Before we start discussing some of the basic techniques for studying differential equations, I want to make a few general observations about first-order differential equations

$$\frac{dy}{dt} = f(t, y)$$

and their solutions.

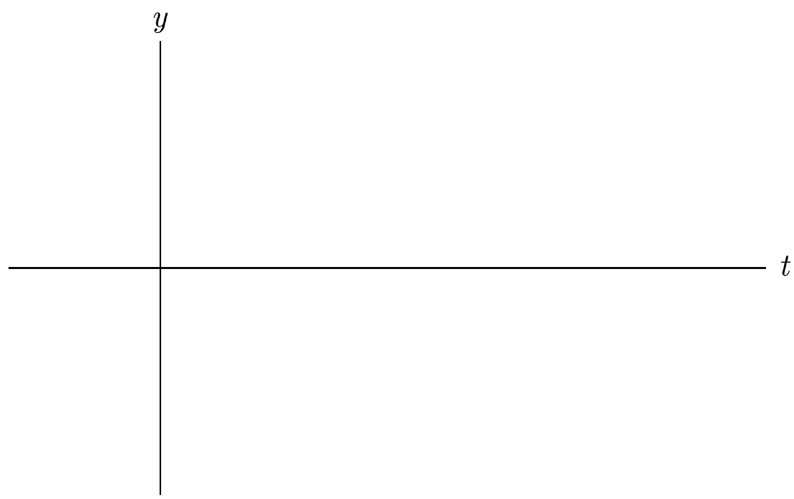
1. What is a differential equation and what is a solution to an **initial-value** problem?

2. Be careful about notation.

3. What does the term **general solution** mean?

4. Why you should never get a wrong answer in this course.

5. Even relatively simple looking differential equations can have solutions that cannot be expressed in terms of functions that we already know and love.



Our general approach in this course:

We will study differential equations

1. using the theory and
2. various techniques:
   (a) analytic techniques
   (b) geometric/qualitative techniques, and
   (c) numerical techniques.

Separable Differential Equations (an analytic technique)

First let's recall the method of substitution for calculating integrals (really antiderivatives):

A differential equation

$$\frac{dy}{dt} = f(t, y)$$

is **separable** if it can be written in the form

$$\frac{dy}{dt} =$$

Two Examples:

1. $\frac{dy}{dt} = -2ty^2$

2. $\frac{dy}{dt} = y^2 - t$

Let's go back to the first example

Example.

$$\frac{dy}{dt} = -2ty^2.$$

We turn to HPGSolver to get a sense of the graphs of these solutions: