

Mechanical Engineer: Heat Transfer

NGSS Standard: MS-PS1-6



Adventure Description:

In this adventure, you will think like a mechanical engineer to build a prototype for a cold pack that can be used by a pharmaceutical company.

Activity

Step 1: Background on Mechanical Engineers and Cold Packs (5 minutes)

- Show [Video: Heat Transfer](#).
- Explain to students that they have been asked by a pharmaceutical company (a company that develops medications) to create a prototype of a cold pack that can be used to refrigerate medications that are transported from one location to another.
- Show [Handout: How Cold Packs Work](#). Discuss how cold packs transfer heat. Explain that cold packs work when a chemical reaction causes heat to transfer from objects around it to the cold pack. The amount of each chemical in the cold pack affects how cold the cold pack gets.
- Explain to students that they will learn how to create their own cold pack.
- Provide students with [Handout: How to Make a Cold Pack](#). As a class read through the instructions. Make sure students understand that they will choose how many spoonfuls of chemicals they want to use. They must use the same number of spoonfuls each time. For example, if you use 3 spoonfuls the first time, you must continue to use 3 spoonfuls).
- Ask students why it is important to use the same amount of chemicals each time. Discuss how changing multiple variables will make it nearly impossible to determine what amount of chemicals work best for the cold pack.

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Step 2: Class Demonstration on How to Make Cold Packs (5-10 minutes)

- Explain that you will first do a demonstration and show the class how to build, test, and modify a cold pack.
- Show students how to do Step 1- building the cold pack.
 - Important Teacher Note: Do not actually place chemicals in the baggie together during the demonstration. You want students to see the reaction when they combine the chemicals! You will just be showing the steps that students will take.
 - Explain to students that they will first choose how many spoonfuls of chemicals they want to place in their bag (the minimum number of spoonfuls is 3 and the maximum number is 6). Tell students that you have chosen to use 3 spoonfuls for your demonstration.
 - Then, they will decide how much of each chemical to add. Discuss how there are multiple ways to get to 3 total spoonfuls. For example: 1 spoons baking soda + 2 spoons vinegar = 3 total spoons; 2 ½ spoons baking soda + ½ spoon vinegar = 3 total spoons; 1 ½ spoons baking soda + 1 ½ spoons vinegar = 3 total spoons
 - Show students how to measure baking soda by placing it on the spoon and leveling it off with a pencil. Students must consistently measure spoonfuls of a powder by leveling off with a pencil. This is very important!
 - Place the baking soda you measured in the baggie. Tell students that they will also measure vinegar and place it in the baggie.
- Next, show students how to do Step 2- testing their cold pack.
 - Explain to students that they will test how cold their cold pack gets using thermometers and their sense of touch.
 - Place the thermometer in the baggie and seal the top. If the thermometer sticks out, show students how to seal the bag as much as they can with the thermometer sticking out. Remind students that your bag contains only baking soda but theirs will contain both baking soda and vinegar.
 - Let students know that they should then watch the thermometer and feel the baggie to see if there are any changes happening.
 - Have students record the lowest temperature and how the bag feels on [Handout: Data Table](#).

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- Lastly, show students how to do Step 3- modifying the cold pack.
 - Explain to students that once they have tested their first cold pack, they need to decide how they want to change the amount of chemicals in the pack to make it even colder next time.
 - Remind students that they can use any combination of spoons of baking soda and vinegar that add up to a total number of spoonfuls that they chose.
 - Tell students that they should empty their baggies before they retest. Have water available for students who need to rinse their baggies before their next test.

Step 3: Making a Cold Pack (20 minutes)

- Explain to students that they will now build, test, and modify their own cold pack.
- Divide students into small groups of 2-3. Provide each group with the following materials: a clear plastic zipper baggie, a container of baking soda, a container of vinegar, spoon, and a thermometer.
- Have groups first fill out how many total spoonfuls they will be using of chemicals.
- Then, have students spend 5-10 minutes completing Steps 1 and 2 and recording their results.
- Then, have students discuss how they want to modify their cold packs. Encourage students to repeat steps 1 and 2 as many times as they want to get their cold pack as cold as possible.

Step 4: Discussing Cold Pack Prototypes (10 minutes)

- Have each team share how much of each chemical they used to create their cold pack. Create a chart on the board.
- As a class, determine what combination of chemicals will create the coldest cold pack. Choose one team to demonstrate this combination while you demonstrate the opposite amounts of chemicals for the whole class.
- Observe the lowest temperature for each bag and create a class statement to send to the pharmaceutical company that describes how the amount each chemical affects the coldest temperature of the cold pack.

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Materials List

Provided online:

- Video: Heat Transfer
- Handout: How Cold Packs Work
- Handout: How to Make a Cold Pack
- Handout: Data Table

Not Provided online (each student or group needs):

- Clear plastic zipper baggie
- Spoon
- Thermometer
- Container of baking soda
- Container of vinegar
- Extra zipper baggies (in case students damage their bags and need new ones)

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