

Name: _____

Date: _____

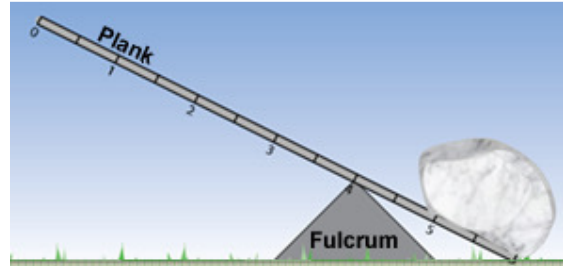
Student Exploration: Levers

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.)

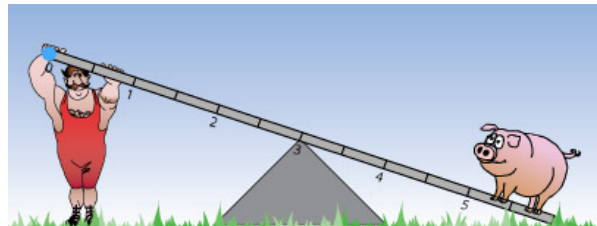
1. A **lever** is a rigid plank or bar that pivots on a **fulcrum**. Look at the lever in the picture. Where would you push on the lever to lift the rock? _____



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

Gizmo Warm-up

1. In the *Levers Gizmo*TM, 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.

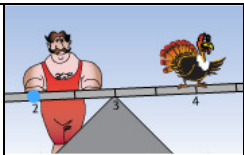


- You can move the **fulcrum** to the left or right by dragging it.
- You can drag **animals** to any spot on the lever.
- You can move the **strongman** by dragging him.
- You can change the strongman's **Effort** with the slider.

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	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> Remove the pig from the lever. Drag the turkey onto the lever. 	
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Question: In a first-class lever, the fulcrum is between the effort (strongman) and the load (turkey). How are first-class levers helpful?

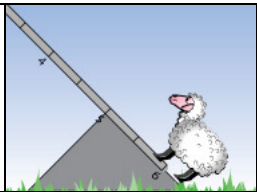
- Observe: Place the **turkey**, **strongman**, and **fulcrum** at a variety of positions. Each time, pay attention to the smallest amount of **Effort** needed to lift the turkey. (Note: The lever itself has a weight of 10 newtons.)
- Form hypothesis: When does a lever make it easiest to lift the turkey? _____

- 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.
 - What is the smallest force that can lift the turkey? _____
 - How does this effort compare to the turkey's weight? _____
- Revise and repeat: Move the **strongman** further away from the **fulcrum** and lift the **turkey**.
 - What is the smallest force that can lift the turkey now? _____
 - Which moves more, the turkey or the strongman's hands? _____
- Draw conclusions:
 - How does a first-class lever help you lift a turkey? _____

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

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

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

Activity B: Mechanical advantage	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Turn on Show grid. • Place the fulcrum at position 5. • Drag the sheep to position 6. 	
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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: $1200 \div 600 = 2$.)

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

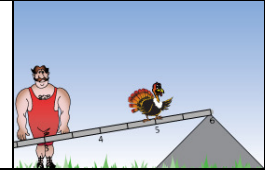
2 meters: _____ 3 meters: _____ 4 meters: _____

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. Set up Gizmo: 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. Run Gizmo: Find the smallest effort to lift the turkey using a second-class lever. How does this effort compare to the load? _____
3. Observe: Does the strongman push this lever up or down to lift the turkey? _____
4. Experiment: 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. Set up Gizmo: 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. Run Gizmo: 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. Predict: Do you think you can lift the pig with a second-class lever? _____
How about a third-class lever? _____
8. Challenge: Try to lift the pig using second-class and third-class levers. Describe your results.

