

Designing a Hand Warmer

Introduction

Put your chemistry skills to commercial use! From instant cold packs to flameless ration heaters and hand warmers, the energy changes accompanying physical and chemical transformations have many consumer applications. The backbone of these applications is calorimetry—measuring heat transfer. Investigate the energy changes accompanying the formation of solutions for common laboratory salts, and then apply the results to design a hand warmer that is reliable, safe and inexpensive.

Concepts

- Enthalpy change
- Heat of solution
- Exothermic versus endothermic
- Calorimetry
- Specific heat
- System and surroundings

Background

Hand warmers are familiar cold weather gear used to quickly provide warmth to frigid fingers. Many commercial hand warmers consist of a plastic package containing a solid and an inner pouch filled with water. When the pack is activated, the solid dissolves in water and produces a large temperature change.

The energy or *enthalpy change* associated with the process of a solute dissolving in a solvent is called the *heat of solution* (ΔH_{soln}). At constant pressure, this enthalpy change, ΔH_{soln} , is equal in magnitude to the heat loss or gain, q , to the surroundings. In the case of an ionic solid dissolving in water, the overall energy change is the net result of three processes—the energy required to break the attractive forces between ions in the crystal lattice ($\Delta H_1 = +C$ kJ/mole), the energy required to disrupt intermolecular forces between water molecules ($\Delta H_2 = -D$ kJ/mole), and the energy released when the dissociated (free) ions form ion-dipole attractive forces with the water molecules ($\Delta H_3 = -F$ kJ/mole). The overall process can be represented by the following equations.



$$\Delta H_{\text{soln}} = \Delta H_1 + \Delta H_2 + \Delta H_3 = (+C + D - F) \text{ kJ/mole}$$

If the amount of energy *released* in the formation of hydrated ions (ΔH_3) is greater than the amount of energy *required* to separate the solute and solvent particles ($\Delta H_1 + \Delta H_2$), then the sum (ΔH_{soln}) of the energy changes will be negative and the solution process exothermic (releases heat). If the amount of energy released in the formation of hydrated ions is less than the amount of energy required to separate the solute and solvent particles, then the sum of the energy changes will be positive and the solution process endothermic (absorbs heat).

Heats of solution and other enthalpy changes are generally measured in an insulated vessel called a *calorimeter* that reduces or prevents heat loss to the atmosphere outside the reaction vessel. The process of a solute dissolving in water may either release heat into the resulting aqueous solution or absorb heat from the solution, but the amount of heat exchanged between the calorimeter and the outside surroundings should be minimal. When using a calorimeter, the reagents being studied are mixed directly in the calorimeter and the temperature is recorded both before and after the reaction has occurred. The amount of heat transfer (q) may be calculated using the heat energy equation:

$$q = m \times s \times \Delta T$$

Equation 1

where m is the total mass of the solution (solute plus solvent), s is the specific heat of the solution, and ΔT is the observed temperature change. The specific heat of the solution is generally assumed to be the same as that of water, namely, 4.18 J/g·°C.

Designing A Hand Warmer Guided Inquiry Answers

J Rink



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Reforming Teaching and Teacher Education Eija Kimonen, Raimo Nevalainen, 2017-03-21 What are the prerequisites for reforming education and how can these reforms be seen in school development and culture How should teacher education support this reform process What are the principles and practices underlying the functioning of the schools of tomorrow These questions are examined in this unique volume The authors in this book argue that the central function of teacher education and education in general is to respond to the challenges brought on by the twenty first century According to this approach the competencies and skills needed in the future are not merely a new addition to school activities but rather something requiring a comprehensive reform of school culture encompassing teacher education curricula and teaching methods Such a fundamental process of change in the action and thinking models used by schools would be an effort to achieve a complete transformation the result of which would be schools developing into organizations that are both creative and imbued with a strong sense of community A central attribute is that the creation of new knowledge is not just restricted to the classroom but also takes place in out of school environments This would link learning to its natural context eventually leading to an ideal instruction that is actively problem oriented holistic and life centered This reform minded volume is divided into three parts The first part focuses on the reform processes in teacher education the second on the reforms of pedagogics at schools and teacher education institutions and the third on the processes of reculturing schools New prospects for active schools in the United States and Europe as well as in Japan and China are discussed *Farmers' Guide* ,1898

Indiana Farmer's Guide ,1921 **The Educational Technology Handbook** Steven Hackbarth,1996 Grade level 1 2
3 4 5 6 7 8 9 10 11 12 k p e i s t *The Lancet* London ,1847 **The Gardeners' Chronicle and Agricultural Gazette**
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