



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY**

Name(s) Grace Lin	Project Number J0618
Project Title Keep the Ice Warm: Measuring How Initial Temperature Affects Sodium Acetate Hand Warmers	
<p style="text-align: center;">Abstract</p> <p>Objectives The objective was to determine what initial temperature for a hand warmer would create the most effective hand warmer in terms of warmth, crystallization rate, and voltage from its heat. It was expected that the hand warmer with an initial temperature of 30 degrees Celsius would last longest due to its closeness to room temperature (which helps increase the crystallization rate and how long the hand warmer stays warm). Its warmth would create more voltage than lower temperatures, and its other factors would make it more efficient than any other variation.</p> <p>Methods Two digital thermometers, a thermoelectric cooler, and a hand warmer were mainly used. The amount of voltage produced as shown by the digital thermometer and thermoelectric cooler was measured when the timer reached one minute, and the temperature s change over time was measured until the hand warmer returned to its initial temperature. Meanwhile, the rate of crystallization was recorded.</p> <p>Results The hand warmer with an initial temperature of 19 degrees Celsius was most efficient based on the factors I tested, while the hand warmer with an initial temperature of 50 degrees Celsius was least efficient. The 19 degrees Celsius variation had the longest warmth time, shortest crystallization rate, and most consistent voltage out of all the variations.</p> <p>Conclusions The 19 degrees Celsius initial temperature hand warmer, which was most effective, produced a decent amount of heat and an average of about 0.4 volts of electricity at the one-minute mark and had a consistent range of 0.3 volts to 0.5 volts. The hand warmer crystallized much faster than other variations. It also lasted extremely long every trial (up to 145 minutes). Thus, the closer the initial temperature is to the room temperature, the more efficient the hand warmer is overall.</p>	
Summary Statement I found that the lower the initial temperature of the reusable sodium acetate hand warmer, the more efficient it is based on its crystallization rate, voltage from its heat, and amount of time it was above its initial temperature.	
Help Received I conducted and recorded the results of the experiment myself. My physical science teacher helped me understand how a sodium acetate hand warmer worked and reviewed my results.	