

Mini-Application Project

Newton Law of Cooling

Overview

Reference: Watch the videos

Khan: <https://www.youtube.com/watch?v=IICR-w1jYcA>

MathIsPower4U: <https://www.youtube.com/watch?v=wEUuaB1esN4>

Sir Isaac Newton stated that the rate a body cools is proportional to the difference between its temperature $T(t)$ and the ambient surrounding temperature M . The resulting differential equation,

$$T(t) = M + (T(0) - M)e^{-kt}$$

(where k is the proportionality constant) is known as Newton's Law of Cooling.

Problems

We'll consider the following problems:

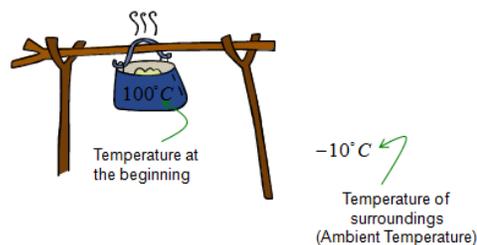


Figure 1 – An example of Newton's Law of Cooling

1. (4 pts) Solve the differential equation and graph the result as a function of time for $M=25$ degrees Celsius, $T(0)=100$ degrees Celsius, and $k=0.1$. What do you notice?
2. (6 pts) We can consider the three constants ($T(0)$, M , and k) as parameters. Examine how each of these affects the solution.
3. (7 pts) Solve the following problem: A pot of boiling water (100 degrees Celsius) is removed from the heat and allowed to cool. After five minutes, the temperature is 80 degrees Celsius, and in another five minutes it has dropped to 65 degrees Celsius. What is the (ambient) temperature of the kitchen?
4. (8 pts) An interesting parameter in the previous problem is the time interval between measurements. Examine how this effects the solution of the problem (or finding the solution to the problem.) Hint: Examine the ratio R between the time intervals. The ratio in the given problem is one, that is, both time intervals are the same. A computer application such as Matlab or *Mathematica* may be helpful here.