Instant Cold Packs

Cartoon of Experiment Setup

Time Required:

- ☒ 0-30 minutes
- ☐ 30-60 minutes
- ☐ 60-120 minutes (1-2 hours)
- ☐ 120-180 minutes (2-3 hours)
- ☐ 180-240 minutes (3-4 hours)
- ☐ > 4 hours

Materials Needed:

- One instant cold pack

Optional Materials:

A wet towel

Concepts:

- ☒ Thermodynamics
- ☒ Solubility

Parental Supervision:

- ☒ Recommended for children under 5
- ☒ Recommended for children under 12
- ☐ Highly recommended for children under 12
- ☐ Recommended for children under 18
- ☐ Adults Only

Age Recommendation:

- ☒ 0-3
- ☒ 3-8
- ☒ 8-12
- ☒ 12-18
- ☒ Above 18

Location of Experiment:

- ☒ Indoors
- ☒ Outdoors

Is Heat Needed?

- ☐ Microwave
- ☐ Stove Top/Oven
- ☐ Refrigerator
- ☐ Freezer

Safety:

Chemical cold packs can obtain temperatures less than 32 °F (0 °C), and can feel very cold if left exposed to direct skin contact for extended periods of time. The cold pack should be wrapped in a soft cloth prior to placing it in contact with skin. If the outer pouch breaks, the contents can be

flushed down the drain. Spills should be absorbed with a cloth or sponge, which should be thoroughly rinsed with water.

Procedure:

1. Shake contents to bottom of the instant cold pack.
2. Locate inner pouch & squeeze firmly to break.
3. Shake the instant cold pack well to mix the contents.
4. The instant cold pack should start to feel cold after 10-15 seconds after activation.
5. Depending on the size of the cold pack, the cold pack can be felt for at least 15 minutes after it has been activated.

Optional:

1. The wet towel can be placed on top of the chemical cold pack or wrapped around it and the towel will freeze to the chemical cold pack.

Clean Up:

Upon completion of the experiment, the cold pack can be placed in the trash can and can be disposed of in the same manner as conventional household waste. No special waste handling is required. If the cold pack breaks, the contents should be flushed down the drain with water (cold water for five minutes).

What is going on?

Each instant cold pack contains two bags that are separated. One bag contains water (sometimes also containing a blue dye) and the other bag contains ammonium nitrate (NH_4NO_3), calcium ammonium nitrate ($CaNH_4(NO_3)_3$), or urea ($CO(NH_2)_2$). To activate the cold pack, the cold pack can be squeezed to break the divider between the bags, allowing the water to mix with and dissolve the contents of the other bag. Ammonium nitrate, calcium ammonium nitrate, or urea are chosen as chemicals in the instant cold pack because they have a negative heat of dissolution. What this means is that as these compounds dissolve, they adsorb heat from the surroundings, generating a reaction that is endothermic (adsorbs heat), resulting in a reaction that feels colder. Common instant cold packs will achieve temperatures of 20°F to 40°F within 10 seconds, and can maintain a temperature between 20°F to 40°F for a period of at least 15 minutes. The amount of cooling you feel depends on the size of the chemical cold pack and the size of item/material being cooled.

In this reaction, ammonium nitrate, calcium ammonium nitrate, or urea act as the solute, which is the compound that is dissolved, and water acts as the solvent, which is the compound that dissolves the solute. Dissolution of the solute can be viewed as occurring in three steps: 1) Breakage of solute-solute attractions in the solid state (endothermic), 2) breakage of the interactions between individual water molecules (endothermic), for instance hydrogen bonding between water molecules, and 3) formation of solvent-solute attractions (exothermic, gives off heat (see the hot pack experiment)) in solution. The dissolution of the solutes in this experiment in water result in an endothermic reaction. The energy released by solvation of the solute or ions of the solute is less than the energy absorbed in breaking up the ammonium nitrate ionic lattice and the attractions between water molecules, resulting in a cooling sensation.

$$NH_4NO_3\,(s) \longrightarrow NH_4^+\,(aq) + NO_3^-\,(aq)$$

Questions and Discussion

1. Which of these processes would be considered an endothermic process: cooking an egg, baking bread, dissolving sugar in water, dissolving table salt in water, mixing a salad, or melting chocolate?

   Answer: The endothermic processes are: cooking an egg, baking bread, and melting chocolate. In each of these processes there is a substance that is adsorbing energy from the surroundings, which is the definition of an endothermic process.

2. Would you expect the melting of ice or the freezing of water to be an endothermic process?

   Answer: The melting of ice is an endothermic process, as it adsorbs energy from the surroundings and causes the surfaces it comes in contact with to feel cooler.

3. Would you expect the evaporation of water or the condensation of water to be an endothermic process?

   Answer: The evaporation of water is an endothermic process, as it adsorbs energy from the surroundings and causes the surfaces it comes into contact with to feel cooler. An example of this is sweat, as sweat evaporates, the location of the sweat feels cooler.