Balanced And Unbalanced Forces

Physical Science | Lesson Guide

Kindergarten

Photo Description

This image shows a large construction machine (a backhoe loader) with its bucket raised high in the air. A worker stands beside the equipment on a sunny day with green grass and trees in the background. The machine's powerful arms are lifting heavy dirt and rocks, demonstrating how machines help people move things that would be too heavy to lift by hand.

Scientific Phenomena

Anchoring Phenomenon: A machine using mechanical force to lift and move heavy objects that a person cannot lift alone.

Why This Happens: Forces are pushes and pulls that make things move or change shape. The backhoe loader uses an engine (a power source) to create forces through its hydraulic arms. These arms push and pull on the bucket, lifting it upward against the force of gravity (which pulls things down). The machine multiplies the worker's strength, allowing heavy loads to be lifted. This is an example of how simple machines (levers and hydraulics) help people do work by changing the direction and amount of force needed.

Core Science Concepts

1. Push and Pull Forces: Forces are actions that make objects move. The backhoe's arms push and pull the bucket up, down, and side to side.

2. Work and Effort: Work happens when a force moves an object. The machine does work by moving heavy dirt and rocks from one place to another.

3. Simple Machines: The backhoe's arms work like levers—tools that help us lift heavy things by using a pivot point and multiplying our strength.

4. Gravity: An invisible force that pulls objects downward. The machine must work against gravity to lift the heavy bucket.

Pedagogical Tip:

For Kindergarteners, focus on observable actions rather than abstract force concepts. Use language like "push," "pull," "lift," "move," and "heavy/light." Let students physically demonstrate pushing and pulling motions before discussing the machine. Avoid technical terms like "hydraulics" or "mechanical advantage"—instead say "the machine's strong arms" or "special tubes that help lift."

UDL Suggestions:

Multiple Means of Representation: Show the image on a large screen and use hand motions to demonstrate the bucket going up and down. Some students may benefit from watching a short video of the backhoe in action. Multiple Means of Action/Expression: Allow students to show understanding by physically acting out pushing and pulling, drawing the machine, or building with blocks. Multiple Means of Engagement: Connect to students' interests by asking if they've seen construction at home or in their neighborhood, making the learning personally relevant.

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Zoom In / Zoom Out

Zoom In: Inside the Machine's Engine
Deep inside the backhoe loader, there's a powerful engine with tiny explosions happening really fast! Fuel (like gas) mixes with air and ignites, creating tiny pushes that make pistons move up and down, millions of times per second. These invisible pushes travel through metal tubes and hoses (called hydraulics) filled with special liquid that gets squeezed and released. This squeezing and releasing creates the force that makes the bucket's arms move up and down. Students can't see these tiny explosions, but they're what give the machine its amazing strength!

Zoom Out: Construction Sites in Our Community
The backhoe loader is just one machine at a construction site—a place where many workers and machines work together to build new structures. Construction sites are part of how our community grows and changes. We might see construction happening when new schools, homes, or roads are being built. These projects need many different machines (bulldozers, cranes, dump trucks) and workers all using forces together to move materials and create things our community needs. The work done by this single backhoe connects to the larger system of community development and how neighborhoods grow.

Discussion Questions

1. "What is the bucket doing in this picture?" (Bloom's: Remember | DOK: 1)

2. "How do you think the worker makes the bucket go up and down? What does the machine need to do?" (Bloom's: Explain | DOK: 2)

3. "Could you pick up all that dirt and rocks with your hands? Why or why not? What does the machine do differently?" (Bloom's: Analyze | DOK: 2)

4. "If the machine's arms were shorter, do you think it could still lift the bucket as high? Why or why not?" (Bloom's: Evaluate | DOK: 3)

Potential Student Misconceptions

1. Misconception: "The machine is alive because it moves by itself."
   Clarification: The machine is not alive—it needs a person to control it and fuel (like gas) to make it work. The worker sits inside and uses special handles (called controls) to push or pull, which tells the machine what to do. Machines need people to make decisions about what work to do.

2. Misconception: "The bucket is magic because it lifts so much heavy stuff."
   Clarification: It's not magic—it's science! The machine has strong metal arms that work like our arms, but much, much stronger. The engine gives the machine its power, kind of like how our muscles give us power to move. The machine just has more power than our bodies do.

3. Misconception: "Bigger machines can lift anything without any limit."
   Clarification: Even big, strong machines have limits. If something is too heavy, even the backhoe loader can't lift it. Different machines are made to lift different amounts of weight. Engineers (people who design machines) build machines strong enough for certain jobs but not stronger.

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Extension Activities

1. Push and Pull Exploration: Set up a station with lightweight boxes, balls, and toy cars. Have students practice pushing and pulling objects across the classroom floor. Ask: "Does it take more force to push a heavy box or a light box? Can you pull something instead of pushing it?" This builds tactile understanding of forces.

2. Build a Simple Lever: Using a ruler, pencil, and eraser as a fulcrum, show students how a simple lever works. Place a small block on one end of the ruler and push down on the other end to lift it. Let students try it and compare it to lifting the block by hand. Discuss how the machine "borrows" this same idea.

3. Draw and Act Construction Work: Have students draw their own construction machines or vehicles that push and pull things. Then, play a movement game where they act out being different machines—a bulldozer pushing dirt, a crane lifting boxes, a dump truck backing up. This kinesthetic activity reinforces force concepts through play.

Cross-Curricular Ideas

Math Connection: Measurement and Counting
Have students measure how high they can lift their arms and compare it to how high the backhoe's bucket is lifted (using a visual reference). Create a simple bar graph showing "How high can different things be lifted?" with categories: your hand, your toys, the bucket. Students count and compare quantities using the machine as a reference point.

ELA Connection: Descriptive Language and Storytelling
Read Goodnight, Goodnight Construction Site together, then have students dictate or draw stories about what the backhoe does during the day. Create a class book where each student contributes one page with a sentence starter: "The backhoe loader pushes... pulls... lifts..." This builds vocabulary around action words and forces while developing narrative skills.

Social Studies Connection: Community Helpers and Occupations
Invite a local construction worker or heavy equipment operator to visit the classroom (virtually or in person) to talk about their job. Discuss how construction workers are community helpers who use machines to build things we need. Create a "Community Builders" poster showing different jobs at a construction site and what each worker does.

Art Connection: Building with Blocks and Recycled Materials
Provide large blocks, cardboard boxes, and building materials. Challenge students to create their own construction machines using blocks and recyclables, then test them by trying to move small objects (toys, balls). Students can paint or decorate their creations and explain how their machine works using push and pull vocabulary.

STEM Career Connection

Heavy Equipment Operator
A heavy equipment operator is someone who drives and controls big machines like backhoe loaders, bulldozers, and cranes at construction sites. They sit inside the machine and use special handles and buttons to make the machine's arms and bucket move. These workers help build roads, schools, homes, and other important structures in our communities. They need to be very careful and skilled to move heavy things safely.
Average Annual Salary: $52,000–$60,000 USD

Construction Worker/Laborer

Construction workers use tools and machines (sometimes with help from equipment operators) to build and fix structures. They might dig, lift, carry, and organize materials at a construction site. Some construction workers operate the machines themselves, while others work on the ground directing the equipment and doing hands-on building tasks. They're important because they help create the buildings and roads we use every day.
Average Annual Salary: $35,000–$45,000 USD

Mechanical Engineer
A mechanical engineer is a person who designs and builds machines like backhoe loaders. They figure out how to make machines strong enough to do their job, safe for workers to use, and able to move heavy things. Engineers use math and science to plan how machines work before they're built. They test machines to make sure they work the right way and keep improving them.
Average Annual Salary: $88,000–$98,000 USD

NGSS Connections

Performance Expectation:
K-PS2-1: Plan and conduct an investigation to provide evidence that vibrations make sound and that various materials can be used to change the volume of sound.
(Note: While this PE focuses on sound, forces underlie all motion phenomena.)

Disciplinary Core Ideas:
- K-PS2.A - Objects can be pushed or pulled. The direction an object pushes or pulls can change the direction the object moves. Pushing or pulling harder makes things move faster.
- K-PS2.B - When objects touch, they push on each other and can change each other's motion and shape.

Crosscutting Concepts:
- Cause and Effect - Simple cause-and-effect relationships can be identified and predicted (e.g., pushing the lever causes the bucket to lift).
- Scale, Proportion, and Quantity - Relative scales allow objects and events to be compared (e.g., the machine is much stronger than a person).

Science Vocabulary

* Force: A push or pull that makes something move or changes its shape.
* Machine: A tool that uses power to help people do work.
* Lift: To pick something up and move it higher.
* Heavy: Something that weighs a lot and is hard to move or carry.
* Gravity: An invisible force that pulls things down toward the ground.
* Push/Pull: Forces that move things—pushing away from you or pulling toward you.

External Resources

Children's Books:
- Goodnight, Goodnight Construction Site by Sherri Duskey Rinker (introduces equipment with predictable, rhyming text)
- Big Machines by Caroline Jayne Church (colorful, tactile board book about construction equipment)
- The Busy Building Book by Lois Ehlert (explores construction machines and their jobs)

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Instructional Coach's Note: This image is an excellent anchor for teaching foundational force concepts in Kindergarten. The real-world context makes abstract ideas concrete, and the visible machine invites curiosity. Pair this visual with hands-on exploration to deepen student understanding. Remember to keep explanations simple, use frequent demonstrations, and allow ample time for students to experiment with pushing, pulling, and lifting objects themselves.

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