# Episode 2: Understanding the Engineering of Electric Skateboards

7th Grade Lesson

## Summary

In this episode, students explore the engineering principles behind electric skateboards, focusing on how forces, motion, and energy apply to their design and function. Through the story of engineers Andrew and Mo from 2Swift, students learn about key design considerations, such as weight distribution, motor placement, and the balance of forces like friction and acceleration. The episode highlights the real-world applications of electric skateboards as an eco-friendly and efficient mode of urban transportation, addressing challenges such as reducing traffic congestion and pollution. Students will engage in a hands-on design challenge, applying these concepts to create their own electric skateboard prototypes, fostering an understanding of how physics and engineering intersect in innovative solutions for sustainable transportation.

## Objectives:

- Understand how principles of forces, motion, and energy apply to electric skateboards.
- Identify engineering challenges in designing technology for urban transportation.
- Explore real-world applications of physics and engineering in sustainable transportation.

## Key Concepts:

1. **Forces and Motion:** Understanding how different forces, such as friction, gravity, and acceleration, affect the movement of an electric skateboard.

2. **Engineering Design Process:** The steps engineers follow to solve problems and design functional products, including testing, prototyping, and iterating.
3. **Energy Conversion:** How electrical energy from the battery is converted into mechanical energy that powers the motor and moves the skateboard.
4. **Sustainability in Transportation:** The role of electric skateboards as an eco-friendly alternative for reducing traffic congestion and pollution in urban areas.
5. **Real-World Applications of Physics:** How principles of physics, such as balance, energy efficiency, and motion, are applied in the design of electric skateboards for practical uses.

## Key Terms:

- **Friction:** The resistance force that occurs when two surfaces come into contact, affecting the movement of objects like skateboards.
- **Acceleration:** The rate at which an object changes its speed or velocity, influencing how quickly an electric skateboard can move.
- **Energy Efficiency:** The ability of a system (e.g., an electric skateboard) to use less energy while maintaining performance, particularly important for battery life.
- **Center of Gravity:** The point where an object's mass is considered to be concentrated; it plays a key role in the stability and balance of the skateboard.
- **Motor:** A device that converts electrical energy into mechanical energy, driving the wheels of the electric skateboard.
- **Prototyping:** The process of creating an early model of a product to test and refine its design before final production.

## Pre-Video Questions:

1. **What do you know about electric skateboards?**
    - Prompt: Think about how they work and what makes them different from regular skateboards.
3. **What do you think engineers have to consider when designing an electric skateboard?**
    - Hint: Think about balance, speed, weight, and power.
4. **If you were designing an electric skateboard, what feature would you prioritize and why?**
    - Example: Would you focus on battery life, speed, or ease of use?
5. **What do you know about how forces like friction and gravity affect a skateboard's movement?**
    - Follow-Up: How might engineers work to reduce or use these forces in their designs?
6. **How do you think a motor helps a skateboard move?**
    - Prompt: Think about how energy changes from one form to another.

7. **What are the advantages of using batteries to power vehicles like skateboards?**
    - Follow-Up: How might battery-powered vehicles help reduce pollution?
9. **What challenges do you think engineers might face when designing electric skateboards?**
    - Prompt: Think about safety, durability, and performance.

## Pre-Video Engagement Activity

**Prediction Exercise:** Ask students to make a list of 3–5 features they think are essential for electric skateboards. After watching the video, they'll compare their list with the features mentioned by Andrew and Mo from 2Swift.

### Activity:

#### Materials Needed

1. Video: *Engineering Electric Skateboards* (Episode 2)
2. Whiteboard and markers
3. Student handouts: Engineering Design Worksheet
4. Projector/Smartboard for visuals
5. Model or images of electric skateboards

## Video and Guided Viewing

Play segments of the *Engineering Electric Skateboards* video. Pause after each segment to discuss:

- Segment 1: Design Considerations
    - Discussion: How does weight distribution affect skateboard performance?
    - Key Takeaway: Center of gravity and motor efficiency are critical in design.
- Segment 2: Urban Transportation & Applications
    - Discussion: What are the advantages of electric skateboards for urban commuting?
    - Key Takeaway: Compact size and electric power reduce emissions and improve mobility.
- Segment 3: Forces and Motion
    - Discussion: How do forces like friction and acceleration affect skateboard motion?
    - Key Takeaway: Engineers balance acceleration and friction for stability and performance.

### Hands-On Activity: Engineering Design Challenge

***Instructions:***
Students will work in pairs to design their own electric skateboard prototype using the *Engineering Design Worksheet*.

- Step 1: Identify a primary purpose for your skateboard (e.g., speed, stability, portability).
- Step 2: Sketch a design and list key features (e.g., motor placement, weight distribution, braking system).
- Step 3: Highlight how your design addresses challenges like energy efficiency or friction.

***Discussion:*** Each group shares their design and explains how it addresses both physics principles and user needs.

## Reflection and Wrap-Up

- Whole-Class Discussion:
  - What did you learn about the relationship between physics and engineering?
  - How could technology like electric skateboards influence future transportation?
- Exit Ticket:
  Write one question you still have about the design or engineering of electric skateboards.

## Extension Ideas

- Research and report on another transportation technology that uses electric motors.
- Build a simple model demonstrating how friction affects movement using toy cars and different surfaces.
- Reflect: Write a short paragraph on how Andrew and Mo's engineering process connects to what they've learned about forces and energy in class.
- Design Challenge: Create their own blueprint for an innovative electric skateboard, highlighting one feature they would prioritize and why.

## Post-Video Questions:

**1. What was the biggest challenge Andrew and Mo faced when designing their electric skateboard?**

**Answer:** They needed to balance the skateboard's weight with its speed and durability. If the board was too heavy, it would affect performance and usability, but it needed to be sturdy enough to handle stress and motion.

**2. Why do Andrew and Mo believe testing is an important part of the engineering process?**

**Answer:** Testing helps identify flaws in the design, like performance under different conditions (speed, terrain, battery life). It ensures the product is safe, efficient, and meets user needs.

**3. How does the motor in an electric skateboard transfer energy to make it move?**

**Answer:** The motor converts electrical energy from the battery into mechanical energy, which powers the wheels to rotate. This energy transfer allows the skateboard to move.

**4. What role does friction play in the movement of an electric skateboard?**

**Answer:** Friction between the wheels and the ground provides the grip needed for the skateboard to move forward without slipping. However, too much friction can slow the skateboard down, so engineers have to find a balance.

**5. What design feature did Andrew and Mo include to make their electric skateboard energy-efficient?**

**Answer:** They designed the skateboard with lightweight materials and a motor optimized for low energy consumption, which helps the battery last longer while maintaining speed and power.

**6. What advice did Andrew and Mo give about approaching engineering challenges?**

**Answer:** They stressed the importance of collaboration, being open to new ideas, and not being afraid to fail. Each challenge is an opportunity to improve the design.

**7. What real-world problems can electric skateboards help solve, according to Andrew and Mo?**

**Answer:** They mentioned reducing traffic congestion in cities, providing eco-friendly transportation options, and making short-distance travel more accessible.