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

**Central Challenge**

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. Design & carry out an experiment to determine which substances, in what amounts, to use in order to make a hand warmer that meets these criteria. Describe procedure, show data collected and calculations. Provide rationale in conclusion for your results.

\*Make sure you are meeting all criteria for your design as described above.

**Context for This Investigation**

Have your fingers ever been so cold they felt numb? Wouldn’t it be great if you could generate heat to warm your hands up anytime you want to? That’s exactly what a “hand warmer” does. Hand warmers are small packets that people put inside gloves or mittens on cold days to keep their fingers warm. They are very popular with people who work outside in winter or engage in winter sports. 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.

**Pre-lab Preparation**

1. When sodium chloride is dissolved in water, the temperature of the resulting solution is lower than the temperature of the water before the salt dissolves. How can this result be explained based on the bond breaking and bond making that is occurring?
2. When some ionic salts are dissolved in water, the temperature of the resulting solution is higher than the temperature of the water before the salt dissolves. What do you think determines whether the resulting solution is cooler or warmer than the starting water?