

Geometer's Sketchpad Exploration

Trigonometric Functions

1. Open Geometer's Sketchpad. Maximize the new sketch in the sketchpad window. Resize the Sketchpad window to suit you. Go to **Edit** → **Preferences...** → **Units** and change **Angle:** to **radians** and **Precision:** to **Ten Thousandths**.

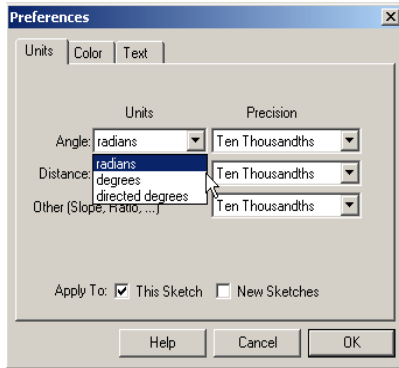


Illustration 1

2. Select **Graph** → **Define Coordinate System**

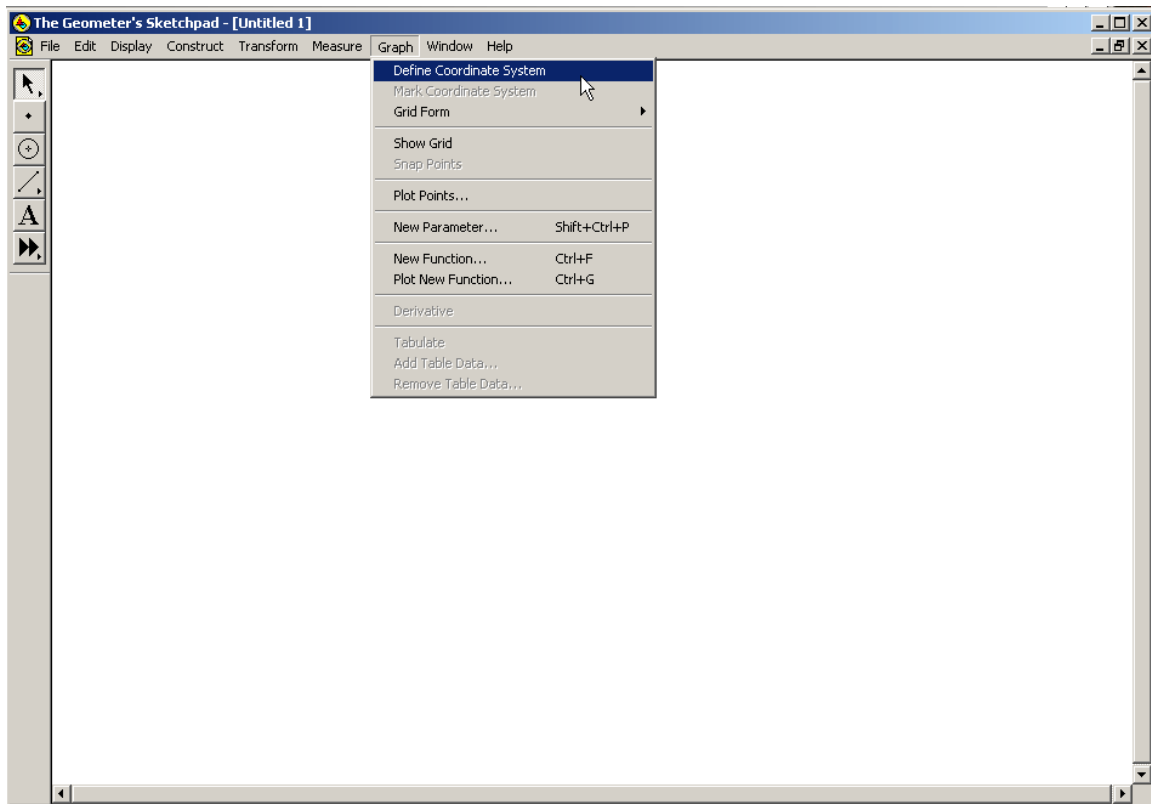


Illustration 2

3. You now have a Cartesian coordinate system. Select **Graph** → **Plot Points...** and plot the point $(2\pi, 0)$. (Enter the value 2π as 2π .) Grab the y-axis or the point $(1, 0)$, one at a time, and resize the graph until the point $(-1, 0)$ is just visible on the left and the point $(2\pi, 0)$ is just visible on the right.

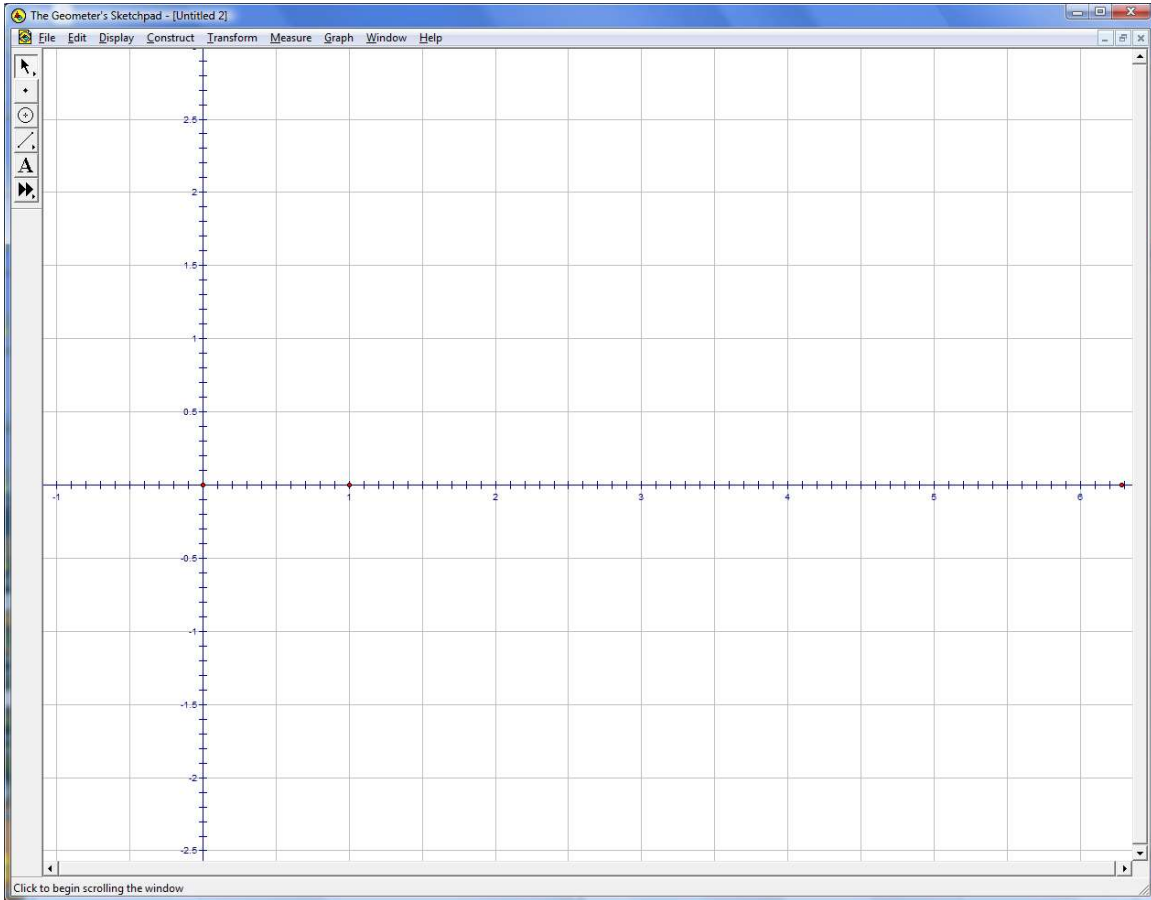


Illustration 3: Adjust view so that the x-axis ranges from $(-1, 0)$ to $(2\pi, 0)$

4. Select first the point at the origin and then the point at $(1,0)$. With both points highlighted, go to **Construct** → **Circle by Center+Point**. Now deselect the circle. You have now constructed a Unit Circle in a Cartesian coordinate system.

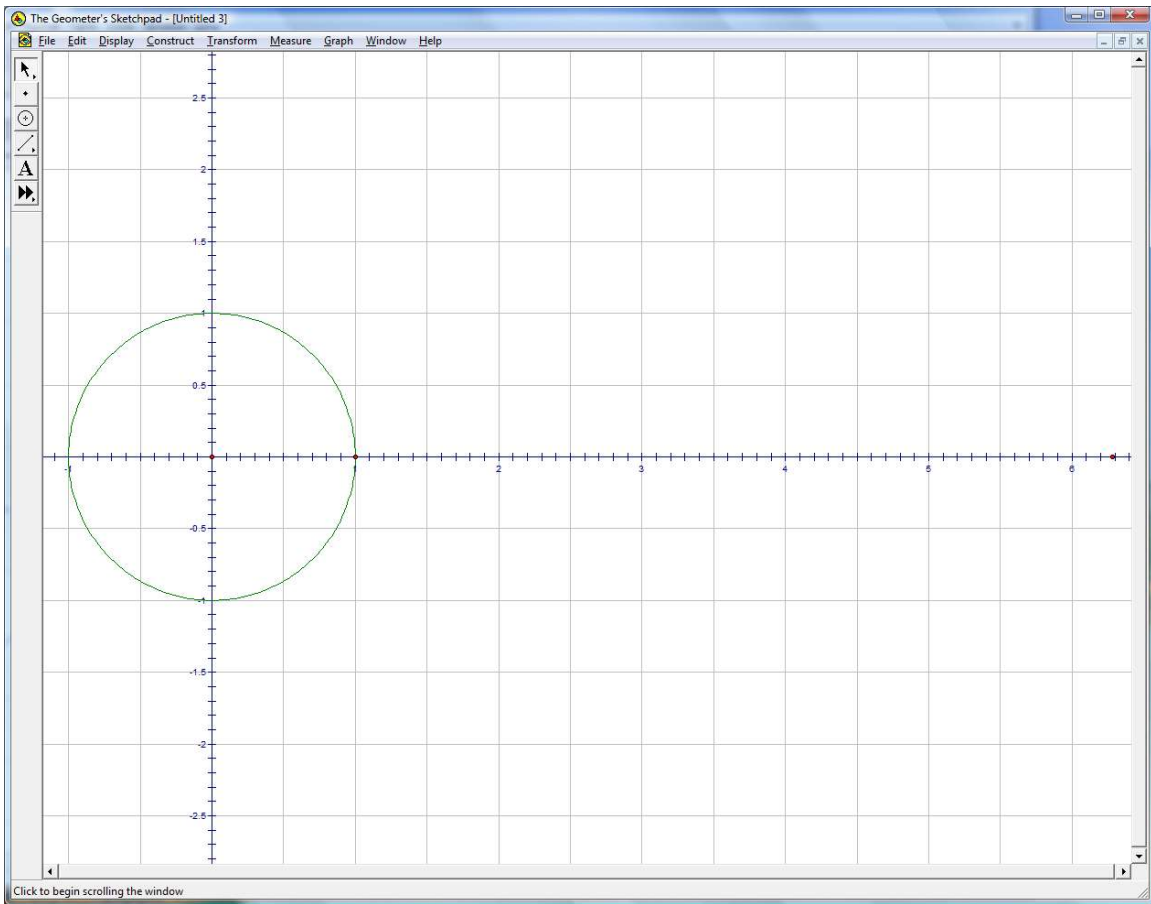


Illustration 4:

5. Select the circle and **Construct** → **Point on Circle**. Move the new point into the first quadrant if it is not already there. Label the point ***a***. Select the origin and then the new point and **Construct** → **Line**. This line forms the angle with the x -axis that we will be exploring.

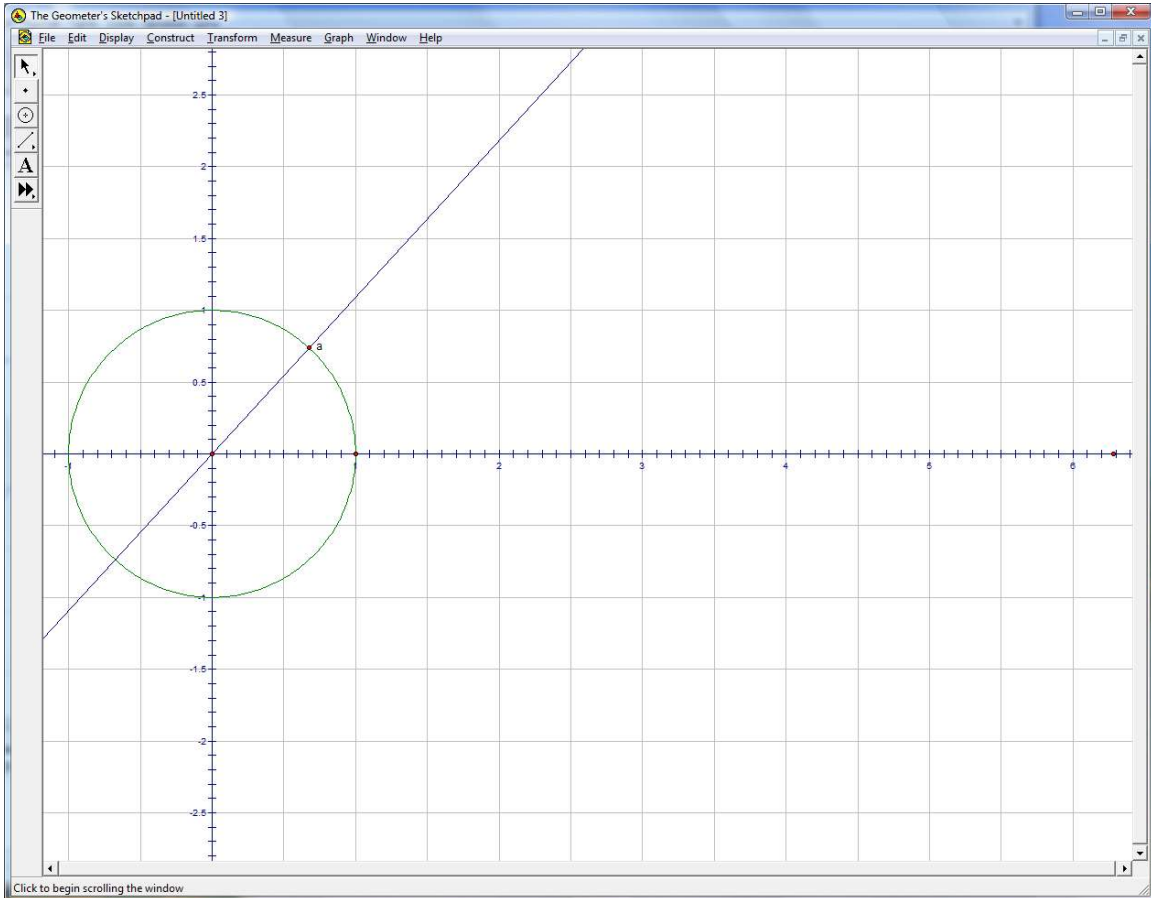


Illustration 5:

7. Select point a and then select the y -axis, **Construct** → **Perpendicular Line**. Construct the intersection of the line and the y -axis by deselecting the line and clicking at the intersection. Now select only the line and hide it by selecting **Display** → **Hide Perpendicular Line** or by typing **CTRL-H**. Move point a around the circle and note how the new point responds. The point you just created on the y -axis will be at $\sin a$. Select the new point and the x -axis and **Construct** → **Parallel Line**. Make this new line dashed.

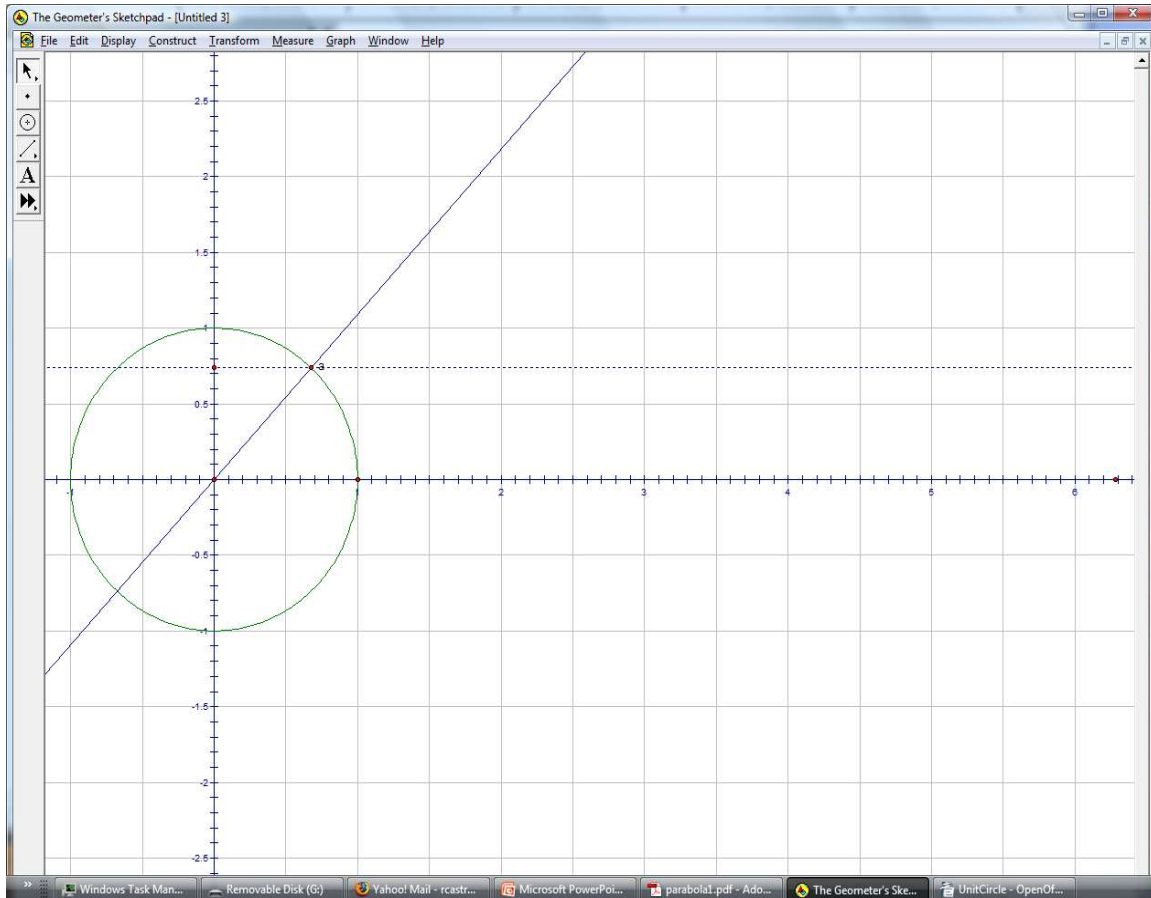


Illustration 6:

8. Select only the origin and the point $(2\pi, 0)$ and **Construct** → **Segment**. Then **Construct** → **Point on Segment**. Label this point x . Deselect the point. Hide the segment just created by selecting it and typing **CTRL-H**. Select the point x and the segment and **Construct** → **Perpendicular Line**. Construct the intersection of this line with the dashed line you constructed in Step 6. With only this point selected, choose **Display** → **Trace Intersection**.

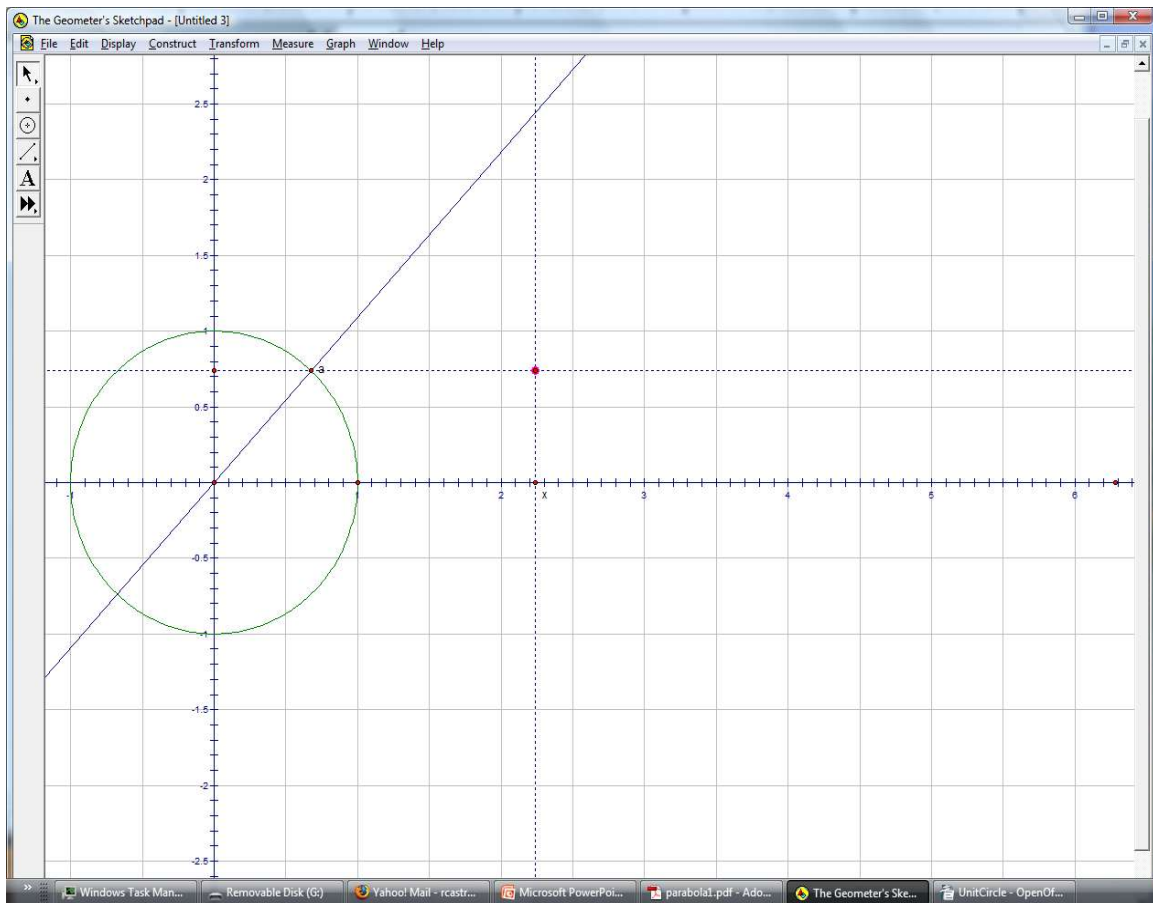


Illustration 7:

9. We now need a way to get the x point and the a point to their “home” positions. Click on x and then the origin. Select **Edit** → **Action Buttons** → **Movement...** and click **OK**. Now deselect the new action button. Select point a and then the point $(1,0)$. Create another action button that will move a to $(1,0)$.

Select both action buttons and **Edit** → **Action Buttons** → **Presentation**. Label this Park It, to park x and a in their home positions. You will notice that a trace is created. You can erase the trace by choosing **Display** → **Erase Traces** or by entering **CTRL-B**.

Hide both of the Move Point action buttons. You should now have a single action button that says Park It.

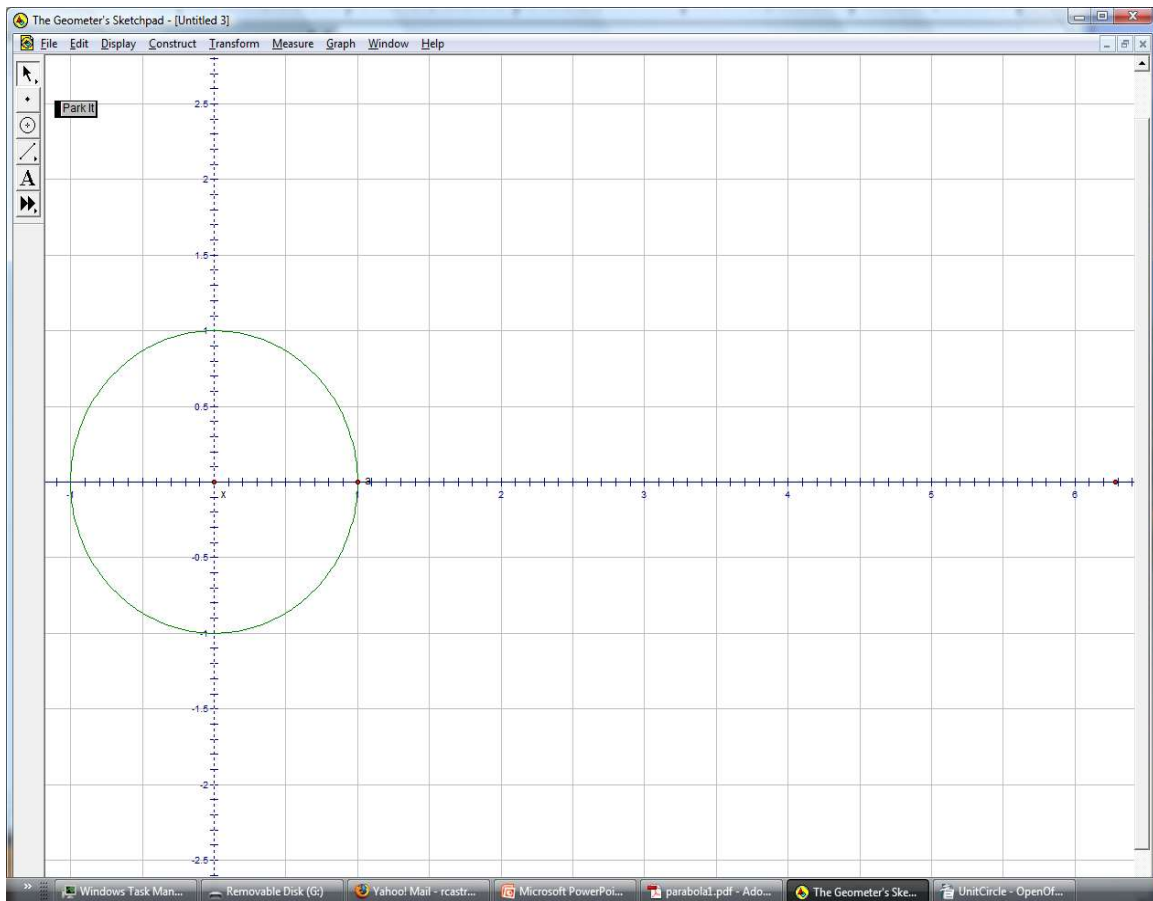


Illustration 8:

11. Select point a and point x . Choose **Edit** → **Action Buttons** → **Animation**. With point x selected in the dialog box, change **Direction: bidirectional** to **forward**. Select the box for **once only**. Select **Speed: slow**.

Select the point a . **Direction: counter-clockwise**. Select the box for **once only**. Select **Speed: slow**.

Label the action box sin x.

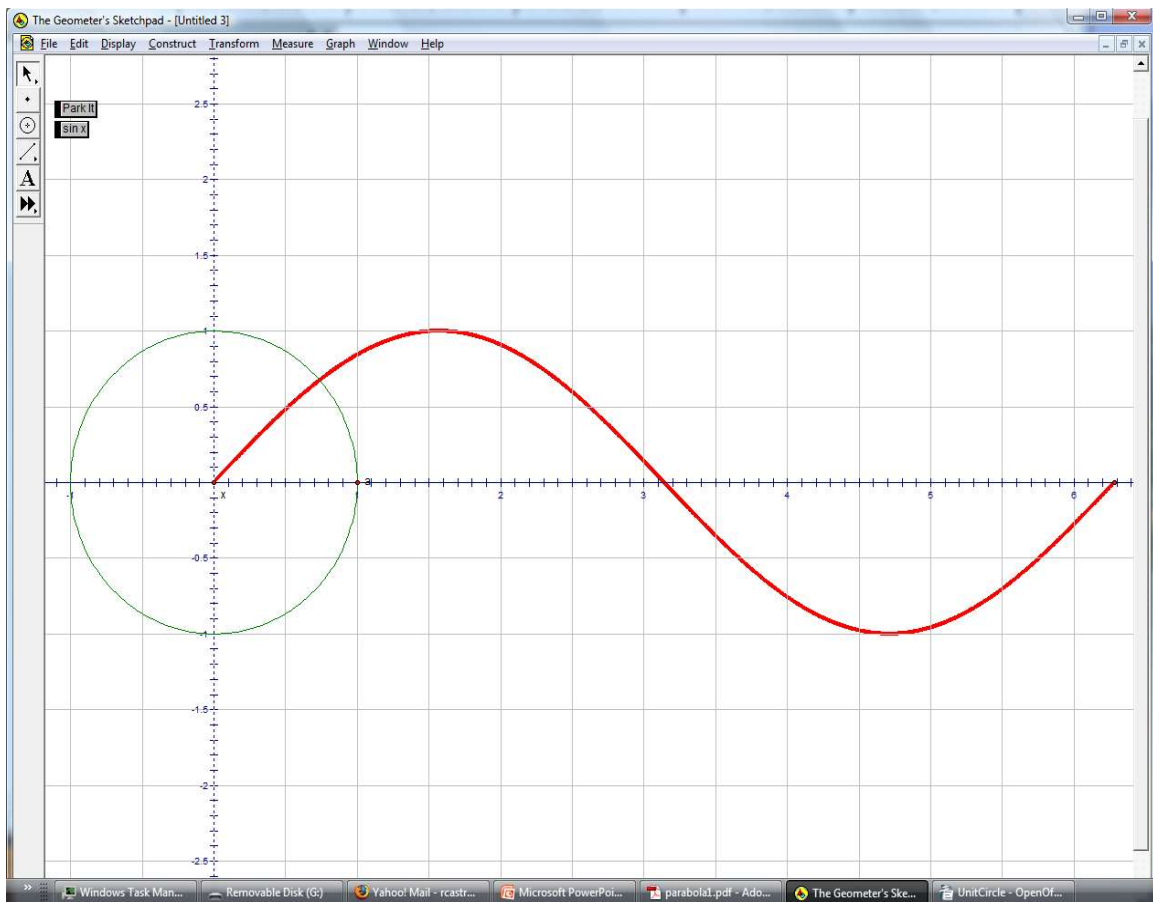


Illustration 9:

12. You can create a similar trace for the $\cos x$ function. First move points a and x away from their home positions. Create a point on the x -axis that corresponds to $\cos a$ similar to the way you created the point for $\sin a$.

Now the point must be transformed to the y -axis to be plotted like $\sin x$. Double click the origin to mark it as the center of a rotational translation. Select to new point on the x -axis and **Transform** \rightarrow **Rotate...** Select a rotation of $\pi/2$. Now proceed as we did for plotting $\sin x$.

13. Can you think of how to create a trace for $\tan x$? Hint: Make a line through $(1,0)$ and parallel to the y -axis.

