

Breadmaking chart

As your students make their loaf of bread, have them record their observations in the chart and use their knowledge of fermentation, gluten formation and the Maillard reaction to identify the type of changes that occur. If any chemical reactions are present, students should identify whether that chemical reaction is exothermic or endothermic and create a diagram showing how the chemical reaction alters the bread chemically and physically.

Process	Observations	What types of changes occur, physical or chemical? Explain why, based on your observations.	Is the process exothermic or endothermic? Why?	When appropriate, create a diagram that represents the chemical changes that take place. (These do not need to include full molecular formulas.)
Knead	<i>Kneading changed the texture of the dough, bringing it together and making it stronger. The longer the dough was kneaded, the tougher it became.</i>	<i>It is a chemical change. Kneading the dough brings gliadin and glutenin into contact, where the proteins link to form the gluten matrix. The cross-links are chemical bonds.</i>	<i>The chemical reaction is endothermic. It takes energy to bring the gliadin and glutenin together.</i>	<i>$\text{Gliadin} + \text{glutenin} + \text{water} \rightarrow \text{gluten matrix}$</i>
Rise	<i>As the dough rested, it began to grow larger, and the texture of the dough became softer.</i>	<i>They are chemical and physical changes facilitated by yeast. In the chemical change, fermentation breaks sugars into carbon dioxide and alcohol. In the physical change, gluten captures the carbon dioxide creating bubbles in the dough.</i>	<i>The chemical reaction is exothermic. When yeast ferment sugars, they produce energy as a by-product.</i>	<i>$\text{Sugar} \rightarrow \text{carbon dioxide} + \text{ethanol} + \text{energy}$ $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{CO}_2 + 2\text{C}_2\text{H}_5\text{OH} + 2\text{ATP}$</i>

Shape	<i>During this step, the dough changed in shape and size.</i>	<i>The change is physical. Shaping the dough only pulls the dough into a tighter shape to prepare it for baking.</i>	<i>Because energy is put into the process, the process is endothermic.</i>	-
Bake	<i>When baked, the dough became darker in color, and it expanded and developed a firm exterior.</i>	<i>It is a chemical change and a physical change. The Maillard reaction changes the color and texture of the bread by producing new compounds through chemical reactions. Heating the bread also causes water to evaporate, drying the bread.</i>	<i>The chemical reaction and physical change, evaporation, are endothermic. The Maillard reaction only occurs because heat, a form of energy, is applied to the dough at 140° to 165° C causing multiple chemical reactions. Water turning from a liquid to a gas is a phase change that happens with energy.</i>	<p><i>Amino acids (protein) + gluten (sugar) + heat → new compounds*</i></p> <p><i>*These new compounds contribute to the color, texture, aroma and flavor of baked bread.</i></p>