



## Milk Plastic

**Target Grade:** K-8<sup>th</sup> Grade Science

**Time Required:** 30 minutes and 2 days to dry

**Standards/Topics Covered:**

*Next Generation Science Standards:*

- 2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
- 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
- 5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
- MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

**Central Focus:**

Milk this activity for all its worth! In this engaging activity, students will create plastic from milk and vinegar. Students will learn about physical and chemical reactions and their reversibility. This reaction involves household materials and can be used to demonstrate environmentally friendly practices and renewable resources.

Key terms: acid, base, nonrenewable, resource, reaction, plastics, protein, proteins

**Background Information:**

Milk contains molecules of casein protein. The protein casein is only denatured, or breaks apart, at temperatures above 80° C (176° F) or when the pH drops below 4.5. In this activity, the milk will be heated above 80° C (176° F) and the pH will be lowered through adding white vinegar or lemon juice as an acid. When the protein is denatured, it is unfolded into long chains called polymers, or a large molecule composed of repeating subunits. This polymer can then be pressed into a mold or shaped by hand to create a plastic once dried.

The method used in this activity to create milk plastic was widely used in the early 1900s to create plastic for buttons, beads, and jewellery. Since then, plastic has been synthesized from using petroleum products. Unlike petroleum products, this plastic is able to eventually



decompose and does not put off greenhouse gas emissions. Milk plastic, or casein plastic, can be considered a renewable resource, as it is made from resources that can be replenished.

## Materials

- 1 cup milk
- 4 teaspoons white vinegar or lemon juice
- Heat resistant bowl or saucepan
- Spoon
- Strainer
- Paper towels
- Molds or tools for shaping



## Instructions

1. Heat one cup of milk in a heat resistant bowl in a microwave or in a saucepan on the stove.
2. Heat until the milk begins to steam then remove from heat.
3. Add four teaspoons of white vinegar or lemon juice.
4. Stir gently for about one minute. Curds (solid clumps) and whey (liquid) will start to form!
5. Use the strainer to drain the whey away from the curds. Let the whey drip away for a few minutes until most of the liquid has drained.
6. Lay out a few layers of paper towels and move the curds from the strainer to the paper towels.
7. Carefully pat and squeeze the curds in the paper towel to remove liquid. Replace the paper towels and repeat 3-4 times or until most of the liquid is removed.
8. Press the curds into a mold or shape by hand.
9. Set the curds aside to dry for about two days or until completely dry.





## Closure

1. Is this a physical or chemical reaction?

This is a chemical reaction. In this activity, the milk is heated and then mixed with the white vinegar or lemon juice, which is an acid. The heat and the acid cause the protein casein in the milk to denature, or break apart. This is a change on the molecular level. Chemical changes occur on the molecular level, while physical changes remain the same on the molecular level.

2. Can this reaction be reversed?

This reaction cannot be reversed. Once the vinegar and milk are mixed, the reaction has occurred and the protein has been denatured. The resulting curds and whey cannot be separated back into vinegar and milk.

3. Has a new substance been formed?

Yes, a new substance has been formed. The vinegar and milk react to form curds (a solid) and whey (a liquid). These curds cannot be returned to vinegar and milk. Once the curds are completely dried, they form a plastic that can be used.