Hot Wax

Introduction

The temperature at which paraffin (candle wax) melts is only about 55 °C. When the melted wax solidifies, however, it releases heat and causes severe skin burns. How much heat is released when "hot wax" solidifies?

Concepts

- Phase changes
- Heat of fusion
- Calorimetry

Materials

Paraffin or candle wax, 10 g
Balance, centigram precision (0.01-g)
Beakers, 250- and 400-mL
Boiling stones
Digital thermometers, 2
Graduated cylinder, 250-mL
Hot plate or Bunsen burner setup
Paper towels
Ring stand and clamp
Stirring rod
Styrofoam® cups, 9-oz, 2
Test tube, large, 25 × 150 mm

Safety Precautions

Exercise care when working with hot water baths and hot melted wax. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review a current Safety Data Sheet for additional information.

Procedure

1. Fill a 400-mL beaker about two-thirds full with hot tap water. Add boiling stones and heat the water to about 90 °C.
2. Add about 100 mL of cold tap water (15–20 °C) to a Styrofoam cup and nest the cup inside a second Styrofoam cup. Place the nested Styrofoam cups in a 250-mL beaker on a ring stand.
3. Obtain about 10 g of paraffin or candle wax shavings in a large test tube and record the precise mass in a data table. Holding the test tube with a clamp or test tube holder, place the paraffin in the hot water bath at about 90 °C and insert a digital thermometer into the paraffin. When the temperature is about 80–85 °C, remove the test tube from the hot water bath and clamp the test tube to the ring stand.
4. Measure and record the precise temperature of the melted paraffin and *immediately* lower the test tube into the cold water bath in the Styrofoam cup. *Start timing.* Carefully stir the paraffin with the digital thermometer and measure the temperature every 30 seconds for 10 minutes, or until the temperature is about 40 °C (whichever comes first). Record all temperature and time measurements in a data table.
5. Plot the cooling curve data for paraffin and estimate its melting point.
6. Replace the test tube containing the solidified paraffin back into the hot water bath (step 1).
7. Empty the water from the Styrofoam cup and switch the positions of the nested Styrofoam cups. Obtain about 125 mL of cold tap water (15–20 °C) in a graduated cylinder and measure and record the precise volume in a data table. Carefully pour the water into the Styrofoam cup and place a clean digital thermometer in the cold water. This will be the calorimeter.
8. When the paraffin (step 6) has remelted, remove the test tube from the hot water bath and clamp the test tube to the ring stand. Dry the test tube with paper towels.
9. Observe the melted paraffin—when the first traces of solid appear, measure the initial temperature of the calorimeter water and immediately immerse the test tube into the cold water. *Note:* The temperature of the paraffin should be very close to its estimated melting point.

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10. Carefully stir the paraffin until it solidifies and the temperature of the cold water stabilizes (3–4 minutes). Measure and record the final water temperature and calculate the heat of fusion of paraffin from the calorimetry data.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. Paraffin may be disposed of according to Flinn Suggested Disposal Method #26a.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (19960:

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constacy, change, and measurement
Content Standards: Grade 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure of atoms, structure and properties of matter, chemical reactions, motions and forces, conservation of energy and increase in disorder, interactions of energy and matter

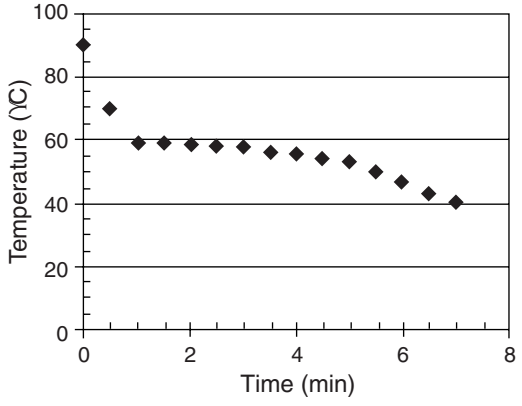
Tip

- There are two main sources of experimental error in this procedure. (1) The paraffin is placed into the cold water calorimeter (step 9) too soon. (2) The solid paraffin is allowed to cool in the water bath before the final temperature is recorded (step 10). Both of these errors will lead to a higher calculated heat of fusion.

Results and Discussion

The melting point of paraffin is 57–58 °C. This is consistent with a straight chain (normal) alkane having the formula $C_{26}H_{54}$ or $C_{27}H_{56}$. Most long-chain *n*-alkanes (> 20 C atoms) exhibit two very closely spaced phase transitions at or just below the melting point. (The second transition corresponds to two crystalline phases, α and β.) Each transition is associated with an enthalpy change. For *n*-$C_{26}H_{54}$, the phase transitions occur at 53 °C and 56.4 °C, and the corresponding enthalpy changes are 21.6 cal/g and 38.6 cal/g, respectively. The literature value for the "heat of fusion" *as determined in this experiment* should be 60.2 cal/g. The experimental value is 61 cal/g (1% error).

Cooling Curve



Calorimetry Results

Mass of paraffin	10.08 g
Mass of water	121 g
Water temperature (initial)	17.7 °C
Water temperature (final)	22.8 °C
Temperature change	5.1 °C

$$Q = (121\ g)(5.1\ °C)\left(\frac{1\ cal}{g \cdot °C}\right) = 617\ cal$$

$$\Delta H_{fusion} = \frac{617\ cal}{10.08\ g} = 61\ cal/g$$

Materials for *Hot Wax* are available from Flinn Scientific, Inc.

Catalog No.	Description
P0003	Paraffin Wax
AP8716	Flinn Digital Thermometer

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.