Electric Vehicles Toolkit

MINI GRAND PRIX

MIDDLE SCHOOL SCIENCE

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Mini Grand Prix

How does a vehicle model energy transfer?

Lesson Overview	Career Highlight
Students will build a car using recyclable materials (or RAFT kits), trace the energy transformations happening in the process, and race them!	Automotive Technician

STEM Course Connections	21st Century Skills	CTE Alignment
Middle School Physical Science Middle School Earth Science	Creativity Innovation	Career Readiness

Engineering Activity	
Science and Engineering Practices #2 & 8	Students will build a model of a vehicle and troubleshoot how to maximize the energy transfer.

Materials

- RAFT Platform Car kits
- Meter Sticks
- A "track" (taped off section of classroom floor)
- Student Handout

Essential Questions

1. How does energy transfer to make a vehicle move?
2. What factors affect the motion of a vehicle?

Background Information

In an electric car, the energy source is an external electrical supply. This electrical energy is stored in the car's battery pack as potential energy. In order for the car to function, energy must be transferred from the battery to the inverter. The inverter switches the direct current (DC) to alternating current (AC). The energy is then sent to the electric motor, the only moving part in the system. The electric motor translates the electrical energy into mechanical energy which the transmission finally sends to the wheels, making the car drive forward.

Mission Prep

Engage (5 mins)

Warm-Up

- Play the "Pull Back Police Cars and Let Go" video clip
- Have students respond to the following questions in their student handout:
  - How do you make this toy car go forward?
  - Why do the toy cars travel different distances? Provide at least three differences.

Explore (30 mins)

BUILD IT Activity

- Students will create a car using the RAFT Platform Car kit supplies and directions
- Students will then sketch the model that they built in their student handout
- Students can then try winding it up and releasing it down the classroom "track" to learn how it works

Launch

Explain (20 mins)

1. Class Video Clip
   - To introduce (or review) the concepts of potential energy, kinetic energy, and energy transfer, show the class this short video clip by NASCAR, "Types of Energy Explained"
2. Conservation of Energy Webquest
   - Have students visit ck-12's Conservation of Energy website and respond to questions in their student handout
   - To build from prior experience, use one of the student-built cars and walk through the question responses, identifying the potential energy and how it transfers to kinetic energy, and having students share ideas for increasing the potential energy.

Elaborate (40 mins)

1. Class Brainstorm
   - Now that students have established working definitions for Conservation of Energy terms, transition back to the cars that they built.
   - Pose to the class: How could we make our cars perform better? Travel farther? Travel faster?
   - Using the whiteboard, or a digital platform like Jamboard, hold a class brainstorm session to determine ways to improve the design of their RAFT cars
   - Students will share ideas like widening/narrowing wheels, increasing mass at front of car, increasing mass at back of car, adding a sail, incorporating a thicker rubber band, etc.
2. REV IT UP Activity
   - Have students pick one of the variables from the brainstorm session and change their car accordingly
   - For these adjustments, you may want to be ready with some common classroom supplies for them to use. Examples might include things like paper clips, binder clips, tape, paper, cardstock/index cards, erasers, etc. Students can also rummage through their desk/backpack to source materials.
   - Students will collect data, graph, and analyze their results in their student handout
3. Pitch

- Once they have finished collecting data, have students create a pitch to sell their design to an interested auto company. The pitch should include design components (name / logo) as well as key structural features that lead to improved performance.

Exploration

Evaluate (25 mins)

Mini Grand Prix Race Day

- Student share: have students share their pitch including their design (style/name/logo), what they chose to change and why it improves their car's performance.
- Students will set up their new and improved car models to race their classmates. Depending on class size and space, you may need to set up a series of "heats" that narrow down the competition.
- Once students have raced, they can complete the race day reflection in the student handout

Extend (Optional)

Case Study: High School Students Building an EV

- Have students check out this high school auto shop class in Arizona that builds electric vehicles.
- There is an accompanying news video clip at the bottom of the article that could be watched as a whole class or individually.
- Additionally, they can check out this Master Guild Technician for Audi's career profile to learn more about automotive industry pathways.

CA NGSS Standards

- MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object
- MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- MS-PS3–5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object
- ETS1.B: Developing Possible Solutions - A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

CTE Alignment

- B2.3 Present conceptual ideas, analysis, and design concepts using freehand graphic communication techniques.
- B4.2 Explain how the laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.
- B6.0 Employ the design process to solve analysis and design problems.
- B6.3 Choose between alternate solutions in solving a problem and be able to justify the choices made in determining a solution.

- B6.6 Construct a prototype from plans and test it. B6.7 Evaluate and redesign a prototype on the basis of collected test data.

Resources

References

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