

## High School Lesson Plans

# Best-Boiled Plans

### Overview:

In this lessons, students investigate popular recipes for hard-boiling eggs with easy-to-peel shells and determine which approach is most scientifically sound. Students explore examples that add baking soda and vinegar as part of their recipe. Students then explain how egg proteins change during physical and chemical reactions.

**Time Frame:** 3 class periods (45 minutes each)

### Objectives:

Students will:

- Identify physical and chemical reactions
- Explain physical and chemical reactions when hard-boiling an egg

### Next Generation Science Standards

- **HS-LS1-1** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells
  - All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1)
- **HS-PS1-5** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs
  - Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.

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### Materials:

- Egg-vestigative Team #1 Investigation sheet
- Egg-vestigative Team #2 Investigation sheet
- Beakers
- Hot plates
- Eggs
- Baking Soda
- Vinegar
- Water
- Ice
- Computer(s) with access to the Internet
- Optional Resource: [The Parts of the Egg](#)

### Background Information:

Scientists divide changes in matter into two categories: physical and chemical. A physical change is a change in the appearance or physical properties of a substance. A physical change does not make a new substance. For example, tearing a piece of paper in pieces is a physical change. A chemical change is a change that makes a new substance. Burning a piece of paper is an example of a chemical change. The ashes left over by the burning process no longer look and feel like the paper you started with. It has been chemically changed into different substances that have different properties.

Students will be able to classify different interactions with an egg into physical and chemical changes. For example, when peeling an egg you are engaging in a physical change. The boiling of the water itself is also a physical change. The egg becoming hard-boiled is a chemical change.

### Engage: (10 minutes)

1. Guide students to review the following list of actions and identify similarities:
  - A grape when stepped on
  - Metal rusting
  - Stomach digesting food
  - Blowing up a balloon
  - Liquid water turning to ice
  - Toasting a marshmallow
  - Mixing salt and sugar

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2. Challenge students to reconsider the list and narrow the actions into two categories.
3. Reveal the two categories of *physical* and *chemical* changes with the correct actions sorted. Ask students to describe similarities and differences between the physical changes and chemical changes.
4. Explain to students they will be investigating physical and chemical changes in eggs as they investigate different methods for cooking an easy-to-peel hard-boiled egg.

## Explore: (30 minutes)

1. Explain to students that hard-boiled eggs, egg salad, egg salad sandwiches, Cobb salad, and deviled eggs are all a lot easier to prepare if you can get the stubborn eggshell off! Various recipes insist that the best method for cooking easy-to-peel hard-boiled eggs require fresh eggs, older eggs, the addition of vinegar, the addition of baking soda, bring the water to a boil with eggs in the pot, adding eggs to boiling water, and on and on! So, what is the best method for boiling an egg with an eggshell that is easy to peel? In this lesson, students will be testing two different methods.
2. Group students into teams of 3 or 4. Assign each team either a #1 (Baking soda) or #2 (Vinegar). This will allow for multiple trials.
3. Distribute the *Egg-vestigation* recording sheets to each group. Guide students through the directions and clarify any questions. Make sure to point out the rating scale so students understand what to look for when peeling the eggshells.
4. Provide at least 20 minutes for students to investigate. **Be sure to monitor students' use of the hotplates and hot water as they complete the investigation.** When all groups are finished, collect and record the class data on the table below. Display the data so all students can see it. Ask students to provide an explanation for their selection.

Group	Baking Soda Rating	Vinegar Rating	Physical or Chemical Change?

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### **Explain:** (30 minutes)

1. Invite students to analyze the results of their class (and other classes if applicable for a larger sample).
2. Have students work in their teams to explain the physical and chemical changes taking place in the egg and eggshell. Encourage students to use the Internet to gather information about the relationship between the properties of the eggshell and their results. (An optional resource is suggested.)
3. If time allows, challenge each group to create and present a paper slide video to explain why vinegar and baking soda helped make the shell easier to peel. Students should use the following vocabulary in their explanation: *acidic*, *basic*, *protein*, *amino acids*, *heat*, *chemical change*, and *physical change*.

### **Elaborate:** (30 minutes)

1. Invite students to use the Internet to identify other techniques that claim to help make peeling a boiled egg easier. Encourage them to use what they know about chemical and physical changes to select and test new methods. Continue the investigations in class and collect and display the additional data to identify best methods.

### **Evaluate:**

1. Review student paper slide videos and explanations using the provided vocabulary.



### Egg-vestigative Team #1 Investigation Sheet

1. Select two raw eggs.
2. Place one in a beaker with 1000ml of plain cold water.
3. Place one in a beaker with 1000ml of plain cold water plus a half teaspoon or 3 grams of baking soda.
4. Starting with the eggs in cold water, bring the water to a rolling boil using a hotplate.
5. Take them off the hotplate and let the eggs sit, covered, for 10 minutes.
6. Place in an ice bath until they are cool enough to handle.
7. Peel the eggshells off and assign a rating.

Egg	Rating <i>(very easy, easy, moderate, somewhat hard, hard, very hard)</i>	Notes
<b>Plain cold water</b>		
<b>Cold water with baking soda</b>		



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# Best-Boiled Plans Student Handout

## Egg-vestigative Team #2 Investigation Sheet

1. Select two raw eggs.
2. Place one in a pot with 1000ml of plain cold water.
3. Place one in a pot with 1000ml of plain cold water plus 2.5 mL of vinegar.
4. Starting with the eggs in cold water, bring the water to a rolling boil using a hotplate.
5. Take them off the hotplate and let the eggs sit, covered, for 10 minutes.
6. Place in an ice bath until they are cool enough to handle.
7. Peel the eggshells off and assign a rating.

Egg	Rating <i>(very easy, easy, moderate, somewhat hard, hard, very hard)</i>	Notes
<b>Plain cold water</b>		
<b>Cold water with vinegar</b>		