

SECTION 3.3 INTRODUCTION

3.3 Explain

◀ 1 class period*

Create an Explanation for How a Lever Changes a Force**Overview**

Students work with their groups to create explanations about levers based on their investigation. Students may include some of their science knowledge about simple machines, but nothing specific to levers. Their explanations will primarily be conclusions supported by evidence from their experiments. Students should include a partial force diagram in their explanation. Students will learn more about the science of levers in a later section and then will revise their explanations. Together, the class discusses the explanations, deciding what claims are trustworthy and what evidence they can use to support them. Through the discussion they create and record a class explanation.

*A class period is considered to be one 40 to 50 minute class.

Targeted Concepts, Skills, and Nature of Science	Performance Expectations
Scientists often work together and then share their findings. Sharing findings makes new information available and helps scientists refine their ideas and build on others' ideas. When another person's or group's idea is used, credit needs to be given.	Students collaborate to create a class explanation based on all groups' explanations.
Scientists must keep clear, accurate, and descriptive records of what they do so they can share their work with others and consider what they did, why they did it, and what they want to do next.	Students use their records of observations and analysis from the previous section to write an explanation. They also record their explanation, which they will revise later.
Scientists make claims (conclusions) based on evidence obtained (trends in data) from reliable investigations.	Students use the data and graphs from their investigations to make claims.
Explanations are claims supported by evidence, accepted ideas, and facts.	Students use evidence from their investigation and science knowledge to construct an explanation about levers. Their explanation includes a force diagram.

Targeted Concepts, Skills, and Nature of Science	Performance Expectations
When the forces exerted on an object are unbalanced, the speed and/or direction of the object will change, otherwise there is no change in motion.	Students draw force diagrams to support their explanations.
There are six different simple machines all of which provide mechanical advantage: Inclined plane, wedge, screw, wheel and axle, lever, and pulley.	Students should describe the lever within their explanations.
Machines provide mechanical advantage to assist in moving objects. Mechanical advantage is the tradeoff between force and distance.	Students should describe the properties of mechanical advantage specific to the lever in their explanations.

Materials

1 per student

Create Your Explanation page

Homework Options

Reflection

- **Science Content:** What evidence did you use to support your claims? *(Students should have used the measurements of how much force was required to lift a load straight up and using the lever with three different positions of the fulcrum and of how far they had to move the load to get it to a certain height lifting straight up and for the lever with the three different positions of the fulcrum.)*

Preparation for 3.4

- **Science Content:** How could the lever help solve the challenge of lifting the crate to the top of the cliff? *(Students should list an idea of how to incorporate the lever into their design of the challenge.)*

SECTION 3.3 IMPLEMENTATION

3.3 Explain**Create an Explanation for How a Lever Changes a Force**

The purpose of a science explanation is to help others understand what was learned from a set of investigations and how the scientist reached this conclusion.

Later, other scientists will use these explanations to help them explain other phenomena and predict what will happen in other situations.

You will do the same thing now. Your claim will be the trend you found in your lever investigation. You will use data you collected and previous science knowledge you have to create a good explanation. It should describe how the applied force changes as the fulcrum is moved closer to the weight. You should also describe the relationship between the applied force and the distance the lever must be moved.

Because your understanding of the science of forces and levers is not complete, you may not be able to write a full explanation. Do your best based on what you understand now. As you learn more, you can make your explanation better.

Explain

Recall that an explanation is made up of three parts:

- Claim – a statement of what you understand or a conclusion that you have reached from an investigation or set of investigations
- Evidence – data collected during investigations and trends in that data
- Science knowledge – knowledge about how things work. You may have learned this through reading, talking to an expert, discussion, or other experiences.

An explanation is a statement that connects the claim to the evidence and science knowledge in a logical way. A good explanation will convince somebody that the claim is valid.

Do your best to explain the results of your investigation. Meet with your group to write an explanation of what happens to the force that must be

MBT 76

Project-Based Inquiry Science

◀ 1 class period*

3.3 Explain**Create an Explanation for How a Lever Changes a Force**

5 min.

Let students know what their explanations should include.

META NOTES

It is not expected for students to write complete explanations here since they have not yet been exposed to a significant amount of science knowledge about simple machines. It is important, however, that students make their explanations clear so that they can see what may be right or wrong when they revise later.

Emphasize to students that they will get to revise their explanations later when they have learned more science knowledge. Let students know that for now, their explanations will basically be claims (conclusions) based on their investigations. Students should use the trends found in their data for their claims, and their explanations should describe the relationship between the force applied to the 1-kg mass and the distance that force must be applied through to move the 1-kg mass 10 cm off the table top. Groups should draw force diagrams as part of their explanations.

*A class period is considered to be one 40 to 50 minute class.

TEACHER TALK

“You will be working in groups to create explanations for the results of your investigations. Remember that an explanation is a claim (a conclusion or interpretation) that is supported by evidence (from your observations) and science knowledge. In this case, your claim will basically be the conclusion for your investigations, and your evidence will be the trends you found in your data. You will need to also include a force diagram in your explanation. After everyone is done writing their explanations you will be sharing them with the class. Later, after we learn more about simple machines, you will get to revise your explanations.”

Explain

15 min.

Have groups create explanations.

Explain

Recall that an explanation is made up of three parts:

- Claim – a statement of what you understand or a conclusion that you have reached from an investigation or set of investigations
- Evidence – data collected during investigations and trends in that data
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Get Going

Have students meet with their groups to write explanations. Distribute *Create Your Explanation* pages and have groups get started.

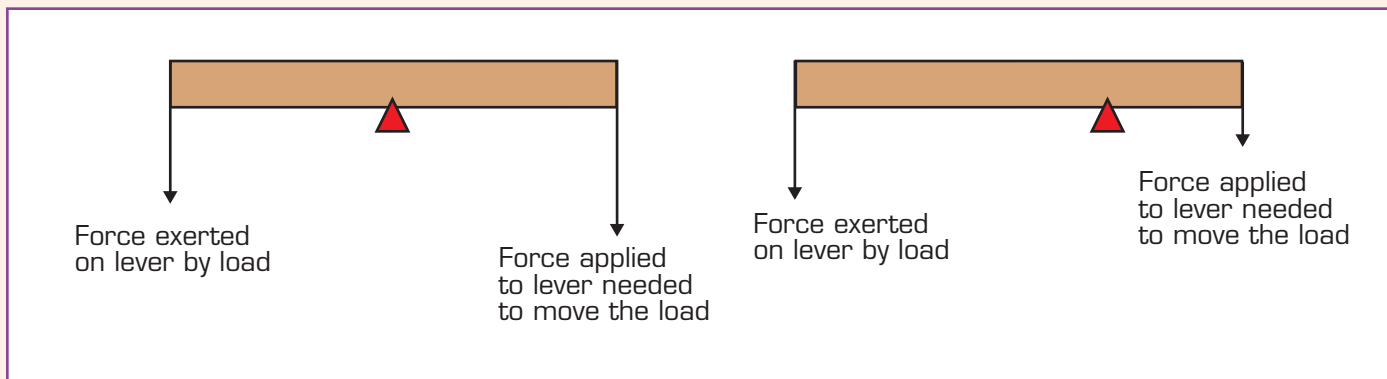
Assess

Monitor student progress. Ask students what claims they are making and how they are supporting their claims. Expect claims like the following:

- When the fulcrum is moved closer to where we apply the force on the lever, the amount of force we need to apply increases.
- When the fulcrum is moved closer to the load, the amount of force applied to the lever to move the load decreases.
- As the fulcrum moves closer to the load, the distance you must apply a force to the lever increases.
- As the fulcrum moves closer to the load, the amount of force that needs to be applied to the lever to move an object decreases and the distance it must be applied for increases.

Groups' evidence should come directly from the investigations. Students may use science knowledge about machines, but they do not have much specific science knowledge about levers.

Help groups as needed with their force diagrams. They should have at least two force diagrams showing either two levers of varying fulcrum positions or a lever and the direct lifting of the same object. The diagrams should show the applied force in the direct lift or in the fulcrum further away from the load with a longer arrow (depicting a greater force) than in lever with the fulcrum closer to the load. Example force diagrams are provided below:



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Communicate:
Share Your Explanation
 20 min.

Have students read their explanations, and create a class explanation.

META NOTES

The claims should come directly from the trends that were just discussed. The evidence should come directly from the investigation. The science knowledge will probably be incomplete. Note any misconceptions and move on. Students will revise their explanations after gaining more science knowledge.

3.3 Explain

applied as the fulcrum is moved closer to the weight. The *Create Your Explanation* page provides hints so that you will remember how to put an explanation together.

Communicate
Share Your Explanation

When everyone is finished, you will share your explanations with the class. Listen to the explanations made by other groups.

Use this information to come up with a class explanation. You will have an opportunity to revise your explanation after you learn more about levers.

Create Your Explanation

Name: _____ **Date:** _____

Use this page to explain the lesson of your recent investigations.

Write a brief summary of the results from your investigation. You will use this summary to help you write your Explanation.

Claim – a statement of what you understand or a conclusion that you have reached from an investigation or a set of investigations.

Evidence – data collected during investigations and trends in that data.

Science knowledge – knowledge about how things work. You may have learned this through reading, talking to an expert, discussion, or other experiences.

Write your Explanation using the **Claim**, **Evidence** and **Science knowledge**.



What's the Point?

Your class has completed an investigation of how a lever can affect how much force needs to be applied to move something. You now know how levers help to reduce the force you need to apply to move a weight. You also noticed that the distance you had to move the weight changed when the fulcrum was moved closer to the weight. Your explanation was a first attempt at describing the relationship between the force that had to be applied and the distance the weight had to be moved.

△ Guide

When groups have finished creating their explanations, ask each group to share their claims and explanations to the class. Record their claims and explanations on a poster or an overhead slide. Keep this to update later. This allows you to see what students are thinking, and to record their initial claims and explanations so that they can revise them later.

Then, discuss whether or not the claims are trustworthy and what it means for a claim to be trustworthy. Students should recognize that a claim is trustworthy when it has reliable data to support it and when evidence from a number of independent experiments supports the claims. If a claim can be disputed by evidence, then it needs to be revised.

TEACHER TALK

“What are the important features of a force diagram and what do they represent? *(Students should recognize that the forces exerted on the object need to be drawn and that the length of the arrow represents the size of the force and that the direction of the arrow represents the direction of the force.)*

What features if any need to be added or changed and why?”

META NOTES

If students drew their force arrows the wrong ways, you can have students help each other understand the way to draw the arrows. Make sure that the class list has the arrows correct (in the right direction and of the right length relative to each other).

Discuss how the force diagrams assist in the explanation and make sure that the force arrows point in the correct direction and have the correct relative length. You may want to do this by selecting two groups with different diagrams and have them draw their diagrams for the class. Then hold a discussion on the diagrams and have the class discuss and correct any features in the diagram.

come up with a class explanation. You will have an opportunity to revise your explanation after you learn more about levers.

What’s the Point?

Your class has completed an investigation of how a lever can affect how much force needs to be applied to move something. You now know how levers help to reduce the force you need to apply to move a weight. You also noticed that the distance you had to move the weight changed when the fulcrum was moved closer to the weight. Your explanation was a first attempt at describing the relationship between the force that had to be applied and the distance the weight had to be moved.



What’s the Point?

5 min.

Summarize the claims students made in the class and let them know that they will be revising them.

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Assessment Options

Targeted Concepts, Skills, and Nature of Science	How do I know if students got it?
<p>Scientists often work together and then share their findings. Sharing findings makes new information available and helps scientists refine their ideas and build on others' ideas. When another person's or group's idea is used, credit needs to be given.</p>	<p>ASK: How did different groups contribute to the class explanation?</p> <p>LISTEN: Students should see that where groups agreed, they reinforced each other, and where they had different ideas, they were able to revise their ideas or they identified where they needed to do more research.</p>
<p>Scientists make claims (conclusions) based on evidence obtained (trends in data) from reliable investigations.</p>	<p>ASK: Where did you get the evidence you used in your explanations?</p> <p>LISTEN: Students should have used the evidence from their investigations.</p>

Teacher Reflection Questions

- What evidence do you have that students understand mechanical advantage? How do you think they will apply their knowledge to the next machine, the pulley?
- How could you tell that groups were collaborating constructively while forming their explanations? Is there anything you can do to help students to collaborate more effectively?
- How do groups' explanations compare to their explanations in *Section 2.3* (the inclined planes)? Have they done more or less to back up their claims with evidence? Are their claims better articulated?