Roll with the Force

In classroom lab activities, students are often given tools that were made specifically for that purpose. In the real world, however, scientists often have to invent and build their own tools. Making new discoveries may require measuring things that have never been measured before! Working together, scientists and engineers create the new tools needed to make new discoveries.

In this activity, students will explore force and motion using tools they create from a modular building kit. Each group may create slightly different tools and perform different experiments to collect data. The laws of physics are the same for everyone, though, so groups should arrive at similar conclusions or be able to explain why they didn't.

Estimated Time: 40 minutes

Materials Needed:

- roughly 30 Lux Blox (including 4 wheels) per group (2-3 students)
- 1 or more rubber bands per group
- 1 Student Handout per student
- A tape measure, meter sticks, and rulers would be helpful

Standards:

NGSS 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.

Student Learning Objectives:

- Invent a test car that rolls smoothly when subjected to a force
- Demonstrate how the change in motion of the car is related to the forces applied
- Demonstrate how the change in motion of the car is related to the mass of the car

Most students enjoy building and competing. Start there. Once they have a car that rolls well, they will already have some experience with the factors that affect the motion of the car. Then they can begin thinking about experiments and how to measure the important variables.

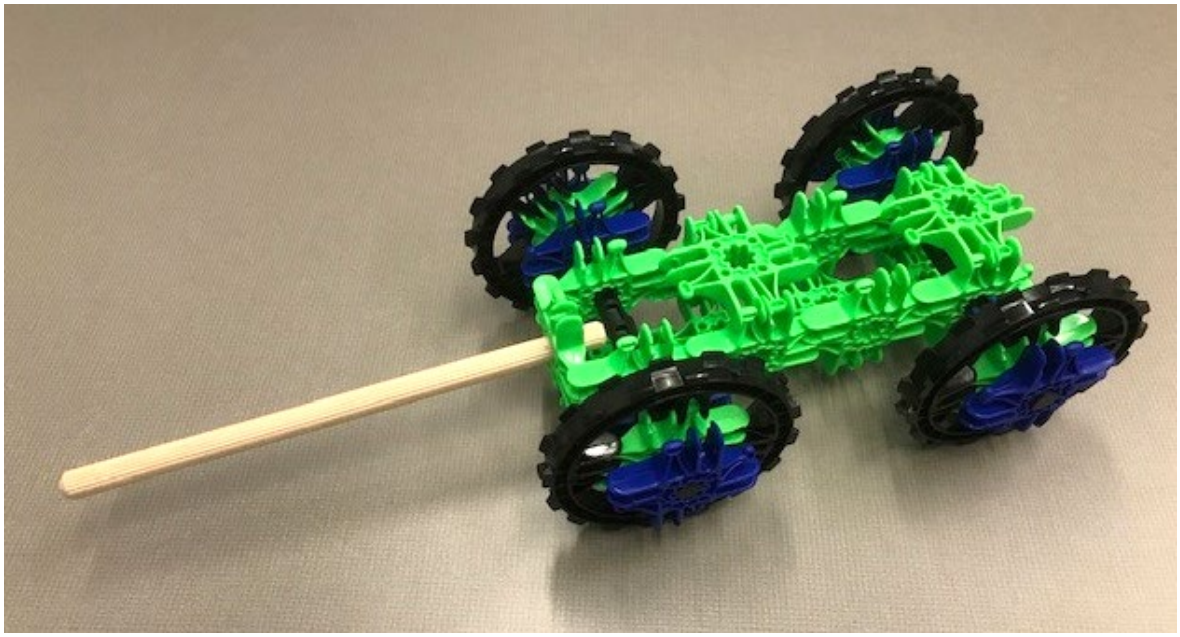
Advanced Preparation:
Print Student Handouts (one per student)

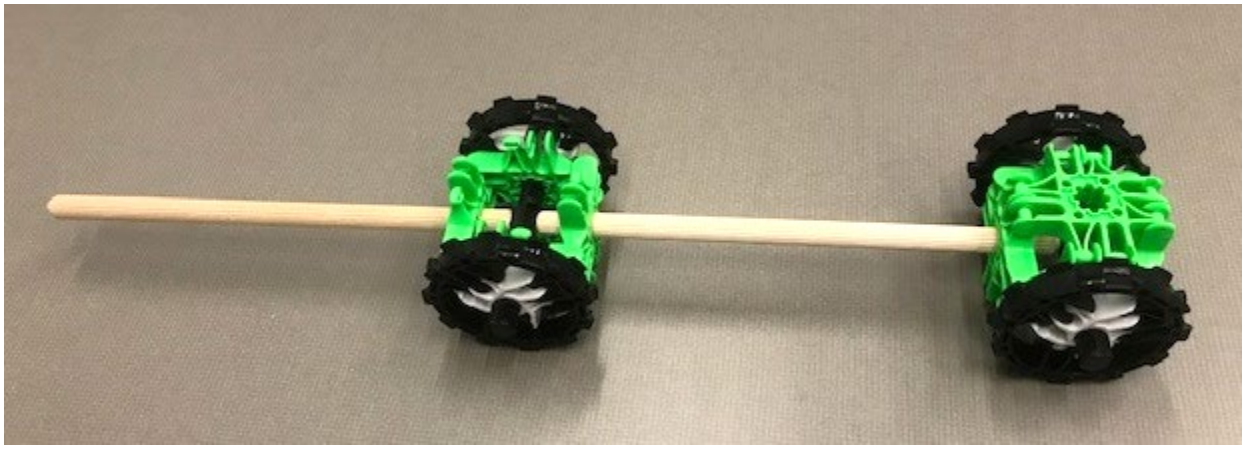
Implementation:

1) Explain to students that:
   - They will be launching toy cars from a rubber band to see how far they go.

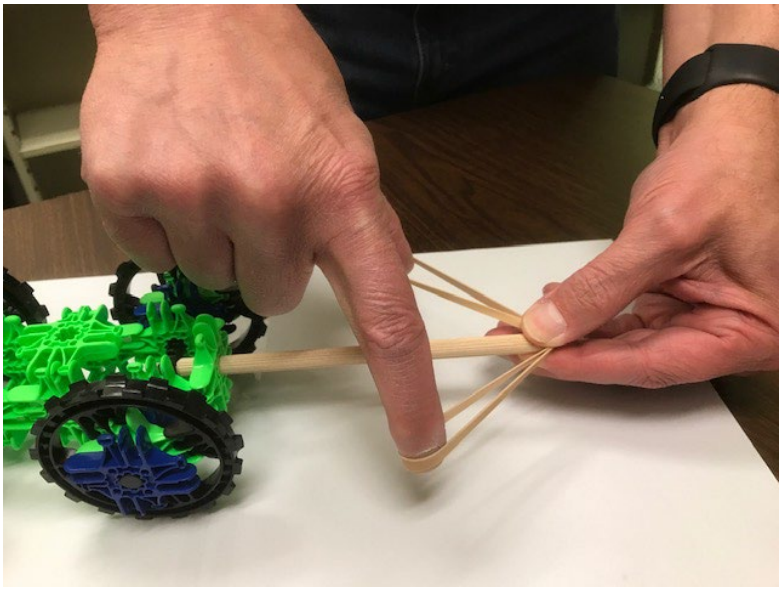
- You don’t have any cars for them. They will need to build their own!
- They will compete to see which car rolls the farthest.
- Then they will experiment to see how the pushing force and mass of the car affect its motion.
- You don’t have any instructions for doing that. They will have to design their own experiments.

2) Give students their handouts and materials.
3) If this is their first time using Lux Blox, show them how the parts snap together. Show them how the dowel rods connect to the plastic parts. Show them how the wheels and axles might be used.
4) Help them to build something that rolls and has a dowel rod protruding from one end. It might look something like one of the following examples, but it doesn’t have to.





5) There are several ways that a rubber band can be used to apply a force to the dowel rod. It may be useful to compare this with a bow string applying force to an arrow, but stress that nothing in this activity should be flying through the air!



6) Allow students to compete to see which car works best. Cars that don't roll well should be modified and improved.
7) Experiments involving the pushing force might involve pulling the rubber band back by two different distances. The more it is pulled back, the more force will be generated when the rubber band is released. Pulling distance can be measure with a ruler. Students might also try using two rubber bands, as this will provide more force than a single band, even if pulled back the same distance.
8) The mass of a car can be increased by attaching objects on top of the cars. A tape dispenser or stapler might serve. Sticks of modeling clay or sandwich bags holding pennies or sand would work. If scales or balances are available, students can measure the mass, otherwise they are simply comparing the car's performance with and without the added mass.
9) Encourage students to document their work and record any measurements. This data serves as the evidence to support their conclusions.

Debrief Questions:

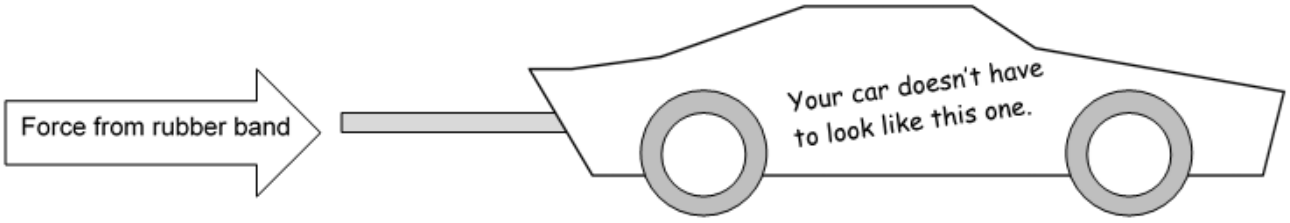
- How was the car's motion related to the forces applied to it? How do you know?
- How was the car's motion related to its mass? How do you know?

Roll with the Force – Student Handout

1) Build

Using the parts provided, build a test car. Your test car should:

- roll smoothly
- have a stick at the rear so you can launch it from a rubber band



2) Compete

Which test car will roll the greatest distance? Let's find out. Have a competition!

3) Experiment with Force

Design an experiment to determine how the distance travelled is related to the amount of pushing force from the rubber band. Describe your procedure below.

Perform your experiment. Record your data below.

Other than the rubber band, is anything else putting force on your car? Explain your thoughts.

4) Experiment with Mass

Design an experiment to determine how the distance travelled is related to the mass of the car.

Perform your experiment. Record your data below.

5) Conclusions

Explain how the motion of the car is related to the forces and the mass of the car.