**STEM CANDY CARS**
**For 4th grade students**

**Objectives:**

Students will:

- engineer a candy car and a cardboard ramp making sure the candy car can roll using the materials provided.
- fill in data on their charts measuring the distance the candy car traveled while implementing the engineering design process and redesign the candy car to see if it will go farther.
- learn about Newton's Laws and Energy Efficient cars by reading through a slide show and class discussion.

**Materials:**

computer/slide show, popsicle sticks, toothpicks, masking tape, Lifesavers candy, index card, straws, scissors, yardstick-rulers for measurement, Create a Data worksheet , paper/pencil

**Introduction (Theory)**

The energy use and pollution associated with transportation is one of the largest issues facing society today. By building energy-efficient cars, engineers can lower the negative impacts that cars have on the environment and ultimately help improve our lives. The energy efficiency of a car is affected by a variety of factors, including size, aerodynamics, weight, and the rolling resistance of the wheels. Engineers must know all about these factors to design better cars. First, let's start with Newton's 3 Laws.

Newton's 3 Laws - Who is Sir Isaac Newton?

Isaac Newton – the brilliant physicist and mathematician, revolutionized our understanding of the universe with his laws of motion and the force of gravity.

In the first law, an object will not change its motion unless a force acts on it.

In the second law, the force on an object is equal to its mass times its acceleration.

In the third law, when two objects interact, they apply forces to each other of equal magnitude and opposite direction.

Can each of these laws apply to a car?

How do they apply?

**Vocabulary**

aerodynamics: The ability of an object to cut through air (or water) efficiently

control: A variable that you are careful to keep the same during an experiment.

dependent variable: A variable that changes in value when you change an independent variable. Usually this is the variable about which you collect data during an experiment.

energy efficiency: Being able to do more with less energy.

independent variable: A variable you intentionally change in an experiment. Usually, the intent of the experiment is to see how a change in this variable affects the dependent variable.

rolling resistance: The force of friction acting on a rolling object by the ground to slow it down.

variable: Something that can be changed in an experiment.

**Energy efficient cars**

How far can a car travel on one gallon of gas?

Do you think all cars are the same? How about a semi-truck? (Answer: Definitely not.)What makes the difference in a vehicle's energy efficiency? A car's energy efficiency depends on

many things, including its weight, its rolling resistance, and its aerodynamics. A car that is energy efficient can travel farther on the same amount of gas, which saves the driver money.

Creating more energy-efficient cars also decreases air pollution and helps decrease greenhouse gas emissions due to automobile emissions. Also, gasoline is made from oil, a fossil fuel. Oil is a non-renewable energy source, which means that when it is used up, no more is available. For these reasons, engineers are continually figuring out ways to make cars more energy efficient by decreasing their air resistance, rolling resistance, and weight.

The aerodynamics of a car is dependent on how much air the car has to move out of the way as it travels along a road. Engineers often design cars to resemble aerodynamic animals and shapes in nature. Can you think of any aerodynamic animals? (Possible answers: Fish, birds, sharks.)These animals move through the air (or water) easily and use little energy because they are sleek in their shapes, having no sharp corners or flat surfaces facing the wind. This causes the air to flow smoothly (efficiently) over them. A sleek car moves more easily through the air than a semi-truck does, which means the car is more energy efficient.

Finally, a car's weight affects its energy efficiency. Is it harder to push a loaded grocery cart or an empty one? (Answer: Loaded) How about if you had to push the grocery cart uphill? Would you rather do it empty or full? (Answer: Empty) A car's weight determines how much energy it takes to accelerate, or speed up, the car, and it also affects how much energy it takes to move the car up a hill. Heavier cars are less energy efficient than lighter ones. Engineers use newly created, innovative materials whenever possible to reduce the weight of cars, as well as find ways to build them smaller so fewer materials are needed, which in turn reduces the weight of the car.

All of these factors contribute to a car's energy efficiency, with some of them being more important at high speeds and others being more important at low speeds.

All of these factors are considered variables, or something that you can change in an experiment or test. Engineers perform experiments on the many different variables to design cars for different purposes. When engineers perform experiments, they test only one variable at a time, while making sure that all of the other potential variables are kept unchanged. A variable that is kept from changing during an experiment is called a control. At the end of this activity, we will conduct several experiments to see how changing the angle of the track affects the speed of a car. In this case, the angle of the track is called the independent variable because we intentionally change it to gauge its effect on our vehicles. The speed of the car is called the dependent variable because it will be affected by the changes we make to the angle of the track. Once we have chosen our variables, we need to be very careful to control all other factors so that we get really accurate results. Let's get started!

**Activity (Practice)**

Instructions for students:
Brainstorm ideas for building a candy car.
Draw ideas on a piece of scratch paper or design in a CAD program on the computer.
Write your design idea in full sentences on paper or on the computer.

**Design**

Engineer and sketch your candy car design on paper or in the CAD program.
Label each material used on your diagram (mints, tape, popsicle sticks, toothpicks, straw, index card)

Note for teachers: Create a cardboard ramp for your class to use for their cars to roll down consistently.

Students will create a data sheet with "# of Trial" in one box and the "distance" their candy car traveled in another. They may also want to jot down in a "Notes" section what may need to be adjusted or redesigned to help their car roll farther. This can be on paper or computer (googledoc).

One at a time, the students will place their candy car at the top of the ramp, and let it roll down on its own. Students will measure the distance of each trial (total of 3) , and fill the distance their car traveled on the data sheet.

Students may redesign their car accordingly and make any adjustments necessary to see if they can get it to roll farther. Then repeat the rolling and measuring process.

**Discussion (Connecting with the theory)**
Reflection Questions: Answer on a separate sheet of paper
What characteristics do the cars that roll the farthest have in common?
What is the most important characteristic that made the cars go far?
What effect does changing the angle of the track have on the car's distance?

**Consolidation (Summary)**
Today we learned how engineers design energy-efficient cars by understanding and applying Newton's Laws of Motion. We explored how factors like aerodynamics, weight, and rolling resistance affect a car's energy use. By building and testing our own candy cars, we discovered how changing one variable—like the ramp angle—can impact how far a car travels. We practiced designing, experimenting, measuring, and improving our cars, just like real engineers. This helped us understand how science and engineering work together to solve real-world problems, like reducing pollution and saving energy.

**STEPAM Components:**
Science:
Students explore real-life transportation issues by applying key scientific principles such as Newton's Laws, friction, force, and energy efficiency.
Technology:
Technology is used through tools like CAD programs or computers to assist with planning, documenting, and recording data throughout the design process.
Engineering:
Students engage in a hands-on design activity where they create, test, and refine candy cars, following the steps of the engineering design cycle.
Project-Based Learning:
This lesson features a meaningful, real-world project that encourages teamwork, creativity, and problem-solving as students work to enhance their car designs.
Arts:
Students use artistic skills in the planning and presentation of their car models, including drawing, labeling, and incorporating creative design elements.
Mathematics:
Math is applied through measuring how far the cars travel, organizing results into tables, and analyzing data to make informed improvements.