

# Grapher Pics

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So an internet search of “batman equation” yields dozens of photos of the same super-nerdy-cool yet super-complicated combination of equations whose graphs depict the famous Batman symbol. Such equations are way too complicated to graph on a typical handheld graphing calculator.

It got me wondering if I could develop my own simpler version of the Batman symbol, using only functions and transformations that I teach in my PreCalculus class.

Within about half an hour I had the following. Granted, I cheated a bit and used the “curly brackets” and “relational operators” found in the Test menu on most Texas Instruments graphing calculators. This notation may not follow the conventions for writing functions on paper, but they perform the desired affect when entered into the TI grapher. I typically show these features to a small number of interested students during office hours, but not the whole class.

And for any such interested students who may wonder what affect such features have on the function, I’d invite them to play around and earn the satisfaction of figuring it out themselves!

Also, it may be easily demonstrated that some of the curves do not to join perfectly at their endpoints. This was necessary in order to compensate for some quirks of the TI graphers.

Set TI-83/84 to Zoom:Decimal, or Window: [-4.7, 4.7]x[-3.1, 3.1].

$$y_1 = \{-1, 1\} \frac{\sqrt{16 - x^2}}{2(|x| \geq 2)}$$

$$y_2 = \frac{2.25 - |.75 - 2x^2|}{|x| \leq 1}$$

$$y_3 = \frac{x^4 + 19}{20(|x| \leq 2)(|x| \geq 1)}$$

$$y_4 = \frac{|\sin(\pi x)| + .5|\sin(\pi x / 2)| - \sqrt{3}}{|x| \leq 2}$$



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And why stop at Batman? Venture #2 gives the Superman logo. Graph on TI-83/84 with Zoom:Decimal.

Set TI-83/84 Window: [-3.525, 3.525]x[-3.325, 1.325]

$$y_1 = \frac{|x| - ||x| - 2| - 2 + \{-1, 1\}(3|x| + ||x| - 2| - 10)}{4(|x| \leq 3)}$$

$$y_2 = 0.075\sqrt{100 - 16x^2}$$

$$y_3 = \frac{-10 - \sqrt{36 - 25x^2}}{8(x \geq -1)}$$

$$y_4 = 0.15 \ln\left(\frac{3.8}{x + 2.525} - 1\right) - \frac{0.625}{|x + 0.625| \leq 1.875}$$



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By request of finicky students, a “block” Superman logo.  
Now I really need to stop.

Set TI-83/84 Window: [-3.76, 3.76]x[-3.48, 1.48]

$$y_1 = \frac{|x| - ||x| - 2| - 2 + \{-1, 1\}(3|x| + ||x| - 2| - 10)}{4(|x| \leq 3)}$$

$$y_2 = \frac{3\sqrt{2.5^2 - x^2}}{10(x \leq 2.25)}$$

$$y_3 = \frac{-10 - 5\sqrt{1.2^2 - x^2}}{8(x \geq -1)}$$

$$y_4 = 0.15 \ln\left(\frac{3.3}{x+2.5} - 1\right) - \frac{0.625}{|x+0.85| \leq 1.63}$$

$$y_5 = \frac{|x| - ||x| - 2.05| - 2.05 + \{-1, 1\}(3|x| + ||x| - 2.05| - 10.95)}{4(|x| \leq 3.25)}$$

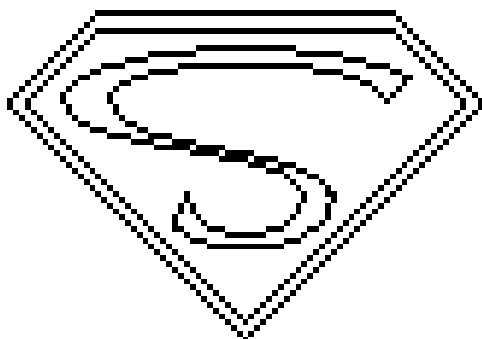
$$y_6 = \frac{11\sqrt{1.9^2 - x^2}}{38}$$

$$y_7 = \frac{-20 - 11\sqrt{0.8^2 - x^2}}{16}$$

$$y_8 = 0.16 \ln\left(\frac{3.1}{x+1.9} - 1\right) - \frac{0.625}{|x+0.35| \leq 1.49}$$

$$y_9 = \frac{2.2x + 0.51}{|x + 0.9| \leq 0.1}$$

$$y_0 = \frac{x - 1.9}{|x - 2.075| \leq 0.175}$$



Okay, seriously this is the last one. But by now I do  
deserve my own logo, don't I?

Set TI-83/84 to Zoom:Decimal.

$$y_1 = \{-1, 1\} \frac{|x| - 3.1}{|x| \leq 3.1}$$

$$y_2 = \{-1, 1\} \sqrt{16 - (|x| + 2.8)^2} + \text{int}\left(\frac{\sqrt{|x| + \{-0.5, 0\}}}{10}\right)$$

where “int( )” represents the greatest integer function

$$y_3 = \frac{\sqrt{9 - x^2} - 2.75}{|x| \leq 1.2}$$

$$y_4 = \{-1, 1\} \frac{\sqrt{4.3^2 - (|x| + 2.8)^2}}{|x| \geq 1.2}$$

$$y_5 = \frac{x + 2.8}{|x + 1.75| \leq 0.75}$$

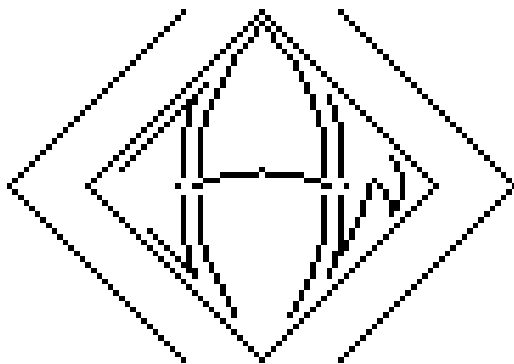
$$y_6 = \frac{-x - 2.8}{|x + 1.6| \leq 0.4}$$

$$y_7 = \frac{-\sqrt{12 - (x + 1.5)^2} + 0.7}{|x - 1.6| \leq 0.4}$$

$$y_8 = \frac{\sqrt{0.5 - (x - 1.6)^2} - 0.5}{x \geq 2}$$

$$y_9 = \{-1, 1\} \frac{\sqrt{0.7^2 - (x - 1.8)^2}}{x \geq 2.3}$$

$$y_0 = \{-1, 1\} \frac{|x| - 4.5}{|x| \leq 4.5}$$



This time I mean it... really the last one.  
Set TI-83/84 to Zoom:Decimal.

$$y_1 = \frac{\{2,-2\}}{\pi} \cos^{-1}\left(\frac{2|x|}{0.7} - 1\right) + \frac{1}{|x| \geq \{0,0.6\}}$$

$$y_2 = -0.4 \cos(1.7|x| + 0.15) + \frac{0.6}{\|x| - 1.45\| \leq 0.85}$$

$$y_3 = \{1,-1\} \frac{\sqrt{0.95^2 - (|x| - 1.85)^2}}{|x| \geq 2.3}$$

$$y_4 = \sqrt{0.92^2 - (|x| - 1.4)^2} - \frac{1}{\|x| - 1.4\| \leq 0.9}$$

$$y_5 = \{1,-1\} \sqrt{0.6^2 - x^2} - \frac{1}{|x| \geq 0.5}$$

$$y_6 = -\left|2.23(|x| - 0.8)^2 - 0.36\right| - \frac{1.22}{\|x| - 1\| \leq 0.5}$$

$$y_7 = -\frac{9}{11} \sqrt{0.55^2 - (|x| - 0.95)^2} - 1.95$$

$$y_8 = \frac{2.1}{\pi} \sin^{-1}(2.5|x|) - 3$$



Decided to explore using lists as a means of consolidating numerous related functions into one equation. Admittedly they became so unwieldy at some point that it would've seemed wiser to just use separate equations, but exploring the utter unwieldiness was part of the challenge. I may need an intervention. Graph on TI-83/84 with Zoom:Decimal.

$$y_1 = \frac{\{0.3, -2.3, 0.6, -2.6, 0, -2\}}{|x + \{4.35, 4.35, 3.3, 2.05, 2.25\}| \leq \{0.65, 0.65, 0.5, 0.5, 0.65, 0.45\}}$$

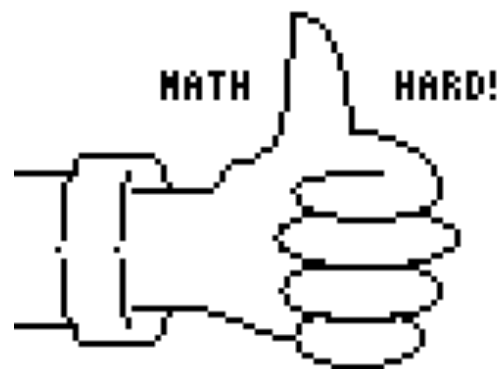
$$y_2 = \frac{\{1, -1, 1, -1\} 3.2 \sqrt{0.5^2 - (x + \{3.5, 3.5, 2.5, 2.5\})^2} - 1}{\|x + \{0, 0, 2.65, 2.65\}| - \{3.75, 3.75, 0.35, 0.35\}| \leq \{0.25, 0.25, 0.2, 0.2\}}$$

$$y_3 = \frac{\{-0.25, 0.25\} \cos\left(\frac{5}{2.5/9} \pi (x + \{1.4, 1.8\})\right) + \{0.25, -2.25\}}{|x + \{1.2, 0.9\}| \leq \{0.2, 0.9\}}$$

$$y_4 = \frac{\{0.5, -1\}}{\cos(\{1.4, 1.23\}(x + \{1, 0\}))} + \frac{\{0, 4\}}{|x - \{-0.5, 0.5\}| \leq 0.5}$$

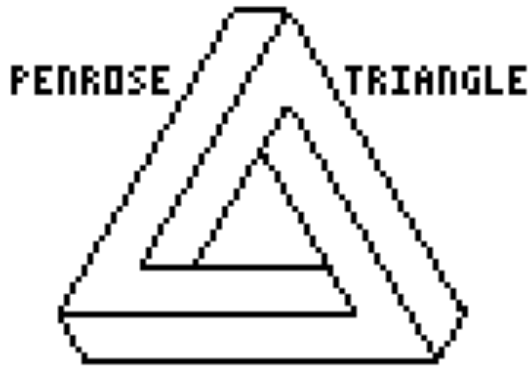
$$y_5 = \left\{\frac{2}{3}, \frac{6}{25}, -\frac{2}{5}\right\} \frac{\sqrt{\{1.5, 1.25, 1.25\}^2 - (x - \{1.1, 1.25, 1.25\})^2}}{|x - \{1.75, 0.75, 1.25\}| \leq \{0.75, 0.75, 1.25\}}$$

$$y_6 = \frac{\left\{\frac{10}{31}, -\frac{10}{31}, \frac{10}{27}, -\frac{10}{27}, \frac{5}{11}, -\frac{5}{11}\right\} \sqrt{\{1.55, 1.55, 1.35, 1.35, 1.1, 1.1\}^2 - (x - \{1.25, 1.25, 1.15, 1.15, 1.1, 1.1\})^2}}{\|x - \{1.25, 1.25, 1.2, 1.2, 1.15, 1.15\}| \geq \{0.85, 0, 0.7, 0, 0.55, 0\}}$$



Going nuts with the lists. Twelve lines crammed into one equation to create the “Penrose Triangle.”  
Graph on TI-83/84 with Window [-4.7, 4.7]x[-1.7, 4.5].

$$y_1 = \frac{\{0,0,0,0,1,1,1,1,-1,-1,-1,-1\}\sqrt{3}x + \{4.4,0,-0.8,-1.6,-6.8,2,3.6,5.2,-6.8,2,3.6,5.2\}}{\left|5\sqrt{3}x + \{0,4,8,0,-28,3,7,17,28,-7,-15,-17\}\right|} \leq \{4,14,22,26,2.4,7,11,13,2.3,7,11,13\}$$



Ummm, a dude. Graph on TI-83/84 with Zoom:Decimal.

$$y_1 = \frac{1}{\{-2,1,1\}\cos(\{0.8,1.9,0.75\}x)} + \frac{\{3.5,-1.5,-3\}}{|x| \leq \{1.5,0.5,1.7\}}$$

$$y_2 = \frac{2 - \left| |3x| - 4.6 \right| - 0.5}{\left| |x| - 1.55 \right| \leq 0.35}$$

$$y_3 = \{0.3,-0.3,0.5,-0.5,1.5,-1.5\} \sqrt{\{2,2,0.8,0.8,0.2,0.2\}^2 - (|x| - \{0,0,0,0,0.5,0.5\})^2} + \frac{\{1,1,0.3,0.3,1.25,1.25\}}{\left| 10x - \{17,17,6.5,6.5,5,5\} \right| \leq \{3,3,1.5,1.5,2,2\}}$$

$$y_4 = \frac{-1}{|x| \leq 0.3}$$

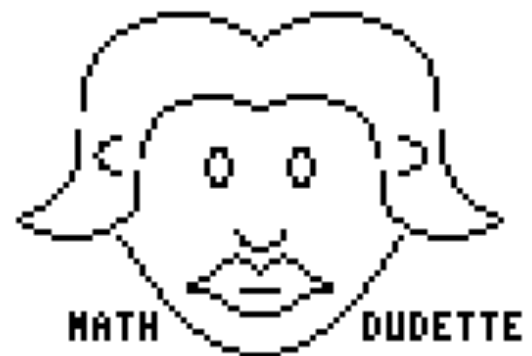
$$y_5 = \frac{\{-3.2,-0.8,0.8,3\}|x| + \{0.4,0.5,-3,-2.7\}}{\left| |x| - \{0.45,1.9,0,0\} \right| \leq \{0.05,0.3,2.1,0.2\}}$$



Errr, a dudette. Graph on TI-83/84 with Zoom:Decimal.

$$y_1 = \{1.8,1.2,-1.5,0.25,-0.25,-8.1\} \left( \cos(\{0.9,1.3,1.5,3.6,2.6,0.3\}(|x| - \{1.3,0.8,0,0.4,0,0\})) \right)^{\left\{ \frac{1}{3}, \frac{1}{3}, 1, 1, 1 \right\}} + \frac{\{1.1,0.3,0.4,-1.5,-2.5,2\}}{\left| 10x \right| \leq \{41,41,4,12,12,24\}}$$

$$y_2 = \left\{ \frac{3}{2}, -\frac{3}{2}, \frac{3}{14}, -\frac{3}{14}, 0 \right\} \sqrt{\{0.2,0.2,2.8,2.8,1\}^2 - (|x| - \{0.7,0.7,0,0,0\})^2} + \frac{\{0.3,0.3,0.5,0.5,-1.8\}}{\left| |x| - \{0,0,2.6,2.6,0\} \right| \leq \{1,1,0.2,0.2,0.3\}}$$



This one's for the kitties. Graph on TI-83/84 with Zoom:Decimal.

$$y_1 = \frac{\left\{ \frac{8}{9}, -\frac{8}{9}, \frac{10}{7}, -\frac{10}{7}, \frac{5}{3}, -\frac{5}{3}, \frac{2}{5}, \frac{10}{19}, -\frac{11}{10} \right\} \sqrt{\{1.8, 1.8, 0.7, 0.7, 0.3, 0.3, 0.5, 1.9, 1\}^2 - (|x| - \{0, 0, 0.6, 0.6, 0.6, 0.6, 0, 0, 0.9\})^2}}{0.1\{4, 4, 3, 3, 0, 0, -2, -13, -13\}} + \frac{|10|x| - \{0, 16, 0, 12, 6, 9, 0, 12, 0\}| \leq \{18, 2, 13, 1, 3, 1, 5, 8, 19\}}$$

$$y_2 = \frac{\{-18, -60, -115, 70, 31, 47, 30\}}{100} (|x| - \{3, 3, 3, 2.9, 2.1, 2.9, 1.9\})^2 + \frac{\{3, 3, 3, -0.5, -0.7, -1, -1.3\}}{|10|x| - \{18, 22, 23.5, 23.5, 25, 25, 24\}| \leq \{12, 8, 6.5, 5.5, 4, 4, 5\}}$$

$$y_3 = \{-0.06, -0.12, -0.21, 1\}x^2 - \frac{\{0.8, 1.1, 1.4, 2.8\}}{||x| - \{1.95, 1.85, 1.7, 0\}| \leq \{1.25, 1.15, 1, 0.6\}}$$

$$y_4 = 1.2|x| - \frac{0.8}{|x| \leq 0.5}$$



And for the doggies. Graph on TI-83/84 with Zoom:Decimal.

$$y_1 = \frac{\left\{ \frac{7}{8}, -\frac{7}{8}, \frac{3}{2}, -\frac{3}{2}, \frac{5}{3}, -\frac{5}{3}, \frac{2}{5}, \frac{2}{3}, -\frac{5}{2}, -1, 1, -1 \right\} \sqrt{\{1.6, 1.6, 0.6, 0.6, 0.3, 0.3, 0.5, 1.5, 0.8, 0.5, 0.3, 0.3\}^2 - (|x| - \{0, 0, 0.6, 0.6, 0.6, 0.6, 0, 0, 0.7, 0.1, 7, 1.9\})^2}}{0.1\{15, 15, 13, 13, 11, 11, 9, -1, -1, -25, 22, -7\}} + \frac{|10|x| - \{10, 14, 0, 11, 0, 9, 0, 10, 0, 0, 0\}| \leq \{6, 2, 12, 1, 9, 1, 5, 5, 15, 5, 20, 22\}}$$

$$y_2 = \{1.2, 0.5, -5, -14.5, -14.5, 2, 1, -5\}|x| + \frac{0.1\{3, -15, 0, 225, 312, 26, 25, -20\}}{||x| - \{0, 0, 0.45, 1.55, 2.1, 0.15, 0.4, 0\}| \leq \{0.5, 0.1, 0.05, 0.05, 0.1, 0.05, 0.1, 0.1\}}$$