Designing a Handwarmer

Concepts:

Enthalpy change, calorimetry, heat of solution, specific heat, exothermic vs. endothermic, system and surroundings

Use the following recommendations to increase and/or decrease the challenge difficulty for your students.

Short-on-time Inquiry Lab:

Students follow a detailed procedure to study the energy change associated with the dissolution of four salts in water. Students must then interpret the data to determine the best salt to be used as a handwarmer based on various properties. Students also calculate the molar heat of solution for the various solids.

Guided Inquiry Lab:

Students follow a detailed procedure to study the energy change associated with the dissolution of six salts in water. Students must then interpret the data to determine the best salt to be used as a handwarmer based on various properties. Students also calculate the molar heat of solution for the various solids.

Open Inquiry Lab:

Students first analyze the dissolution of a salt. Students set up a calorimeter, analyze data, and calculate the molar heat of solution. Then, students plan an investigation to test three additional salts. After comparing data with groups, students analyze six total salts and determine the best hand warmer.

Advanced Inquiry Lab:

This lab builds on the open version. Students first analyze the dissolution of a salt. Students set up a calorimeter, analyze data, and calculate the molar heat of solution. Then, students plan an investigation to test three additional salts. After comparing data with groups, students analyze six total salts and determine the best hand warmer. Students also analyze and research what solid would make the best cold pack.

Outcomes:

Students should discover that different ionic salts can cause different temperature changes when dissolved in water. In addition to recording temperature changes, students must analyze other properties of the salts that would make the salts a good or poor handwarmer. Students study calorimetry, molar heat of solution, and more in this engaging activity.

Associated Phenomena:

Hot and Cold Processes

Standards

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and carrying out investigations	HS-PS3.B: Conservation of Energy and Energy Transfer HS-PS3.D: Energy in Chemical Processes	Systems and System Models

Performance Expectations

HS-PS3-4: Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).