

# Episode 2: Understanding the Engineering of Electric Skateboards

8th Grade Lesson

## Summary

Episode 2, *Understanding the Engineering of Electric Skateboards*, introduces 8th-grade students to physics and engineering concepts through the lens of electric skateboard design. Students explore Newton's laws, energy efficiency, and the impact of design elements like weight distribution and aerodynamics. The lesson connects real-world applications, such as sustainable urban transportation, with hands-on activities where students design their own skateboards, applying key physics principles. Extensions include building prototypes, researching technology advancements, and debating environmental impacts, promoting critical thinking and real-world problem-solving.

Teacher Discussion Guide and Lesson Plan:

## Objective:

- Students will learn how the principles of physics and engineering are applied in the design of electric skateboards.
- They will understand concepts like force, motion, energy efficiency, and design elements through real-world examples from the electric skateboard industry.

## Key Concepts:

1. **Principles of Physics in Engineering Design:** The application of Newton's laws, energy conservation, and other physics concepts in designing an efficient and functional electric skateboard.
  2. **Motor and Battery Integration:** The need for a balanced system where the motor and battery work efficiently together to provide the desired speed, power, and battery life.
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3. **Real-World Applications of Electric Skateboards:** Understanding how electric skateboards can improve urban transportation by providing a portable, eco-friendly alternative to traditional vehicles, reducing traffic congestion and pollution.
4. **Technological Innovation in Transportation:** The potential evolution of electric skateboards and similar technologies, including improvements in battery and motor systems, to make personal transportation more efficient, accessible, and sustainable.
5. **Forces and Motion:** The curriculum focuses on how forces (gravity, friction) influence motion, which aligns with how electric skateboards operate.
6. **Magnetic and Electric Fields:** The relationship between electricity and magnetism connects with how electric motors work in skateboards.
7. **Friction and Drag:** These forces directly affect skateboard speed and stability, key to optimizing design and performance.

## Key Vocabulary:

- **Newton's Laws of Motion:** A set of three physical laws that describe the relationship between a body and the forces acting on it. These laws are crucial in understanding the movement of objects, including electric skateboards.
- **Friction:** The force that resists the relative motion of two surfaces in contact. It's important in understanding how an electric skateboard moves.
- **Acceleration:** The rate of change of velocity of an object. In the context of skateboards, it refers to how quickly the board speeds up.
- **Energy Conservation:** A principle stating that energy cannot be created or destroyed, only converted from one form to another. It's essential for designing efficient electric skateboards.
- **Battery Efficiency:** The ability of a battery to store and discharge energy effectively. Higher efficiency means longer use between charges.
- **Motor Efficiency:** The ability of the motor to convert electrical energy into mechanical energy without wasting too much energy as heat.

## Pre-Video Discussion Questions:

1. **What do you know about electric skateboards? How do you think they work?**
  - Gauge prior knowledge and invites students to share any personal experiences or perceptions of electric skateboards.
2. **What forces do you think are involved in the motion of a skateboard (electric or traditional)?**
  - Encourage students to recall forces like gravity, friction, and thrust and relate them to the skateboard.
3. **How do you think the motor and battery of an electric skateboard might work together to affect its speed and performance?**
  - Prompt thinking about energy transfer, electric motors, and battery power in relation to the skateboard's movement.

4. **How might the design of an electric skateboard (e.g., weight distribution, motor placement) affect its stability and performance?**
  - Connect to the physics concepts of force distribution and design, setting up the video's exploration of design impact.
5. **What role do you think friction plays in the performance of a skateboard? Do you think friction is always a bad thing for speed? Why or why not?**
  - A discussion about friction will prepare students for understanding the concept of kinetic friction and drag, both of which are key to the video.
6. **Can you think of any real-world applications for electric skateboards? How might they impact transportation in urban areas?**
  - Encourage students to consider the societal and environmental impacts of technology, linking to the video's exploration of real-world uses of electric skateboards.

## Class Activity: Design Your Own Electric Skateboard

### Objective:

Students will apply their understanding of physics principles, including forces, friction, energy, and design, to create a conceptual design for an electric skateboard that is both functional and efficient. They will work in small groups to design, test, and evaluate their designs through discussion and modeling.

### Materials Needed:

- Paper and pencils for sketching
- Rulers or measuring tools
- Markers or colored pencils for detailing
- Access to a computer or tablet (for research and virtual design tools, if available)
- Materials for building basic models (optional, e.g., foam boards, small motors, wheels)
- A worksheet for each group to document their design

### Step 1: Introduction to the Activity

1. **Watch the video on electric skateboard design.**
  - After the video, ask students to reflect on the principles of physics they observed in the video (e.g., Newton's laws, friction, force diagrams, etc.).
2. **Discussion and Clarification**
  - Lead a class discussion about the key concepts mentioned in the video, such as the relationship between the motor, battery, and design choices (weight distribution,

aerodynamics). Discuss the importance of balancing speed, stability, and energy efficiency in the skateboard's design.

## Step 2: Design Phase

1. **Form small groups (3-4 students per group).**
2. **Challenge each group to design their own electric skateboard.**
  - Have each group sketch their design on paper. They should consider:
    - **Motor and Battery System:** How will the motor and battery work together to achieve the desired speed and power? What type of battery would be best?
    - **Weight Distribution:** Where should the battery and motor be placed to keep the skateboard balanced and stable?
    - **Aerodynamics and Stability:** How will the design minimize drag and ensure stability at high speeds?
    - **Materials:** What materials would they use to construct the skateboard and why?
    - Label the design.
    - Describe the physics concepts involved in their design choices (e.g., how they addressed friction or balanced forces).
    - Consider any real-world challenges the design might face (e.g., weight, cost, efficiency).

## Step 3: Testing and Evaluation

1. **Group Presentations:**
  - Each group presents their design to the class, explaining their choices for motor and battery integration, stability, and other design features.
  - Other students can ask questions and suggest improvements based on the concepts discussed (e.g., "How does your design minimize friction?" or "What happens if the weight distribution is off?").
2. **Class Evaluation:**
  - After all presentations, discuss as a class:
    - Which designs were most efficient in terms of speed, power, and stability?
    - What common challenges did students face in balancing energy consumption and performance?
    - How did students incorporate real-world issues like cost, environmental impact, and urban mobility into their designs?

## Step 4: Reflection

1. **Reflection Questions:**
  - After the activity, ask students to individually reflect on:
    - What design feature was the most challenging for them and why?

- How did they apply the physics concepts they learned about friction, forces, and energy in their design process?
- How might their design impact urban transportation and sustainability?

## Extension Activities:

- 1. Build a Prototype (Optional):**
  - If materials are available, students could work on building a basic prototype using small motors, wheels, and lightweight materials. They could test their prototypes for speed and stability and modify them based on the results.
- 2. Research and Presentation on Technological Advancements (Homework/Research Assignment):**
  - Have students research the latest developments in electric skateboard technology (e.g., improved battery technology, new materials, or advancements in motor efficiency). Students should present their findings in a short presentation or report.
- 3. Field Test Simulation (Optional):**
  - If possible, take students outside to test the effects of friction and stability on a small-scale model of a skateboard. They could use different surfaces (e.g., smooth concrete vs. rough pavement) to measure how friction affects the motion and performance.
- 4. Sustainability and Environmental Impact (Research and Debate):**
  - Students can research the environmental impact of electric skateboards, comparing them with other forms of transportation. This could lead to a class debate on the pros and cons of electric skateboards as an eco-friendly transportation solution.

## Post-Video Questions & Answers

- 1. How did the engineers from 2 Swift use physics to design their electric skateboards?**

**Answer:** The engineers from 2 Swift applied principles of physics, such as Newton's laws of motion, to design their electric skateboards. For example, Newton's second law (force = mass × acceleration) was used to understand how the board accelerates and reaches high speeds. They also considered forces like friction, which affects how the skateboard moves, and energy conservation, which was key in maximizing battery life and motor efficiency.

- 2. In what ways can electric skateboards help improve urban transportation?**

**Answer:** Electric skateboards offer a compact, efficient, and sustainable alternative to traditional transportation in cities. They are easy to carry, and their electric motors eliminate the need for gas emissions, making them an eco-friendly option. They can help reduce traffic congestion by

providing a quick and portable transportation solution, especially in busy urban environments where cars can be impractical.

**3. What was the role of battery efficiency in the skateboard's design?**

**Answer:** Battery efficiency played a crucial role in ensuring that the electric skateboard could run for extended periods without needing constant recharging. 2Swift engineers focused on maximizing battery life while ensuring that the motor could deliver enough power for uphill climbs and quick acceleration. They also employed innovations like ferrofluid to improve motor efficiency by managing heat, helping the skateboard run longer and with better overall performance.

**4. What real-world challenges did the engineers face when troubleshooting and refining their designs?**

**Answer:** One of the main challenges the engineers faced was ensuring that the motor, battery, and controller worked together seamlessly. The programming of the motor controller was particularly challenging, as it had to account for various real-world scenarios like acceleration, braking, and energy recovery. The engineers conducted extensive real-world testing to troubleshoot these issues and improve performance.

**5. How could the future of electric skateboards and other electric transportation technologies evolve?**

**Answer:** The future of electric skateboards and other electric transportation technologies could see improvements in motor architecture, battery technology, and efficiency. The engineers at 2Swift are looking into innovations that would increase range and speed, as well as new battery technologies that would further improve energy storage and efficiency. With advancements in these areas, electric skateboards could become a more common form of transportation in urban areas, and similar technologies could be adapted to other vehicles as well.

**6. What did you learn about the connection between design, engineering, and real-world applications from this episode?**

**Answer:** This episode highlighted the importance of integrating design, engineering principles, and real-world testing when developing new technologies. In the case of electric skateboards, engineers had to apply physics concepts, like force, friction, and energy transfer, to create a product that was both functional and efficient. The challenges they faced, such as weight distribution, battery efficiency, and troubleshooting, emphasized the iterative process of design and the importance of adapting to real-world conditions. This approach is applicable to other engineering projects, where problem-solving and testing are key to success.

