

OPTION 1: MAKE YOUR OWN HAND WARMERS

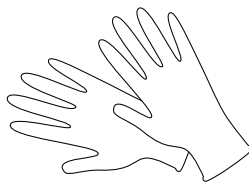
MATERIALS



Iron filings



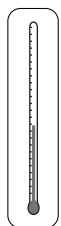
Calcium chloride



gloves



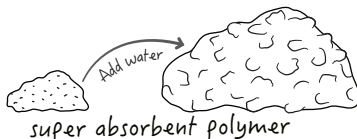
Ziplock bags



Thermometer



Safety goggles



super absorbent polymer



activated charcoal

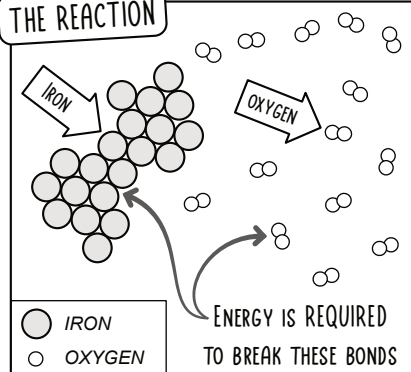
S.A.P. (Super Absorbent Polymer) or activated charcoal

GOALS

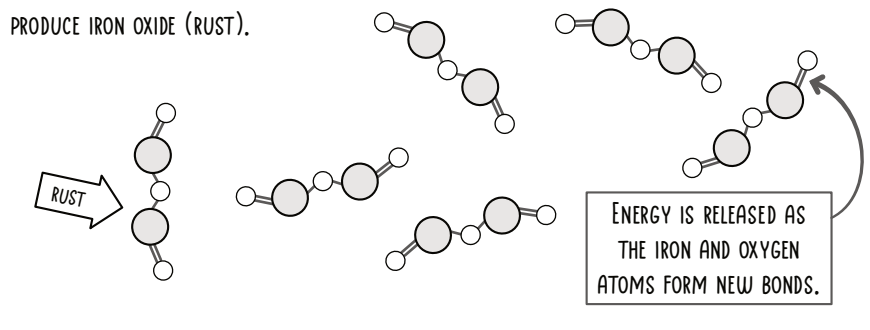
- ★ Design a device that releases thermal energy by chemical processes.
- ★ Conduct experiments and revise the design to improve its function.

Iron (Fe) rusts when it reacts with oxygen (O_2). In everyday life, rusting is a reaction that usually happens very slowly. But the reaction is faster when the pieces of iron are small and when water is present.

THE REACTION

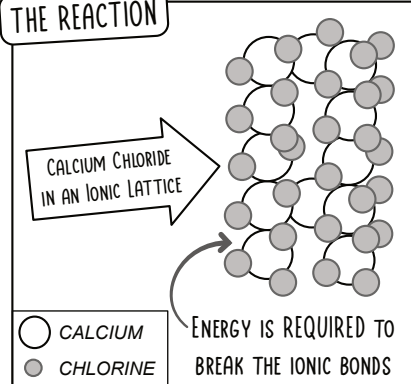


IRON REACTS WITH OXYGEN TO PRODUCE IRON OXIDE (RUST).

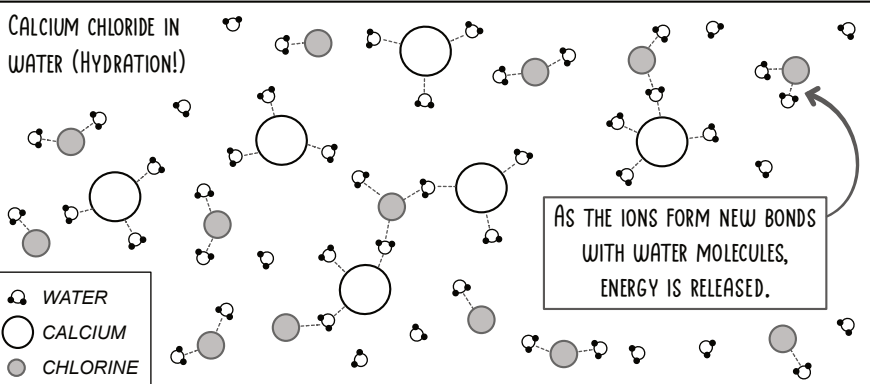


Calcium chloride ($CaCl_2$), also known as ice melt or damp-rid, is well known for its ability to absorb moisture and lower the freezing point of water.

THE REACTION



CALCIUM CHLORIDE IN WATER (HYDRATION!)



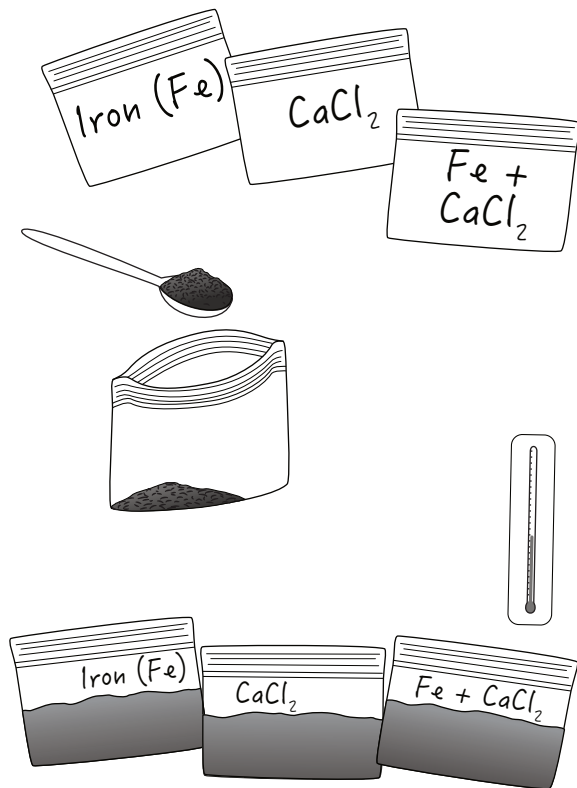
Safety note! Wear gloves and safety glasses or goggles while doing this experiment. Do not ingest materials or let them come into contact with eyes or mouth. Be careful to mix the iron or calcium chloride thoroughly with the absorbent material so the bag doesn't get too hot.

Question 1: Which hand-warmer stays warmest the longest?

Will it be the bag with just iron filings as the active ingredient or the bag with just calcium chloride, or the one with both ingredients?

Steps:

1. Prepare 3 bags by labeling them for the active ingredient they will contain. One bag will have iron only, another will have calcium chloride only, and the third will have both iron and calcium chloride.
2. Add hydrated absorbent material to each bag. If using activated charcoal, use 3 Tbsp charcoal and 2 Tbsp water. If using SAP such as sodium polyacrylate, use 1 tsp of powder and $\frac{1}{4}$ cup water (**CHECK AMOUNTS**)
3. To the first bag, add 2 tsp of iron filings
4. To the second bag, add 2 tsp of calcium chloride.
5. To the third bag, add 1 tsp of iron and 1 tsp of calcium chloride.
6. Mix all three bags well and knead them for 1 minute.
7. Record the temperatures in each bag at 1 minute, 3 minutes, 5 minutes, 7 minutes, 9 minutes, and 11 minutes.
8. Which bag stayed warm the longest? Which had the highest temperature?



Question 2: Design your own!

You could test which ratio of iron to calcium chloride works best by testing a 1:1 ratio, a 2:1 ratio, and a 1:2 ratio. You could also experiment with the amount of absorbent material vs heat-producing material. NOTE: do not use more than ___ of calcium or iron as the bags will get too hot! You could add an insulating layer around the bag such as a cloth.



COMPOSTABLE

The ingredients used in the hand-warmers can be composted. In fact, SAP gel and activated charcoal are both sometimes used as soil supplements in horticulture and agriculture.

When you are finished with the experiment, the contents of the bags can be mixed into the soil of a garden or flower bed.



REUSABLE

The bags can be reused (so long as the heat didn't melt or damage them). Simply wash each bag well with soapy water and then let dry.

The ingredients used to make the hand warmers are all relatively safe and nontoxic. Calcium chloride is used in food preparation (particularly winemaking and pickling) and iron filings, when ground super fine, are used as a nutritional supplement.