

The Hand Warmer Design Challenge: Where Does the Heat Come From?

■ ■ Central Challenge

You are challenged to use chemistry to design an effective, safe, environmentally benign, and inexpensive hand warmer. The ideal hand warmer increases in temperature by 20°C (but no more) as quickly as possible, has a volume of about 50 mL, costs as little as possible to make, and uses chemicals that are as safe and environmentally friendly as possible. You will carry out an experiment to determine which substances, in what amounts, to use in order to make a hand warmer that meets these criteria.

■ ■ Explanation to Strengthen Student Understanding

One type of hand warmer contains water in one section of the packet and a soluble substance in another section. When the packet is squeezed the water and the soluble substance are mixed, the solid dissolves and the packet becomes warm. Breaking bonds and particulate attractions absorb energy from the surroundings, while forming new bonds and particulate attractions release energy to the surroundings. When an ionic solid dissolves in water, ionic bonds between cations and anions in the ionic solid and hydrogen bonds between water molecules are broken, and new attractions between water molecules and anions and water molecules and cations are formed. The amount of energy required to break these bonds and form new ones depends on the chemical properties of the particular anions and cations. Therefore, when some ionic solids dissolve, more energy is required to break the cation–anion bonds than is released in forming the new water–ion attractions, and the overall process absorbs energy in the form of heat. When other ionic compounds dissolve, the converse is true, and the bond making releases more energy than the bond breaking absorbs, and therefore the process overall releases heat. When heat is absorbed, the enthalpy change, q , is endothermic, and the enthalpy change is positive. When heat is released, the change is exothermic, and the value of q is negative. The entropy change of solution formation is always positive, regardless of whether it is endothermic or exothermic, because solutions are much more disordered than are the pure solute and solvent from which they are made. This positive entropy change is thermodynamically favorable.

■ ■ Investigation

You will design and execute an experimental procedure to determine which of three ionic compounds is most suitable for use in a hand warmer. You will be assigned to one of the following groups:

| Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
|---------------------------------|--|--|---------------------------------|--|
| NH ₄ NO ₃ | NaCl | NH ₄ NO ₃ | NaCl | NH ₄ NO ₃ |
| Na ₂ CO ₃ | LiCl | LiCl | Na ₂ CO ₃ | LiCl |
| CaCl ₂ | Na ₂ C ₂ H ₃ O ₂ | Na ₂ C ₂ H ₃ O ₂ | CaCl ₂ | Na ₂ C ₂ H ₃ O ₂ |

H Warmer Design Challenge Answers

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H Warmer Design Challenge Answers:

Challenges, Opportunities and Solutions in Structural Engineering and Construction Nader Ghafoori, 2009-10-29
Challenges Opportunities and Solutions in Structural Engineering and Construction addresses the latest developments in innovative and integrative technologies and solutions in structural engineering and construction including Concrete masonry steel and composite structures Dynamic impact and earthquake engineering Bridges and Architectural Research Addressing Societal Challenges Manuel Jorge Rodrigues Couceiro da Costa, Filipa Roseta, Joana Pestana Lages, Susana Couceiro da Costa, 2019-08-08 The escalating interdependency of nations drives global geopolitics to shift ever more quickly Societies seem unable to control any change that affects their cities whether positively or negatively Challenges are global but solutions need to be implemented locally How can architectural research contribute to the future of our changing society How has it contributed in the past The theme of the 10th EAAE ARCC International Conference Architectural Research Addressing Societal Challenges was set to address these questions This book Architectural Research Addressing Societal Challenges includes reviewed papers presented in June 2016 at the 10th EAAE ARCC International Conference which was held at the facilities of the Faculty of Architecture of the University of Lisbon The papers have been further divided into the following five sub themes a Changing Society In Transit Global Migration Renaturalization of the City Emerging Fields of Architectural Practice and Research on Architectural Education The EAAE ARCC International Conference held under the aegis of the EAAE and of the ARCC is a conference organized every other year in collaboration with one of the member schools universities of those associations alternatively in North America or in Europe **The Cultivator & Country Gentleman** ,1892 **Engineering** ,1925 Garden & Home Builder William Tyler Miller, 1927 **The Building news and engineering journal** ,1884 Interoperability and Open-Source Solutions for the Internet of Things Ivana Podnar Žarko, Krešimir Pripuzić, Martin Serrano, 2015-03-10 This book constitutes the thoroughly refereed post conference proceedings of the International Workshop on Interoperability and Open Source Solutions for the Internet of Things FP7 OpenIoT Project held in Conjunction with SoftCOM 2014 in Split Croatia in September 2014 The 11 revised full papers presented together with the extended abstracts of 2 keynote talks were carefully reviewed and selected from numerous submissions during two rounds of reviewing and improvement The papers are organized in topical sections on OpenIoT platform open platforms and standards and IoT Applications **Engineering Record, Building Record and Sanitary Engineer** ,1888 **Engineering & Building Record and the Sanitary Engineer** ,1888 Scientific American ,1873 **Earth and Space** ,2004 Athenaeum ,1872 English Mechanic and Mirror of Science ,1873 The Chemistry Leaflet ,1929 **Chemistry Leaflet** ,1929 **English Mechanic and Mirror of Science and Art** ,1893 **English Mechanic and World of Science** ,1873 Metropolis ,2004 **Bazaar Exchange and Mart, and Journal of the Household** ,1874 **The Electrical Journal** ,1913

The Enigmatic Realm of **H Warmer Design Challenge Answers**: Unleashing the Language is Inner Magic

In a fast-paced digital era where connections and knowledge intertwine, the enigmatic realm of language reveals its inherent magic. Its capacity to stir emotions, ignite contemplation, and catalyze profound transformations is nothing in short supply of extraordinary. Within the captivating pages of **H Warmer Design Challenge Answers** a literary masterpiece penned by way of a renowned author, readers embark on a transformative journey, unlocking the secrets and untapped potential embedded within each word. In this evaluation, we shall explore the book's core themes, assess its distinct writing style, and delve into its lasting impact on the hearts and minds of those who partake in its reading experience.

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