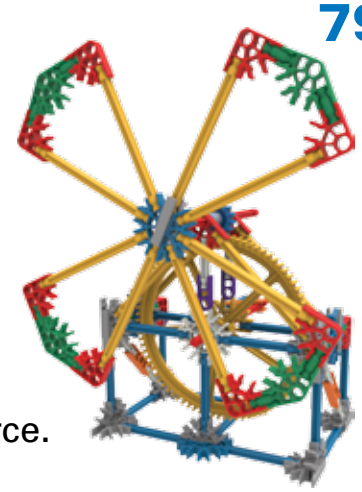
Experiment #1

79318

Using a Spur Gear System in a Crank Fan



Objectives: Understand and describe the transfer of motion through a spur gear system and investigate the relationship between gear size, speed of rotation and force.

Materials You Will Need:

- built **CRANK FAN** model
- masking tape
- paper or notebook

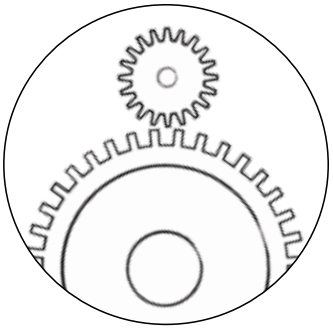
PROCESS:

1. Build the **CRANK FAN** model by following the step-by-step building instructions.

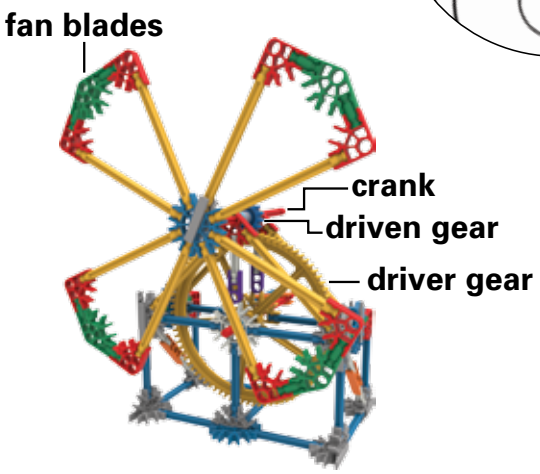
2. Explore your model. Locate and identify the gears. Watch the gear mechanism in operation as you turn the crank.

3. Using your notebook, explain how the gear system turns the fan blades. How do the fan's gears fit together? Are they in line with each other?

4. This arrangement is called a Spur Gear System. In this arrangement, the gears fit together, or mesh, along the same line or in the same plane. In the Crank Fan, the gears are arranged one above the other. Turn your model on its side so you can see how the gears are in line with each other.



5. The names of the various parts of this model are: **Crank, driver gear, driven gear,** and **fan blades**. Using masking tape, label the different parts of your model.



6. Using your notebook, respond to the following:

   (a) Describe how the moving parts that you labeled above are connected to each other.

   (b) Describe the input motion (the motion you use when you operate the crank).

   (c) Describe the motion of the gears.

   (d) Draw a diagram of the gear arrangement in your notebook and use arrows to show the direction each part moves as you operate the fan.

7. Attach a small piece of masking tape to the edge of one fan blade and select a reference point so you can keep track of the fan blade as it rotates.

   (a) Turn the crank to make one rotation. Continue turning the crank but vary the speed at which it is turned. How can you make the fan turn faster/slower?

   (b) Mark the two gear wheels with either a dot sticker or with a pencil mark. The marks should be made at the point where the two gears mesh. Now turn the crank one slow turn. What do you notice?

   (c) Note in your notebook the sizes of the two gears - driver and driven – used in the model.

   (d) Could there be a relationship between the size of the gears and your findings to (b)?

   (e) Turn the crank one additional turn, but this time, notice how far the fan blades travel. Ask a friend, parent, or teacher to count the number of times the blade with the masking tape passes the selected reference point, and focus on making just one full turn with the crank.

   (f) How easy/hard is it to turn the crank with this gear arrangement?

   (g) Summarize your observations concerning the distance the two gears and the fan blades turn with one rotation of the crank.

8. (a) What do you think will happen if you use:

   (i) a large gear wheel to drive a small gear wheel &

   (ii) a small gear wheel to drive a large gear wheel.

   • Make a note of your responses in your notebook.

(b) Discover if your predictions were correct by rebuilding your models with two gears that are different in size using these images.

(c) Think of a way to compare the speed that the fan turns, with the speed of the crank when the big gear is attached to the crank and the small gear is attached to the fan blades.

(d) How easy/hard is it to turn the crank with this arrangement compared to when the gears were the same size?

- Make a note of your responses in your notebook.

(e) Compare the speed at which the fan turns with the speed of the crank, when the small gear is attached to the crank axle and the big gear is attached to the fan blade's axle.

(f) How easy/hard is it to turn the crank with this arrangement, compared to when the gears were (i) the same size and (ii) the large gear was the driver?

- Make a note of your responses in your notebook.

9. (a) Discuss your observations of gear systems using different sized gears.

(b) Do your observations support the prediction that you wrote earlier? Report your conclusions using evidence from your investigations.

EXTENSION ACTIVITY: Gear Ratios

1. You used a crude measurement to compare the input and output speeds of the gear wheels in the experiment you just performed. What you discovered was a simple Gear Ratio.

2. A more accurate approach is to compare results by counting the number of teeth on each gear wheel.

$$\text{Gear Ratio} = \frac{\text{Number of teeth on the driven (follower) gear}}{\text{Number of teeth on the driver gear}}$$

For example: 14/84 gives a gear ratio of 1/6 or 1:6

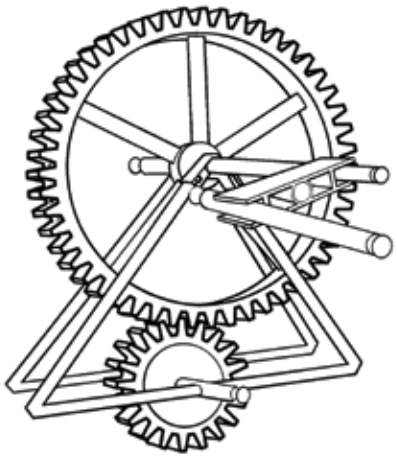
3. A 1:6 gear ratio means that for every complete revolution of the driver gear, the driven gear makes 6 complete revolutions. Or, said another way: the output speed is faster than the input speed.

4. (a) Now remove the fan blades from your crank fan and set aside.

   (b) First, use the large gear as the driver gear and the small gear is the driven gear.

   (c) Second, use the small gear as the driver gear and the large gear is the driven gear.

NOTE: Do not to disassemble your fan. Simply attach the crank to the appropriate shaft. (See diagrams below.) In order to watch the speed of rotation of the second gear in the gear chain, you should attach a yellow connector to the end of that gear's axle. (This connector replaces the blades that, if used on the lower axle, will strike the tabletop unless the model is pushed to the very edge.)



Set-up one: Crank on upper axle. Put the yellow connector on the end of the lower axle.

Set-up two: Crank on the lower axle. Put the yellow connector on the end of the upper axle where the blades used to be.

(d) Determine the gear ratio of your crank fan. Write down the gear ratio in your notebook and describe, in your own words, what the gear ratio means in reference to their crank fan.

(e) What is gained by using this gear train? Did your fan turn quickly or slowly?

5. Use the table below to record your findings and repeat steps (4c-4e) with the small gear as the driver gear and the large gear is the driven gear.

GEAR TRAIN SPEED	FAN SPEED VS. CRANK SPEED	GEAR RATIO (APPROXIMATE)	INCREASED OUTPUT SPEED OR INCREASED OUTPUT FORCE
Gears are same size			
Large driver gear moving small driven gear			
Small driver gear moving large driven gear			

6. Brainstorm how you can change the design of the crank fan so that the crank and the fan turn in the same direction in your journal. **Hint:** What can you add to the mechanism? This will introduce the concept of the idler gear.