MAKEngineering Kit Facilitation Guide: Mint Mobiles

Task adapted from Teach Engineering STEM curriculum developed at the University of Colorado Boulder.
Images from students who completed this task.

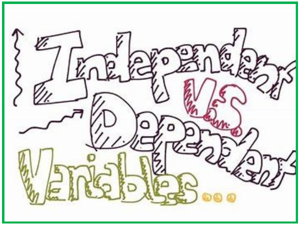
DID YOU KNOW…?

A car that is energy efficient can travel farther on the same amount of gas, which saves the driver money and decreases air pollution. Also, gasoline is made from oil, which is a non-renewable energy source. This 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. Aerodynamics is one example (see https://youtu.be/AXjiThF1LXU for more information.)

ENGINEERING TASK

The automobile company, Rolls-Royce, has produced many cars that are considered of poor fuel efficiency by the United States Department of Energy. Similar to automotive engineers, your task is to build a prototype to test the effect of different variables to report recommendations to the company. The prototype should travel along a straight path down a ramp and travel as far as possible with a minimum of 8 feet.

VARIABLES

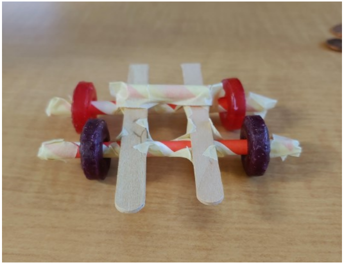


What are variables you might ask? Let's explore this with an interactive video that uses MythBuster experiments to explain.

https://youtu.be/I0jTMDtX4WY

MATERIALS IN KIT

- 12 Lifesavers Mints (individually wrapped)
- 10 index cards
- 8 straws
- 8 toothpicks
- 20 popsicle sticks
- Masking tape
- Scissors
- Tape measure
- 30 pennies
- Items around your home



STEP 1—RESEARCH

What can we learn from others? Let's watch a few videos to find out. Stop the videos as needed to take notes on what you notice that you might include in your own designs.

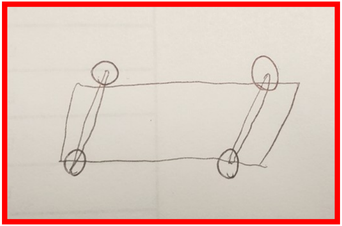
https://youtu.be/rVVB0-6Zgq0

https://youtu.be/SW9lBhgh5SE

https://youtu.be/KMUncKor7FY

STEP 2—PLAN

Brainstorm and sketch 2-3 car designs. For each, make a list of materials and you can only use material from the kit in your design. How do you think the body of the car will make a difference?



STEP 3—CREATE

Pick one of your designs from Step 2 and build your car prototype. But wait? How are you going to test your prototype? We need a ramp! Determine a location inside or outside your home to test the prototype. Construct a ramp using material from your home environment. How will you secure the ramp? Does your ramp need support?

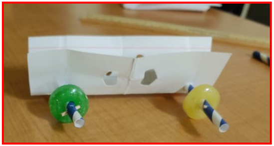
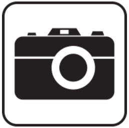


Image:
Teach Engineering

STEP 3—SUPPORT

Potential questions to ask about the ramp:

- What materials might be useful? Do you think we will need supports?
- How long and high should we make the ramp? Why?
- What are you thinking about for an appropriate incline?
- How might this impact where we set up the testing site?



COMMUNICATE

Have a conversation about your planning and building steps. The camera can be focused on the car and/or the sketch.

1. What did you learn from your research that you did or did not use in your prototype?
2. How did you construct the ramp?
3. What one word would you use to describe your car? Why?

STEP 4—PILOT TEST & IMPROVE

Let's test your prototype by sending it down the ramp 3 times. What did you notice? How far did it travel? Did it travel in a straight line?

What can be improved? How is this based on your observations? Make these changes to your prototype. Keep testing and redesigning the prototype until you are satisfied.

STEP 4—SUPPORT

Potential questions to pose:

- ♣ Let's develop a checklist for what would make a successful test. (e.g., Should it roll smoothly? Should it roll straight? Should it roll off the end of the ramp?)
- ♣ How can we use the tape measure to measure the distance travel? Should we measure in inches or cm?
- ♣ How can we figure out how far 8 feet is from the base of the ramp?

STEP 5—TEST #1

Let's test how weight changes the distance traveled by adding or removing pennies each trial. How many trials? At least six. In this test, what is the independent variable and the dependent variable? Let's keep track of our test through a table.

Trial #	# of pennies	Distance traveled
1		
2		

STEP 5—SUPPORT

Potential questions to pose:

- How can we secure the pennies to the prototype?
- I suggest we keep the pennies in one place. Why do you think I am suggesting this? How might where we place the pennies make a difference?
- Is there a variable that we are not changing as part of the test? (e.g., ramp height) This is what is known as a control variable.
- What might you need to do before interpreting the data from the six trials (e.g., calculate average)?
- What claim or recommendation can you make from your data? Explain.

DID YOU KNOW…?

Pennies weigh different amounts depending on the year the penny was made. Pennies made before 1982 are made of 95% copper and 5% zinc. A copper penny weighs 3.11 grams or 0.109702 ounces. Pennies made in the year of 1982 and after are made of 97.5% zinc and 2.5% copper. A zinc penny weighs 2.5 grams or 0.0881849 ounces.

(coincollectingenterprise.com)

10-A

EXTENSION

If one zinc penny weights 0.0881849 ounces, how many pennies are in one pound? We know that 16 ounces = 1 pound, so how can use this information? (16 ounces ÷ 0.0881849 ounces = about 182 zinc pennies per pound)

How much money is 1 pound of zinc pennies? ($1.82)

Predict if there would be more or less copper pennies per pound when compared to zinc pennies. Why do you think this? (Less, 16 ounces ÷ 0.109702 ounces = about 147 copper pennies per pound)

10-B

STEP 6—TEST #2

Let’s conduct a new test on how the number of wheels change the distance traveled. Make a prediction about what you think will happen to the distance the car will travel based on changes to the wheels. How many trials? At least three. Let’s keep track of our test through a table.

Trial #	# of wheels	Distance traveled
1		
2		

STEP 6—SUPPORT

Potential questions to pose:

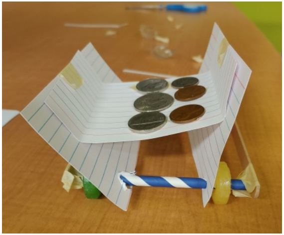
- ♣ Will your car travel a shorter or a longer distance? Explain why you think so.
- ♣ Does your data confirm or refute your prediction? What do you think is happening?
- ♣ Where do you want to add more wheels? Why? What do you think happen by adding a wheel here?

ADDITIONAL TESTS

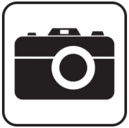
There are additional variables that you can consider before making recommendations to Rolls Royce. As an engineer, remember to document your test(s).

- Change the size of the wheel using objects in your home.
- Texture of the wheel. Wrap the wheel with material in your home (e.g., aluminum foil).
- Position and balance of the wheels.

PARALLEL PROTOTYPING



How do you think the body of the car might change your results? Choose another design from Step 2 and replicate or copy your tests. How are your results similar and/or different? For example, might the size of the prototype make a difference (e.g., large truck versus a small sports car)? Support using evidence from your charts and your observations as an engineer.



COMMUNICATE

Let's prepare for our presentation to Rolls Royce. The camera can be focused on the car.

1. Show us a test of your car and how to measure the distance traveled.
2. What did we learn from our tests? How did the different independent variables effect the distance traveled?

STEP 7—COMMUNICATE

Based on the results from your tests, what recommendations would you make to Rolls Royce regarding changes they should make to increase their fuel efficiency ratings? Support using evidence from your charts and your observations as an engineer.

DID YOU KNOW…?

- ♣ The first engine powered car was built in Mannheim, Germany by Karl Benz in 1885. Between 1888 and 1893 they sold a whopping 25 units.
- ♣ On average, every American will spend approximately two whole weeks of their life stopped at red lights.
- ♣ The first speeding ticket ever issued was in 1902, when most cars could barely reach 45mph.
- ♣ In 1939 the San Antonio Light wrote about future cars that could be folded into a neat and tidy suitcase-sized package. Got that one a little wrong.

For more interesting facts about automotive engineers, check out https://automotive-engineering.weebly.com/index.html

DID YOU ALSO KNOW…?

Mechanical engineers can work in various industries—manufacturing, aeronautics, robotics, oh, and yes, automobiles—as they have an understanding of how machines work. Mechanical engineers are part of a team that designs, tests, and improves parts of a car to pass safety standards. Henry Ford, Karl Benz, and Nikola Tesla were mechanical engineers and known for revolutionizing the automobile industry.

WHAT TYPE OF ENGINEER ARE YOU?

Add a sticker to your Engineering Passport that identifies the type of engineer you were most like in the creation and testing of a mint mobile. Don’t forget to write why you chose the type of engineer.

This engineering kit would not have been possible without funding and support from the National Science Foundation.