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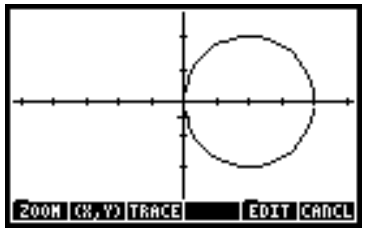
Calculator Lesson 22

Polar Coordinates and Graphs

The calculator can work in any one of three coordinate systems, rectangular, polar (also called cylindrical in three dimensional space), and spherical. The second enunciator at the top of the calculator will show XYZ, R∠Z or R∠∠, respectively to indicate that the calculator is in rectangular, polar, or spherical mode. To change the coordinate mode, press MODE, scroll down to Coord System, press F2-CHOOS and select the desired system from the three presented in the drop down list. We can work with coordinates in the form [*a b*], which is a vector in HP calculator language, or in the form (*a*, *b*), which is a complex number to the calculator for rectangular coordinates. To use the parentheses, system flag 27 must be off (unchecked). For polar coordinates the form will be $(a, \angle b)$ or $[a, \angle b]$. The $\angle$ symbol can be typed from the keyboard by pressing AS > RS > 6. To start the example that follows, set the calculator to RECTANGULAR, DEGREE, APPROXIMATE, and FIX 2.

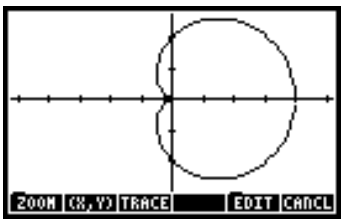
Type LS [] 3 SPC 4 ENTER. The screen should show [3.00 4.00]. Now change to POLAR, and the screen will show $[5.00, \angle 53.13]$, which are the rectangular coordinate (3, 4) converted to polar coordinates in degrees. Now change to RADIAN mode and the screen will show $[5.00 \angle 0.93]$. The degree measure53.13 has been changed to 0.93 radians. Now switch back to degrees and type LS [] 3 +/- SPC 4 ENTER. The screen will show $[5.00 \angle 126.87]$. Even though you entered the information as rectangular coordinates, the calculator immediately changed it to polar because it is in POLAR mode. Now type LS [] 2 SPC AS RS 6 300 ENTER. The screen will show $[2.00 \angle -60.00]$. The calculator always gives the angle as $-180 < \theta \le 180$ in degrees or $-\pi < \theta \le \pi$ in radians. Now set the calculator back to RECTANGULAR and the screen will show [1.00 -1.73], the rectangular coordinates for the point we entered in polar form.

The calculator can also draw graphs of polar equations. Let us graph the equation $r = 2\cos(\theta)$ for $0 \le \theta \le \pi$. In 2D/3D choose POLAR for Type: and change the angle mode to radians. It is not necessary, but to follow the notation of most texts, we will change Indep: to θ, (AS RS T). Now enter $2 \cdot \cos(\theta)$ in Eq:. Set the H-Tick and V-Tick to .5 and make sure that Pixels is not checked, the press NXT and F6-OK. In WIN set H-View: from -2.6 to 2.6, V-View: from -1.80 to 1.36, Low: to 0 and High: to π, then ERASE and DRAW. Recall from Lesson 21 that the Numeric must be checked in CAS for π to be entered as symbol and converted to a number. We see the expected circle in the figure to the right. It is important that we set the window so that the ratio of the length of H-View to V-Vies be 13/7.9 so the circle will look like a circle. Try using AUTO to set the window and see what happens. You



can get rid of the small blank at the end of the circle by stetting Indep High: a little greater than π, say 3.15.

As a second example, let us graph $r = 1 + \cos(\theta)$ for $0 \le \theta \le 2\pi$. In the same window we used for the circle. If you tried the using AUTO as suggested above, reset the window and change Indep High to 2π in WIN. In 2D/3D change Eq: to $1 + \cos(\theta)$, then ERASE and DRAW. This figure, shown on the right, is called a cardiod.



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