

Some Like It Hot, Some Like It Cold

Athletic trainers often use cold packs to treat injuries. Cold packs reduce swelling around the injury. The trainer simply hits a cold pack to break an inner pouch, shakes it to mix the contents and the pack becomes cold almost immediately.

What is in these packs?

Many chemical reactions either release energy so that the reaction mixture gets hot (exothermic), or need energy so the reaction mixture gets cold (endothermic). Sometimes the only reaction that takes place is the conversion of a solid to ions in solution. Then the heat involved in the reaction is often referred to as the heat of solution. These reactions can be easily demonstrated with some common chemicals and a calorimeter. A calorimeter is an insulated container that makes it easy to measure a temperature change when a reaction takes place. It can be something as simple as a polystyrene cup or a piece of polystyrene insulation from a home improvement store with wells pressed into it. In this Activity, your challenge is to find the combination of chemicals that could be used to make an instant cold pack.



Try This

You will need: baking soda, anhydrous calcium chloride (ice melter), ammonium nitrate, dry yeast, water, household vinegar (5%), 3% hydrogen peroxide, small-scale thermometer, measuring spoons, and small-scale calorimeters.

_1. Place 1/4 teaspoon (1.25 mL) of room-temperature liquid (water, vinegar, or 3% hydrogen peroxide) in one calorimeter well. Place a small-scale thermometer in the well. Measure and record the initial temperature of the liquid. Add 1/8 teaspoon (~0.6 mL) of baking soda to the liquid. Measure and record the most extreme temperature that the solution reaches. Did the temperature change? If so, how? Were there any other changes you observed when the liquid and the solid were combined?

_2. Using a clean, dry calorimeter and a room-temperature thermometer each time, ***try all possible combinations of a liquid and a solid*** to find a combination(s) that gets hot or cold. ***Record the initial and final (most extreme) temperatures for each***, along with any other changes you observe. There are ***four possible solids***: baking soda, anhydrous calcium chloride, ammonium nitrate, and dry yeast. There are ***three possible liquids***: water, household vinegar (5%), and 3% hydrogen peroxide. The liquids should be at approximately room temperature.

Modifications

Set up a data table to record the data you are asked to record in the above procedural steps. Your instructor will give you syringes to more accurately measure the different solutions you are using.

Be Safe! All of the solutions can be washed down the drain with large amounts of water. Ammonium nitrate is a strong oxidizer and should not be stored near or mixed with reducing agents or flammables. Ammonium nitrate and concentrated acetic acid may ignite if mixed.

More Things To Try

- __1. Determine what ratio of liquid to solid produces the lowest temperature. Determine what ratio of liquid to solid produces the highest temperature.
- __2. Make a simulated hot pack or cold pack using small plastic bags such as zipper-style freezer bags and sandwich bags.
- __3. Temperature changes can occur when soluble liquids are mixed. Try mixing glycerin with water.
- __4. Temperature changes can also occur when reactive solutions are mixed. Try mixing household vinegar with household ammonia.

Modifications

For the above "More Things to Try," actually carry out 2 of the 4 choices. Explain your reasoning behind your choices and describe and explain your results!

Questions

1. Which reaction of those you investigated involves ***heat of reaction***, which involves ***heat of solution***? What kind of ***evidence*** do you have to support your answer?
2. Suppose you want to use one of these reactions as the basis for a cold pack, what things would you need to consider? Which combination of solid/liquid would be best for a cold pack? Explain why you chose your combination.
3. When calcium chloride or ammonium nitrate are combined with either vinegar or 3% hydrogen peroxide, what reaction is taking place? ***i.e. either heat of solution or heat of reaction.*** Cite evidence to back up your response.

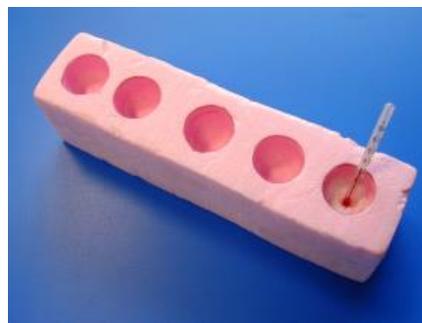


photo courtesy of the Sciencecenter

Information from the World Wide Web

(Accessed October 2003)

Why swelling occurs after injury. http://www.painreliever.com/Ankle/why_swellingoccurs.html

Hot and cold treatment of athletic injuries. http://www.50plus.org/Libraryitems/1_12_Running_Hot_Cold.htm