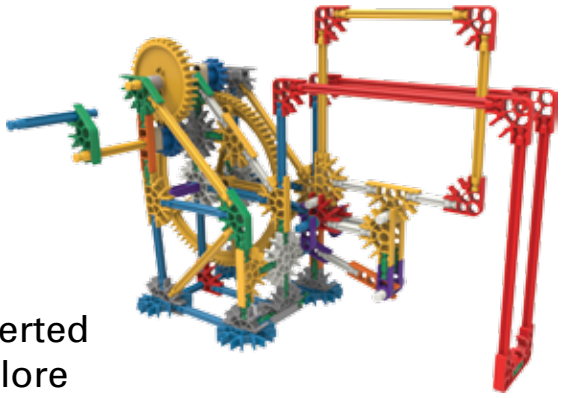
Experiment #2

79318

Converting Rotational Motion into Linear Motion with a Car Window



Objectives: Observe how rotational motion is converted into linear motion using a spur gear system and explore spur gears as a means to multiplying output force.

Materials You Will Need:

- built **CAR WINDOW** model
- small stickers or pieces of masking tape
- paper or notebook

PROCESS:

1. Build the **CAR WINDOW** model by following the step-by-step building instructions.

2. Take some time to explore your model. Locate and identify the gear train.

3. In your notebook, respond to the following:

    a. How does the mechanism work?

    b. Which parts move?

    c. What type of movement is applied to the blue crank (the input movement)?

    d. Describe the movement of the window (the output movement).

    e. Why is a small gear wheel used as the driver to turn a large driven gear?

f. How can you control the speed of the output motion?

g. Why does the crank turn many times but the window rises only slowly?

4. Remember, simple machines make work easier – they multiply the force applied or they increase the distance (speed) the resistance moves. A force and distance cannot both be increased at the same time.

(a) Lower the car window all the way and then turn the blue crank one full turn to raise the window.

(i) When you turn the crank through one full turn how far does the first 14-tooth tan gear turn? You may want to mark a starting point with a pencil or a dot sticker on the gear wheel and count how many teeth it moves as you turn the crank.

Record your answers in a table such the one shown below. (DATA TABLE 1).

DATA TABLE 1

	1st Gear Train	
	14-tooth tan gear	34-tooth yellow gear
Type of gear (driver/driven)		
Result of 1 rotation of the blue crank on the gears		
Fastest gear		
Force gained		

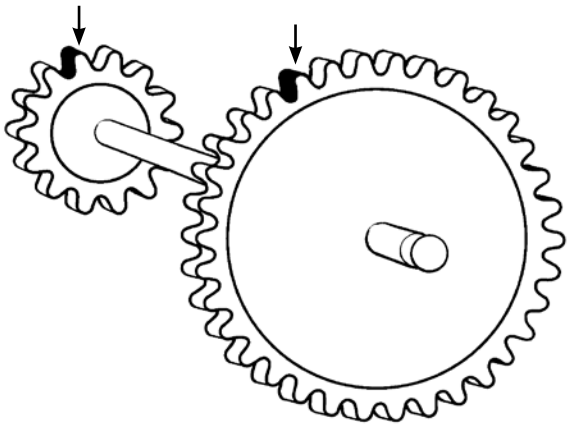
(ii) How far does the 34-tooth yellow gear that meshes with the tan gear turn? Record your answer in the table.

(iii) Based on the observations recorded in (i) and (ii) above, which moves faster - the driver gear or the driven gear?

(iv) Using your knowledge of gear ratios, what is gained, or multiplied, as the effort force moves through the first gear train?

(v) How is force transferred to the second gear train? How are these two gear trains connected?

(b) Place a mark/dot sticker on one tooth of the second 14-tooth tan gear (this shares the same axle as the 34-tooth yellow gear.) Try to place the mark on the tan gear so that it lines up with the one you placed on the yellow gear.



(i) Turn the blue crank through 1 full turn and notice how far the tan and yellow gears turn. You can count the number of teeth the gear moves through, or you may want to consider the movement in terms of the hands on the clock. For example the gear moves from 9 o'clock to 2 o'clock. You should record your answers in a table such the one shown below.

(ii) Given that the yellow and tan gears are different sizes, how do you explain your findings for (i) above?

(c) Place a mark or sticker on the large 82-tooth gear. Lower the car window again and turn the blue crank 1 full turn to raise the window. Watch the large 82-tooth yellow gear and count the number of teeth through which it rotates.

(i) How much does it turn? In comparison to the other gears how fast does it rotate?

(ii) What is gained by using the second gear train with the large 82-tooth gear?

DATA TABLE 2

	2nd Gear Train	
	14-tooth tan gear	82-tooth yellow gear
Type of gear (driver/driven)		
Result of 1 rotation of the blue crank on the gears		
Fastest gear		
Force gained		

d. (i) Describe how the window is moved by the second gear train.

(ii) How is the motion of the window different from the motion of the crank and the gears?

5. Consider how using thicker glass would affect the design of the car window mechanism.

EXTENSION ACTIVITY

1. Calculate the mechanical advantage of EACH gear train. Use the following directions:

(i) Count the number of teeth on the driven gear.

(ii) Count the number of teeth on the driver gear.

(iii) Divide the number of teeth on the driven gear by the number of teeth on the driver gear.