Puzzling Nails

I Wonder Why.....

1. did the nails balance?

The forces were equal on both sides, an equilibrium happened, etc.

2. the nails didn't hang straight down?

Their heads were held by the two horizontal nails.

3. did you have to use an even number of nails?

So there would be a balancing torque or twist to each nail.

4. did the nail in the block have to be straight up and down?

So the nails could be balanced on them, if uneven, they could slide off.

5. does gravity affect these nails, even though they don't move?

Gravity is here, but there were forces keeping the nails balanced and not moving.

Think Like a Scientist.....

1. What is torque?

A twisting force, like swinging a bat or throwing an object.

2. What is the center of gravity?

The middle of the object's mass.

3. Where was the balanced nail's center of gravity?

Located on the head of the nail you balanced them on top of.

4. What is an equilibrium?

When forces are balanced.

5. What is a net force?

The difference between opposing forces, if they're unequal, there is movement.

Puzzling Nails

The Science Connection

Torque Trials

When you push on something, it moves away from you. If you pull on the same object, it moves toward you. This is because the object is free to move. But what would happen if you pushed or pulled on something, but one end of it was unable to move, while the end you push or pull on could move? You're right, it would twist or turn. This kind of movement is called torque.

Just like all forces torque is created by some kind of push or pull. The difference between just pushing or pulling on an object is the object being twisted has a turning point. Here's an example. When you throw a ball, you cause a torque. You push the ball away from you, but your arm is still attached to the shoulder. So the arm turns around that point. That's torque.

Torque is very common. Each movement of your arms or legs is torque. So, swinging a hammer, a golf club, or a tennis racquet is a torque. Engines of cars, motorcycles, ATV's, etc. produce torque to make the wheels turn.

Many tools use torque to accomplish their mission. As you use bigger forces, the amount of torque you produce increases. Tools and their torque have become bigger and more powerful as our machines have increased in size and purpose.

Puzzling Nails Teacher's Guide

The Initial View (Introducing the Activity)

Don't show them the solution picture right away!! Let the kids try to solve this on their own. Allow appropriate time for students to try before you show them how! *You may not want mass hammering and thumb smashing during class time. Feel free to prepare the single nail blocks of wood ahead of time*! *You can substitute blocks of Styrofoam® for the wood*. Challenge the students to see how many nails can be stacked!

Take a Deeper View! (More Science)

Have the kids finger tap an outside nail *very* gently again. Notice how the stack twists and turns over the **Center of Gravity** (c.g.) (the balance point) of the entire stack? That's because all **Forces** go to and from the center of gravity of a **System**. (That's a bunch of parts working together.) You've watched a high-wire circus performer take good advantage of this to stay alive! Any twisting force you see in the nail stack, the circus performer, or on a playground teeter-totter is called a **Torque**. The nails torqued around their center of gravity to demonstrate both torque and how a center of gravity helps movement. A softball or baseball player in the infield crouches down to help their c.g. get them in front of the ball as fast as possible! Athletes use their center of gravity all the time in performing their sports!

More and Bigger Views! (Additional Classroom Ideas)

1. Identify as many torques in action around you as you can find!
2. A system is a group of parts working together. See if the kids can identify some systems working! (Engines, bodies, plants, toys, bicycles, tools, etc. are just a few examples.)
3. Locate the c.g. of objects by balancing. (Only use safe objects to balance!)
4. Find objects which move thanks to a **Net Force**. Identify the two forces working against each other and which force wins. Read and write about your examples.
5. **Newton's Third Law** states for every **Action** of a force there is an equal but opposite force in **Reaction**. Have the kids identify a third law action and reaction with their stack of nails. (A **Push** on the stack makes the stack move away from you is one example.)
6. Find examples of Newton's third law around you. For the example to be correct, there has to be two forces, they must be opposite, and equal. A motionless coffee cup on the table is an example. The table pushes up on the cup as much as **Gravity** is **Pulling** down!
7. Produce a bulletin board with the examples of torque, systems, center of gravity, net forces, and Newton's third law examples you identified!
8. Perhaps a local football coach would bring some padded up players to demonstrate forces, torque, center of gravity, and net forces in action for the kids!
9. Identify torques, net forces, center of gravity, systems, and Newton's third law in your favorite sport or outdoor activity!!
10. Try this activity with giant landscaping nails; however be very careful with these! The activity can also be done with cotton swabs if you're concerned about sharp kids and sharp nails in the same room! *Who can stack the most of whatever object you use?*
11. Have a person who works in a tire shop explain the little lead weights on car rims.
12. Try the activity with other uniform shaped objects. Who can stack the most?

Answers

1. (it wobbles on the nail you drove into the board) 2. (on the head of the driven nail)

Puzzling Nails

Safety Alert:

Sharp nails, Hammer

Getting Ready

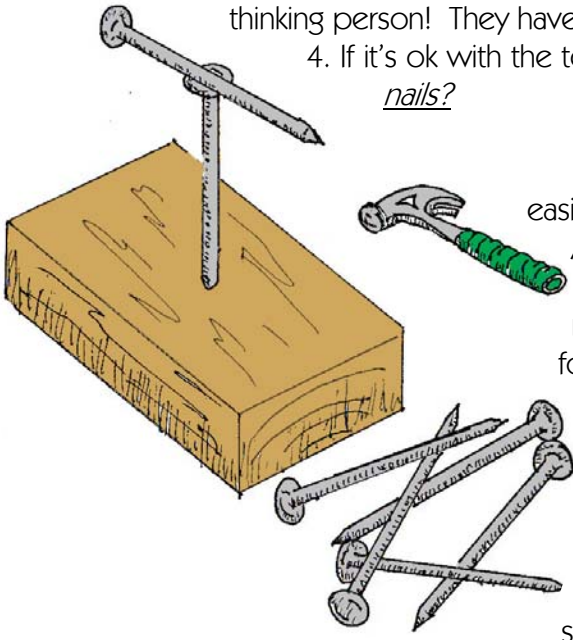
Ok, so how could six nails balance on top of just one nail? NO glue, rubber bands or welding is allowed! Let's face it, they're just plain *Puzzling Nails*!

Stuff to Make it Happen (Materials)

seven nails block of wood or Styrofoam® hammer* extra nails*

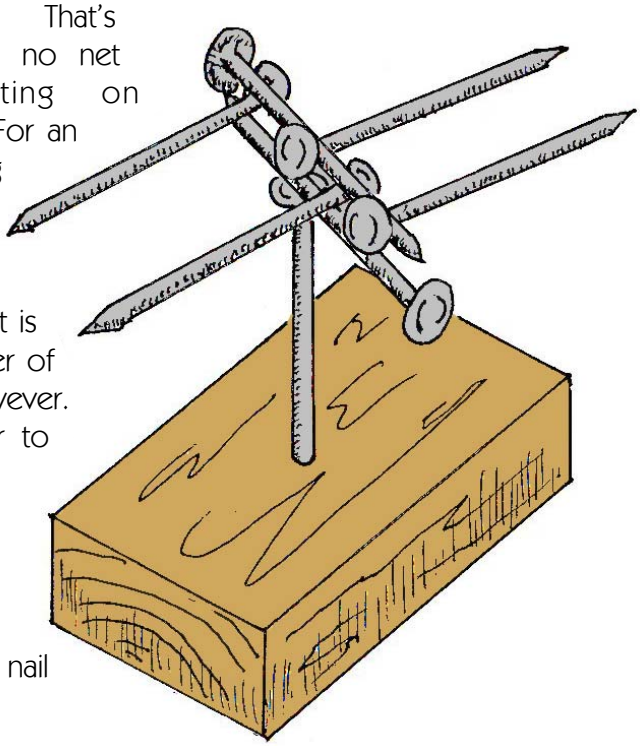
Making it Happen *(Be careful using the hammer, adult supervision is required.)*

1. Drive one nail in the wood block's middle or push it gently into the Styrofoam. *Be careful with the hammer*. Lay out the other six nails on the table.
2. Your job is to balance the six nails on top of the single nail.
3. Think balance!! Give up? See the teacher for the solution, your teacher is a very *sharp* thinking person! They have the solution to help you *nail* down the science involved!
4. If it's ok with the teacher, try stacking more nails. *Who can stack on the most nails?*



Understanding the Science

Once you know the solution, the entire stack of nails is easily balanced. In science balance is called **Equilibrium**. A pencil motionless across your fingertip is another example, so is sitting motionless in a chair. An equilibrium means there is no **Net Force** acting on something. A net force is the difference between two **Opposing** or opposite forces! **Gravity** is **Pulling** down on you and your chair. The chair has to **Push** back with an equal but opposite force. It didn't collapse or toss you upwards. That's equilibrium, no net force acting on something! For an object to move there must be a net force. Standing up from the chair is an example. You have to provide more force than gravity is putting on you before you can get out of the chair! Observe the balance point of the nail stack. This balance point is called an object's **Center of Gravity**. The center of gravity isn't always in an object's exact middle, however. Balance a softball or baseball bat on your finger to prove this!



Let's Check the View! (Questions and Assessments)

1. Tap *very gently* one of the outside nails. What does the entire stack do?
2. Where is the center of gravity of your nail stack?

Puzzling Nails

Safety Alert:

Sharp nails, Hammer

Getting Ready

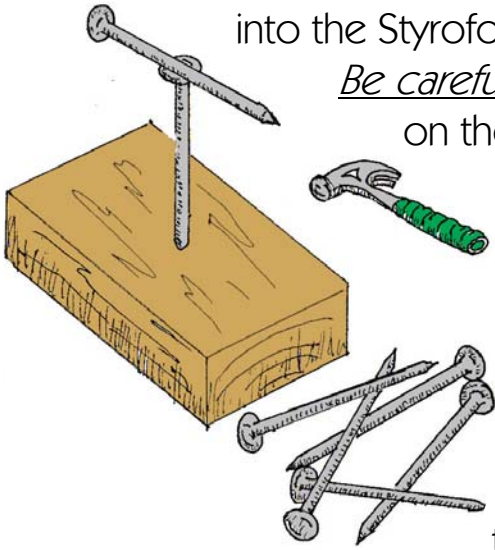
Stanley the Hammer wonders how six nails could balance on the head of just one nail? Especially when he is not allowed to use any glue, rubber bands or welding! Let's face it, they're just plain *Puzzling Nails*!

Stuff to Make it Happen (Materials)

seven nails
hammer*
block of wood or Styrofoam®
extra nails*

Making it Happen *(Be careful using the hammer, adult supervision is required.)*

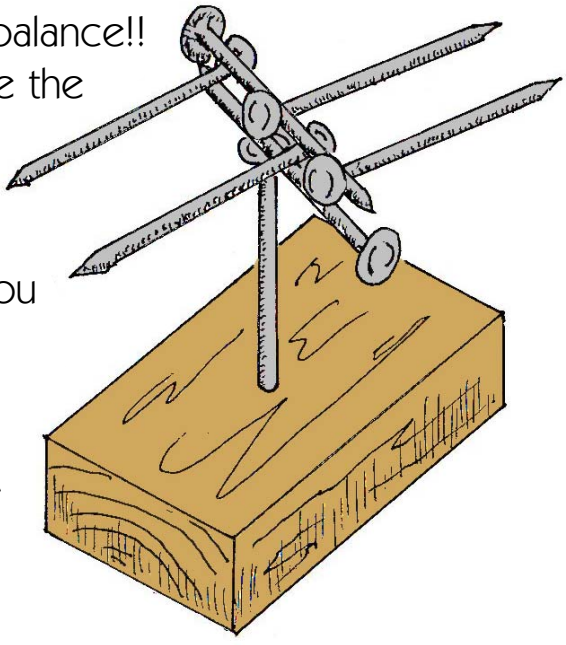
1. Drive one nail in the wood block's middle or push it gently into the Styrofoam.



Be careful with the hammer. Lay out the other six nails on the table.

2. Your job is to balance the six nails on top of the single nail.

3. Think balance!! Give up? See the teacher for the solution, your teacher is a very *sharp* thinking person! They have the solution to help you *nail* down the science involved!



4. If it's ok with the teacher, try stacking more nails. *Who can stack on the most nails?*

Puzzling Nails

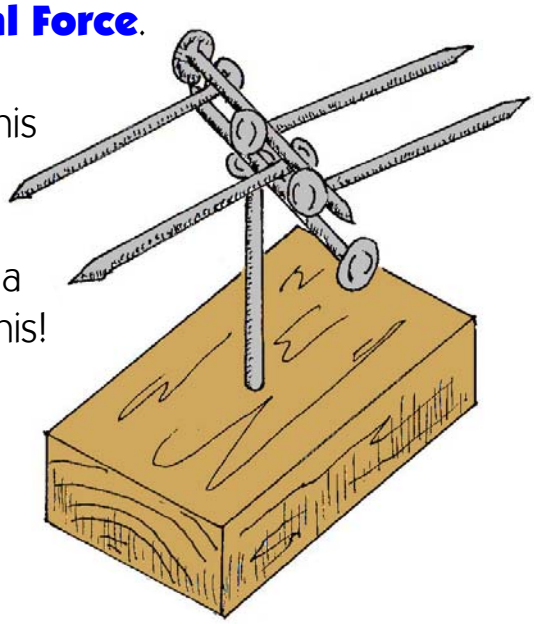
Stanley the Hammer thought that was pretty amazing! He wants to understand the science of how these could balance like that!

Understanding the Science

Once you know the solution, the entire stack of nails is easily balanced. In science balance is called **Equilibrium**. A pencil motionless across your fingertip is another example, so is sitting motionless in a chair.

An equilibrium means there is no **Net Force** acting on something. A net force is the difference between two **Opposing** or opposite forces! **Gravity** is **Pulling** down on you and your chair. The chair has to **Push** back with an equal but opposite force. It didn't collapse or toss you upwards. That's equilibrium, no net force acting on something!

For an object to move there must be a net force. Standing up from the chair is an example. You have to provide more force than gravity is putting on you before you can get out of the chair! If the movement is caused by a tool or a machine it is a **Mechanical Force**.



Observe the balance point of the nail stack. This balance point is called an object's **Center of Gravity**. The center of gravity isn't always in an object's exact middle, however. Balance a softball or baseball bat on your finger to prove this!

Let's Check the View! (Questions and Assessments)

1. Tap *very gently* one of the outside nails. What does the entire stack do?

2. Where is the center of gravity of your nail stack?

Puzzling Nails

Name _____

Student Assessment

Let's Think About It!

1. What force is pulling the nails downward? *Stanley* needs help. Circle the right answer for him.

torque **gravity** **mechanical**
balanced **unbalanced**

2. Once you figure out the trick, the nails stay in place. What can you call this kind of force? *Stanley* might know, but he's relying on you to circle the right answer.

torque **gravity** **mechanical**
balanced **unbalanced**

3. You are stronger than the pull of gravity on an object, so you lift it. What is it called when forces are not equal and there's movement. Circle it for *Stanley*.

torque **gravity** **mechanical**
balanced **unbalanced**

4. The nails on both sides want to twist, but they twist in opposite directions, so the nails stay put. What is another name for a twisting force? Circle it for *Stanley*.

torque **gravity** **mechanical**
balanced **unbalanced**

5. Which of these would be a good name for movement caused by a tool or a machine? *Stanley* is counting on you for this one, so circle it for him.

torque **gravity** **mechanical**
balanced **unbalanced**

"Stanley" the Force **says it's time to learn more about this activity! Follow your teacher's directions!**

Name _____

Puzzling Nails

Student Assessment

Let's Think About It!

1. T or F Forces can be in opposite directions.

2. What is the balance point for the nails?

3-6. What are opposing forces? Give an example of two opposing forces.

7-10. Tell what you did in the activity with the nails to get them balanced. What did you see happen? Why do you think this happened? You may draw pictures to help you explain your answers.

Optional; Give some examples of using balance on the play ground.

Puzzling Nails

Student Assessment

Let's Think About It!

***Transitional* Student Assessment Answers**

Puzzling Nails

1. gravity
2. balanced
3. unbalanced
4. torque
5. mechanical

"Stanley" the Force **says it's time to learn more about this activity! Follow your teacher's directions!**

Puzzling Nails

Student Assessment

Let's Think About It!

Student Assessment Answers

Puzzling Nails

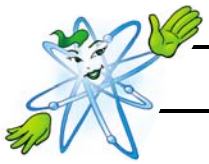
1. T
2. the point the pile of nails balances on, etc.
3-6. two forces in opposite direction, student example
7-10. should show how nails were stacked to oppose each other, etc.
Optional; student examples

Student: _____ Date: _____

Puzzling Nails

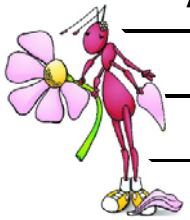
Think It Through Questions

1. What do you think the center of gravity is?



2. Why is center of gravity so important to athletes?

3. Tell how to find the center of gravity of a pencil.



4. What is an equilibrium?

5. Name several examples of something that shows equilibrium.

SeeLA Science

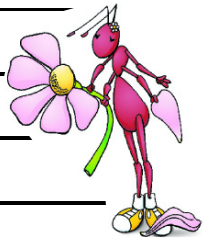
The Learning Zone

Student: _____ Date: _____

Puzzling Nails

Observations, drawings and things I did

My Discoveries —- What did I find?



Internet ideas and places

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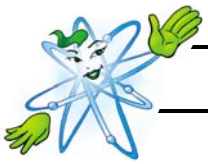
Student: _____ Date: _____

Puzzling Nails

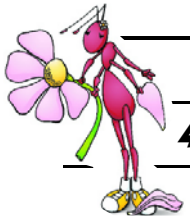
Think It Through Questions — How have my thoughts changed?

1.



2.

3.



4.

5.

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