



# EGG IN A BOTTLE EXPERIMENT

With just a few household items, you can discover how a hard-boiled egg can squeeze right through the mouth of a bottle. The Egg in a Bottle Trick is a science classic, dating back at least a hundred years. It's a brilliant method of teaching just how powerful air pressure can be and the trick is also a great way of messing with your students.

## WHAT YOU NEED

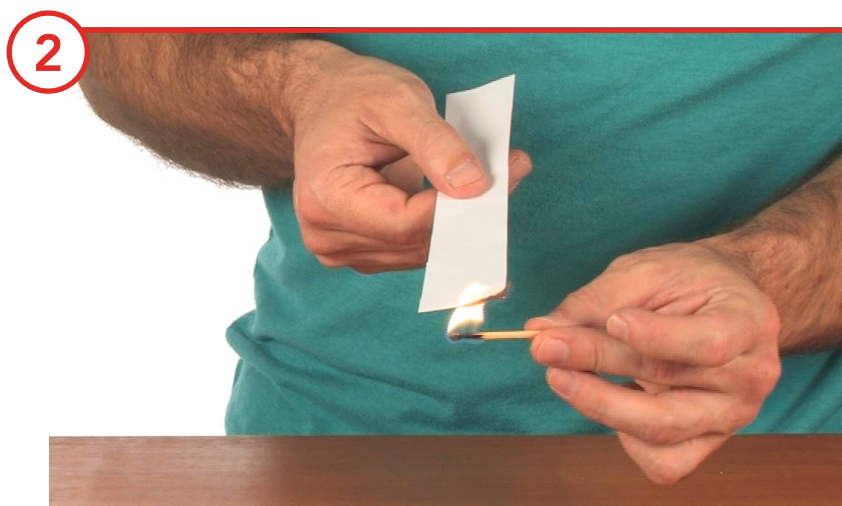
- ERLNMYER FLASK OR GLASS MILK BOTTLE
- STRIPS OF PAPER
- HARD-BOILED EGGS (WITH SHELLS REMOVED)
- MATCHES
- BIRTHDAY CANDLES
- ADULT SUPERVISION



Find a hard-boiled egg that is the correct size to sit on the rim of the flask. Set this egg to the side. Tip - To make the process go more smoothly, lubricate the rim of the flask with vegetable oil, Vaseline®, or by wetting the egg with water.



Drop the lit paper into the flask and quickly place the egg on top.



Use the match to light one strip of paper on fire.



Watch as the egg appears to be sucked into the bottle!



# HOW DOES IT WORK

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The burning piece of paper heats the molecules of air in the bottle and causes the molecules to become excited and move far away from each other. Some of the heated molecules actually escape out past the egg that is resting on the mouth of the bottle (that's why the egg wiggles on top of the bottle). When the flame goes out, the molecules of air in the bottle cool down and move closer together, making room for new air molecules. This is what scientists refer to as a partial vacuum. Normally, the air outside the bottle would come rushing in to fill the bottle. However, the egg is in the way! The pressure of the air molecules outside the bottle is so great that it literally "pushes" the egg into the bottle. You may have also noticed that the egg appeared to bounce a bit on the top of the bottle while the paper was burning. What was happening? The heated air from inside the bottle was expanding and trying to escape the bottle. It was literally pushing the egg up as the egg was being "pushed down" into the bottle.

## ▶ TAKE IT FURTHER

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Perform a gravity defying version of the trick... it's an "eggsclusive" upside-down twist!

- 1 Place three birthday candles into the narrow end of the hard-boiled egg.
- 2 Use the match to light all three candles.
- 3 Turn the flask upside down and place the opening over the egg so that the candles are inside of the flask.
- 4 As the candles burn out, let go of the egg and watch as the egg appears to be sucked upwards into the flask.

### WHAT YOU NEED

- |   |  |
|---|--|
| ◦ 3 BIRTHDAY CANDLES                    | ◦ ERLLENMEYER FLASK OR GLASS MILK BOTTLE |
| ◦ HARD-BOILED EGG (WITH SHELLS REMOVED) | ◦ MATCHES                                |
|   | ◦ ADULT SUPERVISION                      |

## ! ADDITIONAL INFORMATION

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When you fly in an airplane or drive high up into the mountains, you've probably noticed that your ears sometimes need to "pop." This "popping" is caused by the same change in air pressure that "pops" the egg into and out of the bottle. Air pressure decreases as altitude increases, so as you go higher, the air pressure decreases, causing the air trapped in your inner ear to push your eardrums outward. Your body tries to regain equilibrium or balance by allowing some of the air in your inner ear to escape through the Eustachian tubes. When the tubes open, the pressure releases and you feel the "pop."

On the way back down to a lower altitude, the air pressure increases. The extra pressure from the outside of the ear pushes the eardrums inward. Air moves in through the Eustachian tubes, the ears "pop," and balance is restored. Many people don't wait for this to happen on its own because the pressure imbalance can be uncomfortable. Instead, they just plug their noses, close their mouths, and pretend like they're blowing their noses. Because the air from their lungs has nowhere to go, it is forced into the inner ear through the Eustachian tubes, causing their ears to "pop."



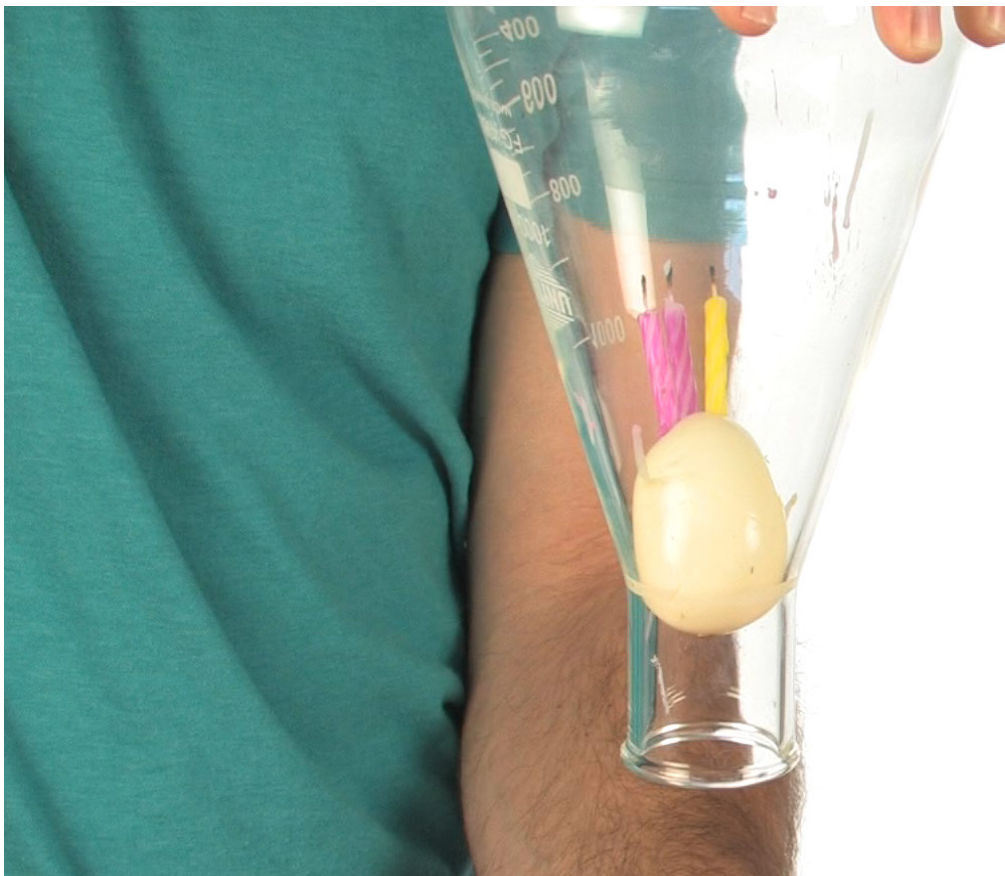
# SCIENCE FAIR CONNECTION

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While forcing an egg into a bottle is pretty cool, it is not a science fair project. You can create a science fair project by identifying a variable, or something that you can change, in this experiment. Let's take a look at some of the variable options that might work:

- ▶ Try changing the number of candles that you use to heat the air. How few can you use? As you add more candles, how does this change the reaction?
- ▶ Try using the water balloon with bottles that have different mouth sizes. How does the size of the mouth affect the balloon?
- ▶ Would the reaction time of the egg dropping into the bottle change if the capacity of the bottle increases-- would a bottle with a lesser capacity react quicker than a bottle with a greater capacity?
- ▶ Does the size of the egg affect the reaction? Try using medium, large and extra large eggs and record your results.

These are just a few ideas, but you aren't limited to them! Come up with different ideas of variables to test and give them a try. Remember, you can only change one variable at a time for each test. For example, if you are testing the number of candles, make sure that all other factors in the test remain the same!



# TEACHER NOTES:

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## SCIENCE CONCEPTS OVERVIEW ▶ Air, Movement, Expansion of Air

The learning experiences contained in the following Experiment Guide are designed to engage students and deepen understanding, not only of the underlying scientific concepts upon which these experiments/demonstrations are built, but also of critical thinking and problem solving skills. Teachers should allow students to actively participate in each activity as an investigation, where questions are being asked, hypotheses are developed and redeveloped, and where students own the discoveries. Vocabulary was included, assessments were created and critical thinking questions were designed with this underlying goal in mind.

**The following are some suggested teaching points that could accompany this experiment/demonstration:**

**SICK Science Teaching Points:** The SICK Science video can be utilized in a variety of ways. It can be used to introduce a scientific concept or in place of doing the demonstration/experiment if materials are unavailable. The video can also be used as a review or to help students complete the various learning experiences included in this guide. The video can also be used as a review or to help students complete the various learning experiences included in this guide.

Visit the landing page below to locate the appropriate video for this activity  
**[stevespangler.com/sick-science-resources](http://stevespangler.com/sick-science-resources)**

**Vocabulary:** Students will enhance their science-content related vocabulary. You may choose to introduce the vocabulary words and explicitly teach the meaning of each. You may also use the vocabulary words as an investigation, where students can research the meanings of the words. Finally, students may develop their own definition for each word through their experience with the experiments and critical thinking work.

**Scientific Method:** Students can complete a full lab report for the demonstration, including asking questions, identifying variables, forming a hypothesis, designing the experiment, collecting data, and drawing conclusions. Differentiation using the lab report is easy. For lower levels, complete the lab report as a class. As students are more independent, encourage students to work in partnerships or groups to complete the lab report. Eventually, students should be able to complete the lab report independently or design a new experiment using the lab report form based on the demonstration completed in class.

**Identify Details** - Students will identify the relevant characteristics of the egg or balloon that make this demonstration possible.

**Summarize** - Students will create a summary that includes the important ideas and details of how the egg gets into the bottle.

**Vocabulary Application** - Students will write and speak while incorporating newly learned vocabulary.

### **Literature Connections:**

After the Fall by Dan Santat

What Really Happened to Humpty Dumpty by Jeanie Franz



# Expert Vocabulary

NAME \_\_\_\_\_

## WORDS AND DEFINITIONS —

Match the word on the left with the correct definition on the right by filling in the blank with the correct letter.

### VOCABULARY WORDS

### DEFINITIONS

1 \_\_\_\_ **Pressure**



**A** The spot where two things come together to prevent anything from passing between them.

2 \_\_\_\_ **Partial Vacuum**



**B** A force that builds to create movement.

3 \_\_\_\_ **Seal**



**C** The weight of air in a particular space.

4 \_\_\_\_ **Molecules**



**D** A space with an air pressure lower than the air pressure in the area around it.

5 \_\_\_\_ **Air pressure**



**E** A group of two or more atoms that stick together.



# Critical Thinking

NAME \_\_\_\_\_

## IDENTIFY DETAILS —

Students will identify the relevant characteristics of the egg or balloon that make the demonstration possible.

Describe the characteristics of the egg and/or balloon that allow it to drop into the bottle. Think about how this demonstration would be different if the egg still had a shell.



# Critical Thinking

NAME \_\_\_\_\_

## SUMMARIZE —

Students will create a summary that includes the important ideas and details of how the egg gets into the bottle.

In your own words, explain how the egg gets pushed into the bottle by the air around it. Be sure to include the term “air pressure” in your answer.





# Critical Thinking

NAME \_\_\_\_\_

## VOCABULARY APPLICATION —

Students will write and speak while incorporating newly learned vocabulary.

The word equilibrium means balance of forces. How does this definition relate to the Egg in a Bottle demonstration? Explain using words or labeled diagrams.



# Assessment

NAME \_\_\_\_\_

## ASSESSMENT QUESTIONS —

Read each question, then circle the letter next to the correct answer or write your response on the back of this page or in the box.

- 1 Which of the following statements about air is true?
  - a. Air takes up space.
  - b. Air can be warm or cool.
  - c. Hot air expands and cold air contracts.
  - d. All of the above.
- 2 When air molecules cool down, they \_\_\_\_\_.
  - a. slow down
  - b. contract
  - c. create low pressure
  - d. all of the above
- 3 Why does the egg fall into the bottle?
  - a. The slippery surface allows for low friction.
  - b. The air pressure outside of the bottle is higher than the air pressure inside of the bottle.
  - c. The oxygen inside of the bottle is all used up by the match.
  - d. The heat increases the pull of gravity.

- 4 On the lines below, explain how the heat from the flame affects the egg in this demonstration.

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- 5 Draw a labeled diagram that shows what the air molecules inside of the bottle are doing while the flame is lit and they are being heated.







# Expert Vocabulary - Answer Key

## WORDS AND DEFINITIONS —

Match the word on the left with the correct definition on the right by filling in the blank with the correct letter.

### VOCABULARY WORDS

### DEFINITIONS

- |   |                           |   |
|---|---------------------------|---|
| 1 | <b>(B) Pressure</b>       |  <b>A</b> The spot where two things come together to prevent anything from passing between them. |
| 2 | <b>(D) Partial Vacuum</b> |  <b>B</b> A force that builds to create movement.  |
| 3 | <b>(A) Seal</b>           |  <b>C</b> The weight of air in a particular space.   |
| 4 | <b>(E) Molecules</b>      |  <b>D</b> A space with an air pressure lower than the air pressure in the area around it.      |
| 5 | <b>(C) Air pressure</b>   |  <b>E</b> A group of two or more atoms that stick together.                                    |



# Critical Thinking- Answer Key

## IDENTIFY DETAILS —

Students will identify the relevant characteristics of the egg or balloon that make the demonstration possible.

Describe the characteristics of the egg and/or balloon that allow it to drop into the bottle. Think about how this demonstration would be different if the egg still had a shell.

### ***Possible Answer:***

*The egg and balloon are both soft, which allows them to change their shape and squeeze into the mouth of the bottle. They also both have slippery surfaces when wet, so they can slide into the bottle more easily without friction.*



# Critical Thinking- Answer Key

## SUMMARIZE —

Students will create a summary that includes the important ideas and details of how the egg gets into the bottle.

In your own words, explain how the egg gets pushed into the bottle by the air around it. Be sure to include the term “air pressure” in your answer.

### ***Possible Answer:***

*When the match is dropped into the bottle, it heats up the air inside of the bottle. The heat speeds up the air molecules inside the bottle and some even escape from the bottle. When the match goes out and the heated molecules begin to cool down, they “squish” together. Now, the air pressure outside the bottle is much greater than the air pressure inside the bottle. The air pressure on the outside of the bottle tries to rush into the bottle and pushes the egg in with it.*





# Critical Thinking- Answer Key

## VOCABULARY APPLICATION —

Students will write and speak while incorporating newly learned vocabulary.

The word equilibrium means balance of forces. How does this definition relate to the Egg in a Bottle demonstration? Explain using words or labeled diagrams.

***Possible Answer:***

*The air on the outside and inside of the bottle want to achieve equilibrium, or balance. Because the pressure on the outside of the bottle is greater than the pressure inside of the bottle, the air from the outside rushes inside the bottle in an attempt to equalize the pressure between the two spaces.*



# Assessment - Answer Key

## ASSESSMENT QUESTIONS —

Read each question, then circle the letter next to the correct answer or write your response in the boxes.

- 1 Which of the following statements about air is true?
  - a. Air takes up space.
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  - d. All of the above.
  
- 2 When air molecules cool down, they \_\_\_\_\_.
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- 3 Why does the egg fall into the bottle?
  - a. The slippery surface allows for low friction.
  - b. The air pressure outside of the bottle is higher than the air pressure inside of the bottle.
  - c. The oxygen inside of the bottle is all used up by the match.
  - d. The heat increases the pull of gravity.
  
- 4 On the lines below, explain how the heat from the flame affects the egg in this demonstration.

*Possible Answer: The heat from the flame affects the egg by heating the air molecules inside the bottle. These air molecules move quickly and some escape from the bottle. When the air molecules cool back down, there is extra space inside the bottle. As air from the outside comes in to fill that space, the egg is pushed back down into the bottle with air.*
  
- 5 Draw a labeled diagram that shows what the air molecules inside of the bottle are doing while the flame is lit and they are being heated.

*Possible Answer: Diagrams may include pictures of molecules from inside the bottle moving around and expanding away from each other. It should also include some of the molecules inside the bottle escaping out of the top of the bottle.*

# Common Core State Standards

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Student Outcomes	Standards
Students will be able to ask and answer questions about key details about their observations and discussion to demonstrate their understanding of the scientific concepts presented through the experiment.	RI.K.1, RI.1.1, RI.2.1, RI.3.1, RI.4.1
Students will be able to ask and answer questions to help determine the meaning of vocabulary presented as part of an experiment.	RI.K.4, RI.1.4, RI.2.4, RI.3.4, RI.4.4, RI.5.4
Students will be able to explain the connection between scientific ideas presented in the experiment.	RI.1.3, RI.2.3, RI.3.3, RI.4.3, RI.5.3
Students will be able to retell key details presented in the experiment in order to understand/determine the main idea.	RI.K.2, RI.1.2, RI.2.2, RI.3.2, RI.4.2, RI.5.2
Students will be able to retell key details presented in the experiment in order to understand/determine the main idea.	RI.4.5
Explain the procedure and ideas presented in a scientific experiment including what happened and why, including cause and effect, based on the information presented.	RI.3.3, RI.4.3
Students will be able to use information gained from observations of the experiment to demonstrate understanding of the concepts presented, including how a diagram can clarify understanding.	RI.2.7, RI.3.7