








## Activity: Hydraulic Hand Prosthesis

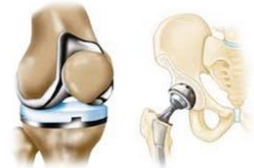
(This activity also requires the Hydraulic Arm handout.)

### Introduction

Materials	
<ul style="list-style-type: none"> <li>• 5 wooden craft spoons</li> <li>• 1 large wooden spring clothespin</li> <li>• 1 small wooden spring clothespin</li> <li>• 10 small rubber bands</li> </ul>	   
<ul style="list-style-type: none"> <li>• 2 small plastic syringes</li> <li>• 2 clear vinyl tubes (1 foot)</li> <li>• 1 foam bowl with water</li> <li>• Hydraulic Arm model from the EWH Muscles-Joints Activity</li> </ul>	  






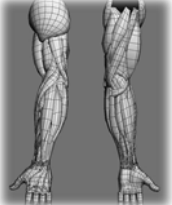
Prosthetic organs manufacturing is one of many career fields available to biomedical engineers. Prostheses are artificial devices put in place for a missing body part. Can you think of any body parts that can be replaced by an artificial device or part?

**Did you know?** Every year, in the United States alone, more than 185,000 prostheses are used in surgeries to replace body parts. The most common prosthetic surgeries are knee and hip replacements.



### Types of Prostheses

Think about the prostheses featured below. Which body part do you think each device resembles most? Draw lines connecting the right type of prosthesis to its corresponding body part.

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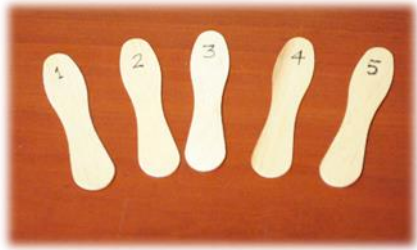
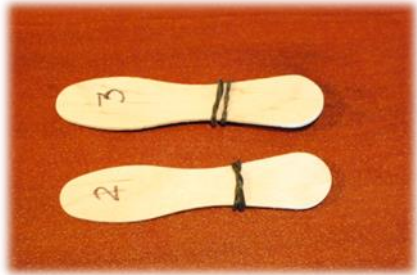

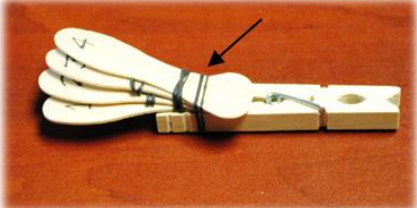
## Hydraulic Hand


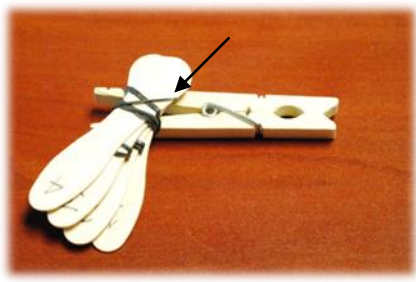
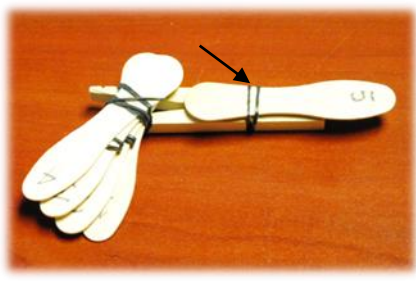
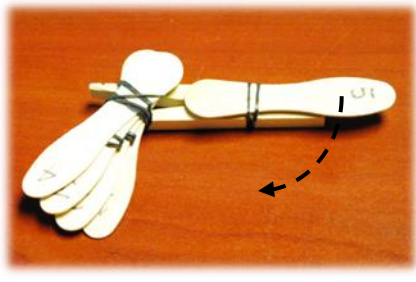
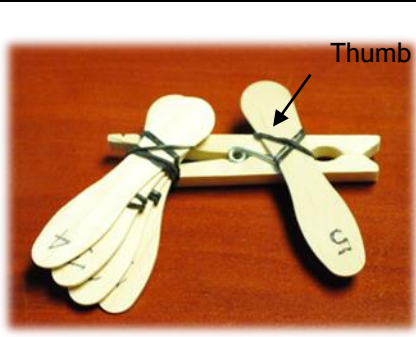
In this activity, you will create a prosthetic hand with hydraulic motions and learn about how these devices can replace muscles and bones.

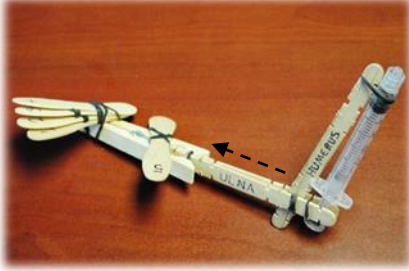
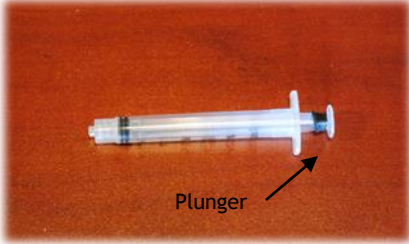

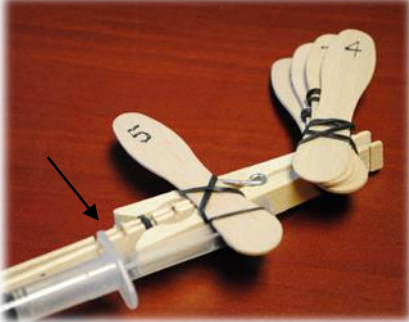

**Hydraulics** is the applied science of using liquids to create mechanical movement. Liquids are not compressible; therefore, they can be used to create stronger forces than gas (pneumatic) systems. By using the pressure of a liquid, we can make things move up and down, side-to-side, or in any direction we want. In this activity we will use principles of hydraulics to make fingers hold an object as shown in the picture to the right.

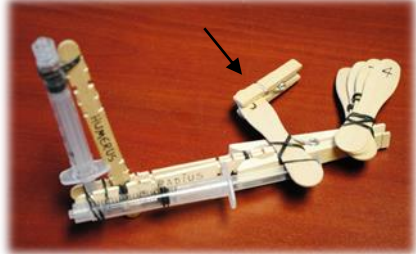
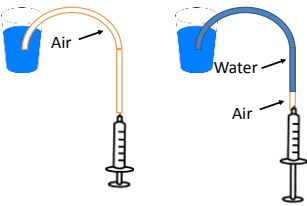
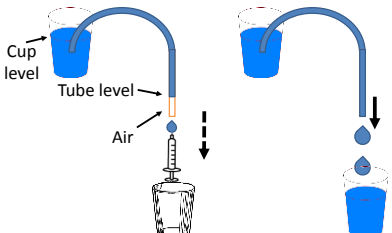
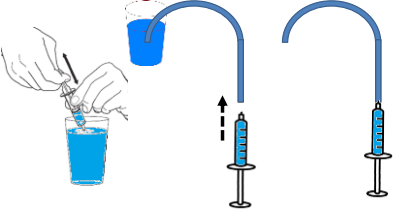
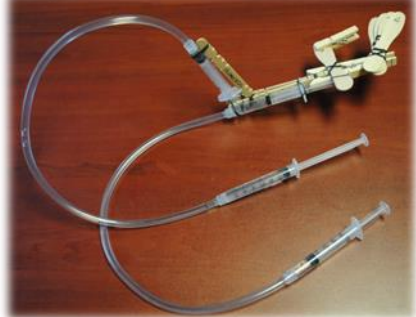


But before we get started, clench your fingers together to make a claw, as if you were holding a baseball. Do you see the motion we want to create with our hydraulic hand?

1	Number each of the wooden craft spoons, 1-5.	
2	Place a small rubber band (two turns) around spoons 2 and 3.	
3	Pile spoons 1, 2, 3 and 4 on top of each other and tie them together at the small end of the spoon with a rubber band (four times around). They should look like fingers now.	
4	Place the fingers on top of the large clothespin. Tie it twice around with a small rubber band.	

<p>5</p>	<p>Bend the fingers 45 degrees in relation to the clothespin.</p>	
<p>6</p>	<p>Tie a small rubber band once around it.</p>	
<p>7</p>	<p>Tie craft spoon 5 to the clothespin with a rubber band (two times around).</p>	
<p>8</p>	<p>Bend spoon #5 45 degrees in relation to the clothespin.</p>	
<p>9</p>	<p>Use another small rubber band to tie (only one turn) spoon #5 diagonally, forming an "X" shape with the bands. This represents the hand's thumb.</p>	

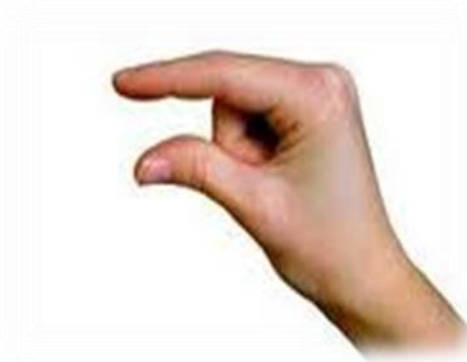
<p>10</p>	<p>Use the arm model made from the Hydraulic Arm project and wedge the end of the two sticks (Radius and Ulna bones) into the opening of the large clothespin. Make sure it fits tightly.</p> <p>This should now look like the whole arm with the hand!</p>	
<p>11</p>	<p>Wrap a small rubber band ten times around the top end of a new syringe plunger.</p>	 <p>Plunger</p>
<p>12</p>	<p>Use the rubber band to connect the syringe plunger to the thumb.</p>	
<p>13</p>	<p>Use the cut out notch in the craft stick to fix the syringe in place so that only the plunger can move.</p>	
<p>14</p>	<p>Rubber band the other end of the syringe to the end of the arm elbow stick (Radius and Ulna).</p>	

15	Use the small clothespin to form a hook shape in the thumb.	
16	Attach the syringe (#2) to the tube. Pull the water from the cup/bowl with the syringe (#2). There will still be some air remaining in the tube.	
17	Be sure that the liquid level in the tube is lower than the cup to create a syphon. Place another cup/bowl underneath the syringe (2). Disconnect the syringe (2) from the tube and let the water flow.	
18	Fill syringe (2) with water completely. Connect syringe (2) back to the tube.	
19	Attach the other side of the tube to the hand syringe. The prosthesis is now ready for testing!! GREAT JOB!	

Let's test our model hand prosthesis!

The hydraulics system allows you to contract and retract the fingers into a claw. Try using your model and your own arm to figure out how this relationship works. Observe the movement of the sticks as the water is pushed up and down, creating or releasing pressure.

Fingers retracting:



Fingers contracting:



Fill in the blanks with one of the following words: prostheses, hands, water or hydraulics.

1. The ability of the human \_\_\_\_\_ to open and close to hold objects is a unique trait that allows us to perform so many meticulous tasks.
2. \_\_\_\_\_ uses liquids to create mechanical movement.
3. Artificial devices put in place for a missing body part are called \_\_\_\_\_.
4. \_\_\_\_\_ is not compressible; therefore, it can be used to create stronger forces and faster movements than air (pneumatic) systems.

**Acknowledgements:** This Engineering World Health STEM module was developed in partnership with North Carolina State University (The Engineering Place) and Biogen Idec.