



Bed of Nails

Amount of time Demo takes: 3-5 minutes

Try this in the classroom!

Lesson's Big Ideas

- This lesson demonstrates weight distribution and the difference between applying force over an area as opposed to concentrating all of a force on one spot.
 - $\text{Pressure} = \text{Force} / \text{Area}$
 - The greater the area is (the more spread out the force is), the less pressure is on the balloon in any given spot.
- Because so many nails are positioned close together, no single nail is solely supporting the balloon.
- The weight is evenly distributed throughout the bed of nails and the balloon remains unharmed. On the side with a single nail, however, all of the pressure is applied to one little spot.

Materials

- Balloons (several bags)
- Bed of nails assembly (homemade)
- Optional: Lead brick
- Trash bags for waste



SAFETY!

- If you decide to allow the participants to feel the nails to see that they are sharp, caution them that the nails are sharp!
- Make sure you have hold of the platform so that it does not fall onto the participant's hand.
- Keep the kids hands away from the bed of nails when you are letting the platform fall so they do not get punctured or pinched.
- If someone does get poked or scratched on the nails, make sure you apply the proper first aid. Band aids, use nitrile gloves for your protection while assisting the person. Make sure you notify an Eboard member or

professional staff member as soon as possible.

- **Do not do this demonstration if there is a known latex allergy!**

Background Information

- Often you will see the bed of nails performed on a much larger scale; instructors will lay on it for a dramatic effect. The human skin won't be hurt because their weight is spread across all of the nails which greatly decreases the amount of pressure felt by each individual nail. This is the same principal we are showing using balloons.

Setup Instructions

1. Put out the bed of nails on the table.
2. Flip lid upside down and secure to base.
3. Blow up and tie several balloons.
4. Have a trash bin/bag for popped balloons.

Instructional Procedure

1. Set up the bed of nails on an open table.
2. Demonstrate that with the single nail a balloon will pop.
3. Using a balloon helps demonstrate how safe it is to lie on a bed of nails. You can press a blown up balloon against the nails and it shouldn't pop.
4. Optional: set the lead brick on top of the bed of nails to show the balloon can still support the weight of brick without popping because it is being distributed across all of the nails.

Tips & Tricks

- Don't blow up the balloons too much. The effect will be much more dramatic if they can flatten out across the nails.
- If you have especially curious students, you can use a piece of paper or a whiteboard to have them to simple calculations using the pressure formula: $P = \frac{F}{A}$ (Pressure = Force / Area)

Assessment Questions

1. What will happen with the single nail on the board?
 - a. The balloon will pop.
2. What happens to the balloon when we push it down on the bed of nails?
 - a. The balloon will be flattened but shouldn't pop.
3. Why didn't the nails puncture the balloon?

- a. The force is being distributed across all of the other nails.
- 4. What if the nails were spread farther apart? Would the bed of nails still safely support a balloon without it popping?
 - a. It would depend how many nails were left to disburse the force on the balloon over.

Careers & Real-World Applications

- Force distribution is extremely important when it comes to architecture or even something as simple as carrying a weighted backpack or purse!
- Careers:
 - Mechanical Engineer
 - Materials Scientist
 - Architect
 - Civil Engineer

Clean Up

- Clean up between demonstrations if needed. When completely finished gather all materials listed for this demonstration and make sure everything is accounted for. If something was used up, broken or damaged. Let someone know so it can get replaced or fixed.
- If one of the nails is higher or there are any issues with the balloon popping by out of place nails, let someone know so it can get fixed.
- Pick up any balloon pieces from around your area.

References

- http://en.wikipedia.org/wiki/Bed_of_nails
- <http://www.physics.usu.edu/shane/science/nails/>

Related Next Generation Science Standards

- K-5
 - K-2-ETS1 Engineering Design
 - 3-PS2 Motion and Stability: Forces and Interactions
 - 5-PS2 Motion and Stability: Forces and Interactions
 - 3-5-ETS1 Engineering Design
- 6-8
 - MS-PS2 Motion and Stability: Forces and Interactions
 - MS-ETS1 Engineering Design
- 9-12

- HS-PS2 Motion and Stability: Forces and Interactions
- HS-ETS1 Engineering Design