

SICK!
science 
insanely cool experiences

**BALANCING
NAILS**
EXPERIMENT GUIDE



as seen on
YouTube™

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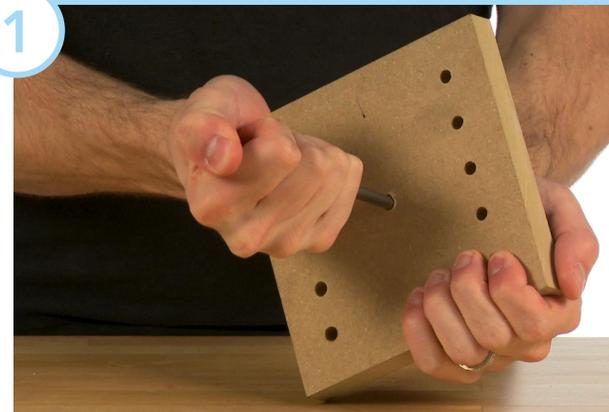
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BALANCING NAILS EXPERIMENT

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

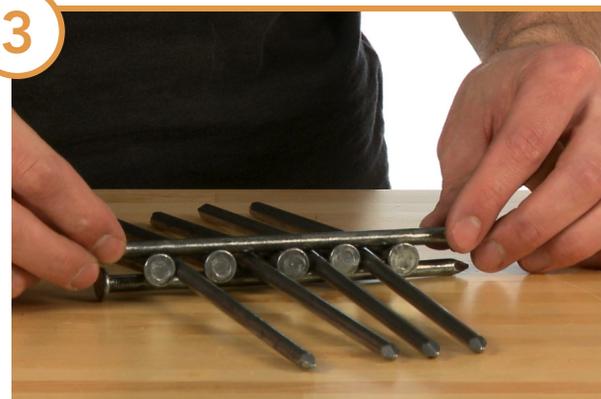
- 12 NAILS
- BOARD
- ADULT SUPERVISION



Firmly place one nail into the center of the board.



Arrange the remaining nails as shown.



Place the final nail across the arranged nails.



Try balancing the remaining nails on the head of the single nail.



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

THIS EXPERIMENT

SCAN TO WATCH



For step by step experiment instructions, the science behind it and ways to take it further, scan the code to the left.

Trouble scanning? Follow the URL below.
<http://spanglersci.com/101wsks43tzofz3t8>



HOW DOES IT WORK

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 the left side or the right 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

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!

ADDITIONAL INFORMATION

Scientific puzzles can often be trickier than they look. The best way to solve a puzzle is to think of an idea and then try it out. Even if one idea doesn't work, you might think of another one at the same time. The key is not to get frustrated and give up. Keep trying! You might have to sleep on an idea and come back to it the next day. Keep notes or even photos of what you try and describe the outcome you had. You may want to share your ideas with someone else to see if they have a different approach to solving the problem. Draw a simple picture of what you're trying to do to organize your thoughts. This is a problem solving process and it's exactly like the scientific method: ask a question, run some tests, ask another question, run some more tests, and eventually you'll come to a conclusion. If your experiments or "solutions" don't work the first time, that's okay. The key is that a scientist doesn't give up if the first attempt flops.

SCIENCE FAIR CONNECTION

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 size 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 different size of nails, make sure that the other factors are remaining the same!

WHAT ARE THESE SYMBOLS ALL ABOUT?



LAB REPORT

In this section, you will learn to define and prepare your experiments like scientists do. You will ask big questions, develop hypotheses, list materials, write procedures, record results and make big discoveries.



EXPERT VOCABULARY

In this section, you will learn to use the language scientists use to discuss and explain the concepts covered in this experiment.



CRITICAL THINKING

Follow the layers of critical thinking density with this icon. As the beakers fill from page to page, you will notice that the level at which the beaker is filled indicates the depth of critical thinking needed to complete the question(s), from least complex being the least full to most complex being the most full.



ASSESSMENT

In this section, you will find questions at a variety of levels which assess student understanding of the scientific content covered in the experiment.

A WORD ABOUT SAFETY

Everything we suggest using in this guide is safe when used with proper adult supervision. We guarantee young scientists will get a lot more from the experience if you're there to guide them. Remember, this is science, and science tends to get a bit messy. Stuff falls on the floor... so you'll need to clean it up. Don't put chemicals in your eyes or ears and don't eat your experiment. Trust us, they don't taste good and it's a bad thing to do. The bottom line is that this science experiment guide requires adult supervision and common sense. These simple concepts help ensure a fun and safe experience.

TEACHER NOTES:

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.

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. Also 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.



Lab Report

NAME _____

BIG QUESTION:

Scientists ask big questions to guide their experiment.

What big question are we answering in this experiment?

HYPOTHESIS:

Scientists make predictions about what they think will happen during the experiment.

What is your hypothesis for this experiment?



Lab Report

NAME _____

MATERIALS AND PROCEDURES:

Scientists make a list of materials they need and will use in their experiments. It is important other scientists are able to duplicate and test each other's experiments.

What materials do you need to conduct this experiment?

Write out a step-by-step procedure for this experiment.



Lab Report

NAME _____

RESULTS AND OBSERVATIONS:

Scientists make observations and take notes as they conduct their experiments. Scientists are good observers and record all results of their experiments. It is important to measure your results using precise units and careful review.

What were the results of your experiment?

What did you observe as you conducted your experiment?



Lab Report

NAME _____

CONCLUSIONS AND DISCOVERY:

Scientists look carefully at their results, think critically about their observations, and draw conclusions about their experiments, as they relate to their big question and original hypothesis.

What conclusions and discoveries did you make after completing the experiment?

NEXT STEPS:

Sometimes after scientists conduct their experiments, they think of new questions they want to test in new experiments.

What new questions do you have after you have completed your experiment?



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 ____ **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've seen and experienced 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.

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. something 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?

- 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.



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've seen and experienced 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 evenly 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 evenly, and if there were only 6 nails, because it is even, I infer that they will not balance evenly.

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.

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. something found in outer space.

- 2 Circle ALL objects below that are symmetrical.
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 - 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?

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

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