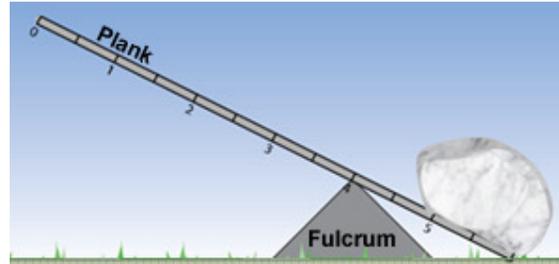Name: _____   Date: _____

Student Exploration: Levers

Vocabulary: effort, first-class lever, fulcrum, lever, load, mechanical advantage, second-class lever, third-class lever

Prior Knowledge Questions
(Do these BEFORE using the Gizmo.)

1. A **lever** is a rigid plank or bar that pivots on a **fulcrum**. Look at the lever in the picture. Where would you push on the lever to lift the rock?

_____

2. Where are some places that you see levers in everyday life? _____

_____

Gizmo Warm-up

1. In the *Levers* Gizmo™, the strongman tries to lift animals by pushing down or pulling up on the lever. The force of his push or pull is the **effort** The weight of the animal is the **load**. Both forces are measured in newtons.
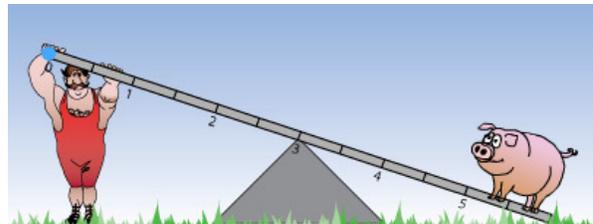
   - You can move the **fulcrum** to the left or right by dragging it.
   - You can drag **animals** to any spot on the lever.
   - You can move the **strongman** by dragging him.
   - You can change the strongman's **Effort** with the slider.

2. Drag the **pig** to the lever. Try to arrange the lever so that the strongman can lift the pig. What did you do so that he could lift it?

_____

3. Did the strongman pull up or push down to lift the pig? _____

4. How much effort was needed to lift the pig? _____

| **Activity A:**

 First-class levers | Get the Gizmo ready:
 • Remove the **pig** from the lever.
 • Drag the **turkey** onto the lever. | |
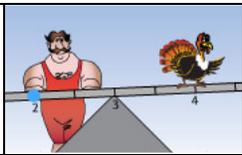
Question: In a first-class lever, the fulcrum is between the effort (strongman) and the load (turkey). How are first-class levers helpful?

1. Observe: Place the **turkey**, **strongman**, and **fulcrum** at a variety of positions. Each time, pay attention to the smallest amount of **Effort** needed to lift the turkey. (Note: The lever itself has a weight of 10 newtons.)

2. Form hypothesis: When does a lever make it easiest to lift the turkey? _____

_____

3. Experiment: Place the **fulcrum** at position 3, the **turkey** at position 4, and the **strongman** at position 2. Slowly increase the **Effort** until the turkey is lifted.

    A. What is the smallest force that can lift the turkey? _____

    B. How does this effort compare to the turkey's weight? _____

4. Revise and repeat: Move the **strongman** further away from the **fulcrum** and lift the **turkey**.

    A. What is the smallest force that can lift the turkey now? _____

    B. Which moves more, the turkey or the strongman's hands? _____

5. Draw conclusions:

    A. How does a first-class lever help you lift a turkey? _____

    _____

    B. What is the "price" that you pay for using less force? _____

    _____

6. Predict: What will happen if the turkey is farther from the fulcrum than the strongman?

_____

7. Test: Check your prediction using the Gizmo. Were you correct? _____

Activity B: Mechanical advantage	Get the Gizmo ready: • Turn on **Show grid**. • Place the **fulcrum** at position 5. • Drag the **sheep** to position 6.	
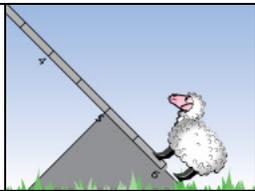
Question: How are forces and distances related?

1. Observe: Move the **strongman** to a few places on the lever and find the smallest effort

   needed to lift the **sheep** at each place. What do you notice? _____

   _____

2. Form hypothesis: As the strongman gets further from the fulcrum, what happens to the effort

   needed to lift the sheep? _____

3. Experiment: Place the **strongman** at position 3. He is now 2 meters from the fulcrum. Find
   the *smallest* effort needed to lift the **sheep**. Record it in the table below. Repeat with the
   strongman at a distance of 3 meters and 4 meters from the fulcrum. (Positions 2 and 1.)

Distance from fulcrum to sheep	Distance from Fulcrum to strongman	Smallest effort needed to lift a 1200 N sheep
1 meter	2 meters	
1 meter	3 meters	
1 meter	4 meters	

4. Analyze: When the strongman's distance from the fulcrum is doubled (like from 2 m to 4 m),

   what happens to his effort needed to lift the sheep? _____

5. Calculate: The **mechanical advantage** of a lever is how much it multiplies your effort. If you
   can lift a 1200-N sheep with only 600 N of effort, the lever doubled your effort, so its
   mechanical advantage is 2. (Notice you can just divide load by effort: 1200 ÷ 600 = 2.)

   Calculate the mechanical advantage of the lever with the strongman at each distance:

   2 meters: _____   3 meters: _____   4 meters: _____

6. Predict: What force will the strongman need when he's 5 m from the fulcrum? _____

   Test your prediction using the Gizmo. Were you correct? _____

| **Activity C:**

Second- and third-class levers | Get the Gizmo ready:

• Place the **fulcrum** at position 6. | |

Question: So far, you have studied first-class levers. How do other kinds of levers work?

1. <u>Set up Gizmo</u>: In a **second-class lever**, the load is between the fulcrum and the effort. Set up a second-class lever with the **turkey** between the fulcrum and the strongman.

2. <u>Run Gizmo</u>: Find the smallest effort to lift the turkey using a second-class lever. How does

   this effort compare to the load? _____

3. <u>Observe</u>: Does the strongman push this lever up or down to lift the turkey? _____

4. <u>Experiment</u>: With the **fulcrum** still at position 6, put the **turkey** at position 3 and the **strongman** at position 0. Find the smallest force needed to lift the turkey.

   A. What was the force needed to lift the 100-N turkey? _____

   B. What is the mechanical advantage of this lever? _____

5. <u>Set up Gizmo</u>: In a **third-class lever**, the effort is between the fulcrum and the load. Set up a third-class lever with the **strongman** between the **turkey** and the **fulcrum**.

6. <u>Run Gizmo</u>: Find the smallest effort to lift the turkey using a third-class lever.

   A. Is the effort larger or smaller than the load? _____

   B. How far was the turkey lifted compared to the strongman's hands? _____

   _____

7. <u>Predict</u>: Do you think you can lift the pig with a second-class lever? _____

   How about a third-class lever? _____

8. <u>Challenge</u>: Try to lift the pig using second-class and third-class levers. Describe your results.

   _____

   _____