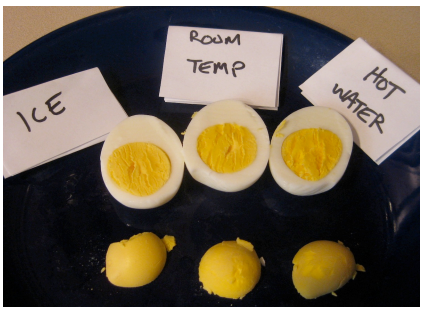
Boil an Egg

Eggsplore gas properties while making a snack



Materials and Preparation

3 eggs
water
ice
a way to boil eggs

To do and notice

1. Place eggs in a pot and cover with water. Heat with the lid on until the water boils and turn to low. Let the eggs cook for 12-15 minutes.
2. Let each egg cool in one of three settings: a ice water bath, room temperature, or left in the pot of warm water. Leave the eggs there for 20-30 minutes.
3. When the eggs are cool enough to handle, peel each one, taking careful notice of how well they peel and how they smell.
4. Cut each egg in half. Is there a difference in how they look and smell based on how they were cooled?

What's going on?

Cooking is all about chemistry, and familiar experiences with boiling an egg are great illustrations of some gas properties. You may have noticed that the ice-cooled egg was the easiest to peel. There are two membranes just inside the eggshell that cause the egg to "stick" to its shell. In between these membranes is an air cell whose volume increases as an egg ages. When this air cell is heated, the gas expands according to Charles' Law. When the egg is rapidly cooled, the volume of the air cell decreases quickly, pulling the membrane away from the shell and making it easier to peel. The slow-cooled egg membrane stays attached to the shell and can be difficult to peel even when cooled. Fresher eggs have smaller air cells, so they make be difficult to peel regardless. This effect is most dramatic with older eggs that have larger air cells.

Once you get the eggs peeled and halved, you may notice that the slow-cooled egg has a greenish ring between the yolk and the white. The gray/green compound is iron sulfide that forms when the hydrogen sulfide gas present in the white reacts with iron compounds in the yolk. The solubility of a gas tends to decrease as temperature increases. Think of a warm soda exploding versus a cold soda that can keep more carbon dioxide in solution. By quickly cooling the white of the egg, more of the hydrogen sulfide stays there and does not diffuse into the center where it can react with the yolk. The slow-cooled eggs are warm throughout, so the hydrogen sulfide is not as soluble in the white and migrates to the yolk where it reacts with iron to give the egg yolks a green rim. So for easy-to-peel eggs with bright yellow yolks, try quickly cooling in an ice water bath after boiling.