Balanced And Unbalanced Forces

1st Grade

Physical Science | Lesson Guide

Photo Description

This image shows a large construction machine called a backhoe loader in action. The machine has a big scoop on the front (called a bucket) that is being used to pick up dirt and rocks. Two workers are operating and observing the machine as it demonstrates how machines help us move heavy things that would be too hard for people to lift by themselves.

Scientific Phenomena

Anchoring Phenomenon: A backhoe loader using mechanical force to lift and move heavy loads of earth and debris.

Why It's Happening: The backhoe loader works because of balanced and unbalanced forces. When the hydraulic arms push downward and outward, they create a strong force that overcomes the weight of the dirt and rocks (gravity pulling downward). The machine's engine provides energy, and the hydraulic system transfers that energy into powerful motion. The bucket applies a force greater than the weight of the materials, causing them to move upward—this is an unbalanced force. Without the machine, gravity would keep the dirt on the ground because human muscles alone couldn't create enough upward force to overcome it.

Core Science Concepts

Force and Motion: A force is a push or pull that can make objects move. The backhoe's hydraulic arms push* the dirt upward, which is a force that causes motion.

* Unbalanced Forces: When forces are not equal, objects move. The upward push of the backhoe bucket is stronger than the downward pull of gravity on the dirt, so the dirt moves up.

* Work and Simple Machines: The backhoe is a machine that makes work easier. Machines like this help us accomplish tasks (moving heavy materials) that would be impossible or very difficult without them.

* Gravity: An invisible force that pulls objects downward. Gravity makes the dirt and rocks heavy, and the backhoe must use force to overcome gravity's pull.

Pedagogical Tip:

First graders learn best through direct observation and hands-on experience. Rather than expecting students to understand "hydraulics" or complex mechanics, focus on the observable cause-and-effect: "The machine's arm goes UP, and the dirt goes UP too!" Use simple language like "push," "pull," "heavy," and "move" repeatedly. Allow students to physically demonstrate pushing and pulling motions with their own bodies before discussing the machine.

UDL Suggestions:

To support diverse learners: (1) Representation: Show multiple images of the backhoe from different angles; use slow-motion video if available so students can clearly see the sequence of movements. (2) Action/Expression: Invite students to act out being the backhoe (using their arms as the bucket) or draw pictures of the machine with arrows showing the direction of movement. (3) Engagement: Connect to students' real-world experience—"Have you seen big trucks or machines at construction sites near your home?"

Zoom In / Zoom Out

Zoom In: The Hydraulic Fluid in Motion
Deep inside the backhoe's metal arms, there is a special liquid (hydraulic fluid) that moves through tiny tubes when the engine runs. This liquid is pushed through the tubes by powerful pumps, and when it reaches the bucket arms, it pushes against metal pieces called pistons. The pistons are so strong that they can lift tons of dirt! The liquid itself is made of tiny molecules moving super fast—we can't see them, but they're what give the backhoe its pushing power. Without this "magic pushing liquid," the machine wouldn't work at all.

Zoom Out: Construction and the Built Environment
The backhoe is part of a much larger system of building and shaping our communities. When we construct roads, buildings, playgrounds, and schools, we need machines like this backhoe to move earth and materials from one place to another. This connects to city planning, where engineers decide where new buildings should go and how to move the land to make room for them. On an even bigger scale, construction sites affect the landscape and environment around them—they change where water flows, create new spaces for people to live and work, and transform natural areas into human-made communities. The backhoe is one small but important piece of how humans change and build their world.

Discussion Questions

1. What do you see the backhoe doing? (Bloom's: Remember | DOK: 1)
   This question establishes baseline observation skills.

2. Why do you think we need a big machine like this instead of people just picking up the dirt with their hands? (Bloom's: Understand | DOK: 2)
   This question connects to the concept of force and human limitations.

3. If the backhoe's arm stopped moving up and stayed still, what would happen to the dirt? (Bloom's: Analyze | DOK: 2)
   This question prompts thinking about gravity and balanced/unbalanced forces.

4. What other heavy things do you see in your neighborhood that need machines or people working together to move? (Bloom's: Apply | DOK: 3)
   This question transfers learning to students' own environment.

Potential Student Misconceptions

Misconception 1: "The machine is alive and can move on its own."
What students might think: Young children sometimes attribute living qualities to machines, especially ones that move like animals. A student might say, "The backhoe is walking to get the dirt" or "It's hungry for rocks."
Scientific Clarification: The backhoe is not alive—it's a machine made of metal, plastic, and rubber. People control it using a steering wheel and levers, kind of like how you control a toy car with a remote. The engine gives it power to move, but a person inside makes the decisions about what to do with it.

Misconception 2: "The bucket lifts the dirt because it's strong, like a person's muscle."
What students might think: First graders understand strength in terms of their own bodies, so they might think the machine "tries hard" or "is very strong," without understanding the concept of force and hydraulic power.
Scientific Clarification: The backhoe doesn't lift like your arm lifts a toy. Instead, the machine uses a special liquid pushing system (hydraulics) to create a bigger force than any person could make. Think of it like this: if you ask ten friends to help you lift a heavy box together, you can lift it because there are many pushes working at once. The backhoe's liquid pushing system is like having many helpers inside working together to create a super-strong push.

Misconception 3: "The dirt falls back down because the backhoe gets tired."
What students might think: Students might think the machine stops lifting because it "needs a rest" or "gets tired," similar to how they experience fatigue in their own bodies.
Scientific Clarification: The backhoe doesn't get tired. When the bucket tips over or lowers back down, it's because the person controlling it decides to make it happen—they pull the levers to let the liquid push in the opposite direction. The machine only stops when the engine shuts off or the person stops controlling it.

Extension Activities

Activity 1: Human Backhoe Demonstration (15 minutes)
Have students work in pairs. One student is the "bucket" (crouching down), and the other student is the "backhoe arm" (gently helping them stand up). Discuss how much easier it is to move something when you have help—just like the machine makes work easier. Ask: "Who had to push harder—one person alone, or two people together?" Connect this to the idea that machines help us push harder.

Activity 2: Pushing and Pulling Forces Exploration (20 minutes)
Set up stations around the classroom with lightweight, safe objects (foam blocks, plastic boxes, bean bags). Have students practice pushing and pulling objects across the floor. Ask: "When you push hard, what happens? When you push gently, what happens?" Record observations on a simple chart. Relate this back to the backhoe: "The backhoe pushes really hard so the dirt moves up!"

Activity 3: Construction Site Walk & Sketch (15-20 minutes, or homework)
If possible, take students on a brief walk around the school grounds or neighborhood to observe other machines, vehicles, or places where people are moving heavy objects. Have students sketch or dictate observations: "What machines did you see? What were they moving?" Display drawings with captions like "The dump truck pushes the dirt" or "The crane pulls the heavy box up."

Cross-Curricular Ideas

Mathematics: Measurement and Weight
Have students estimate how many of themselves it would take to equal the weight of the dirt in the backhoe bucket. Create a simple comparison: "If one bucket of dirt weighs as much as 20 first graders, how many buckets would equal 60 first graders?" Use this as an introduction to multiplication concepts and help students understand why machines are necessary—the dirt is too heavy for people to move alone.

English Language Arts: Narrative Writing and Vocabulary Building
Have students dictate or write simple sentences about what the backhoe is doing, using action verbs: "The backhoe lifts. The backhoe pushes. The backhoe digs." Create a classroom "machine sounds and movements" word bank with words like scoop, dig, lift, lower, push, pull, rumble, beep. Students can use these words in short stories or poems about construction sites. Read aloud books like Goodnight, Goodnight Construction Site and have students retell the story using their new vocabulary.

Social Studies: Community Helpers and Jobs
Invite a local construction worker or equipment operator to visit the classroom and explain their job (or show a video interview). Discuss how construction workers are community helpers who build the places where we live, learn, work, and play. Have students create a simple "Who Helps Build Our Community?" poster with drawings of different machines and workers. Connect this to the places students use every day: "This backhoe might have helped build your school!" This builds awareness of the human effort and teamwork behind infrastructure.

Art: Machine Design and Movement
Have students create large-scale drawings of imaginary machines that push, pull, or lift. Provide orange, yellow, and brown paper to match the backhoe's colors, and encourage students to draw the machine from different angles. Students can also create a kinetic collage by attaching moving parts (paper fasteners) to show how the bucket moves up and down. Display these as a "Student Construction Site" in the classroom and have students explain their inventions to peers.

STEM Career Connection

Heavy Equipment Operator
A heavy equipment operator is someone who controls big machines like backhoes, bulldozers, and cranes. They use levers and buttons to make the machines move exactly where they want them to go. Equipment operators work on construction sites, mines, and farms—anywhere that big machines are needed to move earth or materials. It's like being the best video game player, but instead of moving a character on a screen, you're moving a real machine! Average Annual Salary: $48,000–$65,000 USD

Civil Engineer
A civil engineer is a person who designs and plans big projects like roads, bridges, buildings, and dams. Before any backhoes start digging, civil engineers draw pictures and make plans to decide exactly where the machine should dig and how much dirt needs to be moved. They use math and science to figure out how strong buildings need to be and how to move materials safely. Civil engineers solve real-world puzzles every day! Average Annual Salary: $87,000–$120,000 USD

Heavy Equipment Mechanic
A heavy equipment mechanic is someone who fixes and takes care of big machines like backhoes. When a machine breaks down or isn't working right, the mechanic figures out what's wrong and repairs it so the equipment can work again. They use tools, tools, and more tools! Mechanics need to understand how all the parts of a machine work together, kind of like knowing how all the parts of a bicycle work. Average Annual Salary: $48,000–$68,000 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 or pitch of sound.

Relevant for Forces:
1-PS4-1: Plan and conduct investigations to provide evidence that vibrations in materials send waves around them, but how much they will move depends on a number of factors.

Disciplinary Core Ideas:
* K-PS2.A - Forces and Motion
* K-PS2.B - Types of Forces
* K-ETS1.A - Defining Engineering Problems

Crosscutting Concepts:
* Cause and Effect
* Scale, Proportion, and Quantity
* Systems and System Models

Science Vocabulary

* Force: A push or pull that makes something move or change direction.
* Machine: A tool or device that uses energy to do work and make jobs easier.
* Gravity: An invisible force that pulls things downward toward the Earth.
* Lift: To raise something up by using force or effort.
* Hydraulic: A system that uses liquids under pressure to create powerful movements (simple explanation for teachers; use "powerful pushing liquid" with students).
* Bucket: The scoop or container part of the machine that holds and carries materials.

External Resources

Children's Books:

Big Machines* by Caroline Lupine (explores how machines move heavy objects)

Construction Site* by Richard Scarry (features various construction vehicles in action)

Goodnight, Goodnight Construction Site* by Sherri Duskey Rinker (engaging introduction to equipment on construction sites)

Teacher Note: This image provides an excellent real-world anchor for abstract concepts like force and motion. First graders are naturally curious about big machines, so leverage that enthusiasm to build foundational understanding of how pushes and pulls make the world work.