

## Shoe Soles

**Grade level:** 6-10

**Summary of lesson:**

Students will learn about the biomechanics of the human foot in action. They will research treads and thicknesses of various athletic shoes to observe differences and similarities. Students will also look toward nature (biomimicry) for insight. They will pick a specific athletic activity such as basketball in their small teams for the design of a shoe sole. They will design a shoe sole and use clay to create a model of their sole after researching the activity and interviewing prospective users. Students will create molds of the clay model and will use polyurethane compounds to create their shoe sole prototypes.

**Time/Duration:**

Each unit is designed to be 90 minutes. Teachers break down the lesson based on schedule minutes and available time. Example: 7<sup>th</sup>-8<sup>th</sup> grade science teaches 1 unit a week, and he meets 3 days a week, once for 55 minutes and twice for 90 minutes. It depends on deep educators who want to take it.

**Topics Covered:**

- Design Process
- Forces
- Biomechanics
- Biomimicry
- Materials
- Molding

## Subject areas/Standards:

### Standards

ITEEA STLs

| Standard    | Details                                                                                                                                                            |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Standard 3  | Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.                   |
| Standard 9  | Students will develop an understanding of engineering design.                                                                                                      |
| Standard 10 | Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. |

### SHOE SOLES - NGSS - HIGH SCHOOL

| Meeting/<br>Standards                                  | Core Ideas       | Engineering<br>Standards | Cross-Cutting Concepts                                                                                                                                                       | Practices                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------|------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Meeting 1:<br>Invention<br>Introduction                | ETS1.A<br>ETS1.B | HS.ETS1-3                | <ul style="list-style-type: none"> <li>Structure &amp; Function</li> </ul>                                                                                                   | <ul style="list-style-type: none"> <li>Asking questions and defining problems.</li> <li>Constructing explanations and designing solutions.</li> <li>Obtaining, evaluating, and communicating information.</li> </ul>                                                                                   |
| Meeting 2:<br>Biomechanics                             | ETS1.A<br>ETS1.B | HS.ETS1-2<br>HS.ETS1-3   | <ul style="list-style-type: none"> <li>Influence of Sciences, Engineering, and Technology on Society &amp; the Natural World</li> <li>Structure &amp; Function</li> </ul>    | <ul style="list-style-type: none"> <li>Planning and conducting investigations.</li> <li>Obtaining, evaluating, and communicating information.</li> </ul>                                                                                                                                               |
| Meeting 3:<br>Sketch & Design                          | ETS1.A<br>ETS1.B | HS.ETS1-1<br>HS.ETS1-2   | <ul style="list-style-type: none"> <li>Systems &amp; System Models</li> <li>Structure &amp; Function</li> <li>Scale, Proportion &amp; Quantity</li> </ul>                    | <ul style="list-style-type: none"> <li>Constructing explanations and designing solutions.</li> <li>Developing and using models.</li> </ul>                                                                                                                                                             |
| Meeting 4:<br>Sculpt Clay Models                       | ETS1.B           | HS.ETS1-3                | <ul style="list-style-type: none"> <li>Structure &amp; Function</li> </ul>                                                                                                   | <ul style="list-style-type: none"> <li>Developing and using models.</li> </ul>                                                                                                                                                                                                                         |
| Meeting 5:<br>Cast Clay Models                         | ETS1.B *         | MS.ETS1-4 *              | <ul style="list-style-type: none"> <li>Systems &amp; System Models</li> </ul>                                                                                                | <ul style="list-style-type: none"> <li>Developing and using models.</li> </ul>                                                                                                                                                                                                                         |
| Meeting 6:<br>Shoe Soles<br>Prototype                  | ETS1.A           | HS.ETS1-1                | <ul style="list-style-type: none"> <li>Influence of Sciences, Engineering, and Technology on Society &amp; the Natural World</li> <li>Structure &amp; Function</li> </ul>    | <ul style="list-style-type: none"> <li>Asking questions and defining problems.</li> <li>Constructing explanations and designing solutions.</li> <li>Developing and using models.</li> </ul>                                                                                                            |
| Meeting 7:<br>Test Prototypes &<br>Invention Extension | ETS1.B           | HS.ETS1-3                | <ul style="list-style-type: none"> <li>Influence of Sciences, Engineering, and Technology on Society &amp; the Natural World</li> <li>Systems &amp; System Models</li> </ul> | <ul style="list-style-type: none"> <li>Constructing explanations and designing solutions.</li> <li>Analyzing and interpreting data.</li> <li>Developing and using models.</li> <li>Planning and carrying out investigations.</li> <li>Obtaining, evaluating, and communicating information.</li> </ul> |

## Breakdown of lessons:

### 1. Invention Introduction

Introduction to invention and JV InvenTeams. Students do warm-up activities and discuss invention. Students play “Four Corners” to help the educator assign diverse teams.

### 2. Biomechanics & Biomimcry

<https://lemelson.mit.edu/resources/curricula>

For more information, contact [info-lemelson@mit.edu](mailto:info-lemelson@mit.edu)

Students learn about biomechanics and how footwear is designed to meet specific needs. Students also learn about biomimicry as a method for brainstorming designs. The educator introduces the main design challenge of the unit and assigns students to small teams. They begin to research the shoe soles of a chosen activity.

### 3. Sketch & Design

Students learn to draw to scale and how to make isometric and orthographic drawings of their shoe soles.

### 4. Sculpt Clay Models

Students finalize a shoe sole design and use modeling clay and tools to make 3D models of the soles. Team members share designs and select one model for casting.

### 5. Cast Clay Models

Students prepare a molding box. Students cast the selected shoe sole model in VytaFlex® 30. In the remaining time, students meet Gihan Amarasiriwardena, a footwear inventor and clothing designer.

### 6. Shoe Sole Prototypes

Students remove the clay model and have a mold of the shoe sole. Students cast their prototype in VytaFlex 30. Students learn about real-world shoe design from a designer at Columbia Sportswear Company. Team members use their toolkit of new skills to brainstorm ideas for an invention using shoe design, biomimicry, and/or the molding process.

### 7. Test Prototypes & Invention Ideas

Students test out their shoe soles and provide feedback to other teams. Students conceptualize a new purposeful invention that uses shoe design, biomimicry, and/or the molding process.

**Materials:** [Link to List](#)

