Kinetic Energy

Physical Science | Lesson Guide

4th Grade

Photo Description

A skateboarder in protective gear launches into the air while performing a trick at a concrete skate park. The skateboard separates from the rider's feet mid-jump, showing the moment when energy is transferred from the moving skateboarder to the skateboard. Other people and park structures are visible in the background on a sunny day.

Scientific Phenomena

Anchoring Phenomenon: How does a skateboarder launch into the air and why does the skateboard fly separately?

The Science Behind It: When the skateboarder pushes down and pulls up on the skateboard, they transfer their body's kinetic energy (energy of motion) to the skateboard. As the rider jumps, they and the board are moving forward together. At the moment of takeoff, the skateboarder's legs push the board downward and backward, creating an upward force that propels the rider into the air. Because of inertia—an object's tendency to keep moving in the same direction—the skateboard continues moving forward while the rider launches upward, causing them to separate. The skateboard has kinetic energy that keeps it moving even after leaving the rider's feet.

Core Science Concepts

1. Kinetic Energy: Energy that an object has because it is moving. The faster or heavier an object moves, the more kinetic energy it has. In this image, both the skateboarder and skateboard have kinetic energy.

2. Force and Motion: A force (push or pull) is needed to change how something moves. The skateboarder applies force to the skateboard by pushing down and pulling up, which changes the direction of motion and launches both the rider and board into the air.

3. Inertia: Objects in motion tend to stay in motion unless a force stops them. The skateboard keeps moving forward in the same direction even after the rider leaves it, because nothing is stopping it.

4. Energy Transfer: Energy can move from one object to another. When the skateboarder pushes on the skateboard, they transfer some of their body's energy to the board.

Pedagogical Tip:

Fourth graders learn best through observable, hands-on experiences with motion. Before discussing the skateboarding image, have students predict and test what happens when they push a toy car or skateboard with different amounts of force. This concrete experience builds understanding of the abstract concepts of kinetic energy and force. Start with the skateboard, then introduce the more complex idea of the rider's separation from it.

UDL Suggestions:

Representation: Provide a slow-motion video or multiple still images from different angles of the skateboard trick to help visual learners see the sequence of motion. Create a simplified diagram with arrows showing the direction of forces and motion.

Action & Expression: Allow students to demonstrate understanding by building a ramp with blocks and rolling toy skateboards at different speeds, or by creating their own motion diagrams with drawings and labels.

Engagement: Connect the skateboarding image to students' own experiences with bikes, scooters, or playground

Zoom In / Zoom Out

Zoom In (Microscopic Level): When the skateboarder's muscles push on the skateboard, what's actually happening at the tiniest level? Inside the rider's muscles are special structures called muscle fibers that contain even tinier parts called mitochondria. These mitochondria use energy from the food the skateboarder ate (like carbohydrates and proteins) to create a chemical called ATP, which powers the muscle contractions. This chemical energy is converted into the mechanical energy (movement) that pushes the skateboard. So the kinetic energy we see in the skateboard trick started as chemical energy in the skateboarder's food!

Zoom Out (Larger System): The skateboard trick happens within a skate park community system. The park has concrete structures designed by engineers, lighting systems, and a group of skaters all practicing together. This park exists within a larger city that has roads, schools, and neighborhoods. All these spaces are designed based on how people move and what activities they enjoy. The skate park itself is part of a community's recreation and wellness system—it helps young people stay active, build skills, and gather together. Without understanding how forces and motion work, engineers couldn't design safe, fun skate parks for communities to enjoy!

Discussion Questions

1. What is making the skateboard move forward through the air in this picture? (Bloom's: Understand | DOK: 1)

2. Why do you think the skateboarder and skateboard separate from each other during this trick? What forces are acting on each one? (Bloom's: Analyze | DOK: 2)

3. If the skateboarder pushed harder on the skateboard, how would that change the height of the jump and the distance the skateboard travels? (Bloom's: Apply | DOK: 2)

4. What would happen if the skateboarder tried this trick on a sandy beach instead of concrete? How would that change the kinetic energy and motion? (Bloom's: Evaluate | DOK: 3)

Potential Student Misconceptions

Misconception 1: "The skateboard falls down because the rider jumped off it."
Clarification: The skateboard doesn't fall because it was left behind. Instead, the skateboard continues moving forward in the same direction it was already going (inertia) while the rider launches upward. They separate because forces are pushing them in different directions—the rider's legs push upward on the board, which sends the board forward and the rider up. Both have kinetic energy, but they're moving in different directions!

Misconception 2: "Heavier skateboarders will always jump higher than lighter skateboarders."
Clarification: The height of a jump depends more on the force the skateboarder applies with their legs, not just their weight. A lighter skateboarder who pushes very hard can jump higher than a heavier skateboarder who pushes gently. It's about how much force you use, not just how much you weigh.

Misconception 3: "Once the skateboard is in the air, it will keep going up forever."
Clarification: The skateboard has kinetic energy that keeps it moving forward, but gravity is a force that pulls it downward. Gravity acts on everything, including the skateboard and the rider. That's why both come back down to the ground—gravity is constantly pulling them down the whole time they're in the air!

Extension Activities

1. Rolling Ramps Experiment: Students build ramps of different heights using blocks, books, or cardboard tubes. They roll toy skateboards, toy cars, or balls down the ramps and measure how far they travel. Students predict how changing the ramp height changes the object's speed and kinetic energy, then test their predictions. This directly models how the skateboarder's push creates motion.

2. Energy Transfer Game: Set up a "skateboard station" (or use toy boards) where students practice transferring energy by pushing toy skateboards of different weights with varying amounts of force. They measure the distance each skateboard travels and create a chart showing the relationship between force applied and distance traveled, building understanding of kinetic energy.

3. Design a Skateboard Park: Students work in small groups to design their own skate park using a large piece of paper or digital tool. They must include at least three different structures (ramps, jumps, rails) and write or draw explanations of how kinetic energy would help a skateboarder perform tricks on each structure. This combines engineering design with energy concepts.

Cross-Curricular Ideas

Math: Have students collect data from the "Rolling Ramps Experiment" extension activity and create bar graphs or line graphs showing the relationship between ramp height and distance traveled. Students can calculate the average distance, compare different trials, and use measurements in centimeters or inches. This connects kinetic energy concepts to data representation and measurement skills.

ELA (Writing): Ask students to write a how-to guide or instructional text explaining the steps a skateboarder takes to perform a jump trick. They should use sequence words ("first," "next," "then," "finally") and include diagrams with labels. This helps students organize and explain the scientific process in their own words while building writing skills.

ELA (Reading/Speaking): Have students research and present short biographies of famous skateboarders or skateboard park designers. They can create a poster or digital presentation about their person's accomplishments and how understanding physics and motion helped them succeed. This builds research, presentation, and public speaking skills.

Social Studies/Engineering Design: Students explore the history and culture of skateboarding and how skate parks serve communities. They can research different skate parks in their region or around the world, learn about how skate parks bring people together, and discuss how communities decide to build public recreational spaces. This connects science to community planning, cultural interests, and civic responsibility.

STEM Career Connection

Sports Engineer/Biomechanics Specialist – These scientists study how bodies move and create equipment that helps athletes perform better and stay safe. A sports engineer might design better skateboard materials, safer helmets, or skateboard park structures. They use their understanding of forces and motion (just like in this trick!) to solve real problems. Average Salary: $65,000–$85,000 per year

Skate Park Designer/Civil Engineer – These professionals design and plan skateboard parks and other recreation areas for communities. They need to understand how people move, what forces the concrete structures must handle, and how to make spaces safe and fun. They use math, physics, and creativity to create parks like the one in the photo. Average Salary: $70,000–$95,000 per year

Physicist/Motion Science Researcher – Physicists study how objects move and the forces that make motion happen. Some physicists work with sports teams or equipment companies to understand and improve athletic performance using the science of kinetic energy and forces. They might film athletes in slow motion and analyze every detail of their movements. Average Salary: $75,000–$120,000 per year

NGSS Connections

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

Disciplinary Core Ideas:
- 4-PS3.A The relationship between object speed and kinetic energy
- 4-PS3.B The ways energy can be transferred (motion energy from skateboarder to skateboard)

Crosscutting Concepts:
- Energy and Matter Energy can be transferred between objects through forces
- Cause and Effect The force applied by the skateboarder causes changes in the motion of both the rider and the skateboard

Science Vocabulary

* Kinetic Energy: The energy something has when it is moving; faster-moving or heavier objects have more kinetic energy.

* Force: A push or pull that can make something move, stop moving, or change direction.

* Motion: When something changes position or moves from one place to another.

* Inertia: The tendency of a moving object to keep moving in the same direction unless a force stops it.

* Transfer: To move or pass something from one place or person to another.

External Resources

Children's Books:
- What is Energy? by Mary Wissinger (an introduction to different types of energy including kinetic energy)
- Motion by David Adler (explores speed, force, and how objects move)
- Push and Pull by David Evans (introduces forces and how they affect motion)