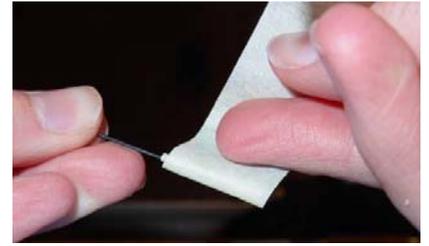


How many pennies?



Summary

Nitinol, otherwise known as *memory metal*, changes with temperature. Artists have used Nitinol to make sculptures that change shape. One of these sculptures, by French artist Olivier Deschamps, is called “Espoir-Desespoir.” This translates into English as “Hope-Despair.” It features a woman holding a baby. When it is cold out, she is laid out on the ground with the baby in front of her. When it is warm out, she is kneeling holding the baby up to the sky. How does this work? Find out by making a model of the statue.

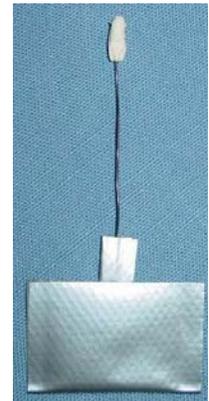


In this activity, you will use the Nitinol’s shape memory properties and the properties of Nitinol’s two phases to make a sculpture that can lift weight (pennies).

Time: 20 minutes. Parents, please supervise children.

Materials

- Piece of Nitinol wire¹
- Hairdryer
- Bowl
- Pennies
- Duct tape or package tape
- Piece of paper
- Ruler
- Scissors
- Clothespin

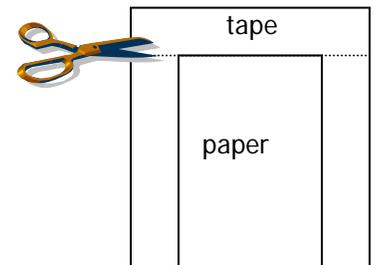


Pre-activity

Bend the Nitinol wire. Put it in the bowl so it won’t blow away, and then heat it up using the hair dryer. What happens? *Nitinol wire can get very hot, so please do not hold the wire while heating it.*

Activity

- First, make a penny holder. Cut a 2 ½ in. x 1 ½ in. piece of paper and a 3 in. x 2 in. piece of duct tape.
- Place the paper on the sticky side of the tape as shown.
- Cut slits in the tape about ¾ of an inch in from each side, as shown.
- Place one end of the Nitinol wire in the center of the tape edge, between the two flaps you’ve just made, and wrap the two flaps around the wire. Squeeze to stick it together.
- Fold the whole thing in half to make a pocket for pennies to go in.
- Now we need to secure the other end of the wire. Wrap this end of the wire with masking tape.
- Pinch the tape-wrapped end of the wire in the clothespin in the small hollow near the spring.



¹ Nitinol wire may be purchased at the following websites, as well as other sources:
Educational Innovations: www.teachersource.com
Images SI, Inc.: www.imagesco.com
Livewire: www.tinialloy.com/livewire.html

- Now it's time to see how many pennies your sculpture can lift! Hold your sculpture on the edge of a table to the pocket hangs down. Blow on the wire with the hairdryer to straighten the wire.

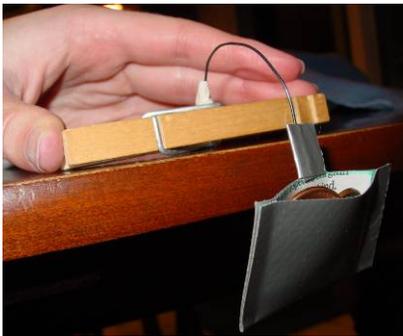
Each time you heat the wire with the hairdryer, observe what happens while it cools. Wait a minute or so before touching it.

- Place a few pennies in the penny holder. What happens to the wire?
- Blow on the wire with the hair dryer. What happens?
- Add more pennies, and repeat. How many pennies can your sculpture lift?

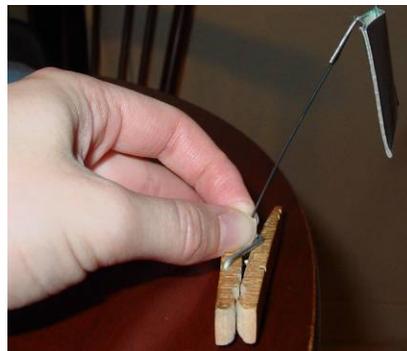
What's going on?

Nitinol is in its soft, bendable phase at lower temperatures. That is why, when the wire is cool, the weight of the pennies bends the wire down towards the ground. When you heat the wire up, it changes to its high-temperature phase, and goes back to its original shape. The force of this change of shape is enough to lift the pennies. In its high-temperature phase, Nitinol is rigid. That is why it can hold the pennies up while it is heated by the hair dryer.

Similarly, when it is warm outside, the sculpture "Espoir-Desespoir" is in its rigid high-temperature phase, and stands up. When it is cool out, the metal is in its soft phase and sags to the ground.



Why does this happen?



Question: What happens as the wire cools down after being heated by the hairdryer?

Extension Activity

The activity, "Shape permanently change the shape and what you have learned in Nitinol sculpture. Use other paper, tape, paper clips, cloth.... Be creative!

Up" in this activity set shows how to of a Nitinol wire. Using that information, this activity, design your own moving materials you have around the house –

For More Information

Many artists have used Nitinol to make sculptures that move. Some of these sculptures move when the temperature changes, like "Espoir-Desespoir." Other sculptures use electricity to change the shape of the Nitinol wire. Some move constantly, looking like muscles. Some move only when someone enters the room, catching them by surprise. These sculptures are really wild!

Here are other examples of Shape Memory sculptures:

- Onibaba: The Magic Reeds

This sculpture, by Etienne Krähenbühl and Dr. Rolf Gotthardt, features reeds that move as you approach.

<http://dpwww.epfl.ch/Gotthardt/ART/Onibaba.html>

The same artists also worked together on a sculpture, now on display in the Science Museum of Barcelona, called *L'Insoutenable légèreté du cube* (which means "Unbearable lightness of the cube" in French).

http://sb.epfl.ch/Jahia/site/sb_en/cache/offonce/pid/53064

- *Octofungi*, a wacky 8-armed robotic sculpture, by sculptor Y. Klein.



Image copyright François Busson. Courtesy of Krähenbühl and Gotthardt.

<http://www.livingsculpture.com/LivingSculptureSite/Sculptures/Octofungi/octofungi.htm>

- Artist Jean-Marc Philippe of France is coordinating a satellite time capsule called “KEO” whose wings will flap using memory metal hinges that change shape with temperature.
Ark De Triomphe, by Robert Kunzig. Discover, June, 1999. Pages 62-66.
A model of the spacecraft’s design:
<http://espaeuro.homestead.com/files/1997/oevres/oiseau1000.jpg>
The same artist has created shape-memory sculptures that change form with daily and seasonal changes in temperature.
- *Office Plant #1*, by Marc Böhlen and Michael Mateas, is a “desktop sculpture” that uses shape memory switches to move.
Intimate Space and Contemplative Entertainment
<http://www.fundacion.telefonica.com/at/vida/paginas/v2/ebohlen.html>
- “N,” a creation by artists Lloyd Gibson and Mark Little, sits on the polluted Isle of Gruinard in Scotland. The statue, which is not accessible to the public, uses Shape Memory metals to make the statue’s “muscles” move with changing temperature.

Vocabulary

Nitinol: An alloy of Nickel and Titanium that returns to its previous shape when you heat it up.

Phase: A specific form of matter that exists within a certain range of temperature and pressure. This includes gas, liquid, solid and plasma. A material may have several solid phases that exist at different temperatures and pressures.

References:

Teaching General Chemistry: A Materials Science Companion. Arthur B. Ellis, Margret J. Gesselbracht, Brian J. Johnson, George C. Lisensky and William R. Robinson. Published by the American Chemical Society, 1993.

Art and Shape-Memory Alloys. J.M. Phillippe. *Leonardo* 22(1), 117-120 (1989).

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