

Super Lens

Grade level: 6-10

Summary of lesson:

Students will gain both minds-on and hands-on skills in this unit to expand their toolkit. Minds-on skills include looking toward nature for insight into how humans and other species achieve vision. They will learn how to calculate refractive index and focal length. They will also learn about the design process—identifying a problem, brainstorming, researching, “getting into the shoes” of the prospective user, sketching ideas, building, and testing.

Time/Duration:

Each unit is designed to be 90 minutes. Teachers break down the lesson based on schedule minutes and available time. Example: 7th-8th 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
- Optical Calculations
- Materials
- Prototyping

Subject areas/Standards:

Super Lens

Massachusetts Science and Technology/Engineering Standards - Middle School

Meeting	Science Standards	Technology/Engineering Standards	Cross-Cutting Concepts	Practices
Meeting 1: Invention Introduction		6 MS.ETS1-1 6 MS.ETS1-5* 6 MS.ETS1-6 MS.ETS2-2 MS.ETS1-2* 7 MS.ETS1-7 MS.ETS3-4 MS.ETS2-4	- Structure and Function - Systems and System Models - Cause and Effect	- Asking questions and defining problems - Constructing explanations and designing solutions - Engaging in argument from evidence - Obtaining, evaluating, and communicating information
Meeting 2: Light Rays & Lenses	6 MS-PS4-2 6 MS-PS4-1*		- Structure and Function - Patterns - Cause and Effect - Influence of Science, Engineering, and Technology on Society and the Natural World	- Asking questions and defining problems - Planning and carrying out investigations - Analyzing and interpreting data - Using mathematics and computational thinking
Meeting 3: Sketch & Design		6 MS-ETS1-1 6 MS-ETS1-5 6 MS-ETS2-2 MS-ETS2-3 MS.ETS1-2* MS-ETS2-4*	- Structure and Function - Systems and System Models - Influence of Science, Engineering, and Technology on Society and the Natural World	- Asking questions and defining problems - Constructing explanations and designing solutions - Developing and using models
Meeting 4: Test Components	6 MS-PS4-2		- Structure and Function - Patterns - Systems and System Models - Influence of Science, Engineering, and Technology on Society and the Natural World	- Using mathematics and computational thinking - Developing and using models
Meeting 5: Build a Lens		6 MS-ETS2-2 6 MS-ETS2-3 MS-ETS1-6* MS-ETS1-4 MS-ETS1-7 MS-ETS2-4*	- Systems and System Models - Structure and Function - Influence of Science, Engineering, and Technology on Society and the Natural World	- Developing and using models - Constructing explanations and designing solutions - Analyzing and interpreting data
Meeting 6: Taking Digital Photos		6 MS-ETS2-2 MS-ETS2-3 MS-ETS1-4 MS-ETS1-7 MS-ETS2-4	- Systems and System Models - Structure and Function - Influence of Science, Engineering, and Technology on Society and the Natural World	- Developing and using models - Constructing explanations and designing solutions
Meeting 7: Invention Extension		6 MS.ETS1-1 6 MS-ETS2-2	- Influence of Science, Engineering, and Technology on Society and the Natural World - Structure & Function - Systems & System Models	- Asking Questions & Defining Problems - Constructing Explanations & Designing Solutions

* Loosely aligned

Standards alignment conducted by graduate students at Boston College's Lynch School of Education

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Massachusetts Science and Technology/Engineering Standards - High School

Meeting	Science Standards	Technology/Engineering Standards	Cross-Cutting Concepts	Practices
Meeting 1: Invention Introduction		HS-ETS1-3 HS-ETS1-6 HS-ETS2-1	- Structure and Function - Systems and System Models - Cause and Effect	- Asking questions and defining problems - Constructing explanations and designing solutions - Engaging in argument from evidence - Obtaining, evaluating, and communicating information
Meeting 2: Light Rays & Lenses	HS-PS4-1 HS-PS4-5 <i>HS-PS4-3*</i>		- Structure and Function - Patterns - Cause and Effect - Influence of Science, Engineering, and Technology on Society and the Natural World	- Asking questions and defining problems - Planning and carrying out investigations - Analyzing and interpreting data - Using mathematics and computational thinking
Meeting 3: Sketch & Design		HS-ETS1-1 HS-ETS1-2 HS-ETS1-5 HS-ETS2-1 <i>HS-ETS2-4*</i> <i>HS-ETS1-3*</i>	- Structure and Function - Systems and System Models - Influence of Science, Engineering, and Technology on Society and the Natural World	- Asking questions and defining problems - Constructing explanations and designing solutions - Developing and using models
Meeting 4: Test Components	HS-PS4-1 HS-PS4-5		- Structure and Function - Patterns - Systems and System Models - Influence of Science, Engineering, and Technology on Society and the Natural World	- Using mathematics and computational thinking - Developing and using models
Meeting 5: Build a Lens		HS-ETS1-3 HS-ETS1-6 HS-ETS2-1	- Systems and System Models - Structure and Function - Influence of Science, Engineering, and Technology on Society and the Natural World	- Developing and using models - Constructing explanations and designing solutions - Analyzing and interpreting data
Meeting 6: Taking Digital Photos		HS-ETS1-3 HS-ETS1-6 HS-ETS2-1	- Systems and System Models - Structure and Function - Influence of Science, Engineering, and Technology on Society and the Natural World	- Developing and using models - Constructing explanations and designing solutions
Meeting 7: Invention Extension		HS-ETS1-1 HS-ETS1-2 HS-ETS2-1	- Influence of Science, Engineering, and Technology on Society and the Natural World - Structure & Function - Systems & System Models	- Asking Questions & Defining Problems - Constructing Explanations & Designing Solutions

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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. Light Rays & Lenses

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

For more information, contact info-lemelson@mit.edu

Students take apart a smartphone phone to examine its camera, including the optics and the image sensor. They learn how others are improving smartphone lenses, drawing inspiration from human and animal vision. Students learn to calculate the refractive index of a lens material.

3. Sketch & Design

Students shine light beams through various lenses to learn how light bends. The educator introduces the main design challenge of the unit. Student teams begin researching various users of cameras and lenses. Students learn to cut cardboard safely.

4. Test Components

Team members calculate focal lengths of various lenses. Based on calculations, they will find a lens that suits their chosen design.

5. Build a Lens

Students learn to create a prototype. Team members build a lens prototype out of glass lenses and cardboard. They test for focus and brightness.

6. Take Digital Photos

Students capture images on their prototype lenses using a smartphone, evaluating properties such as optical zoom and angle of view. Students learn about real-world invention from an engineer of low-cost optometry equipment, energy turbines, and robots. Team members use their toolkit of new skills to brainstorm ideas for inventions using lens design, optical concepts, and the prototyping process.

7. Invention Extension

Students display their images in printed form and provide feedback to other teams. Students conceptualize a new purposeful invention that uses lens design, optical principles, and the prototyping process.

Materials:

Download the list of materials and tools used in this guide.

