LETTER TO PARENTS

Cut here and paste onto school letterhead before making copies.

SCIENCE NEWS

Dear Parents,

Our class is beginning a new science unit, the **FOSS Levers and Pulleys Module.** We will be studying basic concepts in mechanics, a very important subject for fields that involve engineering and design. We will be investigating the benefits of levers and pulleys, two of the six simple machines, finding out how they provide advantage to people, and how they are used in the real world.

We stick to levers and pulleys because they allow us to change part of a system and gauge that part's effect on the whole system. If you want to move a boulder with a lever, for example, where you exert the effort and place the fulcrum will make a difference in how easy the job is. A single pulley helps you move something up or down. However, the job is easier if you add another pulley or change the direction of the pull. No doubt your child will be an expert on this shortly.

Watch for the home/school connection sheets that I will be sending home from time to time. The activities described on them suggest ways you and your child can extend the inquiry into your home, neighborhood, and community. Simple machines are used all around your home and neighborhood. There are pulleys hiding in elevators and fishing poles, and levers inside staplers and scissors. Together, you can analyze the locations of the load, effort, and fulcrum (the pivot point) of levers such as can openers, baseball bats, or even your own arms. Your discoveries may start some family discussions about other simple machines around you.

We're looking forward to weeks of fun with forces and simple machines! If you have questions or comments, or have expertise you would like to share with the class, please drop me a note.

Comments ______________________________

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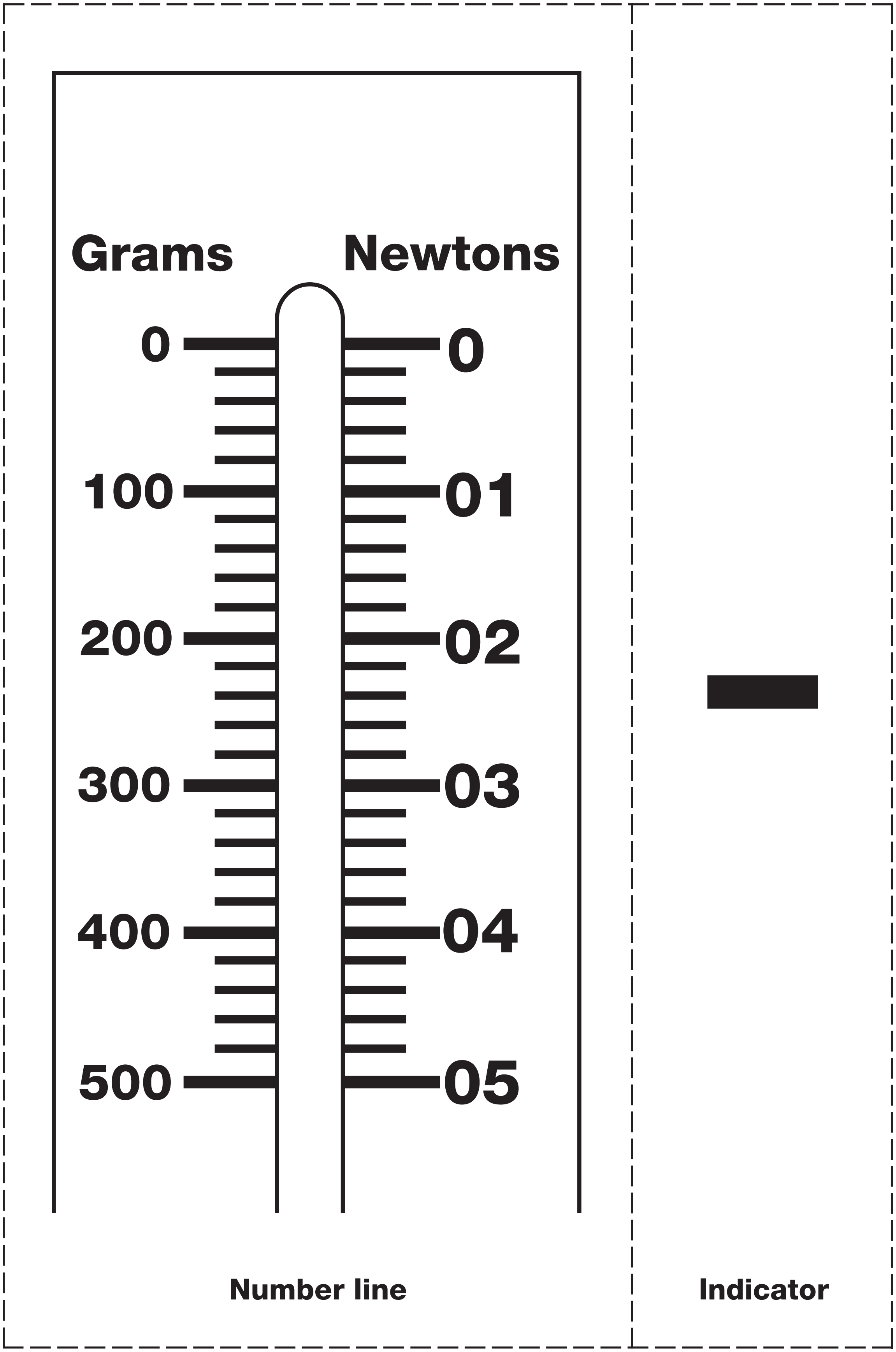
LEVERS AND PULLEYS JOURNAL

Name ____________________________________

SPRING SCALE



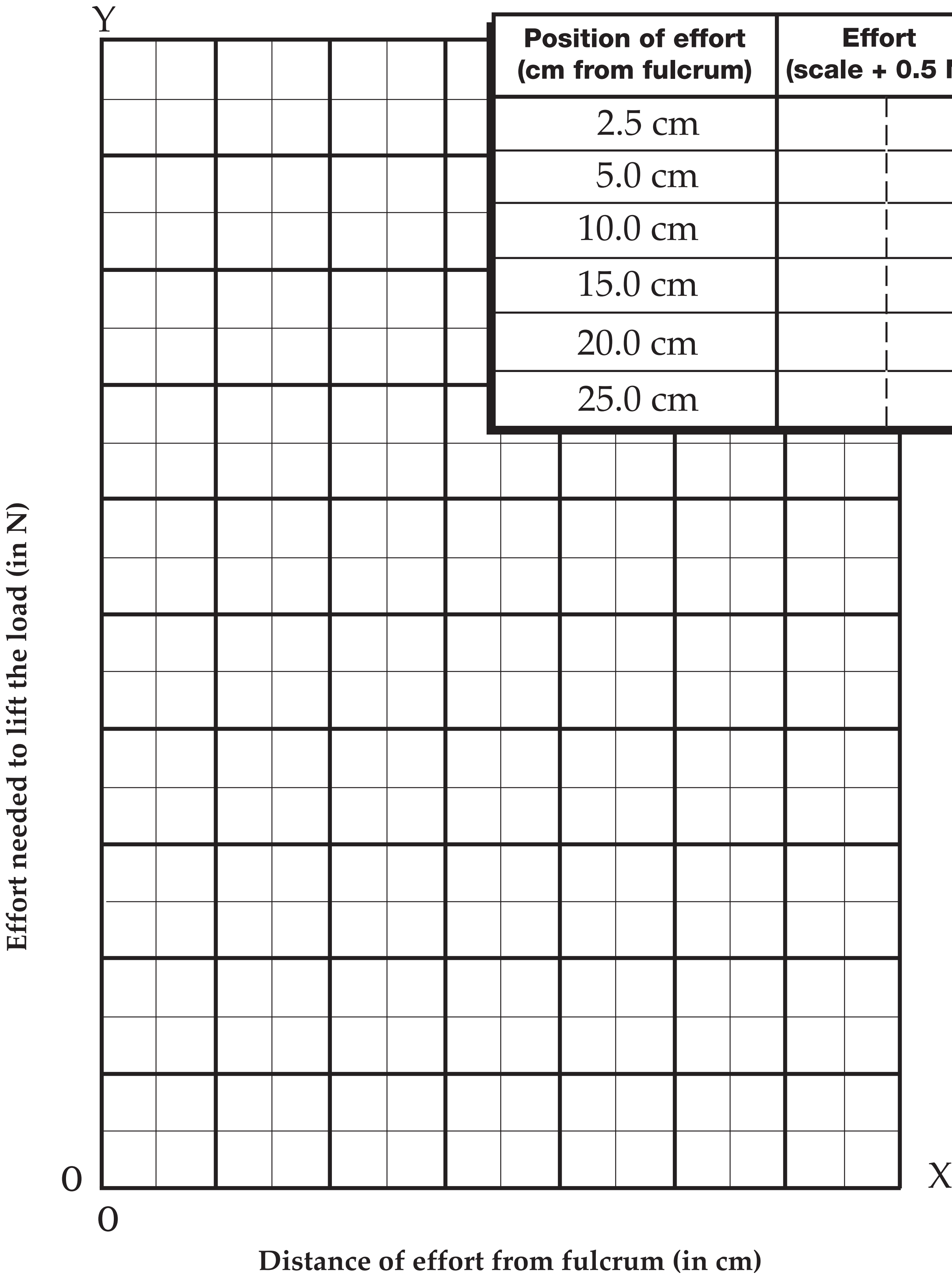
Name ______________________

Date ______________________

LEVER EXPERIMENT A

Lever experiment with LOAD positioned 10 cm from fulcrum

Position of effort (cm from fulcrum)	Effort (scale + 0.5 N)
2.5 cm	
5.0 cm	
10.0 cm	
15.0 cm	
20.0 cm	
25.0 cm	

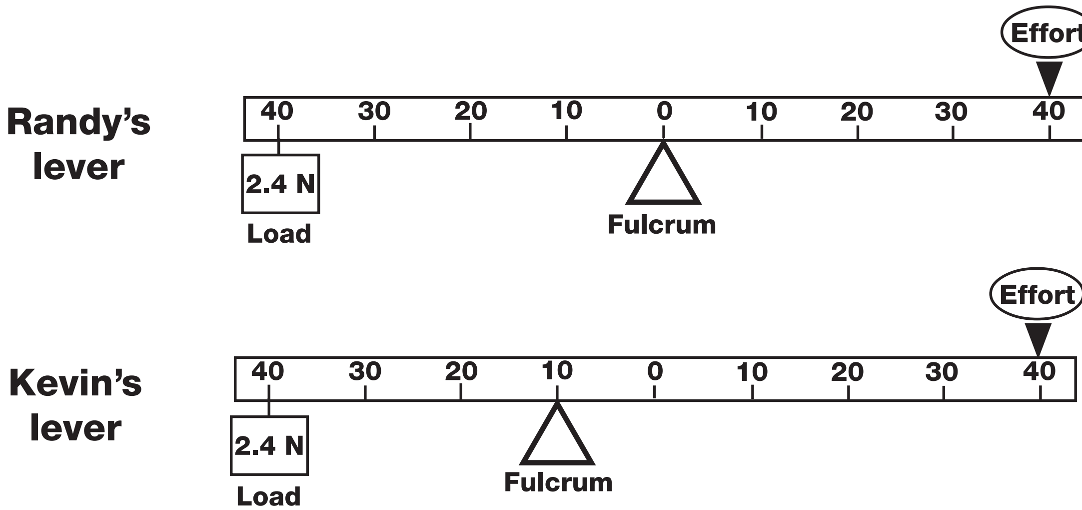


Name ______________________________

Date ______________________________

RESPONSE SHEET—LEVERS

Randy and Kevin had been working with levers for a couple of days. They were trying new ways to set up levers. They each set up a lever system. Both lever systems had the load hanging at the 40-cm position on one side, and the effort pressing at the 40-cm position on the other side.



Randy said, "Our levers are the same. They will both take the same amount of effort to lift the load."

Kevin responded, "I don't think so. One of these systems will require less effort to lift the load."

Which student do you think was right? Explain why you think so.

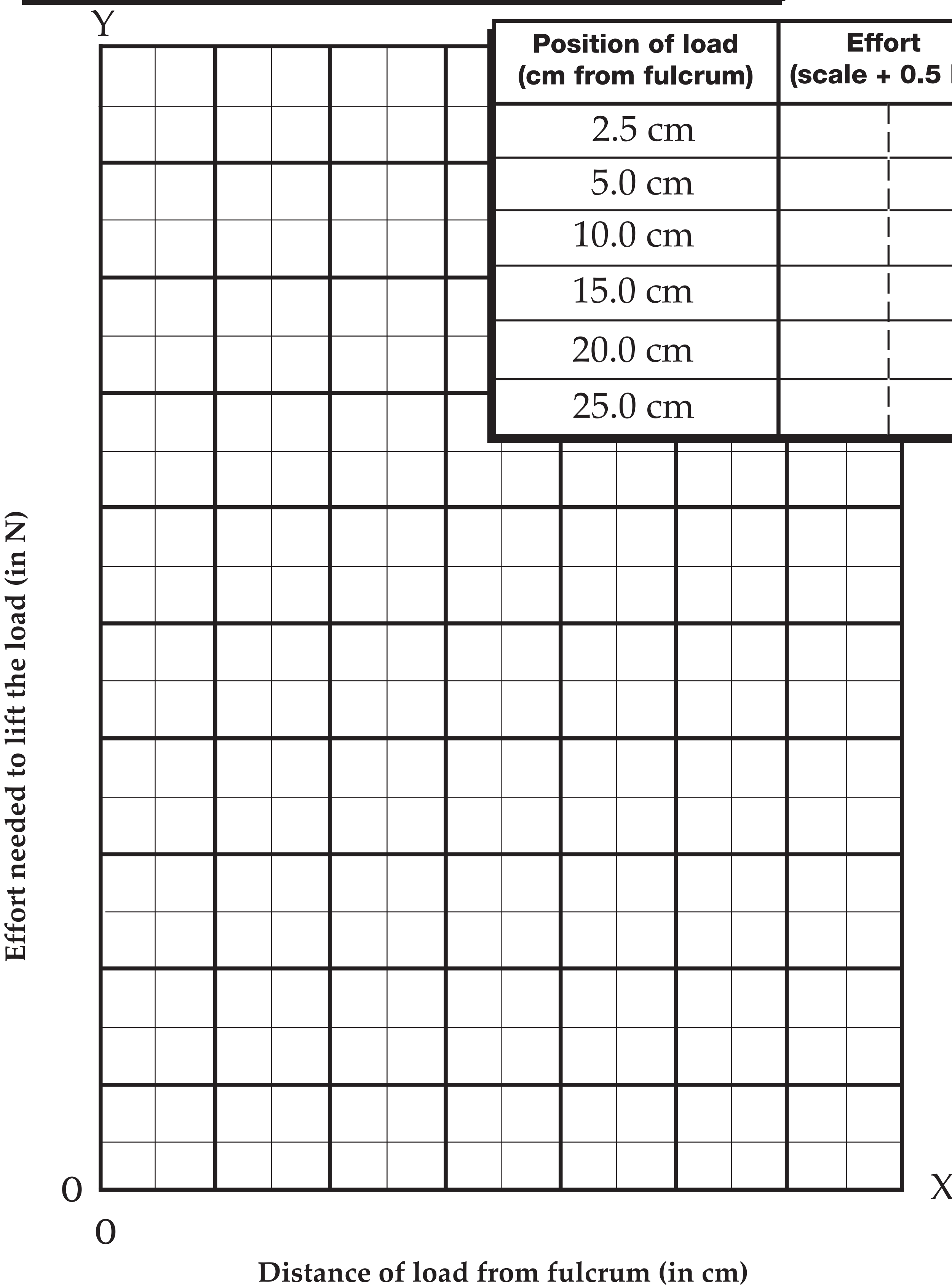
Name ____________________

Date ____________________

LEVER EXPERIMENT B

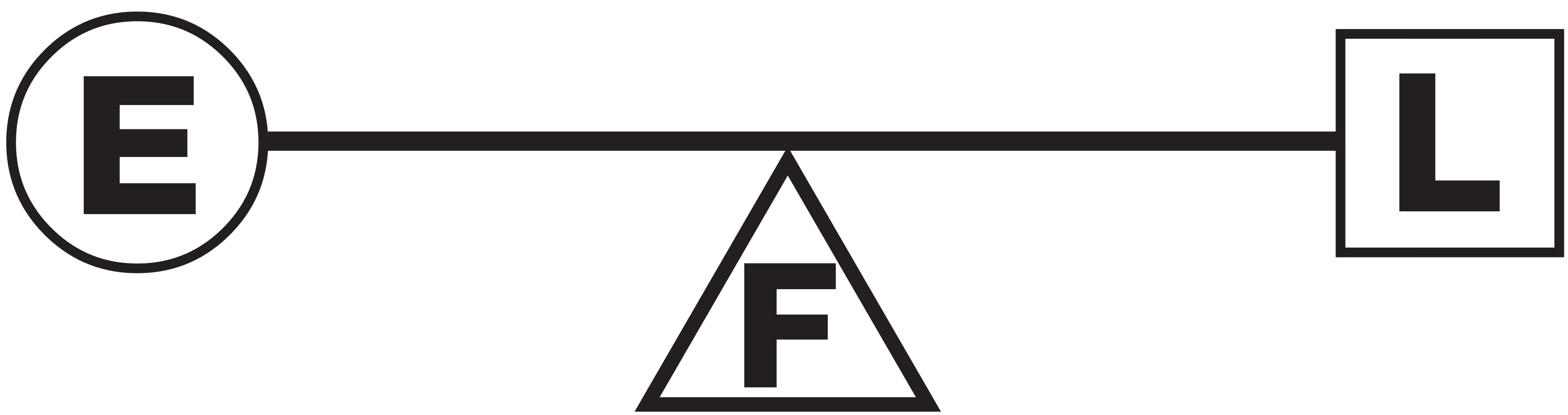
Lever experiment with EFFORT applied 10 cm from fulcrum.

Position of load (cm from fulcrum)	Effort (scale + 0.5 N)
2.5 cm	
5.0 cm	
10.0 cm	
15.0 cm	
20.0 cm	
25.0 cm	



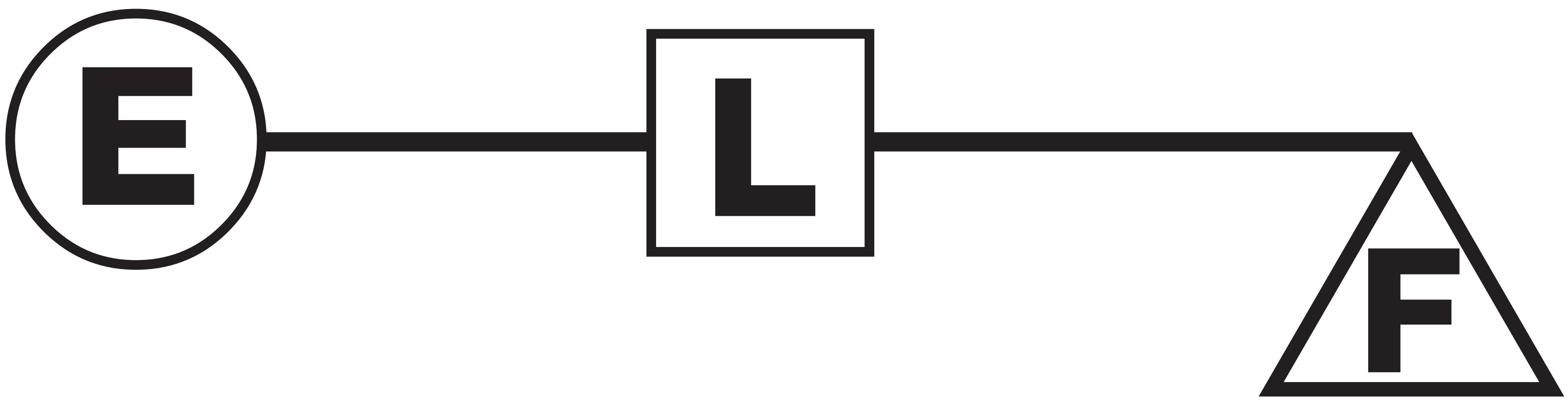
Lever Diagram

CLASS-1 LEVER



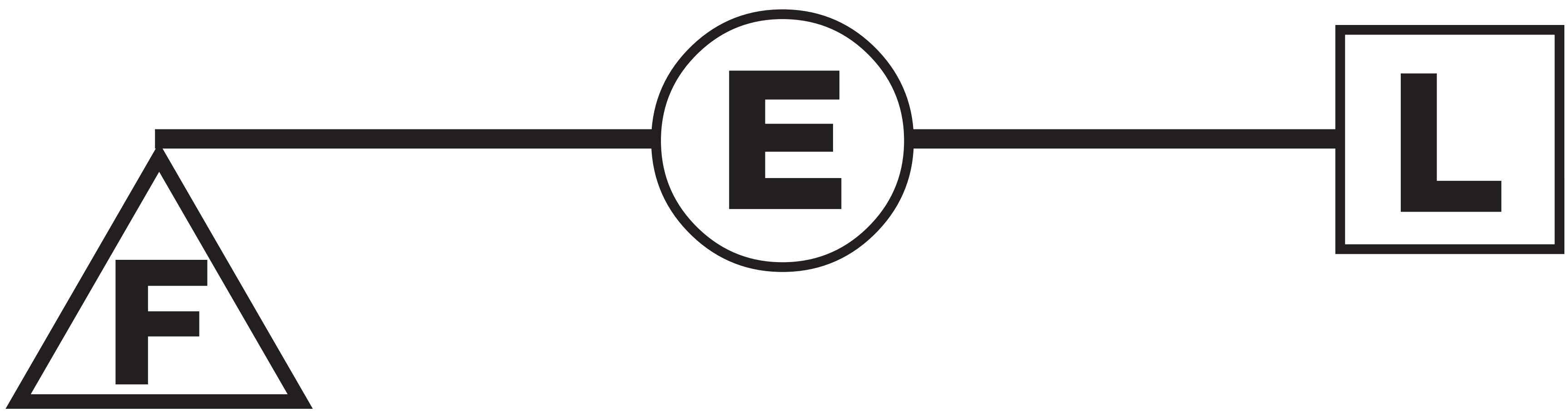
Lever Diagram

CLASS-2 LEVER



Lever Diagram

CLASS-3 LEVER



Name ______________________

Date ______________________

LEVER DIAGRAMS

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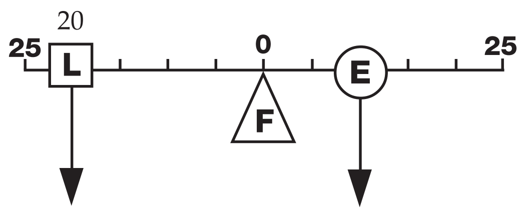

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6

7

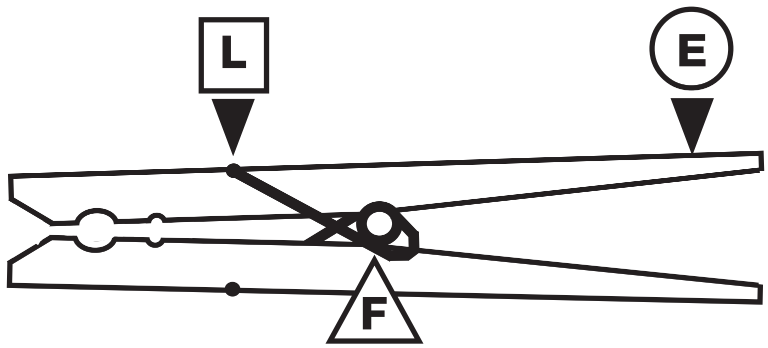
8

Name ______________________________

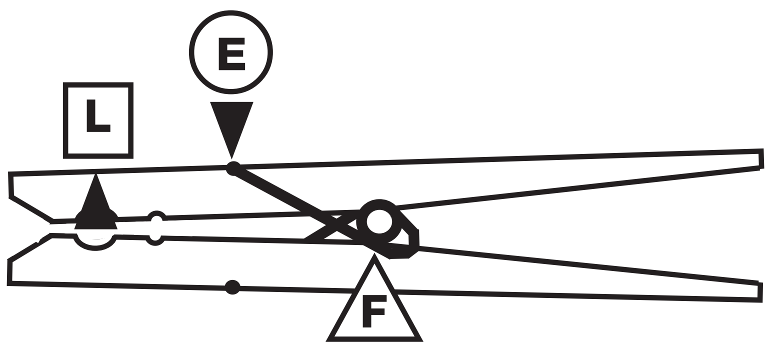
Date ______________________________

RESPONSE SHEET—MORE LEVERAGE

Millie and Jasmine were looking at a clothespin. They were pretty sure that the clothespin is a class-1 lever. They analyzed it like this.



When Carrie looked at the clothespin, she said, "When you squeeze the clothespin, it is a class-1 lever, but when it is holding clothes on the line, it is a class-3 lever." Carrie analyzed the clothespin like this.



Do you agree with the girls? Why or why not? Explain your reasoning.

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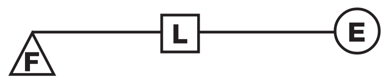
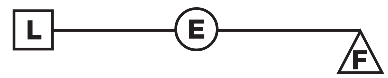
Name ____________________

Date ____________________

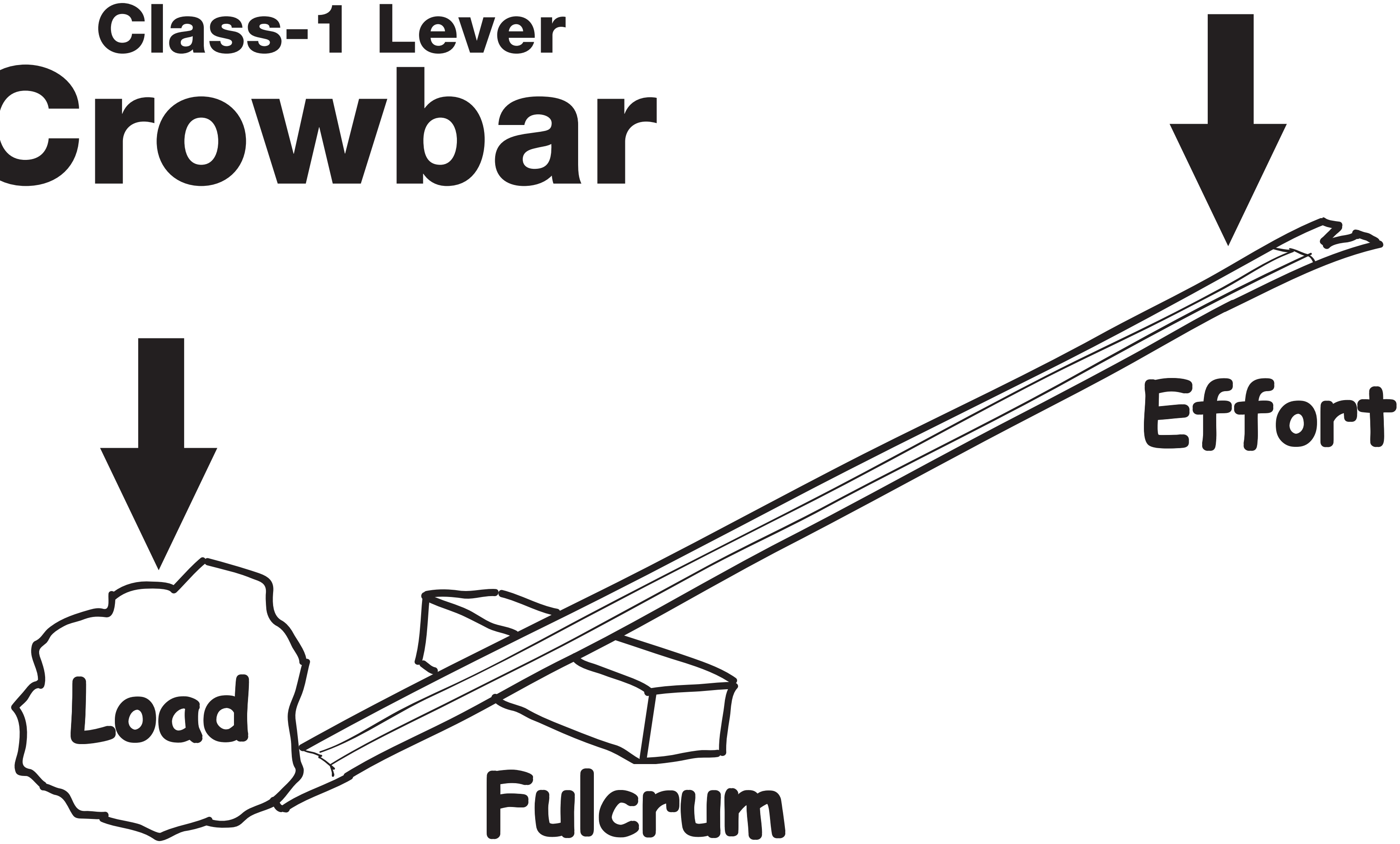
LEVERS AT WORK

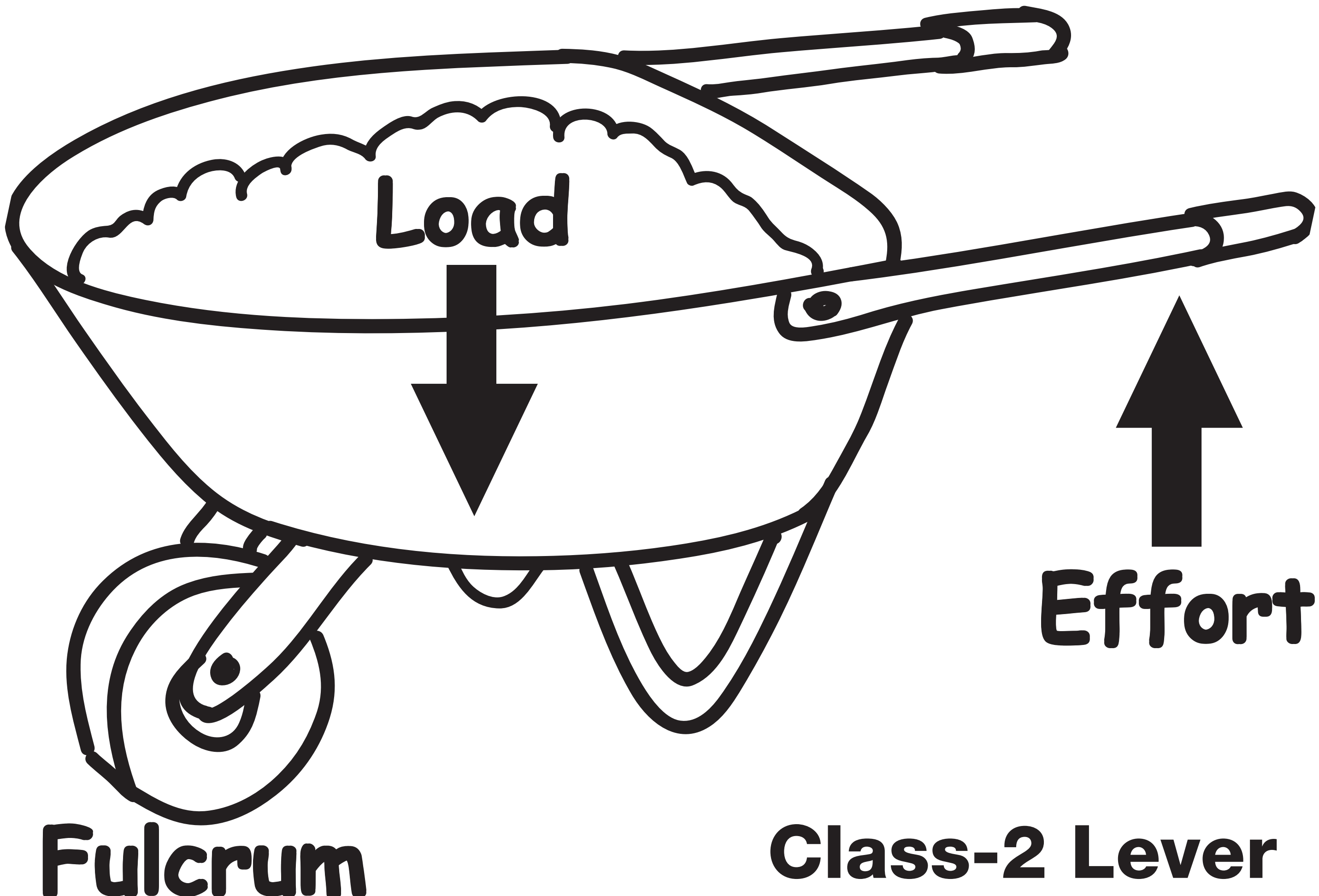
Class-1 lever	Class-2 lever	Class-3 lever
		

1 **BROOM** This is an example of a class-____ lever.	2 **NUTCRACKER** This is an example of a class-____ lever.
3 **SCISSORS** This is an example of a class-____ lever.	4 **BOTTLE OPENER** This is an example of a class-____ lever.
5 **PLIERS** This is an example of a class-____ lever.	6 **TWEEZERS** This is an example of a class-____ lever.
7 **HAMMER** This is an example of a class-____ lever.	8 **HUMAN ARM** This is an example of a class-____ lever.

Class-1 Lever

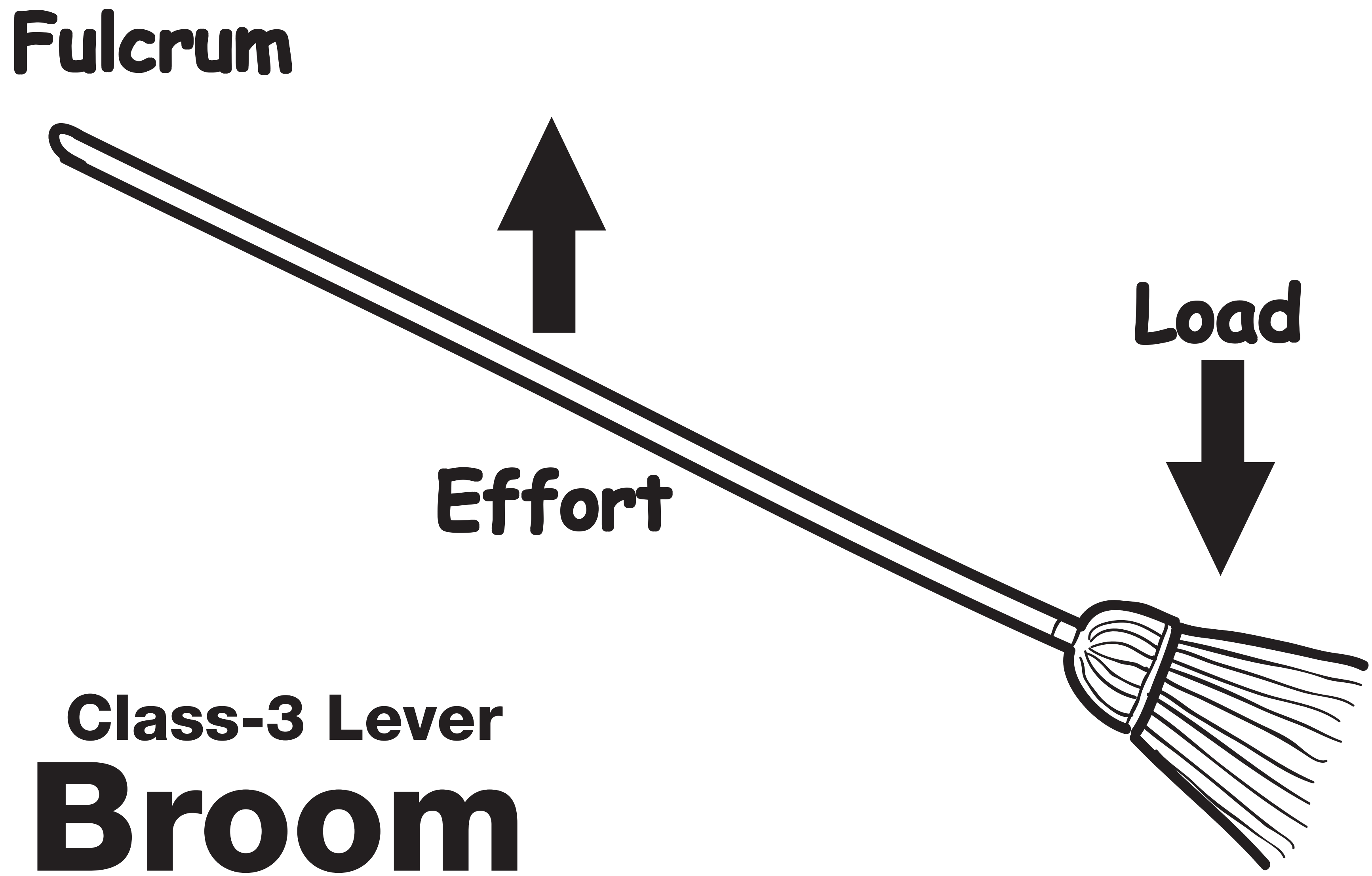
Crowbar





Class-2 Lever

Wheelbarrow



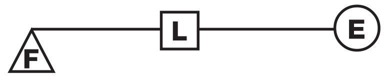
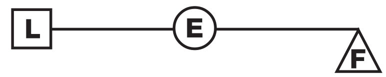
Class-3 Lever

Broom

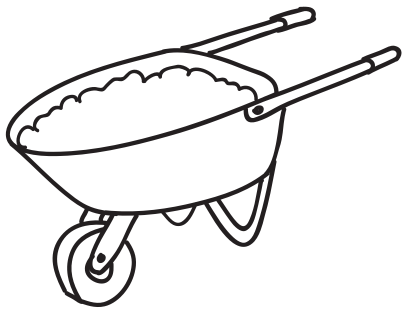
Name ____________________

Date ____________________

LEVER PICTURES A

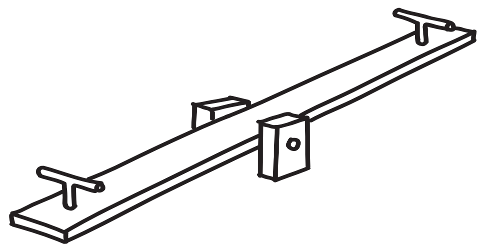
Class-1 lever	Class-2 lever	Class-3 lever
		

WHEELBARROW



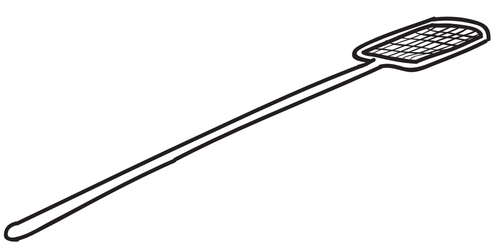
This is an example of a class- ____ lever.

TEETER-TOTTER



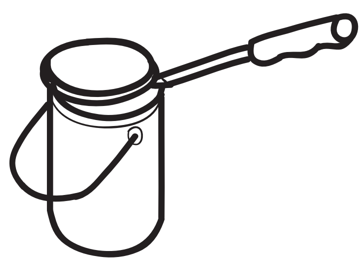
This is an example of a class- ____ lever.

FLY SWATTER



This is an example of a class- ____ lever.

PAINT-CAN OPENER

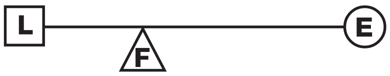
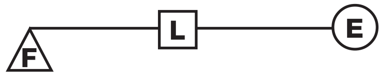
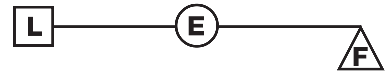


This is an example of a class- ____ lever.

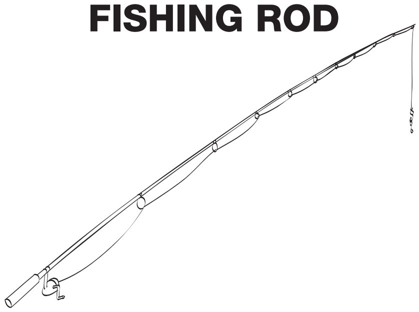
Name ______________________________

Date ______________________________

LEVER PICTURES B

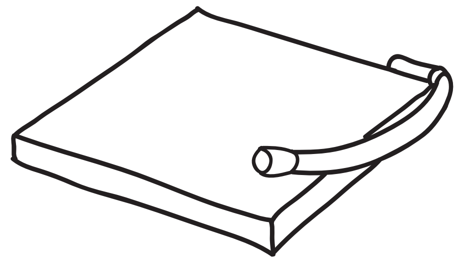
Class-1 lever	Class-2 lever	Class-3 lever
		

FISHING ROD



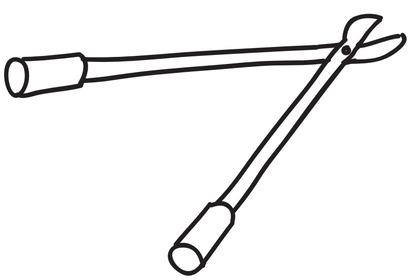
This is an example of a class- _____ lever.

PAPER CUTTER



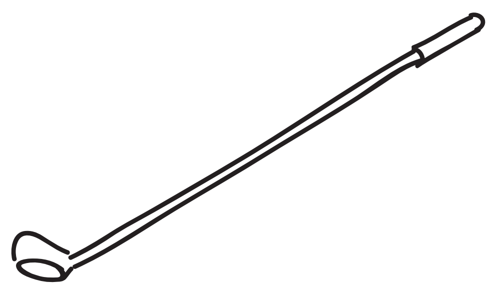
This is an example of a class- _____ lever.

TREE PRUNERS



This is an example of a class- _____ lever.

GOLF CLUB



This is an example of a class- _____ lever.

Name ______________________________

Date ______________________________

PULLEY DIAGRAMS

Part 1. One-Pulley Systems

Pulley system	Load (N)	Direction of pull	Scale reading (N)	Effort (N)
Single-fixed				
Single-movable				

What did you learn about pulleys?

____

____

____

____

Part 2. Pulley-System Diagrams

Single-fixed	**Single-movable**	**Single-fixed/ single-movable**	**Single-fixed/ single-movable**

Name ____________________

Date ____________________

RESPONSE SHEET—PULLEYS

Karl told his brother Charles, “I just couldn't lift that 30-kg bag of cement into Dad's wheelbarrow until I got a pulley and a rope. Then it was easy.”

Charles was surprised. "You got the cement into the wheelbarrow!? How did you do it? How much easier was it?"

Explain how you think Karl lifted the cement and how much effort he had to apply.

Name ____________________

Date ____________________

PULLEY DATA

Part 1

One- and two-pulley systems	Number of pulleys	Direction of effort	Load (N)	Effort (N)	Number of ropes lifting load
Single fixed pulley					
Single movable pulley					
Single fixed/ single movable pulley					
Single fixed/ single movable pulley					

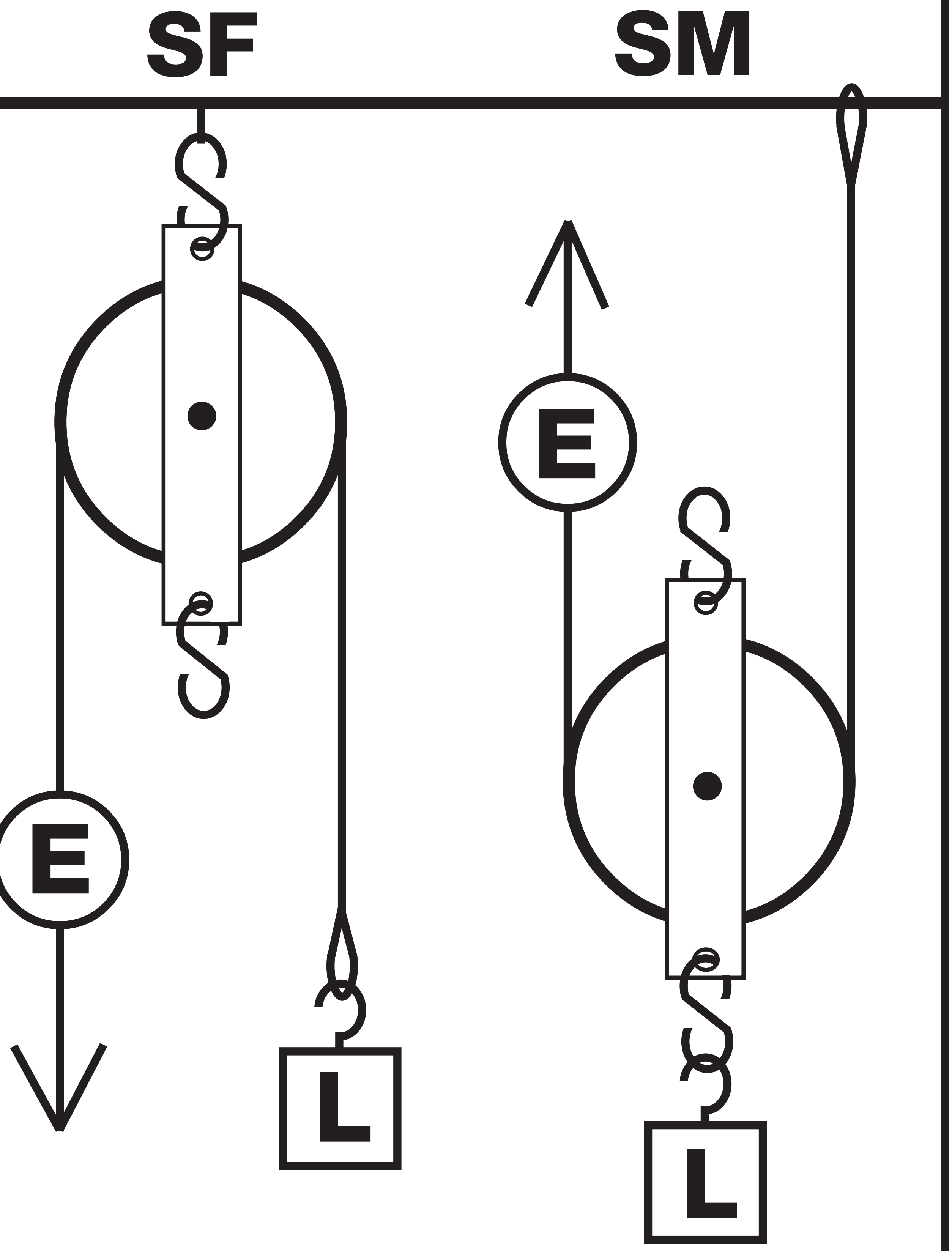
Part 2

Distance effort moved	Distance load moved

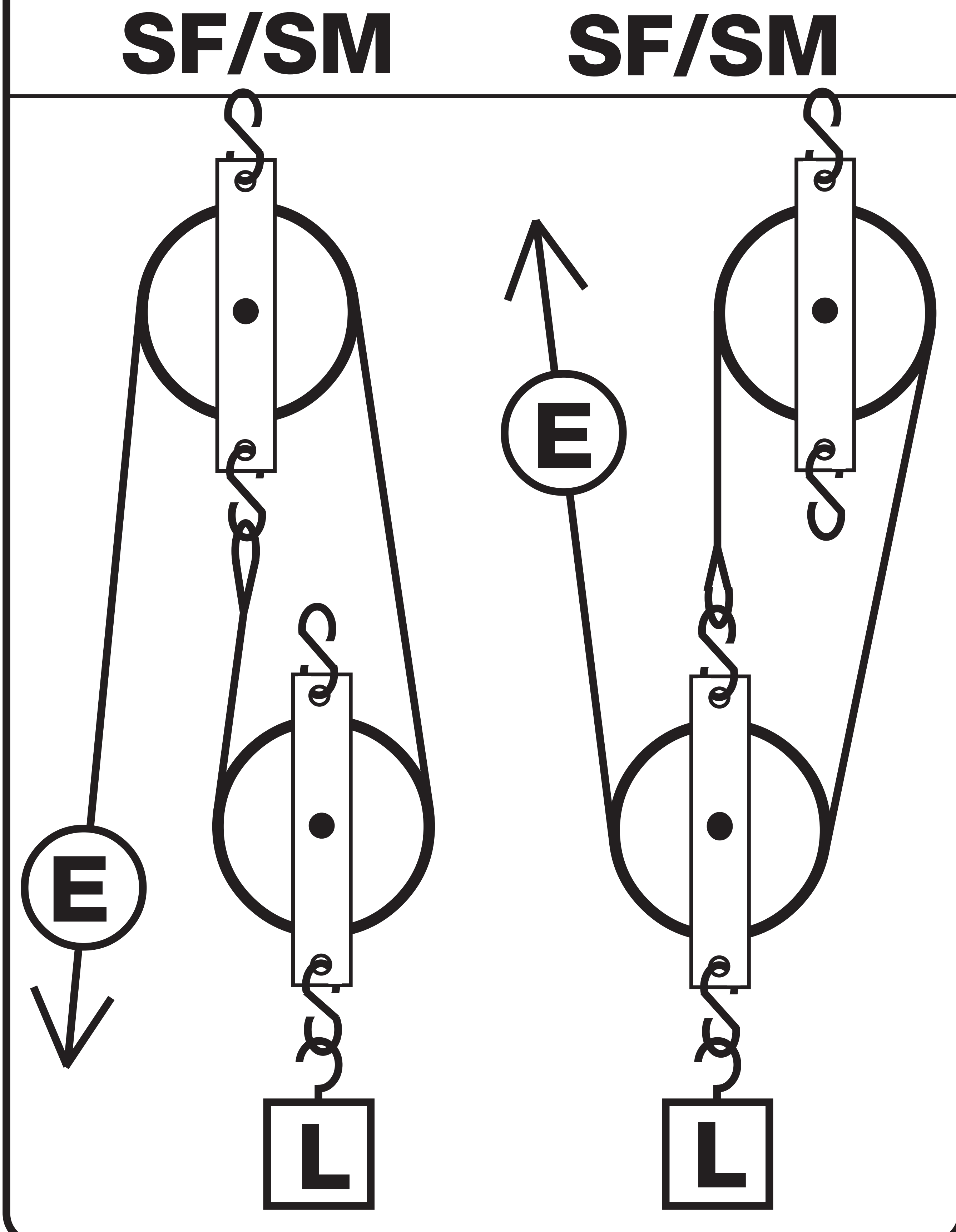
What relationships can you see in this chart? ____________________

What are the advantages and disadvantages of using pulleys? ____________________

One-Pulley Systems



Two-Pulley Systems



STARTING LINE

5 cm

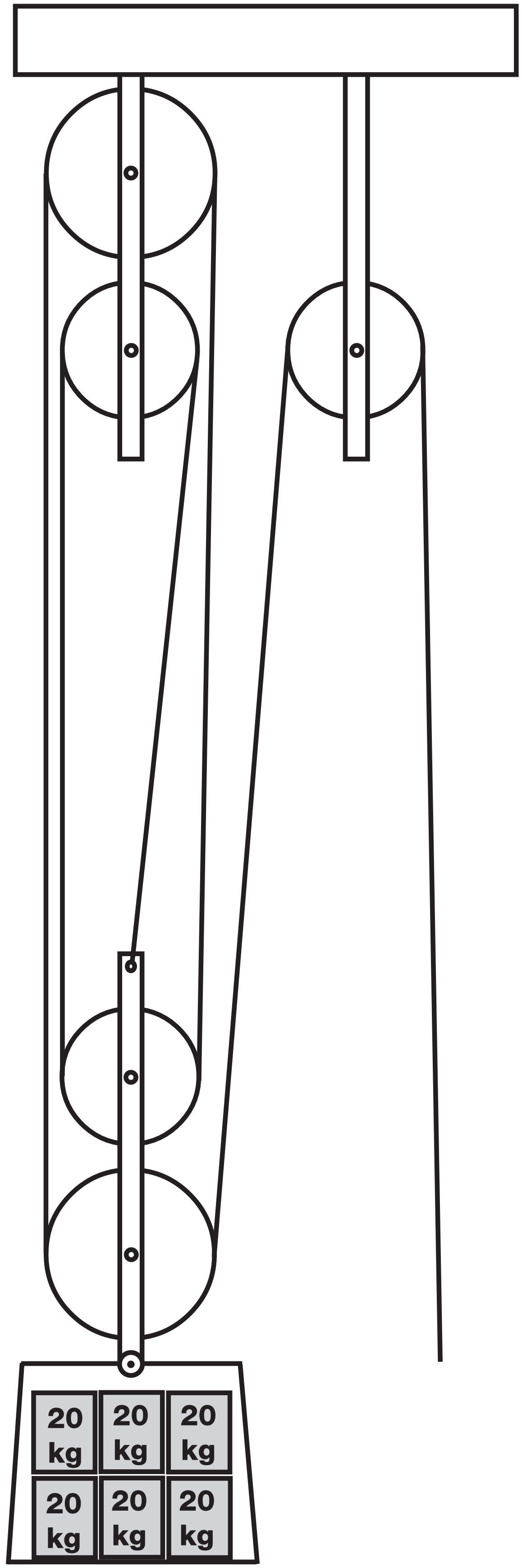
5 cm 0 cm

0 cm

Name ____________________

Date ____________________

RESPONSE SHEET—PULLEYS AT WORK



Belinda and her mother cut and polish rocks to make beautiful bookends. They pack them in crates for shipment. Each crate has a mass of 20 kg. Belinda can lift only one crate of bookends at a time up to the shipping area.

Belinda decided to put together a pulley system to lift the crates up the 2 m to the shipping area. She said,

With this system I will be able to lift six crates at a time. And there is no disadvantage. Using a pulley system is just like getting something for free.

Is Belinda right about the number of crates she will be able to lift? Is her statement right that there is no disadvantage? Explain.

Name ______________________

Date ______________________

PROJECT IDEAS

- Put the scale at the end of a class-2 lever (50 cm from the fulcrum). Find out how much effort is required to lift the load as it moves from the fulcrum to the effort in 5-cm intervals. Graph the results.
- Put the scale 10 cm from the fulcrum of a class-3 lever. Find out how much effort is required to lift the load as it moves from the position of the effort out to the end of the lever in 5-cm intervals. Graph the results.
- Create a diagram of a make-believe lever system (it can be one or more levers). Write an imaginative description of its use, name it, and draw it. Make a model of your lever system.
- Use the half-meter sticks and other materials to build a multiple-lever system where one lever acts on another to provide a double advantage. Compare the effort and load in such a system.
- Assemble pulley systems that use a single and a double pulley (two wheels), two single pulleys, and two double pulleys. (You will need an extra long rope.) Record how many different systems you discover and how much effort is required.
- Get some heavy-duty pulleys and strong rope from a hardware store. Find a place outdoors (tree limb, swing set, etc.) to secure a fixed pulley. Rig up some different pulley systems and lift a heavy load like a bucket of sand or another student. Use work gloves when you haul on the rope.
- Research the other four simple machines (wheel and axle, inclined plane, wedge, and screw) and give a short report to the class.
- A steam shovel is a compound machine made of simple machines—levers and pulleys. Research steam shovels and other machinery, analyze them in terms of simple machines, and write a report. Here are a few examples of compound machines.
  - backhoe
  - crane
  - drilling rig
  - elevator
  - hoist
  - drawbridge
  - exercise equipment
- Use centimeter graph paper to graph the results of your investigations.
  - The number of supporting ropes (x-axis) versus the effort required to lift the load.
  - The number of supporting ropes (x-axis) versus the distance the rope is pulled.
- Assemble a pulley system using two single pulleys that will give a 4:1 advantage in effort reduction. Usually 3:1 is the greatest advantage obtained from two single pulleys. The solution, called a Spanish Barton system, involves two ropes.
- Set up a lever-and-pulley system in which a pulley applies effort to one end of a lever that in turn lifts a load. Compare effort and distance.

Name ____________________

Date ____________________

PROJECT PROPOSAL

1. **What is the question or the project that you are proposing?**

2. **What materials or references will you need to complete the project?**

3. **What steps will you follow to complete the project?**

Name ______________________________

Date ______________________________

PRESENTATION GUIDELINES

You will have exactly 3 minutes to present your project to the class. In those 3 minutes you should answer these questions.

- What were you trying to find out (your question)?
- What materials or references did you need to do your project?
- What procedure did you follow to complete your project?
- What did you learn from doing your project?

When you begin speaking, you will see the *green card* held up for 2 1/2 minutes. When you see the *yellow card,* you have 30 seconds left. When you see the *red card,* it means you can finish your sentence, but you must stop within the next few seconds.

Practice your presentation so you will be sure it is at least 2 1/2 minutes long, but not more than 3 minutes long. Be sure you have included all of the information asked for above.

Name ______________________________

Date ______________________________

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Name ____________________

Date ____________________

MATH EXTENSION—PROBLEM OF THE WEEK

INVESTIGATION 1: LEVERS

Rand and Amy want to make lever arms for their class to do some lever experiments. Read the descriptions of the lever arms they want to make, and figure out what length of board they need to buy and how they should cut it up to make the lever arms.

- They want to make 18 lever arms.
- They are making equal numbers of lever arms of three sizes: short, medium, and long.
- All the lever arms are 2 cm wide.
- The long levers are three times longer than the short levers.
- The medium levers are half as long as the lengths of the long and short levers added together.
- The short lever is six times longer than it is wide.
- The board is 12 cm wide.

What length of board should they buy?

How should they cut the board?

Name ______________________________

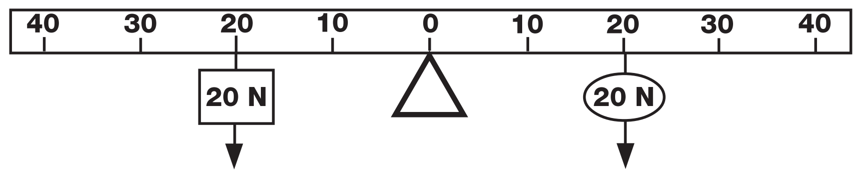
Date ______________________________

MATH EXTENSION—PROBLEM OF THE WEEK

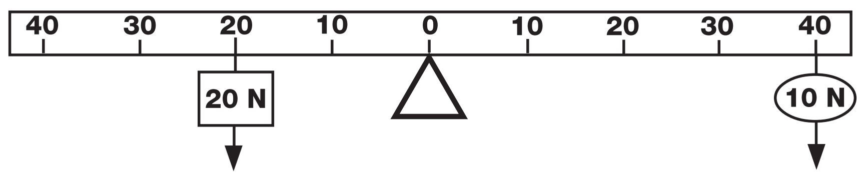
INVESTIGATION 2: MORE LEVERAGE

Buddy was working with a class-1 lever. He had a load that pulled with a force of 20 N. He did these three experiments.

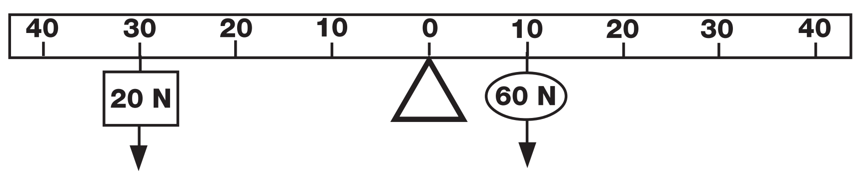
Exp. 1



Exp. 2



Exp. 3

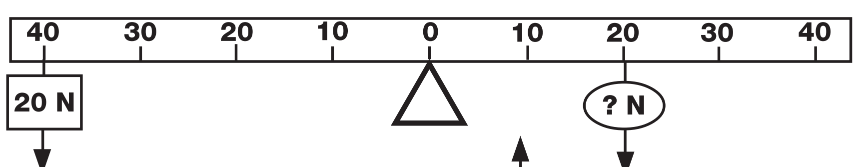


Buddy looked at experiment 1. He looked at the force of the load (20 N) and its distance from the fulcrum (20 cm). Then he looked at the force of the effort (20 N) and its distance from the fulcrum (20 cm). Everything balanced.

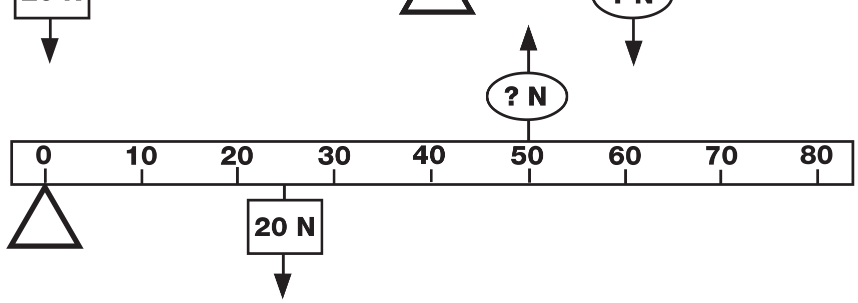
Buddy looked at experiment 2. The load was at the same location, but now the effort was only 10 N, and it was way out at 40 cm. And everything still balanced.

Suddenly Buddy saw something that he thought might be important. He said, "I bet if I move the load 30 cm from the fulcrum, and put the effort 10 cm from the fulcrum, I will have to use an effort of 60 N to lift the load!" He set up experiment 3 and discovered that he was right. What did Buddy figure out? Can you predict the effort needed to lift the load on the levers below?

Exp. 4



Exp. 5

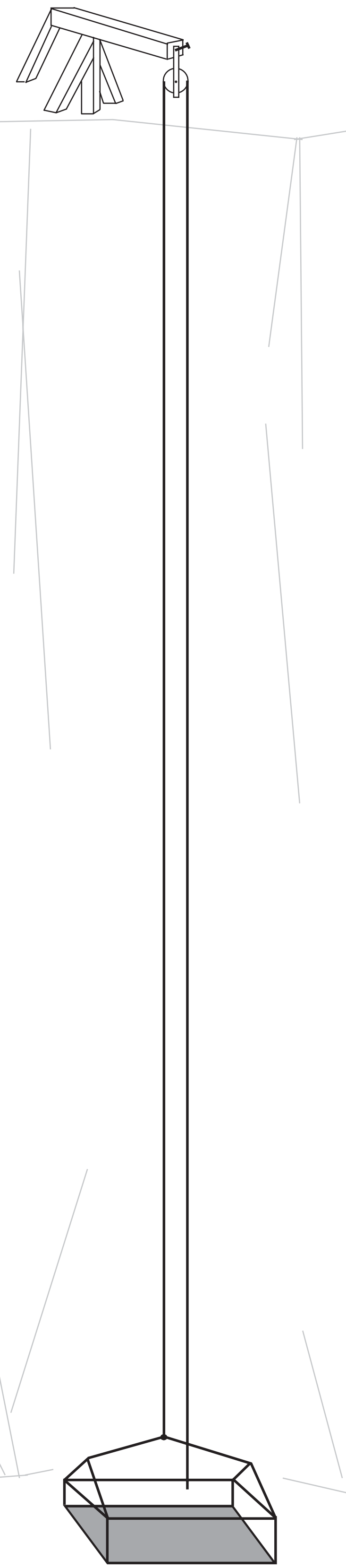


Name ______________________

Date ______________________

MATH EXTENSION—PROBLEM OF THE WEEK

INVESTIGATION 3: PULLEYS



...and then they came to the cliff. A rope was hanging from a single pulley, with a platform attached to the end of the rope. There was no other way up. How would Julie, her mom, her uncle, and her grandfather get to the top of the cliff with Sparky the pony?

Julie had studied pulleys in science. She thought about the problem for about 10 minutes and came up with a plan. Can you figure out how to get the whole troop up the cliff? What is the fewest number of lifts that can get the job done?

	Weight	**Pulling power**
Platform	250 N	0 N
Sparky the pony	2000 N	1800 N
Uncle Pete	1000 N	600 N
Gramps	750 N	300 N
Mom	500 N	250 N
Julie	300 N	100 N

HINT: Julie knew that, if a person could get to the top of the cliff where the pulley was attached, the pulley system could be changed.

Name ______________________________

Date ______________________________

MATH EXTENSION—PROBLEM OF THE WEEK

INVESTIGATION 4: PULLEYS AT WORK

Ted and Jan were working on a search-and-rescue team that needed to lower an injured climber down a 20-m cliff. Ted was at the top of the cliff; Jan was at the bottom of the cliff. The injured climber weighed 720 N. They have two pulleys and three ropes in their rescue kit. The ropes are 50 m, 65 m, and 80 m.

Scenario A. Ted is going to attach the injured climber to the pulley system and lower him to Jan.

- How should they set up their pulleys so Ted can lower the climber using as little effort as possible? ______________________________
- How much effort will Ted have to use? ______________________________
- Which is the shortest of their ropes they can use for the job? ______________________________
- What is the mechanical advantage? ______________________________

Scenario B. Ted is going to attach the injured climber to the pulley system, and Jan is going to lower the climber from her position at the bottom of the cliff.

- How should they set up their pulleys so Jan can lower the climber using as little effort as possible? ______________________________
- How much effort will Jan have to use? ______________________________
- Which is the shortest of their ropes they can use for the job? ______________________________
- What is the mechanical advantage? ______________________________

NOTE: Mechanical advantage $= \frac{\text{Load}}{\text{Effort}}$

Name ______________________

Date ______________________

HOME/SCHOOL CONNECTION

INVESTIGATION 1: LEVERS

The levers we are studying in class are examples of simple machines. Simple machines are used in many tools, appliances, and complex machines. Simple machines provide us with some advantage. Usually they make work easier, but sometimes they provide other advantages. There are six simple machines in all: lever, pulley, wheel and axle, inclined plane, wedge, and screw.

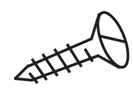
Three of these simple machines are somewhat related, the inclined plane, the wedge, and the screw. An inclined plane is a slope or ramp; a wedge is a modified inclined plane used to insert, open, or pierce; and a screw is an inclined plane spiraled around an axis.

Here's your challenge. Look around your home and neighborhood to see where you can find examples of these three simple machines. Look in tool drawers, kitchens (particularly at utensils), and cars. See how many examples you can list in the spaces below.

Inclined plane

Wedge

Screw



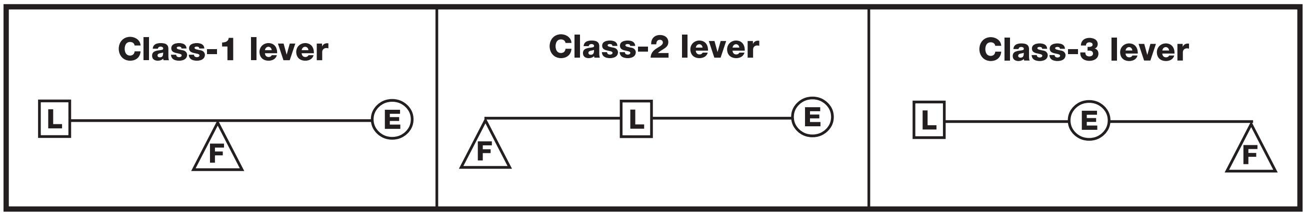
Inclined plane	Wedge	Screw
Curb cut	Ax	Nut and bolt
	Nail	Jar lid

Name ______________________________

Date ______________________________

HOME/SCHOOL CONNECTION

INVESTIGATION 2: MORE LEVERAGE



Levers are everywhere. You can find them at work in tools, construction machinery, sports equipment, kitchen utensils, and the bodies of humans and other animals.

Levers come in three classes. The class of lever is determined by the relationship of the fulcrum (pivot point), load (weight to be lifted or resistance to be overcome), and effort.

Look through some magazines, catalogs, or newspapers for examples of levers at work in the real world. Try to find at least one picture of each class of lever. The pictures will be fun to share at school.

Name ____________________

Date ____________________

HOME/SCHOOL CONNECTION

INVESTIGATION 3: PULLEYS

Here's an old parlor stunt that should be fun to try on friends.

Get a length of lightweight rope. Fifteen meters would be a good length, but a shorter length will probably work. Nylon cord is good because it is fairly smooth. You will also need a couple of brooms or mops. Any long, smooth stick will do.

Get two or more people to hold each stick while you lace the two sticks together, as shown in the illustration. Start by tying the rope to one of the sticks. Then wrap the rope around the two sticks.

Challenge the two teams to pull on the sticks to keep them from coming together. When everyone is ready, start pulling on the loose end of your rope. Are the teams able to resist the force pulling them together? How many turns of rope do you need in order to overcome the resistance of your opponents?

This is actually a kind of pulley system. Can you figure out the mechanical advantage?