# SCOPE, SEQUENCE, and COORDINATION

A National Curriculum Project for High School Science Education

This project was funded in part by the National Science Foundation. Opinions expressed are those of the authors and not necessarily those of the Foundation. 

# SCOPE, SEQUENCE, and COORDINATION

Student Materials

Learning Sequence Item:

# 935

# Work and Energy

***March 1996***
***Adapted by: Arthur Eisenkraft***

---

## Contents



This micro-unit was adapted by **Arthur Eisenkraft** (Fox Lane H. S., Bedford, N.Y.)

*Student Sheet*

Science as Inquiry

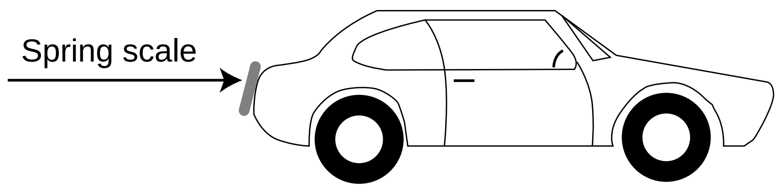
# A Moving Experience

**How does force and distance relate to kinetic energy?**

**Overview:**

How hard is it to push a car? How far can you push a car? If you wanted to win the car-pushing contest, what type of car would you choose to push? This activity will use the fine art of car pushing to gather some important data!

**Procedure:**




Your teacher will meet with you in a designated location in the school parking lot. To conduct this experiment, you will use two cars with different masses. Working in pairs, push the first car by pressing on the bathroom scales (positioned at the back of the car). Push as hard as you can, and to continue to push—using the same level of pressure or force—after the car begins to move. The ticker tape (provided) will record the motion of the car. Create a data table and record the force registered on the bathroom scale; the total distance the car moved; the final velocity of the car (computed from the ticker tape); and the mass of the car as given in the manual (or on the driver registration). Repeat the experiment, using less force to move the same car, and record these results. Repeat the experiment using the second, more massive car, and record these results.

**Questions:**

1. What force do you think is being applied to the cars?

2. Hypothesize what relationship may exist between the force applied to a car, the distance the car travels, the mass of the car, and the speed it acquires.

3. How might the force or distance be changed to provide an increase in the speed of a car?

4. Describe this activity in terms of work and kinetic energy.

Science as Inquiry

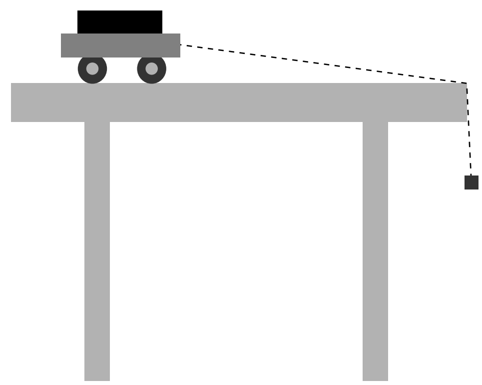
# Move It!

**What is the relationship between work, force and kinetic energy?**

**Overview:**

Imagine designing a cart that could travel the longest distance possible. What would your cart look like? What types of things should you worry about in your design? This activity examines the movement of carts.

**Procedure:**



Set up the lab cart so that it is pulled by the smaller mass that is hanging over the table. Record the force of the pulling weight; the mass of the cart (plus bricks); the distance the cart moves; and the final velocity of the cart. The force of the pulling weight is determined by hanging the mass from a Newton spring scale. The mass of the cart (plus bricks) is measured with a triple beam balance. Measure the distance the cart travels with a meter stick; and the final velocity of the cart with a ticker tape timer or sonic ranger.

Vary the hanging mass; the mass of the pulled cart; and the distance the cart travels. Record these variables and your results.

**Questions:**

1. Hypothesize what relationship may exist between the force applied to the cart, the distance the cart travels, the mass of the cart, and the speed it acquires.

2. How might the force or distance be changed to provide an increase in the speed of the cart. How is this technique utilized in car racing?

3. Describe this activity in terms of work and kinetic energy.

Science as Inquiry

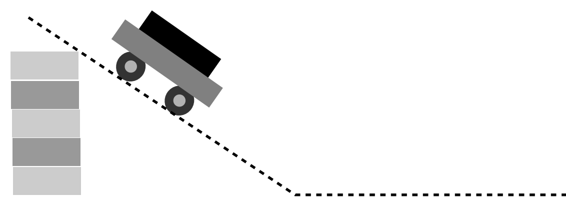
# Give Me A Brake!

## What is the relationship between work, force and kinetic energy?

**Overview:**

If you are moving a cart or car, does the steepness of the road have an impact on the speed? Try this experiment to examine speed on different surfaces.

**Procedure:**



Roll the cart down the ramp and let it come to rest on the floor. Record the mass of the cart (plus bricks), the distance the cart moves, and the velocity of the cart at the bottom of the ramp. Measure the mass of the cart (plus bricks) with a triple beam balance; the distance the cart travels with a meter stick; and the velocity of the cart at the bottom of the ramp with a ticker tape timer, sonic ranger, or photogate.

Try varying the mass of the cart; the steepness of the ramp or the distance the cart travels down the hill; and the friction by "freezing-up" the wheels. List the variables that you change and record the data in order to determine the mathematical relationships between the variables.

Determine the force of friction of the cart on the floor. This can be accomplished by measuring the force required to keep the cart moving at a constant velocity. Pull the cart on a level surface, with a spring scale, at a constant speed. Note that a larger force will produce an increase in the speed of the cart and that with a smaller force, the cart is not able to maintain the speed. The reading of the spring scale is equal to the force of friction.

Compare the work (force ∞ distance) with the increase in kinetic energy of the cart ($1/2mv^2$). Note: changes in force or distance provide changes in kinetic energy.

**Questions:**

1. For a given braking force, how does the stopping distance relate to the velocity of a car?

2. If the mass of a car has increased (e.g., full of passengers) how is the braking distance affected?

3. Hypothesize what relationship may exist between the force applied to the cart, the distance the cart travels, the mass of the cart, and the speed it acquires.

4. How can the frictional force which stops the force be measured?

5. Analyze and describe this activity in terms of work and kinetic energy.