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Calculator Lesson 21

Graphing Parametric Functions

In this lesson we will learn to plot parametric equations. We will also learn to distinguish between intersection of the paths and collision of two moving particles when their paths are given in parametric form.

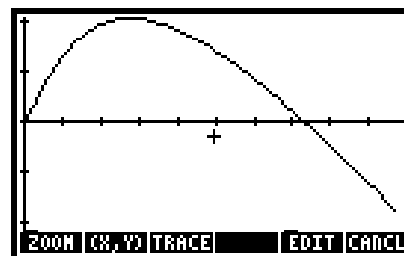
First we must be aware that if the parametric function is given in the form $x = x(t)$ and $y = y(t)$, then what needs to go in EQ: is ' $x(t),y(t)$ '. (NOTE: If you want it to look like that in the EQ: field then system flag 27 must be unchecked otherwise it will look like a complex function.) Let us start by plotting the parametric equations

$$\left. \begin{aligned} x(t) &= .5t^3 + 3t \\ y(t) &= 5t - 3t^2 \end{aligned} \right\} 0 \leq t \leq 2$$

Press LS(hold) 2D/3D and highlight Type:, press F2-CHOOS, and select Parametric. Go to Indep: and type in 't' for the independent variable, uncheck Simult, check Connect, set H-Tick: and V-Tick each to 1, and uncheck Pixels. Now go to EQ: and enter

' LS () .5 × t y^x 3 + 3 × t RS , 5 × t - 3 × t y^x 2 F6-OK

then NXT F6-OK to get back to normal operation. Now press LS(hold) WIN, set Indep Low to 0 and High to 2, then press F4-AUTO. The H-View and V-View will be set to fit this curve for the given domain of t . In order to see the y-axis, change the left end of the H-View: to -1. Press ERASE and DRAW, and you should see the curve shown on the right.



Now suppose we have two particles moving on separate paths. The first moves on the path

$$\left. \begin{aligned} x_1 &= 3\cos(t) \\ y_1 &= 2\sin(t) \end{aligned} \right\} 0 \leq t \leq 2\pi$$

and the second on the path

$$\left. \begin{aligned} x_2 &= \sin(t) - 3 \\ y_2 &= \cos(t) + 1 \end{aligned} \right\} 0 \leq t \leq 2\pi.$$

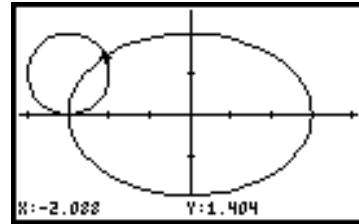
We are wondering if the particles will collide. Get into 2D/3D, make sure the Type: is Parametric and the angle mode is Radians. In EQ: enter

{ '(3 · cos(t), 2 · sin(t))' '(sin(t) - 3, cos(t) + 1)' }

then press NXT and F6-OK. For the next step we must be sure the calculator is set to give numeric values for constants. Press MODE F3-CAS and make sure that Numeric is checked.

Now get into WIN, set H-View from -4.3 to 4.3, V-View from -2.6 to 2, and Indep Low: to 0. Highlight High: and press $2 \pi \times$

F6-OK, then ERASE and DRAW. We see first an ellipse and then a circle being drawn. In the figure to the right we can see they intersect at $(-3, 0)$ and approximately $(-2.088, 1.404)$, so the paths of the particles intersect, but do the particles collide? To answer this get back into 2D/3D, check Simult and ERASE and DRAW.



As the calculator draws both graphs at the same time we can see that the particles do not collide at $(-2.12, 1.42)$, but they do seem to collide at $(-3, 0)$. Of course, to make sure they collide there we need to check that both curves are exactly equal to $(-3, 0)$ for the same value of t . We observe that when $t = \pi$ both curves are at $(-3, 0)$, so the particles do in fact collide there.

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