

Photo Description



This image shows a white Ford truck with an extended boom lift (called a Stellar lift) that uses a long arm with a pulley system to lift a large spherical object into the air. A worker is operating the lifting mechanism, which demonstrates how machines can use ropes, pulleys, and mechanical advantage to move heavy objects that would be difficult or impossible to lift by hand alone.

Scientific Phenomena

Anchoring Phenomenon: Using a pulley system and mechanical advantage to lift a heavy load.

Why This Happens: The pulley system attached to the truck's boom allows the worker to use less force to lift the heavy sphere than would be needed to lift it directly. When you use a pulley, the rope changes direction and can support the weight across multiple strands, distributing the load. The mechanical advantage created by this system means that the worker can lift something much heavier than they could pick up with their own strength alone. This is an example of a simple machine—specifically, a pulley combined with a lever (the boom arm itself)—working together to make work easier.

Core Science Concepts

1. **Simple Machines:** Pulleys are simple machines that change the direction of a force or provide mechanical advantage, making it easier to do work (move or lift objects).
2. **Mechanical Advantage:** By using a pulley system, the worker can lift a heavy object using less force than the object's weight, because the load is distributed across multiple rope segments.
3. **Force and Motion:** The pulley system demonstrates how forces cause objects to move. The upward force from the rope overcomes gravity, which pulls the object downward.
4. **Energy Transfer:** The truck's engine provides energy that powers the hydraulic system in the boom lift, which then transfers that energy to lift the heavy sphere against gravity.

Pedagogical Tip:

When teaching pulleys to fourth graders, start with students experiencing pulleys in their own environment (flagpoles, window blinds, playground equipment). Have them physically feel the difference between lifting an object directly versus using a pulley before introducing vocabulary. This kinesthetic experience builds conceptual understanding before abstract thinking.

UDL Suggestions:

To support diverse learners: (1) Provide labeled diagrams of pulley systems with color-coding for the rope, load, and effort force; (2) Allow students to manipulate physical pulley models while discussing the image; (3) Offer video demonstrations of pulleys in action for visual learners; (4) Use think-pair-share activities so students can verbalize their observations before whole-group discussion.

Discussion Questions

1. What problem is the pulley system solving in this picture? (Bloom's: Understand | DOK: 1)
2. Why do you think the worker uses a pulley instead of trying to lift the sphere by hand? (Bloom's: Analyze | DOK: 2)
3. If the sphere is very heavy, how does the pulley make the job easier for the worker? (Bloom's: Explain | DOK: 2)
4. What would happen if the rope broke while the sphere was being lifted? Use what you know about gravity to explain your answer. (Bloom's: Evaluate | DOK: 3)

Extension Activities

1. Pulley Investigation Station: Set up a simple pulley system using a clothesline, carabiner, and bucket. Have students predict, then test, how many "weights" (sand-filled bags or books) they can lift using the pulley versus lifting directly. Record predictions and actual results on a chart. Discuss why the pulley made the task easier.
2. Design a Simple Machine: Provide students with toy figures, string, paper cups, and cardboard tubes. Challenge them to design their own lifting system to transport a small object (like a toy ball) from the ground to a height of 2 feet. Have them draw a diagram and label the parts, then test their design. Encourage them to modify it if it doesn't work the first time.
3. Real-World Pulley Hunt: Take students on a scavenger hunt around the school or classroom to find examples of pulleys or simple machines in use (flagpole, window blinds, door handles, scissors, ramps, etc.). Create a class poster showing pictures or drawings of pulleys found in their environment, with captions explaining how each one makes work easier.

NGSS Connections

Performance Expectation:

4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.

Related Performance Expectation:

3-PS2-1: Plan and conduct an investigation to provide evidence that balanced and unbalanced forces on an object change its speed or direction of motion.

Disciplinary Core Ideas:

- 3-PS2.A Forces and Motion
- 4-PS3.A Definitions of Energy
- 3-ETS1.B Developing Possible Solutions

Crosscutting Concepts:

- Systems and System Models (the pulley system works as connected parts)
- Energy and Matter (energy from the truck's engine lifts the object)
- Cause and Effect (applying force causes motion upward)

Science Vocabulary

- * Pulley: A wheel with a groove that holds a rope, used to lift or lower things with less effort.
- * Mechanical Advantage: A benefit you get from using a tool or machine that makes work easier by using less force.
- * Force: A push or pull that can make something move, stop, or change direction.

- * Gravity: An invisible force that pulls objects downward toward Earth.
- * Hydraulic: A system that uses liquid pressure to power machines and move heavy parts.
- * Load: The weight or object being lifted, moved, or supported by a machine.

External Resources

Children's Books:

- Simple Machines: Pulleys by David Adler (Let's Read and Find Out Science series) — Clear, illustrated explanations of how pulleys work
- Machines Go to Work by William Low — Engaging illustrations of machines, including pulley systems, in everyday use
- Simple Machines by Sian Smith (Usborne Beginners) — Interactive and colorful introduction to six types of simple machines

YouTube Videos:

- "Simple Machines: Pulleys" by Crash Course Kids (approximately 5 minutes) — Age-appropriate explanation with clear visuals demonstrating pulley systems in action. URL: <https://www.youtube.com/watch?v=4pGr03D8gfl>
- "How Do Pulleys Work?" by National Geographic Kids (approximately 3 minutes) — Fun, animated explanation of pulleys with real-world examples that fourth graders can relate to. URL: https://www.youtube.com/watch?v=hg3tZF4KU_E