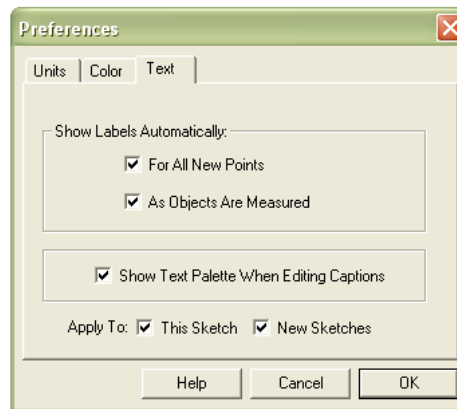
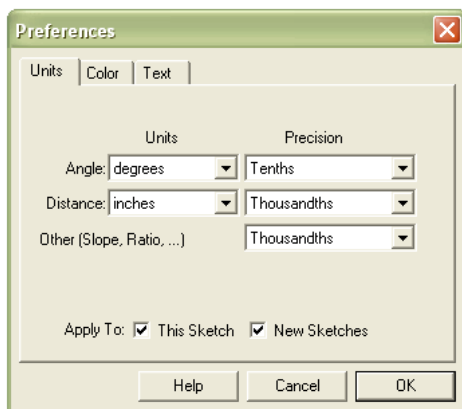



Getting Started

To begin, under the **Edit** menu at the top of the screen select **Preferences**. Make sure all of the preferences under the **Units** tab and the **Text** tab are the same as below. Then click **OK**.




Line Segments

The first figure we will draw is a simple line segment. If at any point in these instructions you make a mistake, there is an undo feature under the **Edit** menu.

- On the toolbar at the left of the screen click on the **Straightedge Tool** . Then, click anywhere on the blank screen and hold down the mouse button. While continuing to hold down the mouse button, move the mouse to somewhere else on the screen. A line segment should be drawn as you do this. When you have a line segment you like, release the mouse button. You should now have a line segment on your screen with endpoints labeled **A** and **B**. (If your endpoints are labeled with different letters, simply use those letters in place of **A** and **B** in these instructions.)

Let's find out how long your line segment is.

- Under the **Measure** menu, choose **Length**. The program will put the measure of the length of the line segment in the upper lefthand corner of the screen. If we change the size of this line segment, the program will update its measurement automatically. To change the length of the line segment, we must choose one of the endpoints to move.
- On the toolbar at the left of the screen click on the **Selection Arrow Tool** . Now click on either endpoint of your line segment. Hold down the mouse button and use the mouse to move this endpoint anywhere on the screen. Notice that the reported measurement of the line segment changes as you do this.
- Now repeat the process to move the other endpoint of the line segment around. Click in the middle of the line segment to select the entire object. Then move the whole line segment around the screen. As expected, the measurement of the line segment does not change as you do this.

Once you are done moving the line segment around, measure its length using the following alternate method:

- Use the mouse to select one of the endpoints. Then select the other endpoint. Under the **Measure** menu, choose **Distance**. This returns the distance between the two selected points, which in this case is the same as the length of the line segment.


The last thing we will do with this line segment is to construct a midpoint on it and take some more measurements.

- Select the entire line segment. Under the Construct menu, choose Midpoint. This should add another point to your picture in the exact middle of the line segment.
- By hand, figure out the distance from the new point to each of the endpoints. Now have the computer measure the distances to see if you are correct. (Note the computer will round the final number in its answer.)
- Move one of the endpoints so that you stretch, shrink, or rotate the original line segment. Notice that the midpoint will stay at the center.

Intersections

- Under the File menu, choose New Sketch.
- Construct two line segments that intersect each other.
- Now select both line segments (make sure they are both highlighted.). Under the Construct menu choose Intersection. You now have 5 points on your picture. Experiment by moving each of the 5 points around individually to see what happens. What is the difference between what happens when you move an endpoint of one of the line segments and what happens when you move the intersection point?

If you were paying close attention while constructing the intersection point, you may have noticed another way to construct the intersection point of two line segments. Let's try the other way.

- Under the File menu, choose New Sketch.
- As before, construct two line segments that intersect each other.
- Now, select the Point Tool . At the bottom left corner of the screen you will see the words "Construct Point ...". Move the cursor towards the place where the line segments intersect. Eventually, the words at the bottom of the screen will change. When these words are "...of Intersection", click the left mouse button. You should have a point at the intersection of the two segments, just as before.

In the future, pay attention to the words at the bottom of the screen, because they will often alert you to possible shortcuts like this.


Angles

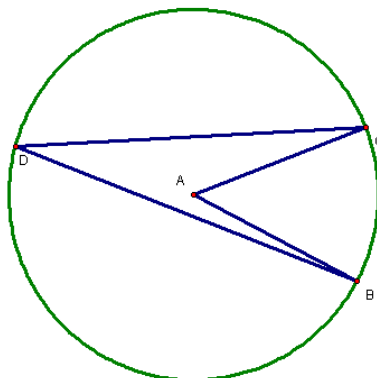
- Under the File menu, choose New Sketch.
- Draw a line segment. From the endpoint labeled B, extend another line segment out. (Make sure your second line segment shares an endpoint with the first.)
- Estimate in degrees the size of the angle you have drawn. Let's find out how close your estimate is. Select all three of the points in alphabetical order. Under the Measure menu choose Angle. Make sure that the reported angle it returns has the points listed in alphabetical order. How far off was your estimate?
- Select one of the line segments and move it around to see how the picture changes. Play around with moving various points or segments of your picture to see what happens.

Triangles

- Under the File menu, choose New Sketch.
- Draw a triangle by constructing 3 line segments in a row. Make sure that only three labeled points show up on your picture.
- Measure angle ABC . Now, select only point B . Move this point around until angle ABC measures as close to 90° as you can get. (It will be easier to get exactly 90° if you make your triangle larger.)
- Now measure the length of each of the three line segments. Calculate the square of each of these lengths. Now add the two squares of the lengths of segments AB and BC . Is this sum the same as the square of the length of segment AC ? Should it be?

Circles

- Under the File menu, choose New Sketch.
- On the toolbar at the left of the screen click on the Compass Tool . Click on the blank screen and hold down the mouse button at the place you would like to have the center of the circle. While continuing to hold down the mouse button, move the mouse to somewhere else on the screen. A circle should be drawn as you do this. When you have a circle you like, release the mouse button.
- You should now have a circle with center labeled A and a point on the circle labeled B . Experiment with moving each of the points to see what happens to the circle.
- Construct the line segment between the two points. Note that this is a radius of the circle. Measure the length of this radius.
- Use the Point Tool to place another point (labeled C) on the circle not too far away from point B . Construct the line segment AC to create another radius of this circle. What should its length be? See if you are correct?
- On the opposite side of the circle, construct yet another point (labeled D). Construct line segments from D to each of points B and C . If you are having trouble setting this up, see the Figure below.



- Measure angles BAC and angles BDC . What is the relationship between the two measurements (you may have to ignore some rounding error)? Move point D around a little bit. Does the relationship still hold? Move point C around a little bit. Does the relationship still hold? Is there any way to make the relationship not hold?

Now, we will try a different way to make a circle.

- Start a new sketch.
 - Construct the two points A and B. Use the **Compass Tool** to click on point A and continue to hold down the mouse button. Move the pointer toward point B. As you do this, you should see a circle centered at point A that is increasing in size as you move outward. Stop when you get to point B (use the messages at the bottom of the screen to know when you are there) and release the mouse button.
 - Click on the **Selection Arrow Tool** and move each of the two points around. Notice that no matter which point you move, you always have a circle centered at point A and passing through point B.
-

Exercises [Start a new sketch and type your name.]

1. Draw a triangle. Construct the midpoint for each of the sides. Construct the three line segments that join each vertex to the midpoint that is opposite from it. What do you notice about these three segments? (Hint: How many intersections do you usually get if you draw three random line segments?) Move the vertices of the triangle around until you are convinced that this phenomenon is no accident. The new point you have introduced is called the **CENTROID** in mathspeak.
2.
 - a. **How to Construct a perpendicular line segment:** Draw a sloping line segment, that is, not horizontal or vertical. Create a point on the line segment. Select both this point and the line segment. Under the Construct menu, choose Perpendicular Line. Unfortunately, this creates a perpendicular line, not a line segment (that is, there are no endpoints). Create your own endpoints by placing two points on the line where you would like the segment to begin and end. Then select the line and choose Hide Perpendicular Line under the Display menu. Finally, connect the two endpoints you created to form your line segment. Move around the endpoints of the original line segment to verify that the second segment remains perpendicular to it.
 - b. **How to Construct a parallel line segment:** Begin again with a sloping line segment. Create a point that is not on the line segment. Select both the point and the line segment. Under the Construct menu, choose Parallel Line. Then proceed as above to change the line into a line segment.
 - c. **How to Construct a parallelogram:** Start with a sloping line segment. This will be the first side of your parallelogram. Attach another line segment to it to create an adjacent side of your parallelogram. Create a line parallel to the first side that passes through the free endpoint of the adjacent side. Then create a line parallel to the adjacent side that passes through the free endpoint of the original side. The intersection of the two lines will be the fourth corner of the parallelogram. Draw in the remaining two sides of your parallelogram and then hide the lines. Check to make sure that you have constructed it correctly by moving one of the original two points around. The figure should stay a parallelogram.
3. Construct two different **non-rectangular** parallelograms. For each parallelogram, construct the two diagonals and then place a point at their intersection. Measure the lengths of the full and partial diagonals and use these measurements to write a conjecture about how the diagonals intersect each other in a parallelogram.