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# Pair of Pull Back Cars

ROB-340

**Force:** A push or a pull. Weight is the force due to the acceleration of gravity. Objects have weight because their mass is being pulled downward toward the earth. The unit of force is a Newton (N). 1 kilogram is equal to about 9.8 Newtons.

**Work:** The transfer of energy through both force and motion. The force must be in the direction of the motion. The mathematical equation for work is force times distance (W = F x d). The unit of work is the Newton meter, more commonly referred to as a Joule (J).

**Power:** The rate at which energy is transferred, used or transformed. It can also be said that power is the rate at which work is done. The mathematical equation for power is work divided by time. (P = W / t). The unit of power is a Joule per second or a Watt (W).

## Class Activity

### Procedure:

1. When you have two identical cars that travel the same distance, they do the same amount of work, but if one travels faster than the other, one will use more power than the other.

2. In order to calculate the power of each car for this activity, you must first determine the amount of work that will be done.

**Materials:**

- Low Gear Car
- High Gear Car
- Meter stick
- Stop watch
- Masking tape
- Spring scale or balance

3. Using a meter stick and masking tape, mark off one meter on the floor or lab table. Using a spring scale or a balance find the weight of each car in Newtons. Calculate the amount of work each car will do by multiplying the force (weight of the car) times the distance (1m).

4. Now wind-up the first car by pulling it back while the wheels are pressed firmly on the ground. Position the car on the masking tape that marks the start of the meter. Release the car and time how long it takes for it to travel to the end of the meter. Calculate the amount of power it took for the car to travel that distance.

# Check for Understanding:

## Question:

If a big person and a small person run up the stairs in the same time, which person exerts the largest force on the stairs, the big person or the small person?

*Answer: The big person exerts the largest force on the stairs because he weighs more.*

## Question:

Which of them does the most work?

*Answer: The big person does the most work because the big person exerts more force over the same distance.*

## Question:

If a big person and a small person run up the stairs in the same time, which of them develops the most power?

*Answer: The big person develops the most power because the big person does more work and the time is the same.*

# More Challenging Questions:

## Question:

Do you think a bicycle helps you to develop more power than you would develop walking the same distance? Do you do less work using a bicycle?

*Answer: A bicycle helps you develop more power as long as you move at a faster rate than you would without the bicycle. The same amount of work is done with the bicycle as without; however, the bicycle gives the rider a greater mechanical advantage.*

## Question:

Jack and Jill ran up a hill. Jack is twice as massive as Jill, yet Jill ascends the same distance in half the time. Who did the most work? Who delivered the most power?

*Answer: Jack does more work than Jill. Jack must apply twice the force to lift his twice-as-massive body up the same hill. Yet Jill is just as "power-full" as Jack. Jill does one-half the work yet does it in one-half the time. The reduction in work done is compensated for by the reduction in time.*

# NGSS Correlations

Our Pull-Back Cars and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

## Elementary

**K-PS2-1**
Students can plan and conduct an investigation using the Pull-Back Cars to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

**3-PS2-2**
Students can make observations and/or measurements of the Pull-Back Cars motion to provide evidence that a pattern can be used to predict future motion.

## Middle School

**MS-PS2-2**
Students can plan and conduct an investigation using the Pull-Back Cars 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-PS3-5**
Using the Pull-Back Cars, students can develop an investigation and model to describe that when the arrangement of objects interacting at a distance change, different amounts of potential energy are stored in the system.

## High School

**HS-PS2-2**
Students can plan and conduct an investigation using the Pull-Back Cars to use mathematical representation to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

**HS-PS3-3**
Students can use the Pull-Back Cars to test a design, build, and redefine a devise that works with given constraints to convert one form of energy into another form of energy.

## Suggested Science Idea(s)

**K-PS2-1 • 3-PS2-2 • MS-PS2-2 • HS-PS2-2**
Students can plan and conduct an investigation using the Pull-Back Cars to demonstrate forces and energy release.

# Take Your Lesson Further

**As science teachers ourselves, we know how much effort goes into preparing lessons.**
**For us, "*Teachers Serving Teachers*" isn't just a slogan—it's our promise to you!**

**Please visit our website for more lesson ideas:**

**TeacherSource.com/lessons**

**Check our blog for classroom-tested teaching plans on dozens of topics:**

**http://blog.TeacherSource.com**

To extend your lesson, consider these Educational Innovations products:

**Wooden Car Kit** (WK-1)
This wooden car is powered by an elastic band. When the potential energy of the stretched elastic is converted into kinetic energy of motion, the car will travel about three meters (10 feet). Students can experiment by varying the method of winding the elastic, the number of turns, and the type of surface used.

**Dance with our Stars: Robots** (ROB-320)
Though they don't perform on TV, these simple wind-up machines include levers and rotating cams, and show the change from elastic potential into kinetic energy. The Dancing Robot has a visible cam in its belly that moves the hips and arms while bobbing the head.

**Mousetrap Racing Car Kits** (MID-100)
How can a mousetrap power a vehicle? What is friction and how can it be managed? How is energy stored? How is speed calculated? Your students will "build the answers" with our line of mousetrap racing car kits. Student will learn faster and retain more with hands-on activities that challenge all their senses. Designed, manufactured and refined with care based on years of classroom testing and teacher input. Complete illustrated teacher's guides with learning exercises and background information are included with each kit.

**OneCar** (PHY-280)
OneCar is a comprehensive, open-ended STEM system that allows students to explore energy and motion in as many ways as they can imagine - without soldering! Every Kit includes eight OneCars. Each has a low-friction car chassis, four wheels, and ample components that can be assembled and de-constructed for multiple use. Students can design, build, test, and propel their cars in six different modes, using a solar panel, electric motor, capacitor, kitchen chemicals, compressed air, propeller and more. Your students will be in the engineering fast lane as they learn about simple machines, Newton's laws, electrical circuits, renewable energy, chemical reactions, energy conversion and more!