Force And Motion

Physical Science | Lesson Guide

5th Grade

Photo Description

This image shows a student in mid-air, jumping over an orange cone during an outdoor athletic activity. The student's body is in a dynamic jumping position, demonstrating the motion created when muscles push against the ground with force. Other students and spectators can be seen in the background, indicating this is part of an organized physical activity or competition.

Scientific Phenomena

Anchoring Phenomenon: How does a person jump into the air and land safely?

This photograph captures the moment when a student applies a large downward force through their leg muscles to push against the ground. According to Newton's Third Law of Motion, when the student pushes down on Earth with force, Earth pushes back up on the student with an equal force. This upward force is greater than the pull of gravity for a brief moment, causing the student to accelerate upward and become airborne. The student's mass, muscle strength, and the speed of the push all affect how high they jump and how long they stay in the air before gravity pulls them back down.

Core Science Concepts

* Force and Motion: A force is a push or pull that causes an object to start moving, stop moving, or change direction. The student's leg muscles apply a large force downward, which creates the jumping motion.

* Newton's Third Law of Motion: For every action, there is an equal and opposite reaction. The student pushes down on the ground; the ground pushes up on the student with equal force.

* Gravity: This invisible force pulls all objects toward Earth. As the student rises into the air, gravity continuously pulls them back downward, ending the jump.

* Acceleration: The student's velocity (speed and direction) changes rapidly during takeoff due to the net force acting on them. This change in velocity is called acceleration.

Pedagogical Tip:

Students often struggle to visualize forces that aren't visible. Use slow-motion video replays of jumps to help fifth graders "see" the acceleration phase. Have them observe how the student's body position changes from crouched to extended—this visible change helps them understand the invisible forces at work.

UDL Suggestions:

Provide multiple means of engagement by offering choice in how students demonstrate understanding: kinesthetic learners can perform and measure their own jumps, visual learners can create force diagrams or annotated photos, and verbal learners can explain jumping mechanics to peers. Use a force scale or pressure mat (if available) to give quantitative feedback that appeals to different learning preferences.

Discussion Questions

1. What forces are acting on the student while they are in the air? (Bloom's: Analyze | DOK: 2)

2. Why does the student come back down to the ground after jumping? (Bloom's: Understand | DOK: 1)

3. How would the student's jump be different on the Moon, where gravity is weaker than on Earth? (Bloom's: Evaluate | DOK: 3)

4. What changes would the student need to make to jump higher—more force, less force, or the same amount of force? (Bloom's: Apply | DOK: 2)

Extension Activities

1. Jump Height Challenge: Have students perform standing broad jumps and measure the horizontal distance. Then have them perform vertical jumps and measure how high they can reach on a wall. Students can graph their results and compare jump distances across the class, exploring how leg strength and technique affect distance.

2. Force Investigation with a Bathroom Scale: Have students stand on a bathroom scale (which measures the normal force pushing up). Ask them to predict what happens to the scale reading when they crouch to jump, during the jump, and when they land. Record the numbers and discuss why the reading changes—connecting it to Newton's Third Law.

3. Design a Jump Course: Challenge students to design an obstacle course with cones at different heights and distances. Have them predict which jumps will be hardest and why (based on distance, height, and required force). Test predictions and discuss how mass, muscle strength, and technique affect performance.

NGSS Connections

Performance Expectation:
5-PS2-1: Support an argument that the gravitational force exerted by Earth on objects is directed down.

Disciplinary Core Ideas:
- 5-PS2.A Forces and Motion: An object is pushed or pulled by a force, which can have a magnitude and direction. The direction and magnitude of forces on an object determine the changes that will occur.
- 5-PS2.B Types of Interactions: Objects in contact exert forces on each other (friction, normal forces). Some forces act at a distance (gravitational, magnetic, and electrostatic forces).

Crosscutting Concepts:
- Cause and Effect The student's muscle force causes motion; gravity causes the student to return to the ground.
- Systems and System Models The jumping system includes the student's muscles, bones, the ground, and gravity all working together.

Science Vocabulary

* Force: A push or pull that makes something move, stop, or change direction.
* Gravity: An invisible force that pulls objects downward toward Earth.
* Acceleration: A change in how fast something is moving or the direction it is moving.
* Motion: A change in position; the act of moving from one place to another.
* Newton's Third Law: The rule that says for every action, there is an equal and opposite reaction.

External Resources

Children's Books:
- Gravity by Jason Chin (simple explanations with illustrations of gravity in action)
- Forces Make Things Move by Kimberly Bradley (explores different types of forces through everyday examples)
- What Makes Things Move? by Kathleen Weidner Zoehfeld (beginner-friendly exploration of force and motion)

YouTube Videos:
- "Newton's Third Law Explained" by Crash Course Kids — A clear, engaging explanation of action-reaction forces with real-world examples. https://www.youtube.com/watch?v=xNJfzIbEy8E
- "Gravity for Kids" by National Geographic Kids — Demonstrates how gravity affects motion, including jumping and falling. https://www.youtube.com/watch?v=FxDlI8UWChU