# Design a pocket handwarmer

## Time

1–2 h.

## Curriculum links

Simple thermochemical changes.

## Group size

2– 4.

## Materials and equipment

### Materials per group

- 25 g sodium ethanoate trihydrate (Low hazard)
- deionised water

and samples of supersaturated sodium ethanoate solution prepared in advance (see *Demonstration*).

### Materials for class demonstration

- 250 g sodium ethanoate trihydrate
- deionised water.

### Equipment per group

- boiling water bath or beaker of hot water on a hot plate
- boiling tubes with stoppers
- wash bottles
- heavy duty plastic bags
- small size miscellaneous household items that might be useful in designing the handwarmer – *eg* small plastic bottles or other containers
- 'klippits'
- rubber bands
- paper clips *etc*
- safety glasses.

### Equipment for class demonstration

- boiling water bath or beaker of hot water on a hot plate
- large boiling tube or conical flask (with stopper).

## Safety

All chemicals are of low hazard. Eye protection may be desirable when dealing with the hot liquid.

## Risk assessment

A risk assessment must be carried out for this activity.

This is an open-ended problem solving activity, so the guidance given here is necessarily incomplete. Teachers need to be particularly vigilant, and a higher degree of supervision is needed than in activities which have more closed outcomes. Students must be encouraged to take a responsible attitude towards safety, both their own and that of others. In planning an activity students should always include safety as a factor to be considered. Plans should be checked by the teacher before implementing them.

You must always comply with your employer's procedures and in some cases may decide that a particular activity is inappropriate in your situation. Further information on Health and Safety should be obtained from reputable sources such as CLEAPSS [*http://science.cleapss.org.uk/*] in England, Wales and Northern Ireland and, in Scotland, SSERC [*https://www.sserc.org.uk/*].

## Commentary

Handwarmers based on the transfer of heat in various different chemical reactions are available commercially. The best design will be reusable – *ie* it will be possible either to regenerate the reaction or to 'recharge' the device by heating it up.

## Possible approach

The 'rechargeable' type requires a closed cycle in which an exothermic process releases heat at a low temperature and the reverse endothermic process takes in heat at a higher temperature. It is suggested that the students are shown the exothermic crystallisation of supersaturated sodium ethanoate described below. The handwarmers sold in many shops use this phenomenon. If the students are encouraged to pursue this approach several samples of supersaturated solutions need to be prepared in advance. The method of initiating recrystallisation will be challenging to students. They should remember that a bump or shock could be sufficient!

## Demonstration

**Crystallisation from supersaturated solutions of sodium ethanoate**

**1.** To 250 g of sodium ethanoate trihydrate in a large boiling tube add 100 $cm^3$ of deionised water.
**2.** Set up a boiling water bath or set up a large beaker of boiling water on a hot plate.
**3.** Heat the mixture in the water bath with occasional swirling until a clear solution is obtained.
**4.** Using a wash bottle, carefully rinse the glass surface at the top of the tube.
**5.** Insert a stopper and allow the tube and its contents to cool to room temperature (this will take 1–3 hours). The process can be speeded up by placing the tube in a large beaker and cooling it with running water.
**6.** To start recrystallisation remove the stopper and carefully drop a single crystal of sodium ethanoate trihydrate into the tube. Crystallisation occurs with the evolution of heat.
**7.** The tube can be reheated and the process repeated.

An alternative approach[1] involves a mixture of iron powder, sodium chloride, vermiculite and water in a closed plastic bag. An exothermic reaction occurs as the iron is oxidised. The reaction can be controlled by restricting the amount of air entering the bag.

## Extension

**1.** The design of cold packs could also be considered. These can be based on the absorption of heat when ammonium nitrate dissolves in water.
**2.** The reaction described in the *Commentary* could be the basis of a chemical heat pump.

## Reference

**1.** L. R. Summerlin, C. L. Borgford, and J. B. Ealy, *Chemical demonstrations: A sourcebook for teachers, Vol 2*. Washington: ACS, 1987.

## Acknowledgement

This activity is based on a suggestion by Karen Davies.

## Credits



*Health & safety checked May 2018*

Page last updated October 2018