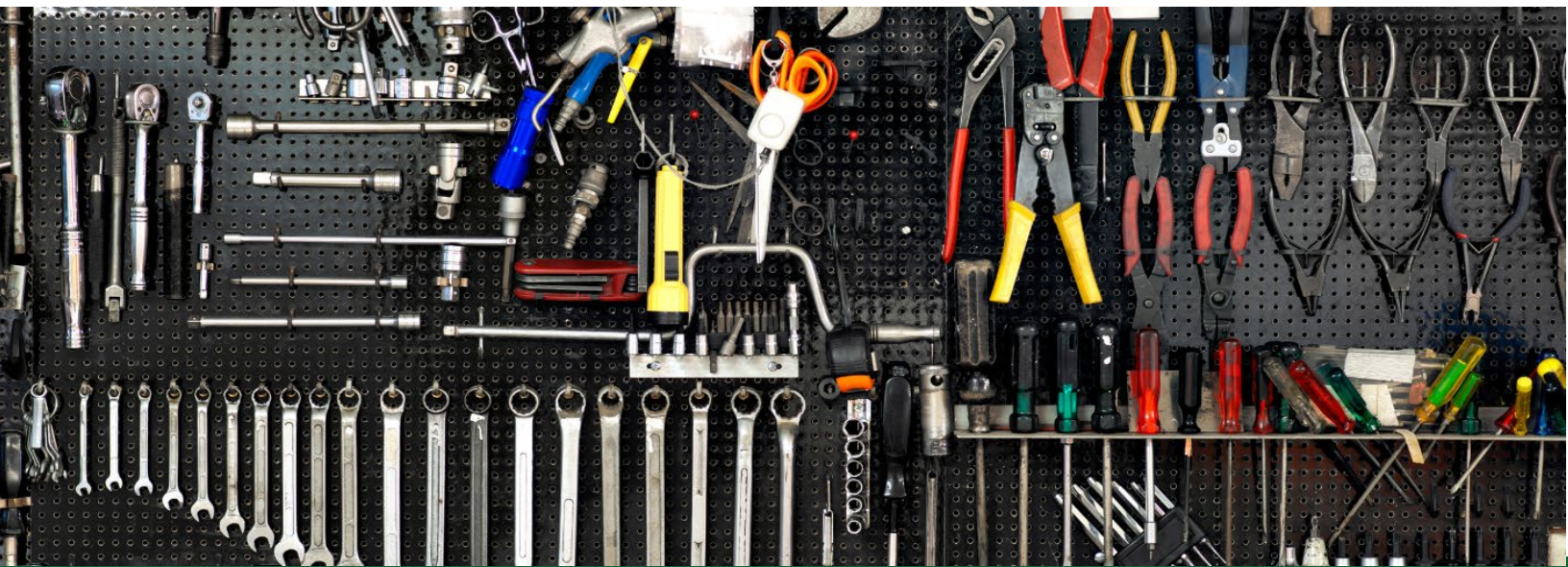


Participant Resource Guide

Mechanical Foundations

September 2026



Course Outline

- Module 1: Fasteners
- Module 2: Hydraulics and Pneumatics

Module 3: Leverage

- Module 4: Physics
- Module 5: Tools Reference Guide



U.S. Department of Transportation
Federal Transit Administration

A program of the Federal Transit Administration administered by the International Transportation Learning Center

Course: Mechanical Foundations

Version Date: September 2026

This document was prepared by the Transit Workforce Center with the financial assistance of the Federal Transit Administration, U.S. Department of Transportation.

Transit Workforce Center

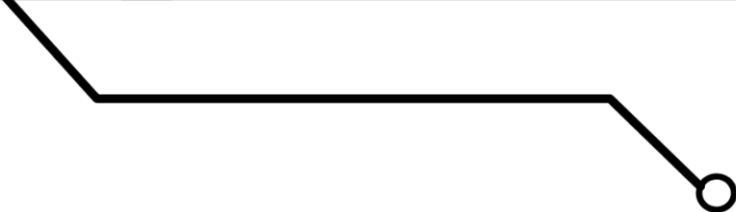
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Mechanical Module – Leverage



Objectives

- Explain how leverage helps move or lift a load with less effort.
- Recognize tools and maintenance tasks that use leverage.
- Describe why leverage is important for safe and efficient transit maintenance.



Participant Resource Guide

Leverage

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Leverage

Transit Core Competencies Curriculum (TC3)
Mechanical Foundations

U.S. Department of Transportation
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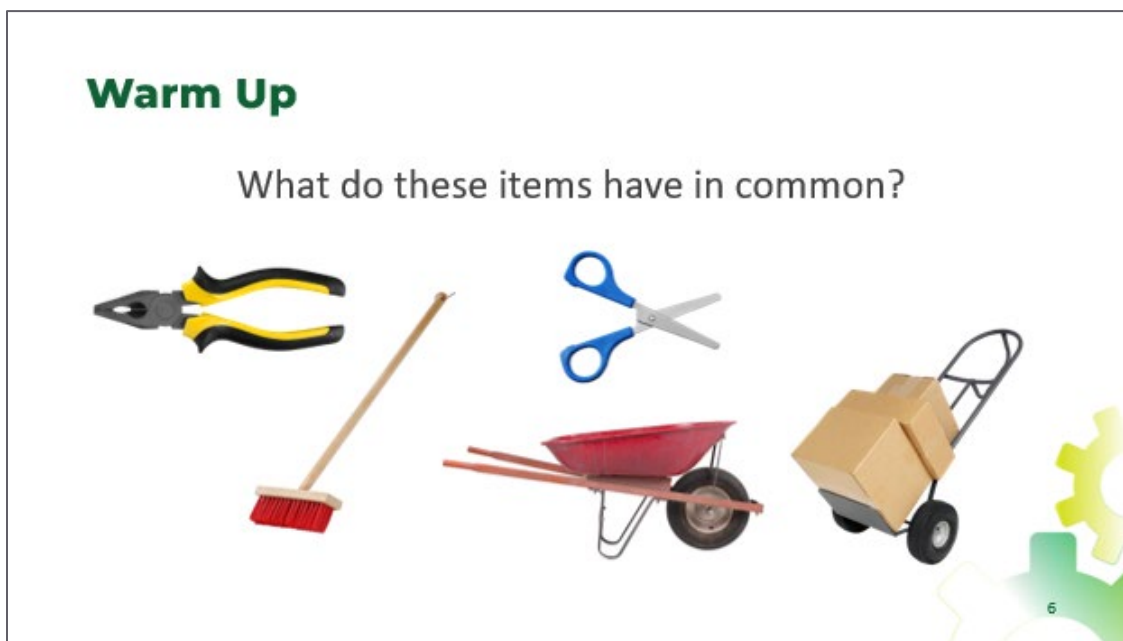
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Agenda

- Welcome and Warm Up
- 1.1 The Mechanical Lever
- 1.2 Classes of Levers
- 1.3 Transit Maintenance
- Quiz and Wrap Up



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Notes:

- Take a look at these everyday objects. Before starting today's lesson, I'd like you to think about one question: **What do these items have in common?**
- There may be several good observations, but they all share one important characteristic—they all use **leverage** to make work easier.
- Some help lift heavy loads, while others help cut, pry, or move objects.
 - Although they look very different, each one uses the same basic mechanical principle.
- Throughout this lesson, you'll explore how levers work, why they make tasks easier, and how these same principles are applied every day in transportation maintenance.



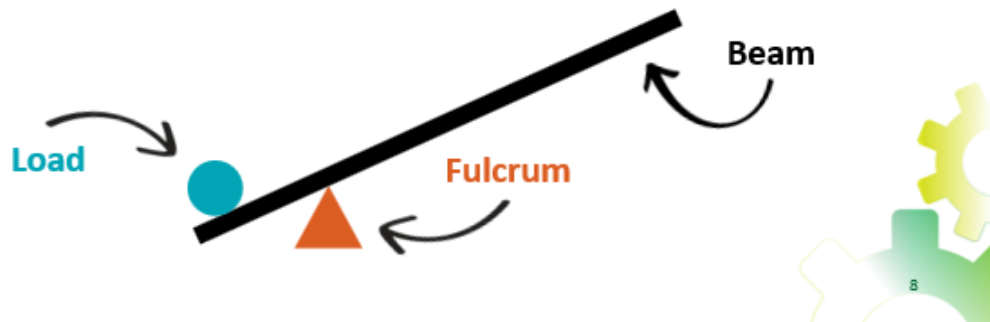
Notes:

- In this section, we'll review what a lever is and how they make work easier.

What is a lever?

Lever - A simple machine made of a rigid beam that pivots on a fulcrum to help move or lift a load with less effort.

Fulcrum - The fixed pivot point that a lever rotates around.

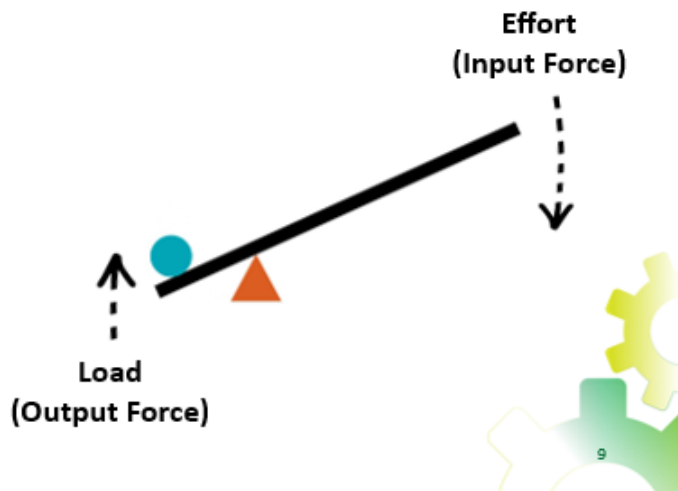


Notes:

- Levers are one of the oldest and simplest machines ever created, but they are still used every day in transportation maintenance.
- A mechanical lever consists of a rigid beam that rotates around a fixed point called the fulcrum.
- The beam transfers force from one end of the lever to the other, allowing us to lift, move, or pry objects with less effort.
- You'll see levers built into many common hand tools, making difficult jobs easier and safer. Now let's look at exactly how a lever works.

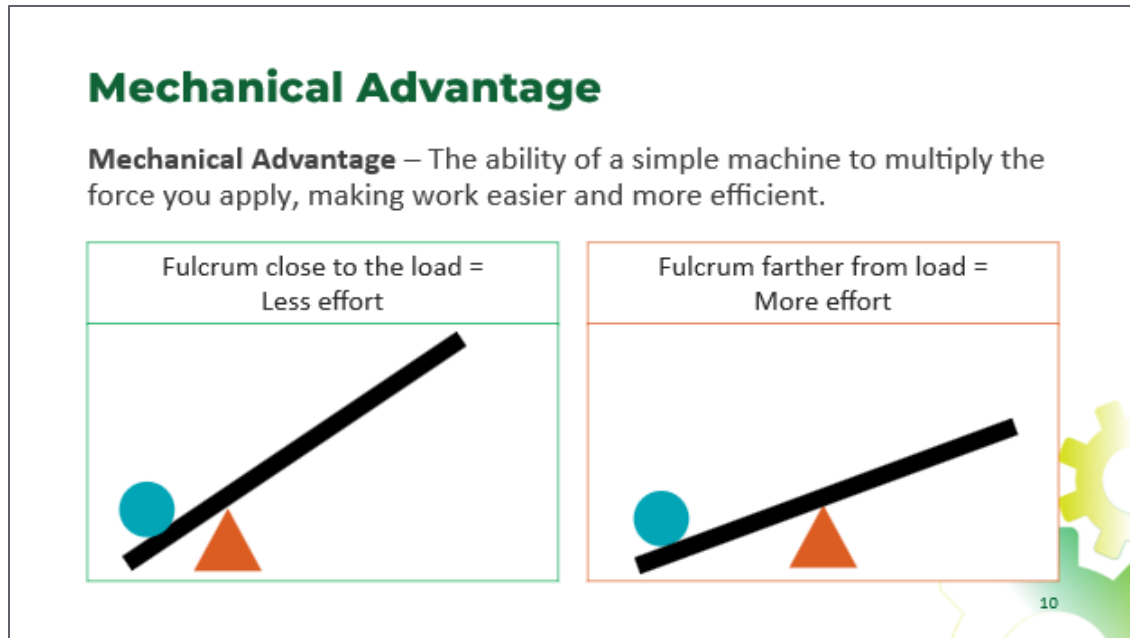
How Does a Lever Work?

A lever pivots around a fulcrum to **transfer and multiply force**, making heavy loads easier to move.



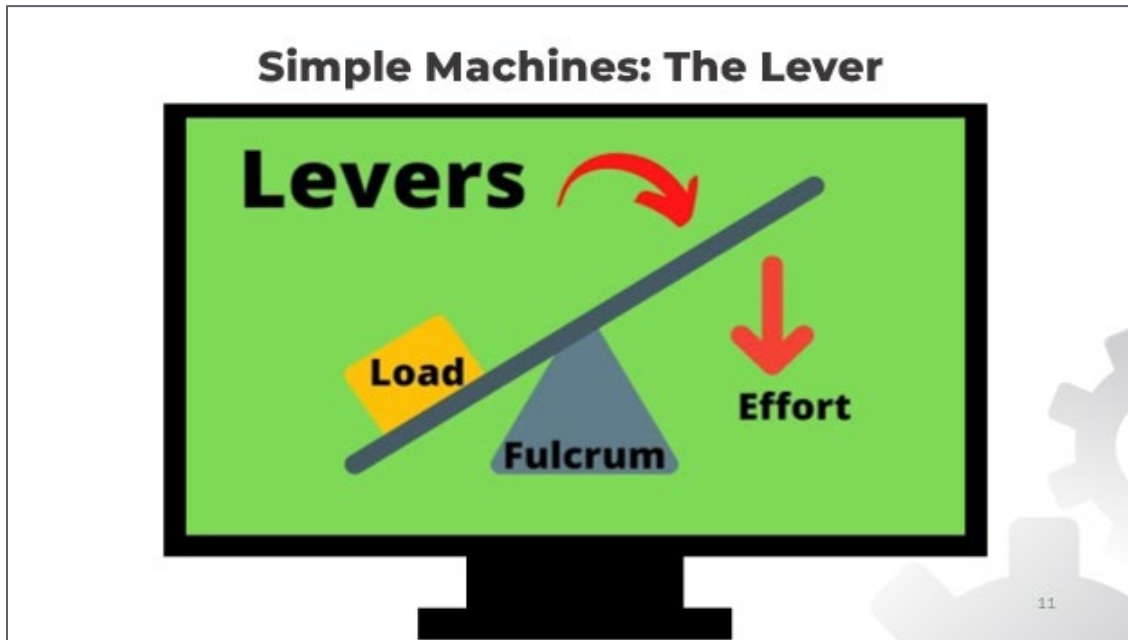
Notes:

- A lever works by rotating around the **fulcrum**.
- When you apply force, called the **effort** or **input force**, to one end of the lever, the beam pivots around the fulcrum and transfers that force to the opposite end.
- The object being moved is called the **load**, sometimes referred to as the **output force**.
 - Because of the way the lever is designed, it can multiply the force you apply. This allows a smaller effort to move or lift a much heavier load.
- Think about using a long pry bar to lift a heavy cover or a breaker bar to loosen a tight bolt. Instead of relying on brute strength, the lever helps you do the work more efficiently.
- The amount of force the lever can multiply depends on where the fulcrum, effort, and load are positioned. You'll look at that next when we discuss **mechanical advantage**.



Notes:

- Mechanical advantage is one of the main reasons we use simple machines like levers.
- Mechanical advantage refers to a machine's ability to **multiply the force you apply**. In other words, it allows you to move or lift an object using less **effort** than would be required without the machine.
- With a lever, mechanical advantage depends on several factors, including the location of the fulcrum, where the effort is applied, and the weight of the load.
- When the fulcrum is positioned closer to the load, the lever provides greater mechanical advantage. This means you can lift the same load using less effort.
- Choosing the right lever and using it correctly makes the job safer, easier, and more efficient.
- As we continue, we'll see how different lever designs create different types of mechanical advantage.



Video Debrief

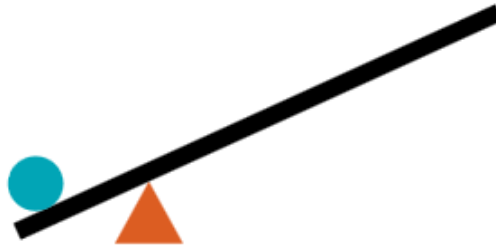
1. Describe one lever you could find in your home. Identify each part of the lever.
2. What is one way a lever exists in the human body? Identify each part of the lever.
3. What does FLE 123 mean?



Knowledge Check



Label each of the three parts of a lever.



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Knowledge Check



The term effort can also be defined as _____.

(A). Mechanical Advantage

(B). Input Force

(C). Load Force

(D). Output Force

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Knowledge Check



A lever pivots around a fulcrum to _____ and _____ force, making heavy loads easier to move.

(A). Create, balance

(B). Measure, control

(C). Transfer, multiply

(D). Reduce, duplicate

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Summary and What's Next

- A lever is a simple machine.
- A lever consists of a beam and a fulcrum.
- Levers reduce the effort needed to move a load.
- Mechanical advantage depends on lever design.

Now that you understand the basic parts of a lever and how leverage works, it's time to look at the different types of levers.

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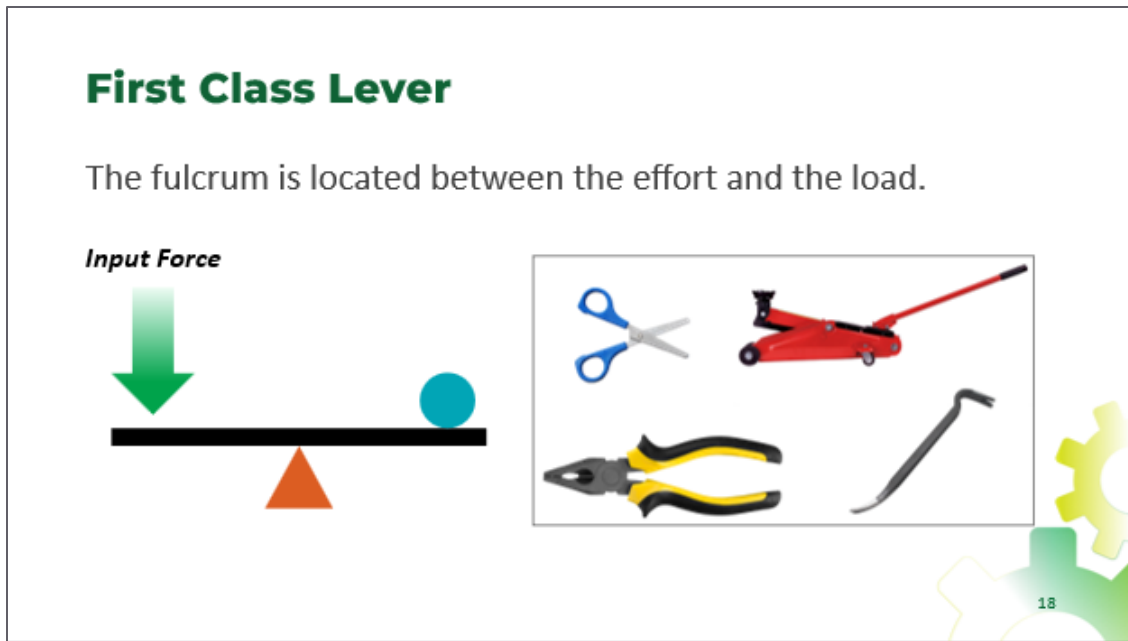
Notes:

- *What are the most key takeaways from this part of our lesson?*
- You've covered the basic concepts behind how a mechanical lever works.
 - Remember that a lever is a simple machine made of a rigid beam that pivots around a fulcrum.
- When force is applied to one end of the lever, it is transferred through the beam to move or lift a load with less effort.
- You reviewed the idea of **mechanical advantage**, which explains why the design of a lever affects how much effort is needed to do the job.
- Next, you'll explore the **three classes of levers** and see how the positions of the fulcrum, effort, and load change the way each type of lever works.
 - You'll also look at common tools and maintenance tasks that use each class of lever.



Notes:

- This section will discuss the different classes of levers and their real-life applications.

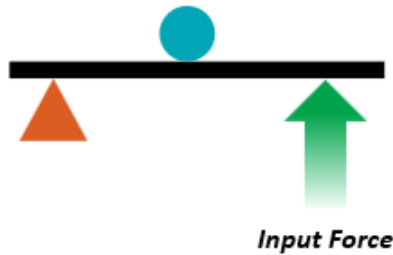


Notes:

- A first-class lever has the **fulcrum positioned between the effort and the load**.
- When you apply effort to one side of the fulcrum, the opposite side moves the load.
- One of the biggest advantages of a first-class lever is that it can change the direction of the applied force. For example, pushing down on one end of a crowbar lifts the load on the other end.
- Transportation maintenance workers often use pry bars and crowbars to lift covers, separate components, or align heavy parts during repairs.
- Other familiar examples include scissors, a car jack, and pliers.

Second Class Lever

The load is located between the fulcrum and the effort.



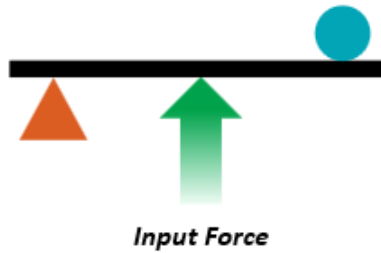
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Notes:

- In a second-class lever, the **load is positioned between the fulcrum and the effort**.
- This arrangement provides a large mechanical advantage, allowing heavy loads to be moved with relatively little effort.
- A wheelbarrow is a common example. The wheel acts as the fulcrum, the load sits in the middle, and the effort is applied by lifting the handles.
- A hand truck, or dolly, works in a similar way when transporting heavy equipment or materials.
- Second-class levers are designed to maximize lifting force, making them useful whenever heavy loads need to be moved efficiently.

Third Class Lever

The effort is located between the fulcrum and the load.



Notes:

- A third-class lever places the **effort between the fulcrum and the load**.
- Unlike second-class levers, these levers do not increase lifting force. Instead, they increase the speed and distance that the load moves.
- A broom is a good example. One hand acts as the fulcrum, the other hand applies the effort, and the brush at the end moves the load.
 - A shovel works in a similar way when lifting dirt or gravel.
- Your own forearm is also a third-class lever. Your elbow acts as the fulcrum, your bicep provides the effort, and your hand moves the load.
- Third-class levers are common in both everyday activities and maintenance work because they provide greater control and movement.

Activity: Clever Lever



Your instructor will place a heavy object on the floor with a block of wood to serve as the fulcrum.

Take turns using different tools as levers to determine which lever allows you to lift the object with the least amount of effort.



Predict: Which lever do you think will be the most efficient?

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Activity: Clever Lever



- Which lever worked best? Why?
- How did the length of the lever affect the amount of effort needed?
- Why is it important to choose the right tool for the job? Use evidence from today's activity to support your answer.
- How can selecting the correct tool help prevent workplace injuries?



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Notes:

Activity Debrief Questions:

1. Which lever worked best and why?
2. How did the length of the lever affect the amount of effort required?
3. Why is it important to choose the right tool for the job?
4. How can selecting the correct tool help prevent workplace injuries?

Knowledge Check



A hand-dolly is an example of what class of lever?

- A. First-Class Lever
- B. Second-Class Lever
- C. Third-Class Lever
- D. Fourth-Class Lever



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Summary and What's Next

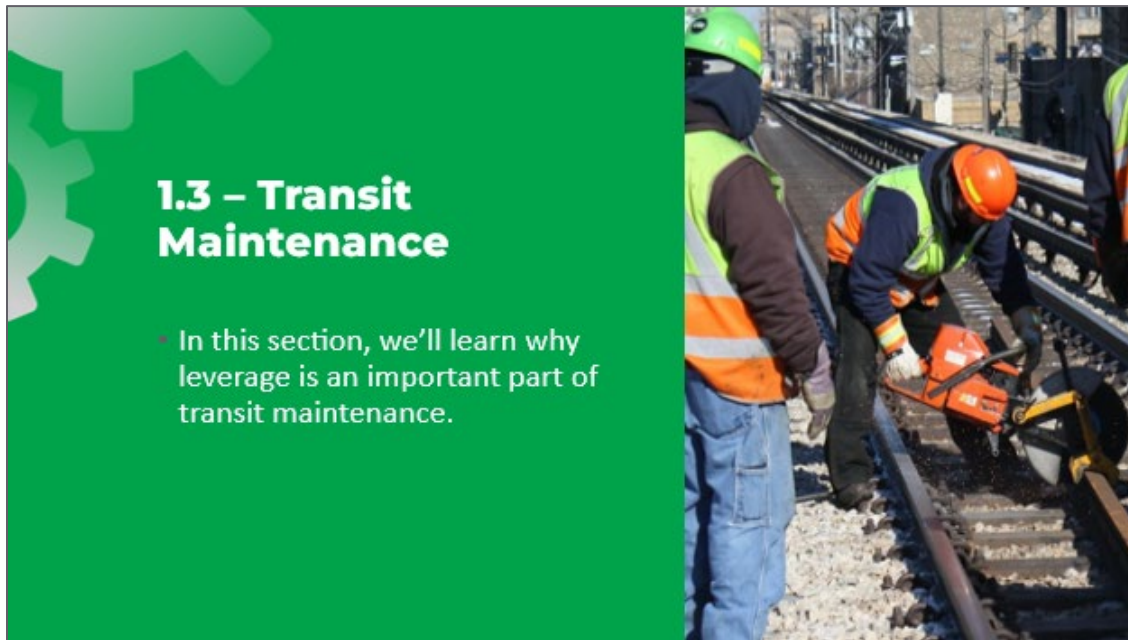
- First-class: Fulcrum between effort and load
- Second-class: Load between fulcrum and effort
- Third-class: Effort between fulcrum and load
- Different lever classes are used for different tasks

You'll identify common transportation maintenance tools and recognize how leverage is applied in real-world maintenance scenarios.

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Notes:

- *What are the most key takeaways from this part of our lesson?*
 - Let's review what you've learned about the three classes of levers.
 - The difference between each class is the position of the **fulcrum**, **effort**, and **load**.
 1. In a **first-class lever**, the fulcrum is located between the effort and the load.
 2. In a **second-class lever**, the load is between the fulcrum and the effort, providing a large mechanical advantage for lifting heavy objects.
 3. In a **third-class lever**, the effort is between the fulcrum and the load, allowing for greater speed and control.
 - Understanding these lever classes helps you recognize why certain tools are designed the way they are and how they make maintenance tasks safer and more efficient.
 - Next, you'll apply these concepts by examining common transportation maintenance tools and identifying how leverage is used in real-world maintenance scenarios.
-
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Notes:

- In this section, we'll learn why leverage is an important part of transit maintenance.

Leverage in Transit Maintenance

Leverage helps technicians perform many maintenance tasks more safely and efficiently.

- Operating a hand throw lever
- Lifting a bus with a jack
- Loosening or tightening lug nuts
- Opening stuck panels or doors
- Aligning or separating components



Notes:

- Leverage isn't just a concept found in textbooks. It's something transportation maintenance workers use every day.
- Many common maintenance tasks rely on leverage to move heavy components, apply force, or make precise adjustments.
- Whether you're operating a hand throw lever, lifting a vehicle with a jack, loosening lug nuts, or separating parts during a repair, leverage helps make the job easier and safer.

Common Leverage Tools

Common Leverage Tools

- Pry bar
- Crowbar
- Alignment (drift) bar
- Torque wrench
- Pliers
- Bolt cutters
- Hand truck (dolly)
- Hydraulic or manual jack



Notes:

- Many of the tools you use in transportation maintenance are designed to take advantage of leverage.
 - For example, pry bars and crowbars help lift or separate heavy components.
 - Alignment bars help position parts during assembly or repair.
 - Torque wrenches use leverage to apply a specific amount of torque to fasteners.
 - Bolt cutters use long handles to multiply force and cut through heavy materials.
- Even equipment like hand trucks and jacks rely on leverage to move or lift heavy loads with less physical effort.

The Importance of Leverage on the Job

Understanding leverage helps you:

- Work more efficiently
- Reduce physical strain
- Complete repairs faster
- Improve problem-solving
- Increase workplace safety



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Notes:

- Understanding leverage is about more than knowing how a simple machine works. It directly affects your performance on the job.
- Using leverage correctly allows you to complete tasks with less physical effort, reducing fatigue during the workday.
- It can also improve repair times because the right tool allows the work to be completed more efficiently.
- Perhaps most importantly, understanding leverage helps you work more safely by reducing unnecessary strain and encouraging proper tool selection.
- Experienced technicians don't simply work harder; they work smarter by using leverage to their advantage.

Knowledge Check



A technician needs to remove a stuck access panel from the side of a transit bus. Which tool would provide the best leverage for the task?

(A). Torque Wrench

(B). Pry Bar

(C). Needle-Nose Pliers

(D). Socket Wrench

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Knowledge Check



A maintenance worker chooses a longer pry bar instead of a shorter one to lift a heavy component. What is the primary benefit of using the longer tool?

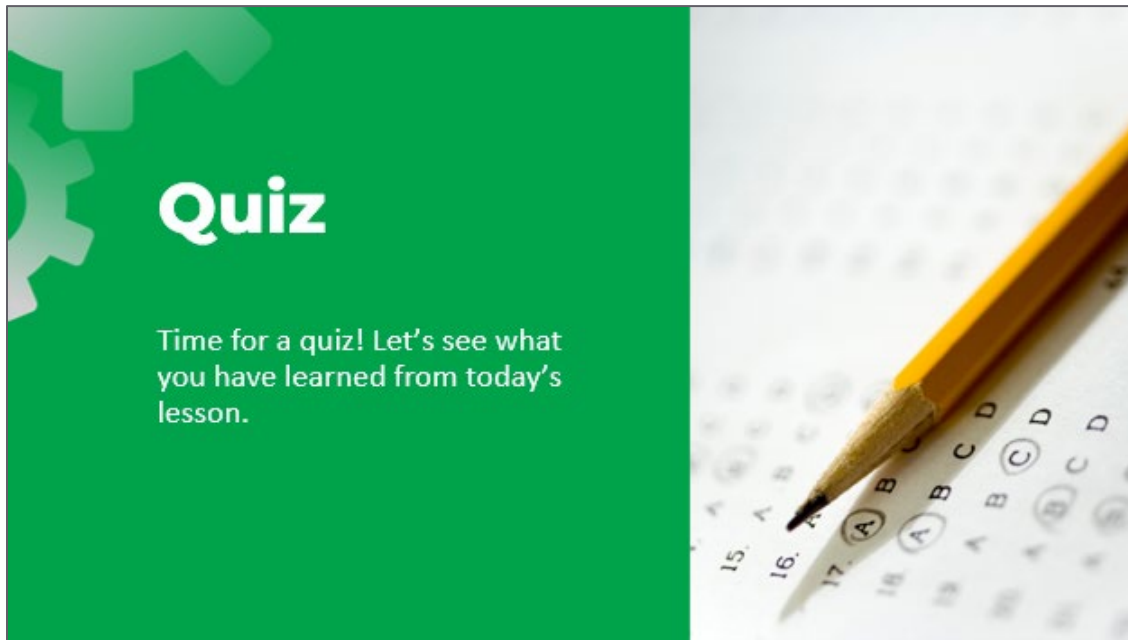
(A). It increases the weight of the tool.

(B). It allows the worker to use more body weight.

(C). It provides greater mechanical advantage.

(D). It eliminates the need for a fulcrum.

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Notes:

- Time for a quiz! Let's see what you have retained from today's lesson.

Revisiting Objectives

- Explain how leverage helps move or lift a load with less effort.
- Recognize tools and maintenance tasks that use leverage.
- Describe why leverage is important for safe and efficient transit maintenance.

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Notes:

- If you were explaining today's objectives to someone else, how would you summarize what they mean and why they matter?
- Which of today's objectives do you feel most confident about? Which were most challenging?
 - Explain your reasoning.
- Can you give an example of how you could apply one of today's objectives in a real-world situation?
