PHYSICS LABORATORY: Newton's Law of Cooling

BACKGROUND INFORMATION AND PURPOSE

A container of hot water at temperature, T, placed in a room of lower temperature T_{room}, will result in an exchange of heat from the hot water to the room. The water will eventually cool to the same temperature as the room. You observe this cooling process every time you wait for a hot drink to cool. In this experiment you will examine the cooling of hot water, with the goal of creating a model that describes the process. You can also predict the time it takes for the hot water to cool to room temperature.

Isaac Newton modeled the cooling process by assuming that the rate at which thermal energy moved from one body to another is proportional (by a constant k) to the difference in temperature between the two bodies, ΔT. In the case of a sample of water cooling in room temperature air,

$$\text{cooling rate} = T'(t) = \frac{d\,T(t)}{dt} = -k\,\Delta T$$

From this simple assumption he showed that the temperature change is exponential in time and can be predicted by

$$T(t) = \Delta T_0\, e^{-kt} + T_{room}$$

where ΔT_0 is the initial temperature difference. Exponential changes are common in science. When a rate of change is proportional to the changing quantity the behavior is exponential.

The goal of this investigation is to determine an experimental value for the constant k.
Then, use this value to predict the time it takes for this water to reach room temperature.

See *'Newton's Law of Cooling – Related Questions to Consider'* for extensions to this lab.

Remember:

1. **Refer to the 'Physics Lab Report Guide' before submitting your report.**
2. **Attach the 'Physics Lab Report Rubric' as a cover page to your paper copy.**

You will be marked on Data Collection and Processing (DCP) and Conclusion and Evaluation (CE) for this lab.