Example 1 (Exercise 4 from the textbook):

A feature of radioactive decay is that the amount of a radioactive substance decreases at a rate proportional to the current amount of the substance. The *half life* of a substance is the amount of time it takes for half of a given amount of substance to decay. The half life of carbon-14 is approximately 5730 years. If an ancient object has a carbon-14 amount that is 20% of the original amount, how old is the object?

Let $C(t)$ be the amount of carbon-14 in the object.

The differential equation in this case is $dC/dt = kC$.

Example 2: Newton's Law of Cooling is the simple assumption that the temperature of an object changes at a rate proportional to the difference between the temperature of the object and the ambient temperature of the room. Let T be the temperature of the object and A the constant ambient temperature.

Then Newton's Law of Cooling can be expressed as the differential equation

$$dT/dt = k(A-T).$$

So, I put a bottle of Dr. Pepper in the freezer to cool it down. It was in my car, so it is pretty warm at 32 C (about 90 degrees Fahrenheit). My freezer is -20 C. After 10 minutes, my Dr. Pepper has cooled to about 27 C. How long will it take to cool to 1 C (shortly before it freezes)?

Example 3 (based on Example 8.4.7): Suppose a disease spreads through a population at a rate proportional to the product of the number of infected and uninfected individuals. If 4% of the population is sick initially and 12% of the population is sick one week later, find a formula for the proportion of the population that is sick at time t.

The differential equation in this case is $dy/dt = k\,y(1-y)$.