Vector Fields and Predator-Prey Relationships Using Mathematica

I. Vector fields in Mathematica

1. Open Mathematica and input the following (you can copy and paste), then press Shift+Enter:

VectorPlot[{x^2 + 3, y}, {x, -10, 10}, {y, -10, 10}, Axes -> True, AxesLabel -> {"x", "y"}, VectorScale -> {.03, .03, None}, VectorStyle -> {Thickness[.001], Black}]

You should have a picture identical to this:



2. To make a 3D vector field, use the VectorPlot3D tool. For example, input the following:

VectorPlot3D[{x^2 + 3, y\*x, z}, {x, -10, 10}, {y, -10, 10}, {z, -10, 10}, Axes -> True, AxesLabel -> {"x", "y", "z"}, VectorStyle -> {Thickness[.001], Black}]

You should have a picture identical to this:



3. Match the following to their slope fields using Mathematics

a) x = 2y, y = 2x + 1 b) x = y2 + 5, y = x5 c) x = 2x + y, y = 2y + x

 

II. Predator-Prey Relationships in Mathematica

1. Input the following into Mathematica:

VectorPlot[{30 x - .05 (x\*y), -7 y + .001 (x\*y)}, {x, 0, 12000}, {y, 0, 1000}, Axes -> True, AxesLabel -> {"x", "y"}, VectorScale -> {.03, .03, None}, VectorStyle -> {Thickness[.001], Black}]

You should get an image identical to this:



This is known as a Lotka-Volterra relationship, in which one species is preyed upon by the other.

1. What do you notice about the graph? Where does the “center” appear to be?
2. The two equations used are x = 30x – 0.05xy and -7y + 0.001xy. Which species is the predator? Which is the prey?
3. What do you think a generic Lotka-Volterra set of equations would look like?