Newton's Model of Cooling Revisited

Requirements
This section has an optional CBL experiment that requires a temperature probe.

There are many situations in which the variation of one quantity are driven by the variations in another quantity -- for example,

(•) The daily variation of temperature is driven in part by the sun's position in the sky and the corresponding variation in the energy received from the sun.

(•) Without heating or air conditioning the variation in the temperature inside a house is driven by the variation of the temperature outside.

We begin this module by looking at data for several situations like this. You can also collect similar data using the CBL. We look at a variation of Newton's Model of Cooling

$$\frac{dT}{dt} = k(\sin(2\pi\omega t) - T)$$

in which the ambient temperature varies. We will eventually discuss this equation using numerical, graphical, and algebraic methods.

This module is intended in large part to illustrate the interplay between mathematics and the real world as we build models. As you work through this module it is important to answer the questions in the module **as they come up**.

We begin by looking at our differential equation graphically. Be sure to answer the questions about the long term behavior of the model based on the data discussed at the beginning of the module and our graphical study of the model. Send your instructor email in the usual format with your discussion **now before going on**.

After you've sent your email continue with a numerical look at the model. **Then send your instructor additional email** modifying, if necessary, your earlier discussion. This is a good classroom technique. Ask your own students to discuss the same questions several times with different perspectives and a different knowledge base.

Now continue with a discussion of the same model using calculus. The discussion in the module works with the model

$$\frac{dT}{dt} = k(\sin(t) - T)$$

You should repeat this discussion with the more general model

$$\frac{dT}{dt} = k(\sin(2\pi\omega t) - T)$$

Send your instructor a third email message describing the effects of ω and k on the long term behavior of this model.

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Questions

1. You should have sent your instructor email as you were working through this module.

2. Send your instructor email with your best guess about whether it is possible to build an adobe house whose walls produce a lag of 12 hours between the variation of the exterior temperature and the variation of the interior temperature.