

# Episode 4: The Science of E-Bikes: Energy, Efficiency, & Innovation

7th Grade Science Lesson

## Summary

Students will explore how e-bikes work, focusing on energy transfers, transformations, and sustainability. Using the case study of Orion E-Bikes, students will investigate how gravitational potential energy, mechanical energy, and electrical energy interact to create efficient transportation solutions. Hands-on activities will include analyzing energy efficiency and designing their own sustainable transportation systems.

## Objective:

- Describe how energy transfers and transformations occur in e-bike systems.
- Explain the role of gravitational potential energy, mechanical energy, and electrical energy in transportation.
- Investigate the sustainability implications of e-bike technology.

## Key Concepts:

1. Energy transfer and transformation.
  2. Gravitational potential energy and height.
  3. Mechanical energy and motion.
  4. Electrical energy conversion in motors and batteries.
  5. Sustainable transportation solutions.
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## Key Vocabulary:

- **Gravitational Potential Energy** – Energy associated with an object’s height and mass.
- **Mechanical Energy** – Energy associated with motion or position of objects.
- **Electrical Energy** – Energy produced by the flow of electric charge, often converted into other forms.
- **Dissipated Energy** – Energy transformed into heat or other forms, making it difficult to recapture.
- **Sustainability** – Meeting current needs without compromising future resources.

## Pre-Video Discussion Questions:

1. **Why do you think transportation is important for daily life?**
  - Discussion Point: Accessibility to work, school, and resources.
2. **What are some challenges with traditional transportation methods?**
  - Discussion Point: Pollution, cost, inefficiency, and limited accessibility.
3. **What do you know about energy transfer?**
  - Discussion Point: Examples include a ball rolling downhill or a battery powering a device.
4. **Have you ever used or seen an e-bike? What do you think makes them different from traditional bikes?**
  - Discussion Point: E-bikes use electricity to assist riders, making hills and long distances easier to manage.
5. **How do you think e-bikes might contribute to sustainability?**
  - Discussion Point: Reduced reliance on fossil fuels and lower emissions.

## Activity: Design and Test a Mini E-Bike System

### Objective:

Model energy transfers and transformations while exploring efficiency in sustainable transportation.

### Materials Needed:

- Small toy cars or bikes
- Rubber bands (to simulate mechanical energy)
- Ramps of varying heights (e.g., cardboard or books)

- Stopwatches and measuring tape

## Procedure:

1. **Set Up Ramps:** Build two ramps at different heights to model how gravitational potential energy changes with height.
2. **Test Energy Transfer:**
  - Attach a rubber band to a toy car and release it on each ramp.
  - Measure the distance traveled and time taken for each ramp.

## Using Rubber Bands to Launch the Cars:

- **Prepare the Toy Car:** Wrap a rubber band securely around the front of the toy car, ensuring it won't slip off.
  - **Anchor the Rubber Band:** Hold the other end of the rubber band against a fixed point, such as the edge of a ramp or a heavy object (like a book).
  - **Stretch and Release:** Pull the car backward to stretch the rubber band, creating tension (stored elastic potential energy). Release the car, allowing the rubber band to propel it forward.
  - **Experiment:** Adjust the stretch length to observe how the amount of stored energy (rubber band tension) impacts the car's speed and distance.
3. **Analyze Results:**
    - Record observations about how height affects speed and distance.
    - Discuss where energy is lost (e.g., friction).
  4. **E-Bike Connection:** Compare these findings to how e-bikes use electrical energy to assist mechanical energy in overcoming gravitational potential energy.

## Guiding Questions for Analysis:

- How did ramp height impact the car's movement?
- What factors made the system more or less efficient?
- How do e-bikes reduce energy loss while improving performance?

## Extension Activities:

1. **Battery Innovation Research:** Assign students to research alternative battery technologies and present findings.
2. **Energy Systems Comparison:** Compare e-bikes to other forms of transportation (e.g., cars, trains) in terms of energy use and sustainability.

## Post-Video Discussion Questions:

1. **How does an e-bike use gravitational potential energy, mechanical energy, and electrical energy?**

**Answer:** E-bikes convert electrical energy from batteries into mechanical energy to assist pedaling, and gravitational potential energy is observed when riding uphill or downhill.

2. **What makes Orion's e-bikes unique compared to others?**

**Answer:** Orion e-bikes are lightweight (under 50 lbs), have tubeless tires for smoother rides, and feature swappable lithium-ion batteries.

3. **How does sustainable transportation like e-bikes help with climate change?**

**Answer:** E-bikes reduce carbon emissions by offering a cleaner alternative to fossil-fueled vehicles.

4. **Why is understanding energy transfer important in designing better e-bikes?**

**Answer:** It helps optimize efficiency, improve performance, and ensure sustainability.

5. **What innovations do you think could make e-bikes even better in the future?**

**Answer:** Improved batteries, regenerative braking, lighter materials, and more accessible bike-sharing programs.

