEVERS are machines used to increase force.
- They are SIMPLE MACHINCES because they have only a few moving parts.

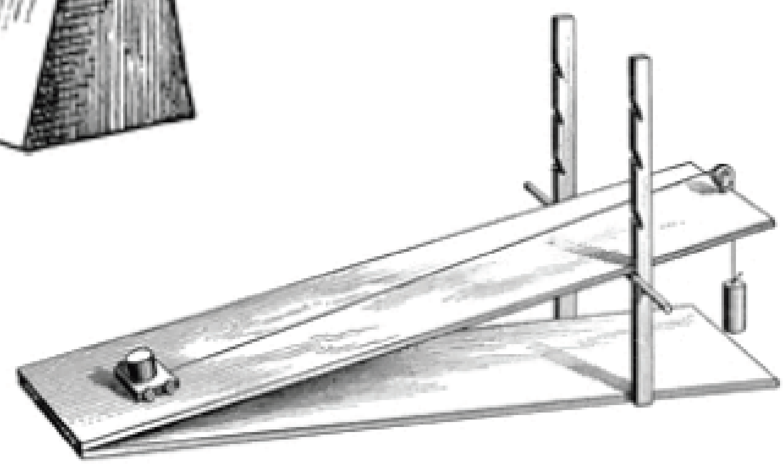
What are some other simple machines?







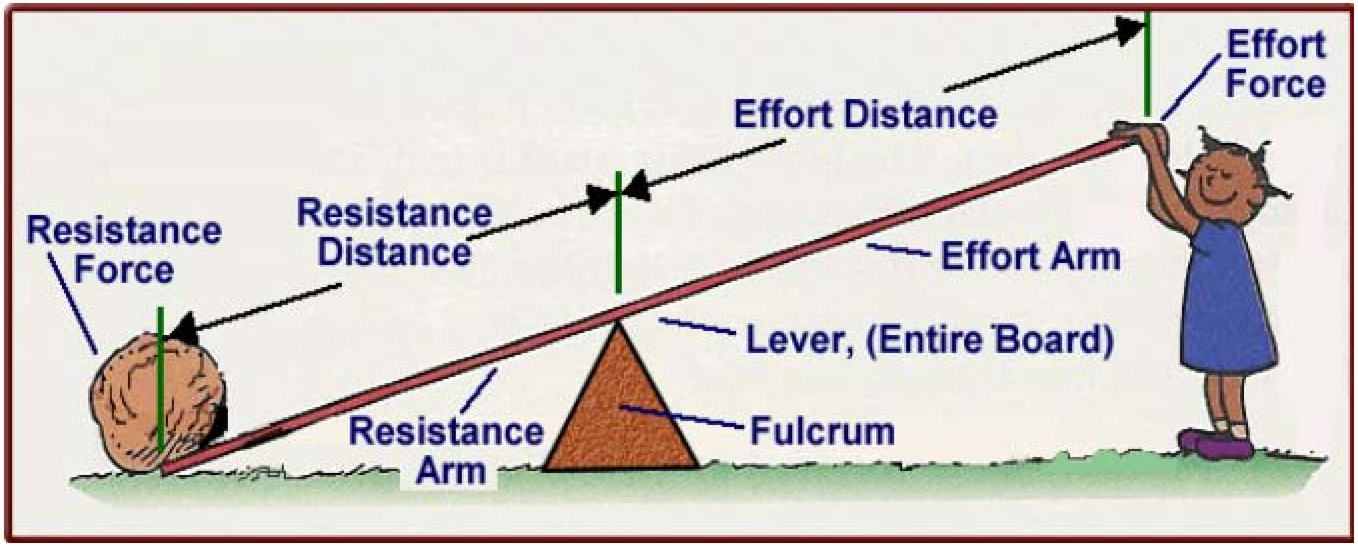




http://www.teacherspayteachers.com/Product/Simple-Machine-Raps-598228

Parts of a LEVER?

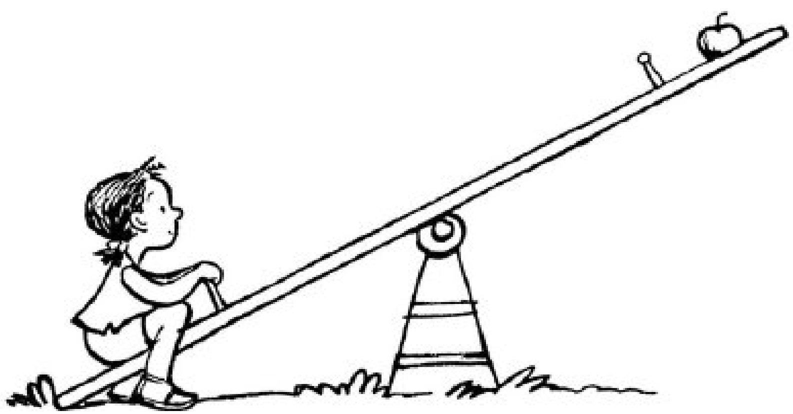
- The ARM or handle is the part that you push or pull on.
- The FULCRUM is the point on which the lever turns or balances.



http://www.mlms.loganschools.org/~mlowe/LoweHome/SciberText/SciberStandard4ForceAndMotion.html

READ

Levers are Simple Machines



YOUR TASK!!!

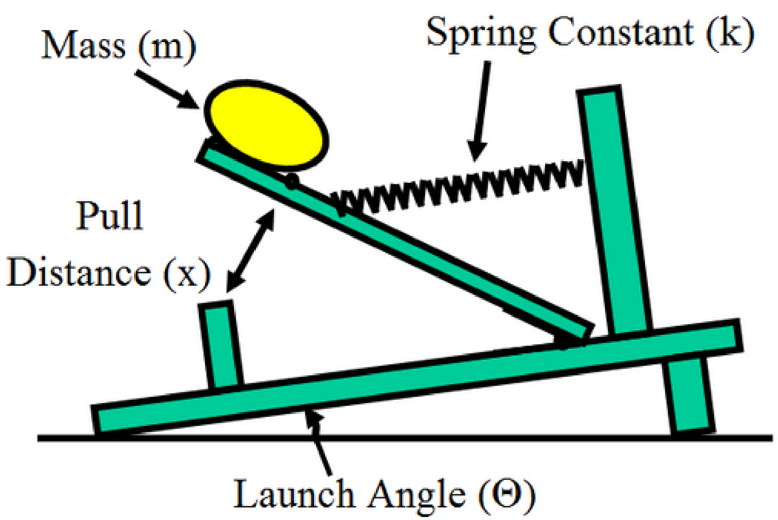
You, the farmer, are in the process of cleaning up your fenced backyard so that you can plant a vegetable garden. The yard is filled with heavy, large rocks. You need to move the rocks over the fence into the pond.

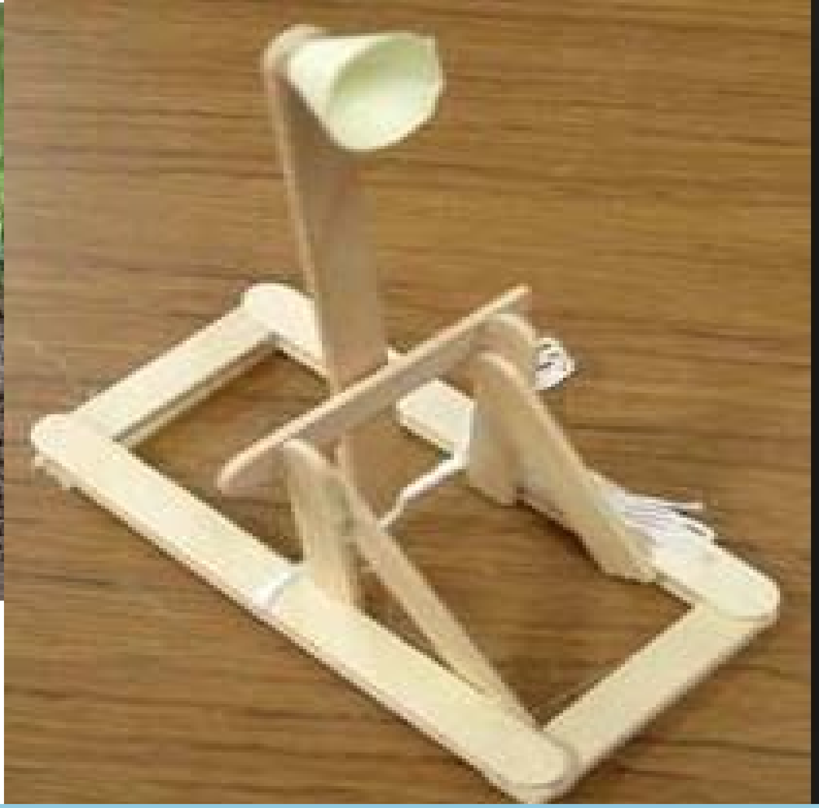
What are some ways that you can do this?

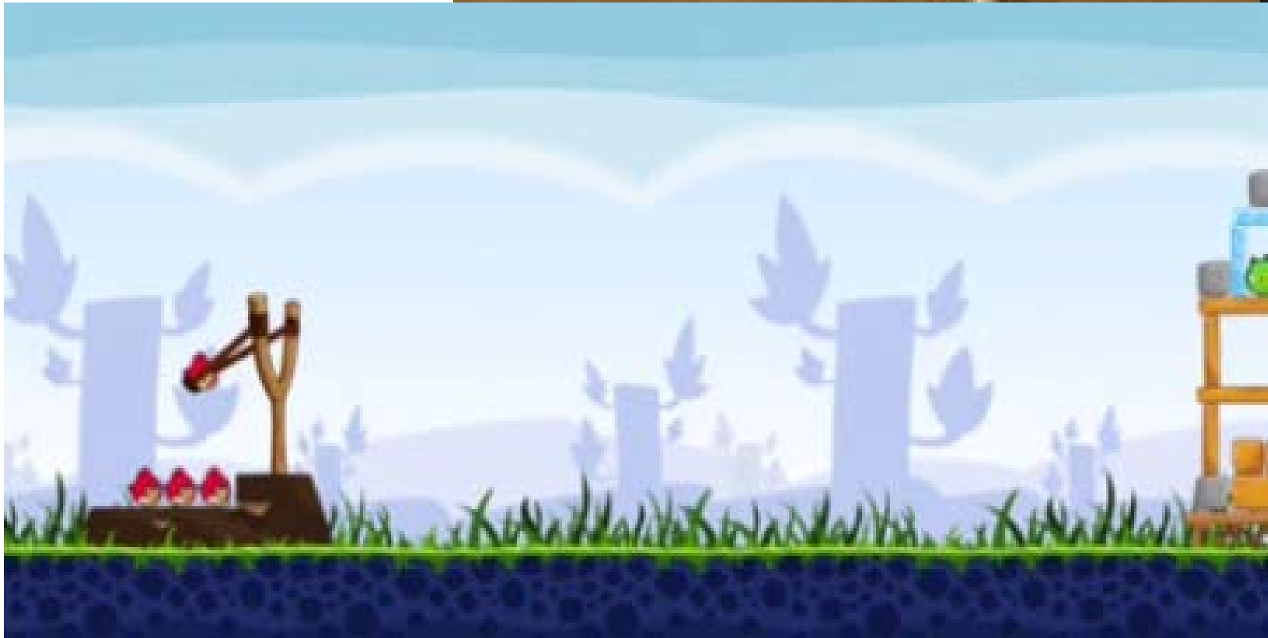
Your job is to create a catapult that will allow you to propel the rocks over the fence into the pond.

CATAPULTS

A **CATAPULT** is a machine that can propel or launch an object into the air.



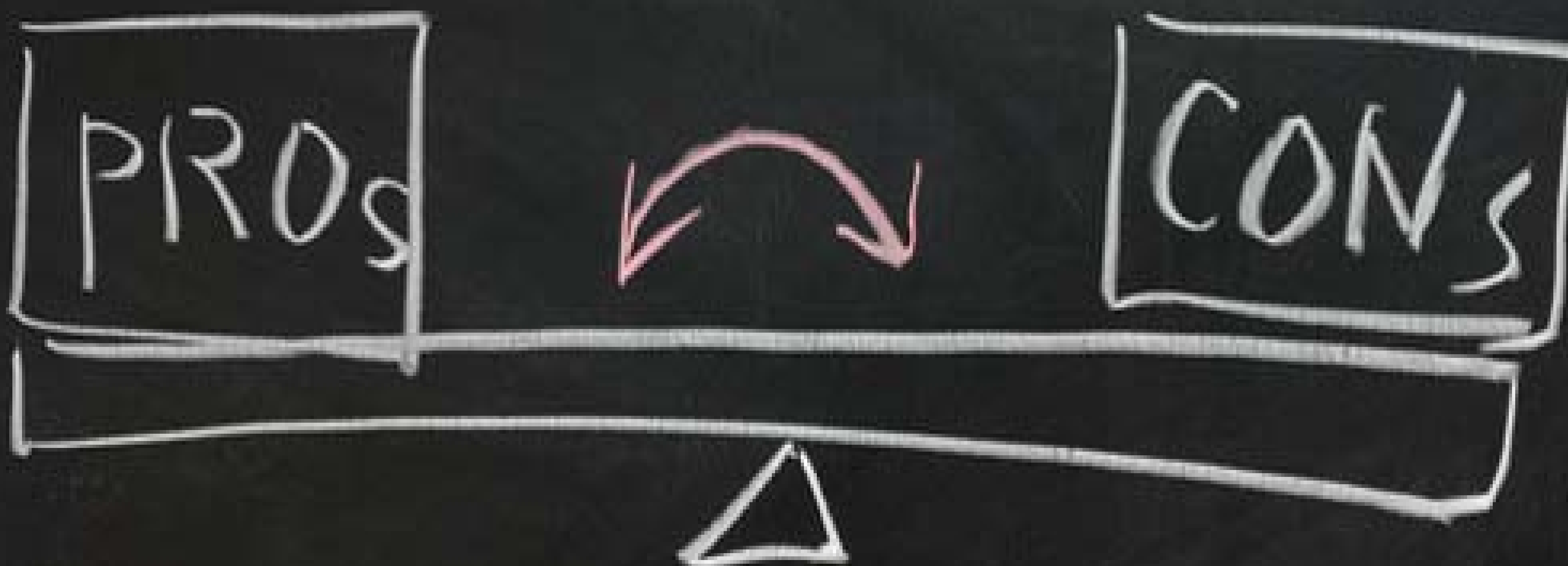





6
Pause


CrazyPenguin
CATAPULT

WHY DO WE WANT TO USE A CATAPULT?



RULES!!!

- The pond is surrounded by a beautiful meadow of wildflowers and lush green grass. This area is mowed twice a year, so large rocks will be a hazard to the person mowing the meadow. Therefore, you should not shoot any boulders into the meadow. If you do, you will lose 5 points for each boulder landing in the meadow.
- It is permissible to throw the rocks into the forest. However, you will only earn 10 points for rocks that land in that area.

RULES!!!

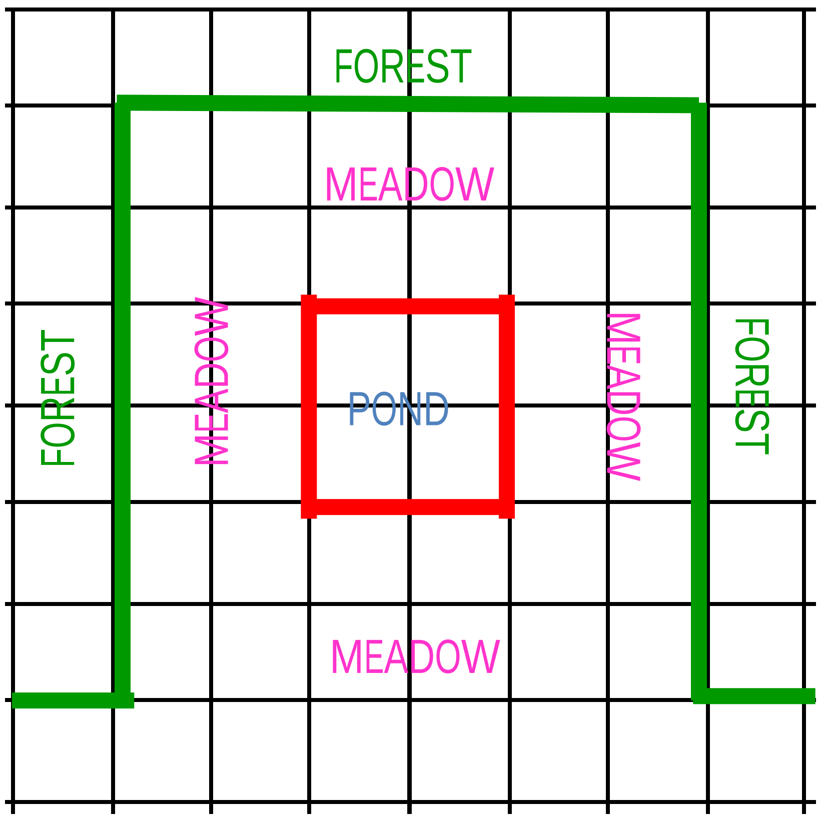
- Your goal is to propel the rocks into the pond where you will earn 20 points each time you hit the target. The team with the most points after 20 trials will be declared the winner of the contest.
- Each rock catapulted outside of the farmer’s land will deduct 15 points from your team’s score.
- Rocks that do not make it over the fence will score your team no points.

RULES!!!

- You may only use the supplies provided in your bag.
- You may not get any new supplies.
- You do not have to use all of your supplies.
- You may test your prototype during the design process. However, you may not get additional supplies.
- You may redesign/recreate your prototype.
- Your catapult must be free standing.

YOUR TARGET!!!

TOTAL AREA: 64 ft^2



Scale: 1 cm^2 = 1 ft^2

Variables in the Scientific Process

Constant- things that remain the same throughout the experiment.

Dependent Variable- what is measured or observed in the experiment

Independent Variable- the one thing changed by the scientist in the experiment

Constants + Independent Var. = Dependent Var.

REVIEW

- THEORETICAL PROBABILITY- what should happen
- EXPERIMENTAL PROBABILITY- what does happen when conducting the experiment
- FREQUENCY TABLE- a table used to record trials using tally marks
- CUMULATIVE FREQUENCY- a running total of trials which should equal the total number of times you completed the experiment

REVIEW

- HISTOGRAM- a bar graph that uses **INTERVALS**
- DiaPeR- Decimal to Percent RIGHT
- PuDdLe- Percent to Decimal LEFT
- Fraction to a Decimal- LONG DIVIDE $\frac{in}{out}$
- Intger rules for adding/subtracting-

SAME SIGNS **ADD**

DIFFERENT SIGNS **SUBTRACT**

Keep the sign of the **BIGGEST NUMBER**

Let’s
Get StartED!

Constants + Independent Variable = Dependent Variable

Levers and Force
http://www.school-for-champions.com/machines/levers.htm#.U4S25SiGeSo

See-saw image
http://www.discovery.com/tv-shows/mythbusters/about-this-show/physics-of-
seesaws.htm

Simple machines images
http://www.teacherspayteachers.com/Product/Simple-Machine-Raps-598228

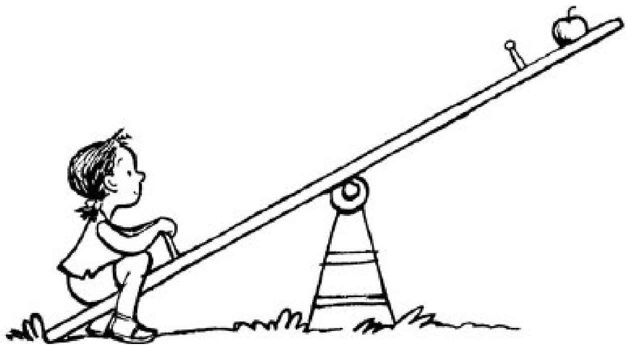
Parts of a lever images
http://www.mlms.loganschools.org/~mlowe/LoweHome/SciberText/SciberStandard4Force
AndMotion.html

Pros/cons image
Googleimages.com

Constant, dependent, and independent variable slide
http://www.sasd.k12.pa.us/Downloads/Dependent%20and%20Independent%20Variables%20Explaine
d.pdf

Mad Scientist image
http://teachers.oregon.k12.wi.us/sundstrom/Physical%20Science/Measurement/Variables_Worksheet.
pdf

Levers are Simple Machines



Levers are Simple Machines

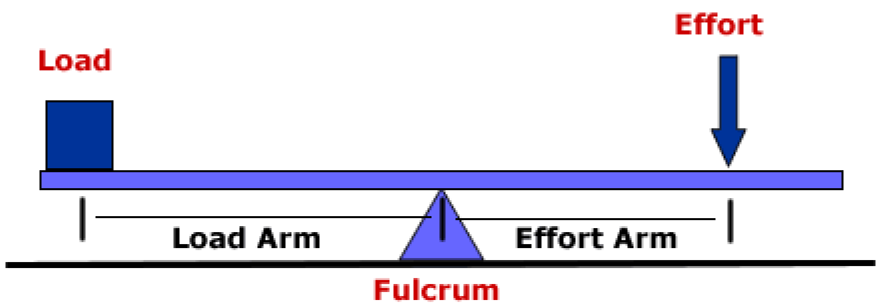
by Ron Kurtus (revised 20 May 2014)

A lever is a simple machine that allows you to gain a mechanical advantage in moving an object or in applying a force to an object. It is considered a "pure" simple machine because friction is not a factor to overcome, as in other simple machines.

A lever consists of a fulcrum, applied force and load. There are three common types or classes of levers, depending on where the fulcrum and applied force is located. The mechanical advantage is that you can move a heavy object using less force than the weight of the object, you can propel an object faster by applying a force at a slower speed, or you can move an object further than the distance you apply to the lever.

Parts of a lever

A typical lever consists of a solid board or rod that can pivot about a point or **fulcrum**. A force or **effort** is applied, resulting in moving or applying force to a **load**. The distance from the applied force or effort force to the fulcrum is called the **effort arm** and the distance from the load to the fulcrum is called the **load arm**.



Parts of a Lever

Since there is typically a very small amount of friction at the fulcrum, overcoming friction is not a factor in a lever as it might be in another simple machine like a ramp or wedge. Thus, we consider a lever a pure simple machine.

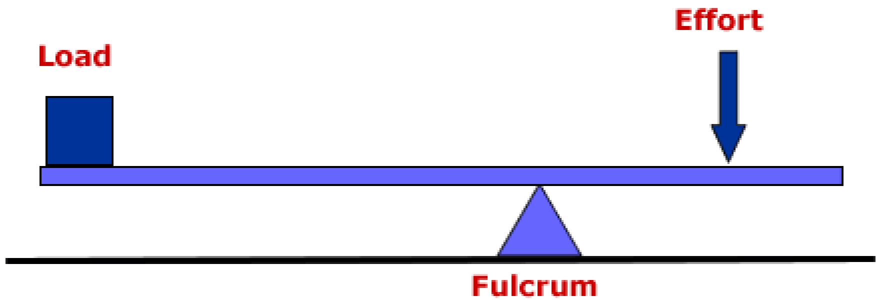
Levers are Simple Machines

Three lever classes

There are three types or classes of levers, according to where the load and effort are located with respect to the fulcrum.

Class 1

A class 1 lever has the fulcrum placed between the effort and load. The movement of the load is in the opposite direction of the movement of the effort. Note that the length of the effort arm can be greater than, equal to or less than the length of the load arm in a class 1 lever.



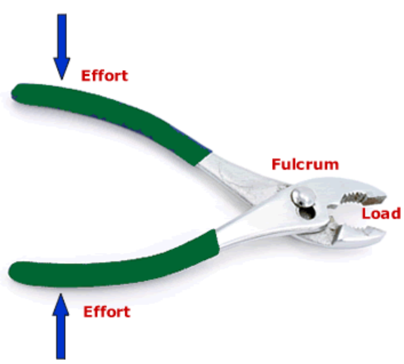
Class 1 lever

Examples of class 1 levers include:

- Teeter-totter
- Oars on a boat
- Catapult
- Shoehorn
- Scissors
- Pair of pliers

Double class 1 lever

A scissors and a pair of pliers are considered *double* class 1 levers.

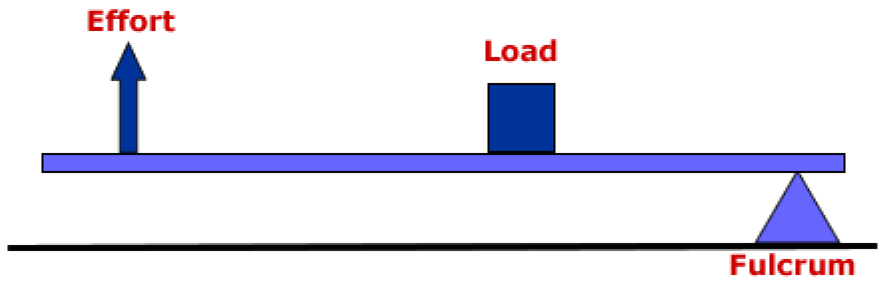


A pair of pliers is a double class 1 lever

Levers are Simple Machines

Class 2

A class 2 lever has the load in between the effort and the fulcrum. In this type of lever, the movement of the load is in the same direction as that of the effort. Note that the length of the effort arm goes all the way to the fulcrum and is always greater than the length of the load arm in a class 2 lever.



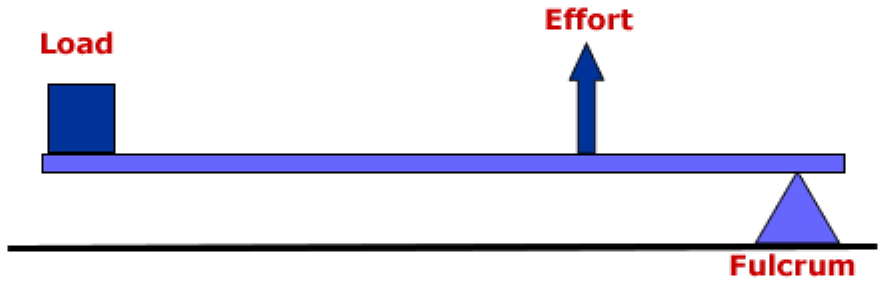
Class 2 lever

Examples of class 2 levers include:

- Wheelbarrow
- Crowbar
- Nut cracker

Class 3

A class 3 lever has the effort in between the load and the fulcrum. Both the effort and load are in the same direction. Note that the length of the load arm goes all the way to the fulcrum and is always greater than the length of the effort arm in a class 3 lever.



Class 3 lever

Examples of class 3 levers include:

- Tweezers
- Stapler
- Mousetrap
- Broom
- Hockey stick

Levers are Simple Machines

Uses for a lever

The reason for a lever is that you can use it for a *mechanical advantage* in lifting heavy loads, moving things a greater distance or increasing the speed of an object.

Summary

A lever is a simple machine that allows you to gain a mechanical advantage. It consists of a fulcrum, applied force and load. The three types or classes of levers, depend on where the fulcrum and applied force is located. The mechanical advantage you can gain is to a heavy object using less force than the weight of the object, to propel an object faster by applying a force at a slower speed or to move an object further than the distance you apply to the lever. A lever does the work for you, allowing you to lift objects you'd never be able to budge by yourself.

http://www.school-for-champions.com/machines/levers.htm#.U4S25SiGeSo
http://www.discovery.com/tv-shows/mythbusters/about-this-show/physics-of-seesaws.htm (image)

Catapult Contraption

A catapult is a machine that can propel or launch an object into the air.

Your task:

You (the farmer) are in the process of cleaning up your fenced backyard so that you can plant a vegetable garden. The yard is filled with 20 heavy, large rocks. You need to move the rocks over the fence into the pond. Your job is to create a catapult that will allow you to propel the rocks over the 20 inch high fence into the pond.

The pond is surrounded by a beautiful meadow of wildflowers and lush green grass. This area is mowed twice a year, so large rocks will be a hazard to the person mowing the meadow. Therefore, you should not shoot any boulders into the meadow. If you do, you will lose 5 points for each boulder landing in the meadow. It is permissible to throw the rocks into the forest. However, you will only earn 10 points for rocks that land in that area. Your goal is to propel the rocks into the pond where you will earn 20 points each time you hit the target. Rocks that do not make it over the fence earn no points. Rocks that go out of bounds will deduct 15 points from your total. The team accumulating the most points after 20 trials will be declared the winner of the contest.

Restrictions:

You may only use the supplies provided in your bag.
You may not get any new supplies.
You do not have to use all of your supplies.
You may test your prototype during the design process. However, you may not get additional supplies.
You may redesign/recreate your prototype.
Your catapult must be free standing.

Your Grade:

Your grade will consist of the following items:

- Design Summary
- Catapult design and prototype
- Theoretical and Experimental Probability/FDP Chart
- Frequency table and bar graph
- Variables Graphic Organizer
- Reflection Paragraph

Your work will be evaluated using the attached rubric.

Let's Research: (13 minutes)

As a group, ***read the article***, "Levers are Simple Machines" to get an idea of how a lever/catapult works.

From this article, ***outline*** on your record sheet at least 3 strategies that may be important in designing a catapult contraption that will be effective in placing your rocks into the pond.

Let's Start: (15 minutes)

1) Using your cm grid paper, ***draw*** your "playing field".

2) Calculate the ***theoretical probability*** of the rock landing in the pond, meadow, and forest.

3) Write the theoretical probability as a ***ratio in simplest form*** in the table.

4) Convert each theoretical probability into a ***decimal and a percent***.

Let's Design: (10 minutes)

5) ***Open*** your supply bag. You will have the following items:

   -2 3 x 5 index cards
   -3 large paper clips
   -10 popsicle sticks
   -10 rubber bands
   -5 coffee stirrers
   -2 straws
   -1 plastic spoon
   -1 long piece of string

   *You will need your own calculator, scissors, glue and colored pencils.

6) You will have 5 minutes to ***brainstorm possible designs*** for your catapult contraption. You may not begin building.

7) Next, your group will have 5 minutes to ***write a paragraph*** describing your design idea. Write your paragraph on your recording sheet.

Let's Build!!! (25 minutes)

8) You will have 25 minutes to create a catapult contraption that will propel your "boulder" over the fence into the "playing field".

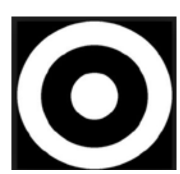
9) You may test your prototype at any time to see if it works, if it is accurate, etc.

10) You may redesign your catapult contraption at any time, but you may not have extra supplies.

Let's Try It!!! (20 minutes)

11) You will ***conduct 20 trials***.

12) ***Record your data*** on the recording sheet in the frequency table, calculating the ***cumulative frequency*** after you conduct the experiment.



Let's Calculate!!! (20 minutes)

13) Calculate the ***total points*** your team earned.

14) Calculate and record your experimental probability of the rock landing in the pond,

meadow, forest, out of bounds, and not over the fence on the table.

15) Write the experimental probability as a ***ratio in simplest form*** in the table.

16) Convert each experimental probability into a ***decimal and a percent***.

17) Using the space provided on the recording sheet, construct a bar graph that displays your data. Use colored pencils to shade the bars.

Let's Reflect: (10 minutes)

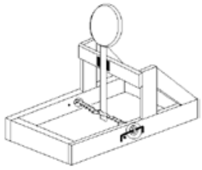
18) Think back to your design process and experiment. Discuss with your group the following:
    *Does the type/design of catapult affect the probability of hitting the target?
    *What were the constants in your catapult and experiment?
    *What was the dependent variable?
    *What was the independent variable?
    Complete the graphic organizer on your Catapult Contraption Recording Sheet.

19) Using the data you collected and your design project, each group member must write a 5-10 sentence paragraph reflecting on your results. Some thoughts to include in your essay might include:

    *I learned that ...
        *What do I know now about theoretical and experimental probability...
    *Explain how I represented my data using a bar graph
    *If I would redesign the catapult contraption again, I would...
    *Some things that I thought my group did well were...
    *What design elements worked well with our catapult contraption...
    *What went wrong with our catapult contraption and how what could I do to fix the prototype...
    *If I could use any other supplies to create my catapult contraption, I would use...
    *What would happen if we increased the number of trials to 50 or 100...

20) Draw a picture of your Catapult Contraption at the bottom of your reflection.

Name ______________________



CATAPULT CONTRAPTION RECORDING SHEET

Levers are Simple Machines

- ____
- ____
- ____
- ____
- ____

	RATIO	DECIMAL	PERCENT
Theoretical P(pond)			
Theoretical P(meadow)			
Theoretical P(forest)			
Experimental P(pond)			
Experimental P(meadow)			
Experimental P(forest)			
Experimental P(out of bounds)			
Experimental P(not over fence)			

Theoretical and Experimental Probability

Design Idea

____
____
____
____
____
____
____
____
____
____
____
____

Trials Frequency

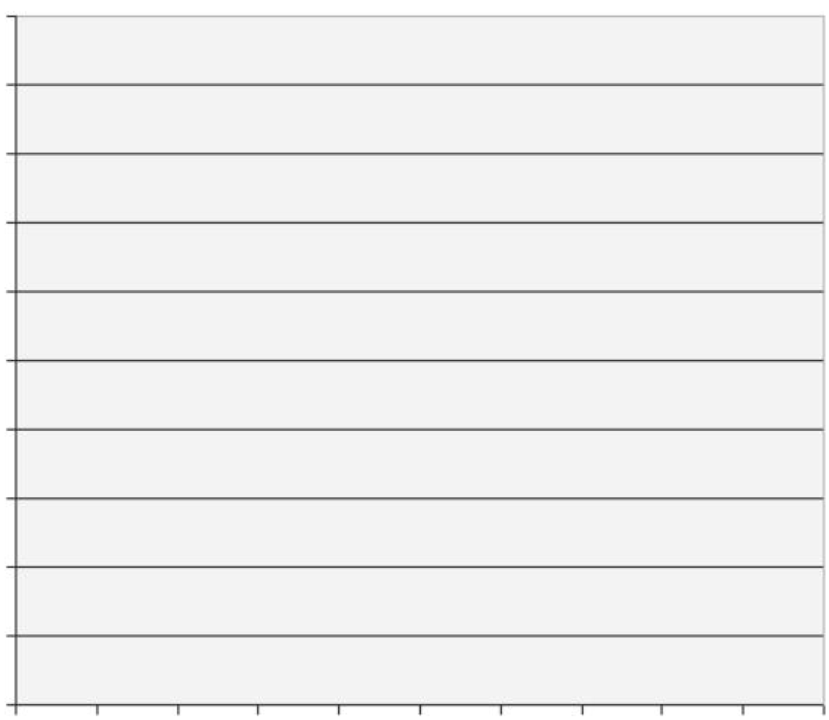
	Frequency	Cumulative Frequency
Pond (20 points)		
Meadow (-5 points)		
Forest (10 points)		
Out of Bounds (-15 points)		
Not over Fence (0 points)		

Score

Calculate the TOTAL number of points your team earned. Show your work and record your score.

Representing Data

Construct a bar graph to represent your data. Include the TITLE, a vertical axis title and a horizontal axis title. LABEL each axis. You may add rows/columns if needed.



Reflection #1

CONSTANTS	+	INDEPENDENT VARIABLE	=	DEPENDENT VARIABLE

Reflection #2

Name ______________________

CATAPULT CONTRAPTION
Rubric

Your grade will consist of your performance on the following items:

- Design Summary
- Catapult Contraption Design and Prototype
- Theoretical and Experimental Probability/FDP Chart
- Frequency Table and Bar Graph
- Variables Graphic Organizer
- Catapult Contraption Reflection

Skills	Needs Improvement 1	Partially Proficient 2	Proficient 3	Advanced 4
Design Summary: *demonstrates creativity *explains in depth design strategy *uses proper English skills				
Catapult Prototype: *utilizes materials provided *creates effective prototype *the prototype shows creativity and unique aspects				
Theoretical and Experimental Probability/FDP: *demonstrates understanding of theoretical and experimental probability *demonstrates understanding of converting FDP *simplifies ratios				
Frequency Table and Bar Graph: *demonstrates an understanding of constructing a frequency table *demonstrates an understanding of calculating cumulative frequency *constructs bar graph by accurately representing data *labels all parts of the bar graph				
Catapult Contraption Reflection: *demonstrates an understanding of data results *identifies variables in experiment *makes conclusions based on the theoretical and experimental probability *adjusts design to correct flaws in prototype *reflects on data results				

Grade ___________

Comments:

1-CENTIMETER GRID PAPER