

**SICK!**  
science   
insanely cool experiences

**BALANCING  
NAILS**  
EXPERIMENT GUIDE

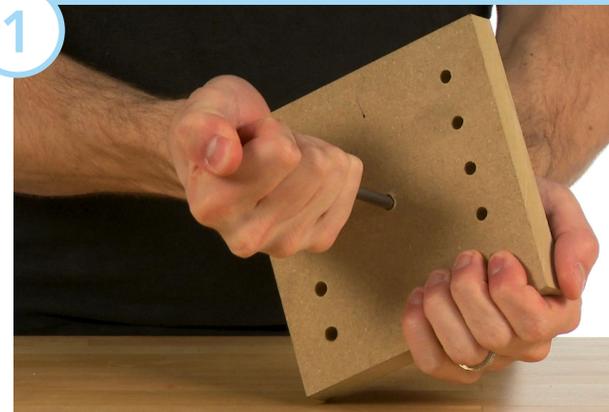


# BALANCING NAILS EXPERIMENT

Find the center of gravity as twelve nails find precarious stability on the head of just one nail. The object of the challenge is to balance all of the nails on the head of a single nail. All of the nails have to be balanced at the same time and cannot touch anything but the top of the nail that is stuck in the base. The key is finding a way to keep the nails held together, then positioning them on their center of gravity or balancing point.

## WHAT YOU NEED

- 12 NAILS
- BOARD
- ADULT SUPERVISION



Firmly place one nail into the center of the board.



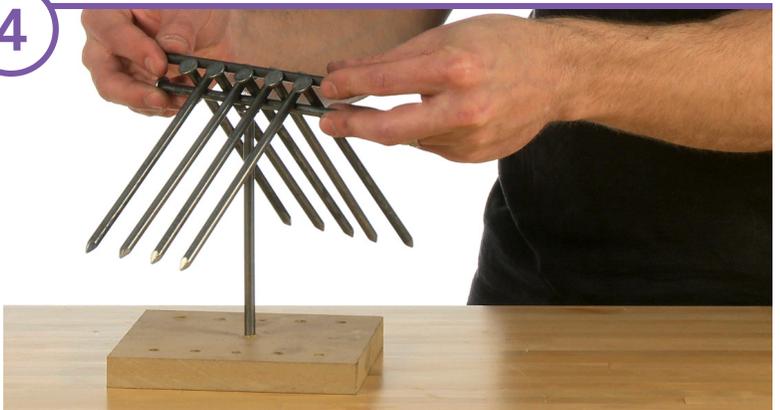
Arrange eight nails as shown.



3



Place the final nail across the arranged nails.



Carefully lift the structure using only the top and bottom nails, then balance the structure on the head of the single nail.



# HOW DOES IT WORK

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The trick to balancing the nails is in locating their balance point. Gravity pulls an object toward the Earth as if all of the object's weight were concentrated at one point on the object. It's called the center of gravity or the center of mass (if gravity is uniform). As you'd expect, an object falls over when its center of gravity is not supported. For balanced, symmetrical objects, like a baseball or a meter stick, the center of gravity is exactly at the center of the object — inside it. For non-symmetrical objects, like a baseball bat or a hammer or your nails, the center of gravity is closer to the heavier end and can sometimes even be outside the object. In this trick, the stability of the nails depends on the center of gravity being right at or directly below (that is, outside of) the point where they touch the lone standing nail. Add more nails to one side and not the other side, you'll move the center of gravity in that direction or away from its support. The mass becomes unstable and falls off the lone nail with a crash!

## TAKE IT FURTHER

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Now that you have mastered the Balancing Nails puzzle, try different ways to experiment with it. Are there other objects that you can use instead of the nails that you can still balance? How about larger or smaller nails? Just remember that it's all about the center of balance and you will never go wrong!

## SCIENCE FAIR CONNECTION

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Performing the Balancing Nails experiment is pretty cool, but it isn't a science fair project. You can create a science fair project by identifying a variable, or something that changes, in this experiment. Let's take a look at some of the variable options that might work:

- ▶ Try testing different sizes of nails. Which nails work the best?

That's just one idea, but you aren't limited to that! Try coming up with different ideas of variables and give them a try. Remember, you can only change one thing at a time. If you are testing a different size of nails, make sure that the other factors are remaining the same!

# TEACHER NOTES:

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## SCIENCE CONCEPTS OVERVIEW ▶ Force and Motion | Gravity | Center of Gravity | Symmetry

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 Video:** The SICK Science video 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.

[https://www.youtube.com/watch?v=9xtXg\\_6C8QE](https://www.youtube.com/watch?v=9xtXg_6C8QE)

**Vocabulary:** Students 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 may research the meanings of the words. Finally, students may develop their own meaning for each word through their experience with the experiments and critical thinking work.

**The 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 form based on the demonstration completed in class.

**Paraphrase:** Students will be able to restate the main ideas of relevant vocabulary in their own language.

**Inference:** Students will use knowledge gained from the demonstration/experiment to make judgments about outcomes and conditions of a scenario.

**Real World Application:** Students will learn to apply their critical thinking strategies and scientific concepts to a real world scenario.

**Literature Connection:** [The Man Who Walked Between the Towers](#), by Mordicai Gerstein. Reading strategies that are supported by this text include identifying character traits, using text to infer, and supporting opinions using text. Also, there is a focus on themes of bravery, determination and courage.

**Informational Writing:** Students should write an informational piece about any familiar activity that requires balance (i.e. gymnastics, tight-rope walking, skateboarding, surfing, hopping or jumping, etc.). They should explain why balance is important and how balance happens, using knowledge from this experiment/demonstration. Students should include relevant vocabulary, diagrams, facts, etc.

**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 \_\_\_\_\_ **Force**

⋅**A**⋅ A force that pulls two objects together. It is the force that pulls objects toward the ground.

2 \_\_\_\_\_ **Balance**

⋅**B**⋅ The place on an object where the weight is even or the force is pulling evenly.

3 \_\_\_\_\_ **Gravity**

⋅**C**⋅ Having weight spread equally over an object.

4 \_\_\_\_\_ **Center of Gravity**

⋅**D**⋅ The push or pull exerted on an object.

5 \_\_\_\_\_ **Symmetrical**

⋅**E**⋅ When an object is the same, or reflective of itself, on both sides.



# Critical Thinking

NAME \_\_\_\_\_

## PARAPHRASE —

Students will be able to restate the main ideas of relevant vocabulary in their own language.

Read the following definitions.

**Gravity:** A force that pulls two objects together. Gravity is the force that pulls objects toward the ground.

**Center of Gravity:** The place on an object where the weight is even or the force is pulling evenly down.

Explain what each vocabulary word means in your own words. Also, explain how these words are similar or different.



# Critical Thinking

NAME \_\_\_\_\_

## INFERENCE —

Students will use knowledge gained from the experiment demonstration to make judgments about outcomes and conditions of a scenario.

Think about what you observed in the experiment. What inferences can you make from the following statements related to the experiment? Be sure to explain your thinking with "I infer this because..."

**a)** What will happen if you line up 11 nails and try to balance them on the head of a nail? What will happen if you try to use 6 nails? Sketch a picture below to help show your thinking. Explain.

**b)** How would you balance a baseball bat on your finger tip? Sketch a picture below to help show your thinking. Explain.



# Critical Thinking

NAME \_\_\_\_\_

## REAL WORLD APPLICATION —

Students will be able to apply their critical thinking strategies and scientific concepts to a real world scenario.

Tie a pipe cleaner around a popsicle stick, leaving both ends sticking evenly out on the sides. Then, connect a small weight such as a hex nut to each tip. Try to balance the end of the popsicle stick on your finger, adjusting the level of the pipe cleaners to find the center of gravity.

Think about all you have learned about center of gravity and balance.

Why do you think people hold their hands out at their sides when they try to walk in a perfectly straight line? You may want to try it and use your experience and observations to explain your thinking.



# Assessment

NAME \_\_\_\_\_

## ASSESSMENT QUESTIONS —

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

- 1 Gravity is
  - a. a force.
  - b. a magnet.
  - c. just like glue.
  - d. only found in outer space.
  
- 2 Circle ALL objects below that are symmetrical.
  - a. A meter stick
  - b. A baseball bat
  - c. A hammer
  - d. A baseball
  
- 3 Why were all of the nails able to balance on the head of just one?
  - a. They were locked and balanced on their center of gravity.
  - b. Gravity was pulling them down.
  - c. It is a magic trick.
  - d. The nails are made of metal and they are magnetic.
  
- 4 Imagine your PE teacher tells you that you will be walking across the balance beam. What are some things you should remember as you take your turn on the balance beam?

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- 5 Now that you have mastered the Balancing Nails experiment, think of a way you could change this experiment. Think of a variable and a big question you are wondering about related to center of gravity and balance.

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# 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 **(D) Force**

**⋅A⋅** A force that pulls two objects together. It is the force that pulls objects toward the ground.

2 **(C) Balance**

**⋅B⋅** The place on an object where the weight is even or the force is pulling evenly.

3 **(A) Gravity**

**⋅C⋅** Having weight spread equally over an object.

4 **(B) Center of Gravity**

**⋅D⋅** The push or pull exerted on an object.

5 **(E) Symmetrical**

**⋅E⋅** When an object is the same, or reflective of itself, on both sides.



# Critical Thinking- Answer Key

## PARAPHRASE —

Students will be able to restate the main ideas of relevant vocabulary in their own language.

Read the following definitions.

**Gravity:** A force that pulls two objects together. Gravity is the force that pulls objects toward the ground.

**Center of Gravity:** The place on an object where the weight is even or the force is pulling evenly down.

Explain what each vocabulary word means in your own words. Also, explain how these words are similar or different.

***Possible Answer:***

*Gravity is the force that makes objects fall to the ground and makes it so that I don't float away.*

*Center of Gravity is the place where an object is best able to balance and where gravity is pulling down evenly.*



# Critical Thinking- Answer Key

## INFERENCE —

Students will use knowledge gained from the experiment demonstration to make judgments about outcomes and conditions of a scenario.

Think about what you observed in the experiment. What inferences can you make from the following statements related to the experiment? Be sure to explain your thinking with “I infer this because...”

a) What will happen if you line up 11 nails and try to balance them on the head of a nail? What will happen if you try to use 6 nails? Sketch a picture below to help show your thinking. Explain.

### **Possible Answer:**

*When we watched the video (or did the experiment) I saw that the nails were able to balance when the number of nails was odd. I saw that when the number of nails was even the nails moved around and were unbalanced. I infer that with 11 nails they will balance, and if there were only 6 nails, because it is even, I infer that they will not balance.*

b) How would you balance a baseball bat on your finger tip? Sketch a picture below to help show your thinking. Explain.

### **Possible Answer:**

*To balance a baseball bat on its side on my fingertip, I know that I have to find the center of gravity. Looking at a baseball bat I notice that it is not symmetrical. Therefore, I infer that the center of gravity will not be in the exact center of the bat. Instead, I will have to find the place where the weight is balanced (the center of gravity) and then balance it on my fingertip.*



# Critical Thinking- Answer Key

## REAL WORLD APPLICATION —

Students will be able to apply their critical thinking strategies and scientific concepts to a real world scenario.

Tie a pipe cleaner around a popsicle stick, leaving both ends sticking evenly out on both sides. Then, connect a small weight such as a hexnut to each tip. Try to balance the end of the popsicle stick on your finger, adjusting the level of the pipe cleaners to find the center of gravity.

Think about all you have learned about center of gravity and balance.

Why do you think people hold their hands out at their sides when they try to walk in a perfectly straight line? You may want to try it and use your experience and observations to explain your thinking.

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

*Normally, a person's center of gravity is right above his or her belly button. This means that we balance from this part of our body. Holding out your arms to the side lowers your center of gravity. A lower center of gravity makes it easier to balance while walking a straight line.*



# Assessment - Answer Key

## ASSESSMENT QUESTIONS —

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

- 1 Gravity is
  - a. a force.
  - b. a magnet.
  - c. just like glue.
  - d. only found in outer space.
  
- 2 Circle ALL objects below that are symmetrical.
  - a. A meter stick
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- 3 Why were all of the nails able to balance on the head of just one?
  - a. They were locked and balanced on their center of gravity.
  - b. Gravity was pulling them down.
  - c. It is a magic trick.
  - d. The nails are made of metal and they are magnetic.
  
- 4 Imagine your PE teacher tells you that you will be walking across the balance beam. What are some things you should remember as you take your turn on the balance beam?

**Possible Answer:** One thing that I should remember when walking across the balance beam is that I have to focus on my center of gravity. The center of gravity in a person is about half way between the toes and the top of the head. I know that one way to help myself balance would be to put my arms out to my sides. I also know that if I drop my hands a little lower to the ground, I can lower my center of gravity. If I lower my center of gravity, it will be easier for me to balance on the balance beam.
  
- 5 Now that you have mastered the Balancing Nails experiment, think of a way you could change this experiment. Think of a variable and a big question you are wondering about related to center of gravity and balance.

**Possible Answer:** I wonder if I used different sizes of nails if I could make the nails balance like they did in this experiment. My variable would be the different sizes of nails. OR I wonder if I used screws instead of nails if I could make the nails balance like they did in this experiment. My variable would be the different sizes of screws.

# 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
Students will be able to draw inferences from a specific scientific learning experience.	RI.4.1, RI.5.1
Students will be able to retell key details presented in the experiment.	RI.K.2, RI.1.2, RI.2.2, RI.3.2, RI.4.2, RI.5.2
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
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 use information gained from observations of the experiment to demonstrate understanding of the concepts presented.	RI.3.7
Students will participate in shared writing projects and record scientific observations.	W.2.7
Students will be able to recall information from experiences to answer a question.	W.K.8, W.1.8, W.2.8
Students will be able to write an informative/explanatory text that includes facts.	W.K.2, W.1.2, W.2.2, W.3.2, W.4.2, W.5.2