SAMS 2018

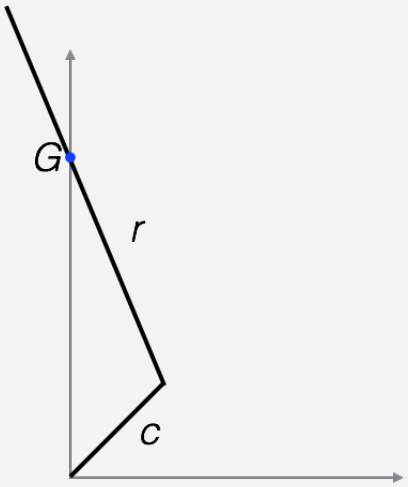
Mechanisms in Motion

Controlling the Movement of Mechanisms

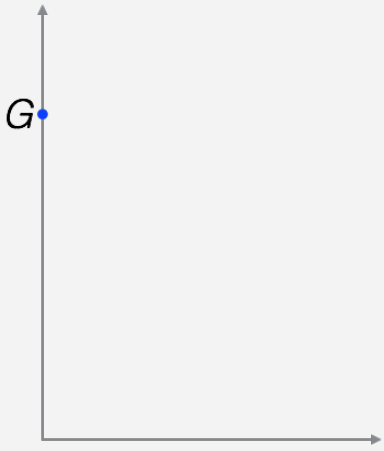
This lab is adapted from the Hummingbird Robotics Kit web pages
https://www.hummingbirdkit.com/teaching/sketches/laser-cut-mechanisms

1. Calculating how far the crank moves

You can use geometry to calculate how far the crank will move horizontally and vertically. This diagram shows an idealized version of the crank mechanism. The length of the crank is c, and r is the length of the rod. G is the point where the guide keeps the rod in place. The rod must always pass through this point.



On a piece of graph paper, draw the crank and guide when the rod is at its highest point. (See the template below.) What are the coordinates of the top of the rod in terms of *c* and *r*?



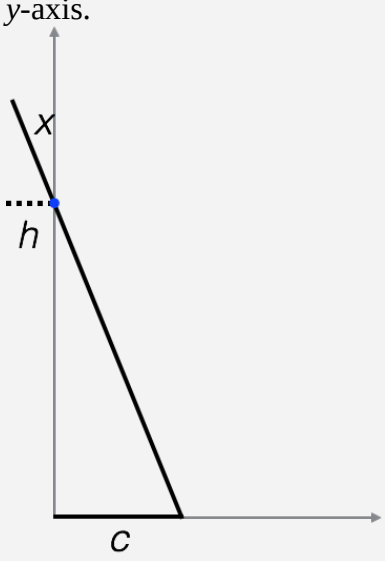
Make a separate diagram with the crank and guide when the rod is at its lowest point. What are the coordinates of the top of the rod in terms of *c* and *r*?

In terms of *c* and *r*, what is the vertical distance that the top of the rod moves between its highest and lowest points?

Measure *c* and *r* for your crank mechanism. The length of the rod should be measured from the center of the connecting pin to the center of the hole at the end of the rod. The length of the crank should be measured from the center of the motor to the center of the connecting pin at the end of the crank, as shown in the picture below.

Use your measurements to calculate the vertical distance that the rod moves.

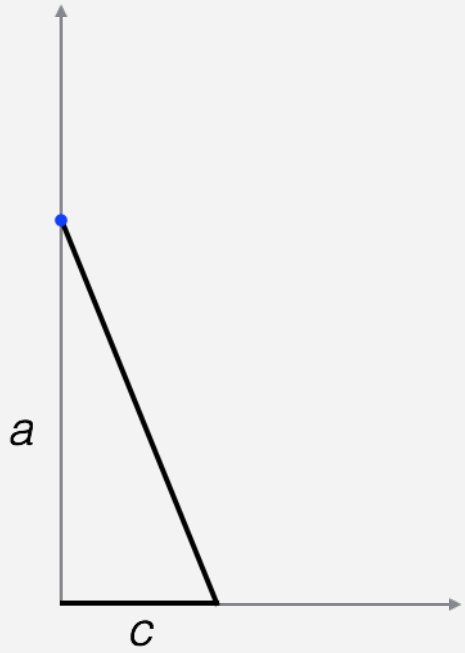
Next, find the horizontal distance that the rod moves as it travels. The crank mechanism is shown below with the crank lying along the *x*-axis. The distance *h* is the maximum distance that the top of the rod moves to the left of the *y*-axis.



What similar triangles can you find in the diagram above? Use the properties of similar triangles to fill in the blanks in the equation below.

$$\frac{h}{x} = \frac{c}{\quad}$$

Consider the triangle below point *G*. We will call the height of this triangle a. Measure the value of *a* for your crank mechanism by measuring the vertical distance from the center of the motor to the guide.

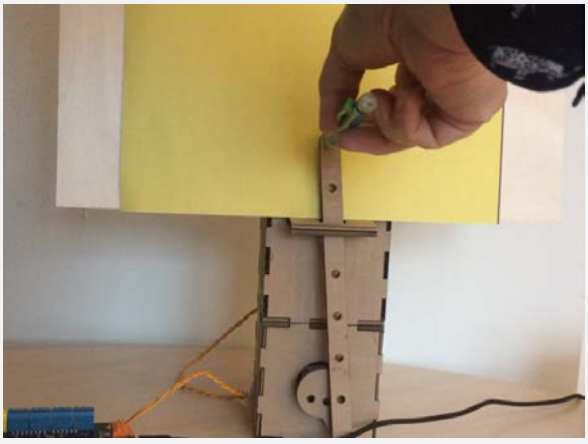


Now that you have values for *a* and *c*, find the length of the third side of the triangle in the diagram above. Now you have enough information to find *h*. What is the total horizontal distance that the end of the rod moves?

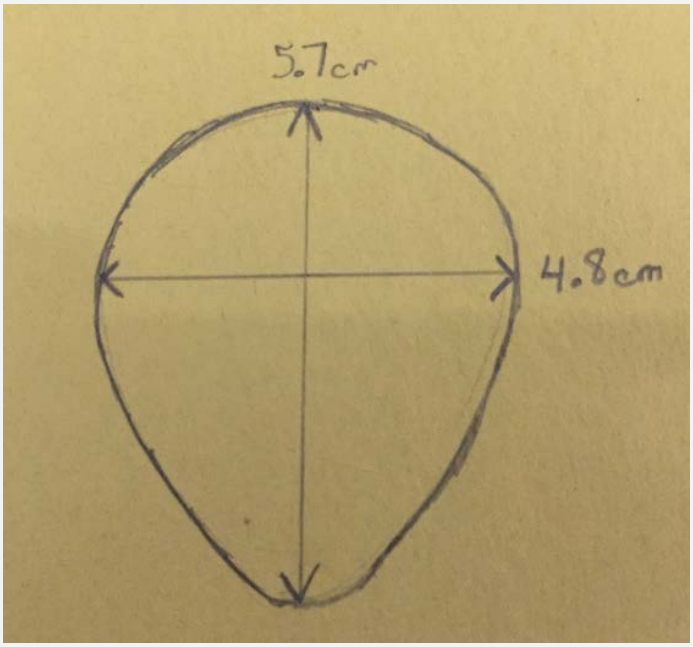
1.1 Finding the Path of the Rod

Next, you will trace the path of the end of the rod. This way, you can get a better idea of the type of movement caused by a crank.

Tape a piece of paper onto a piece of cardboard about the same size. Place this behind the end of the rod. Place a pencil through the top hole of the rod.



As the rod moves, use the pencil to trace its path. Try not to affect the motion of the rod; just follow it with the pencil. Remove the paper and the pencil. Darken the path you traced and measure its maximum width and height.



How do these values compare with the ones that you calculated?

1.2 Changing the Length of the Crank

Now you will investigate how you can change the motion of the mechanism by changing the length of the crank. You can change the length of the crank by using the other two holes along the length of the crank.

- Move the connecting pin to the next hole on the crank.
- Trace the path of the rod. Measure the maximum width and height of the new path.
- Change the length of the crank again. This time, place the connecting pin in the hole closest to the center of the motor.
- Trace the path of the rod. Measure the maximum width and height of the new path.
- How does changing the length of the crank affect the path of the rod?