

# Real Geometry: The Pantograph

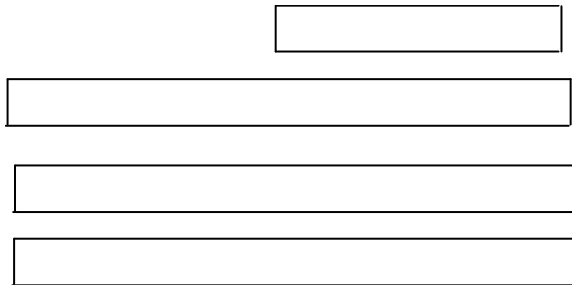
**Overview:** A pantograph, first invented in the early 1600s, was used to make exact copies before there were any Xerox machines around. It's a simple mechanical device made up of four bars linked together in a parallelogram shape.

Here's how it works: By simply tracing an object with the pointer, the pantograph makes a copy larger or smaller depending on which point you attach your pen and pointer. Some pantographs were adjustable – meaning that they could change their pivot points to adjust the size of the copies. We're going to make one of these to see how geometry can really be used in the real world.

## Materials

- Paper
- 2 mechanical pencils
- Masking tape
- 4 brass fasteners
- 2 yardsticks
- Strong scissors or saw to cut the yardsticks into three 16" lengths and one 8" length
- Drill with drill bits
- Scrap piece of cardboard, wood, or other old table space to practice on (your table may get scratched)

**Activity:** To assemble the pantograph, first divide the yardsticks into three 16-inch pieces and one 8-inch piece.

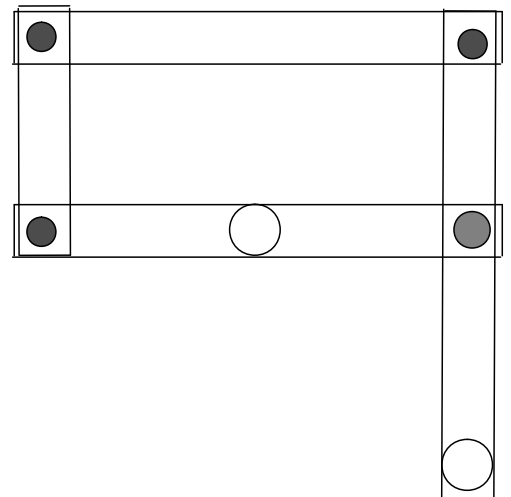


Drill holes into the sticks and assemble them so that they form a rectangle as shown in the figure.

Insert the brass fasteners into the four shaded holes. If the holes aren't large enough so that the brass fasteners can fit freely without falling through, then drill the holes out a little more.

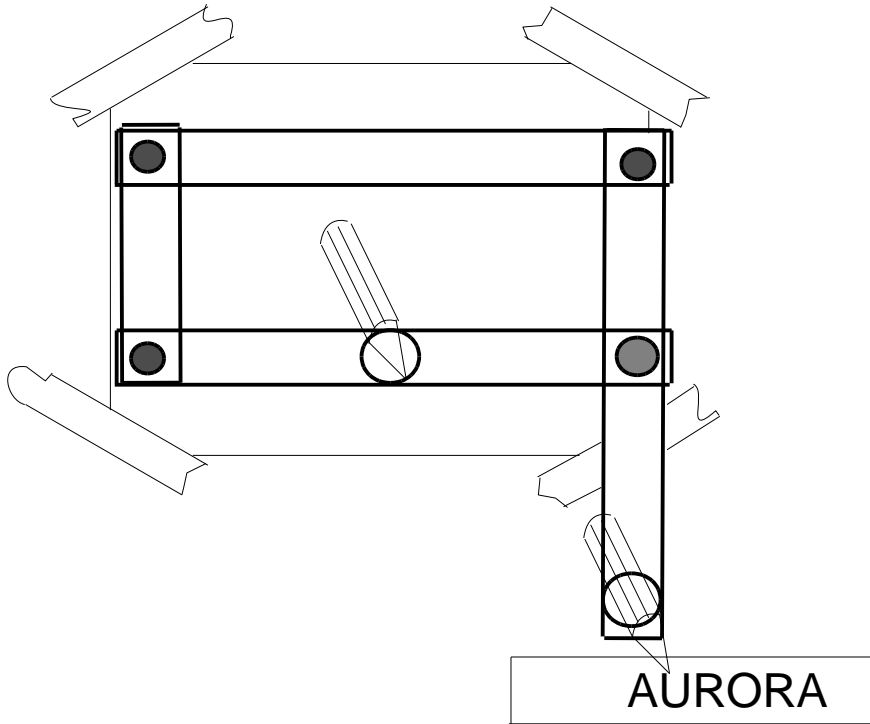
Drill two more holes (shown by the open circles in the image) *slightly* smaller than the diameter of the pencils. Insert pencils into each of the holes – you should need to press-fit them in. If your holes are too large, wrap your pencils with tape to fill in the gap.

The pencil in the horizontal bar is for drawing, and the pencil in the vertical bar is for pointing (called the *pointing pencil* or *pointer*).



Mount a blank sheet of paper on a drawing board using the tape.

On a second sheet of paper, write your name. I wrote AURORA on mine. Put the name under the pointer.

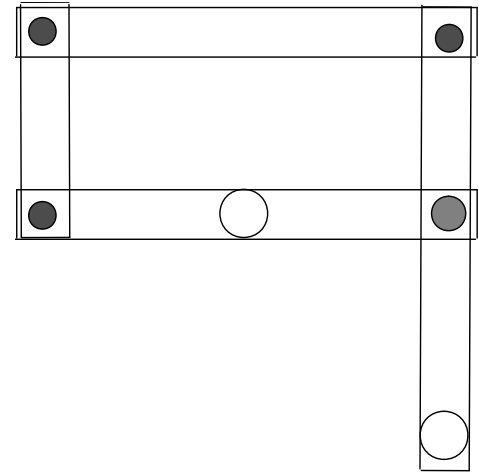


To use the pantograph, hold the top left joint in a fixed position and use the pointer to trace the name. Make sure your drawing pencil is touching the paper enough to leave a mark so you can see what it's writing!

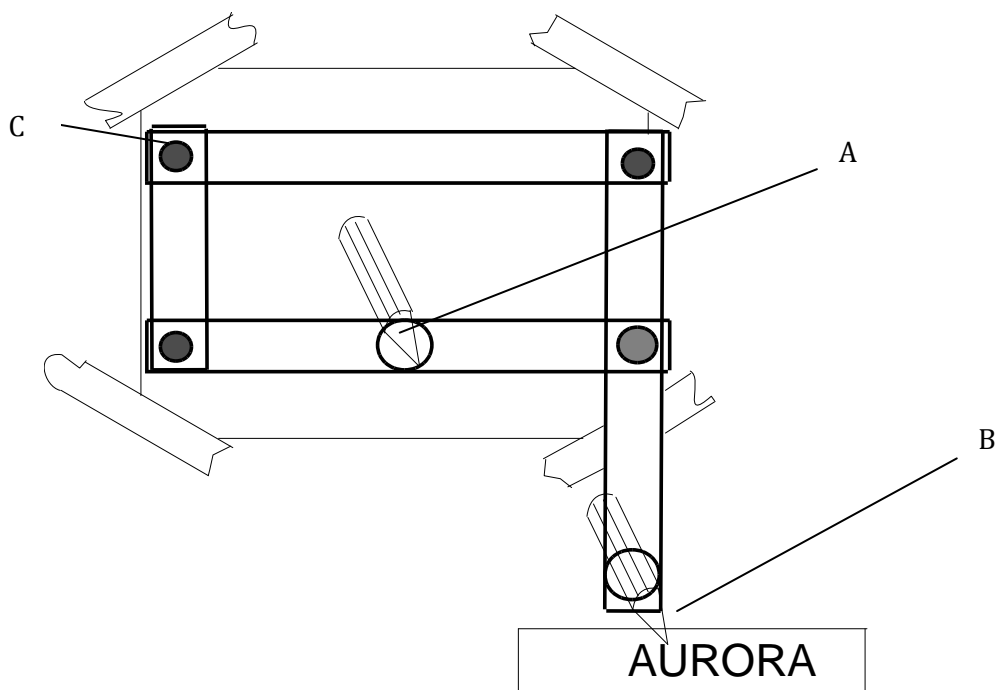
Which one (the drawing pencil or pointer) makes the smaller drawing?

## Exercises

1. Identify the name of the image at the right:
2. What is the use of the instrument shown?
3. Why is the drill necessary in assembling the instrument?
4. What is the purpose of the masking tape in the above procedure?
5. Identify the names of the two pencils as used in the drawing procedure.



Use the diagram below to answer question 6, 7 and 8.



6. What is the size of the object at B as compared to that of the original object?
7. What is the size of the object at A as compared to that of the original object?
8. How is the joint at C treated to allow the instrument to work as designed?
9. How are the holes at the joints treated so ensure the instrument works efficiently?
10. When the instrument is at work, what kind of geometrical figure does is formed between the horizontal and the vertical bars?

## **Answers to Exercises: Real Geometry: The Pantograph**

1. Pantograph
2. Scale down and enlarge drawings
3. Drill the holes where the screws will be fixed to hold the bars in position
4. Mount the sheet of paper on the drawing board
5. Drawing and pointing pencils
6. Larger than the original object
7. Smaller than the original object
8. It is fixed stationary
9. Enlarged to allow movement of the bars at the joints
10. Parallelogram