

# Heat Capacity

## Equipment

- Immersion heater, beaker and stirring rod
- Temperature sensor, power meter
- Insulated container (Styrofoam cup)

## Objective

Data collection

- Quantitative analysis of temperature

Data analysis

- Measure power (heat) and temperature

Physics Concepts

- Heat Capacity

## Conceptual (C-Level)

An unknown material is added to some water. The unknown material is at a higher temperature than the water. After some time the water with the unknown material in it reaches an equilibrium temperature. You know the heat capacity of water, the mass of the water and the mass of the unknown material.

- Determine an equation for the heat capacity of the unknown material.

Draw a graph of the temperature as a function of time for an ideal container of ice that is being heated till it is a container of steam. Assume the heater inputs a constant power to the container.

- The heat capacity of ice and steam is roughly half the heat capacity of water.
- The heat of fusion is 334 kJ/kg
- The heat of vaporization is 2257 kJ/kg
- The specific heat capacity of water (at 1 Atm) is 4.218 kJ/(kg K) [at 0 °C], 4.1814 J/(g K) [at 25 °C] and 4.205 J/(g K) [at 90 °C] Note: The heat capacity changes as temperature changes when the pressure is constant.

EXPLORE: The *States of Matter* and *Reversible Reactions* simulations

## Basic Lab (B-level)

- Determine the heat capacity of an unknown substance.
  - Minimize the amount of water on the substance prior to immersion in your cup.
  - Make sure to stir the water to determine the equilibrium temperature.
  - Stir the water – with a stick not the temperature sensor.
  - Determine the substance.
- Determine the heat capacity of water from a graph of temperature as a function of time.
  - Use the *KillaWatt* power meters to determine the power of the immersion heaters.
  - Stir the water – with a stick not the temperature sensor.

## Advanced/Extended Lab Ideas (A-level)

Note: An advanced lab includes a quantitative component with error analysis. The exact question(s) explored is your choice but it should relate to the basic lab.

- Create and explore a thermocline.
- What might you be curious to investigate?