

Inside the Sensor: How Physics Powers Blood Oxygen Monitoring

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for the STEM Education Center at WPI's Summer 2023 Research Experience for Teachers program

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Subject: Physics

Grade Level: High School

United Nations Sustainable Development Goal 3: Good Health and Well-Being

Overview

Students are introduced to the importance of blood oxygen testing. Students will learn about how the COVID-19 crisis affected hospitals and highlight the importance of newly updated biomedical devices. They will also be introduced to the current need for widely translated informative posters in hospitals and will create a poster that can be placed on a hospital room wall that explains how Transcutaneous Blood Oxygen Sensors work.

Standards & Learning Targets

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*

Clarification Statements:

Emphasis is on qualitative information and descriptions. Examples of technological devices could include solar cells capturing light and converting it to electricity, medical imaging, and communications technology. Examples of principles of wave behavior and wave interactions with matter include resonance, photoelectric effect, refraction, and constructive and destructive interference.

State Assessment Boundary: Band theory is not expected in state assessment.

Vocabulary	Tier 1 - Everyday	Tier 2 - School	Tier 3 - Classroom
	Wave Period Frequency Amplitude	Mechanical wave Transverse wave Longitudinal wave	Wave Pulse Crest Troughs Simple Harmonic Motion
What do students need to KNOW ?	<ol style="list-style-type: none"> Differentiate between mechanical and electromagnetic waves in terms of speed, types of wave motion, and whether they have the ability to travel through a vacuum. Recognize that the frequency of a light wave determines its color (if visible) and position in the electromagnetic spectrum. Differentiate between transverse and longitudinal wave motion. Understand what a wave is 		



What do students need to DO ?	<ol style="list-style-type: none"> 1. Describe the measurable properties of waves (Velocity, frequency, wavelength, amplitude, and period) and explain the relationships among them. 2. Identify examples of simple harmonic motion 3. Distinguish between the two types of mechanical waves, transverse and longitudinal. 4. Use the formulas $v = \lambda f$, and $T = 1/f$ to determine the relationship of velocity, period, and frequency in a wave. 5. Communicate how technological devices use wave behavior and interactions with matter to transmit and capture information and energy.
What will students CREATE ?	<ol style="list-style-type: none"> 1. Students will design and create a medical poster that can be placed on a hospital room wall on how a Transcutaneous Blood Oxygen Sensor work.

ELA Standard: Grades 11–12 Reading Standards for Literacy in the Content Areas: Science and Career and Technical Subjects [RCA-ST]

Craft and Structure

4. Determine the meaning of general academic vocabulary as well as symbols, notation, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

Integration of Knowledge and Ideas

7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

Vocabulary	Tier 1 - Everyday	Tier 2 - School	Tier 3 - Classroom
	Long Numbers Meeting Drawing Organize	Units Assignment Poster Assignment	Scientific Notation Engineering Report Visual Report Engineering Notebook
What do students need to KNOW ?	<ol style="list-style-type: none"> 1. Know the meaning of general academic vocabulary as well as symbols, notation, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics. 2. Comprehend multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. 		
What do students need to DO ?	<ol style="list-style-type: none"> 1. Interpret the electromagnetic spectrum by using scientific notation 2. Organize findings into concise notes 3. Interpret information from various sources of the internet 		
What will students CREATE ?	<ol style="list-style-type: none"> 1. Students will design and create a medical poster that can be placed on a hospital room wall on how the Transcutaneous Blood Oxygen Sensor works 		



Prior Knowledge

Students should know the parts of a wave and be introduced to The Electromagnetic Spectrum before they engage in this lesson. Although this background knowledge is recommended for the learner, it is not necessary.

Materials/Resources

- Electronic Projector
- Whiteboard
- Poster Board
- Markers
- Pencils
- Blood Oxygen Sensor

Timeline of Activities

Duration	Activity	Instructions	Product
15 Minutes	They Do	<p>Review of this Week: Students will be asked what they think What do Physics majors Do?</p> <p>They then will place their sticky notes on the category that most fit their response.</p> <p>Students would have completed the Career In Physics Survey for homework</p> <p>Hold a discussion on the results of the survey and the salary of a Physics Undergraduate Major</p>	Students will enter class and begin working on Do Now
20 Minutes	I Do	<p>How Does It Work?: Students will summarize the research by creating a Medical Poster Project on how the sensor works.</p>	Students will work on these questions individually
15 Minutes	They Do	<p>Guest Speaker: A Guest Speaker will visit the class and share their role in STEM research</p>	Students will work on these questions individually
5 Minutes	They Do	<p>Students will interact with the Speaker: Students prepare questions for the speaker beforehand on a shared classroom document. After the speaker goes over their presentation, the teacher will lead a group Q&A using the document as a guide.</p>	Students will work on these questions individually



Attending to Equity - Teaching Strategies

Strategy	Explain how the strategy contributes/relates to the lesson/activity
Get to know your student interests and regularly use those interests in problems/highlight when you use those interests in problems	Students are allowed to complete the poster using various software including Canva and Google Slides in addition to paper only. In addition to this students are able to change the device they make the poster on depending on their interests.
Give students tools to check and correct their own work	Students are able to do their own research on the internet on the device that they are doing their presentation about
Help students interrupt negative self-talk	There is a slide on the Research Slides that opens up a discussion on common negative self-talk and how to combat it
Share pieces about your life	There is a portion of the slideshow where I share more about my background in STEM and encourage students to do the same.

Career Connections

There are multiple parts of the lesson that I connect to STEM careers. At the beginning of the lesson, I have students read about different careers one can pursue with a degree in Physics. This allows them to reflect on the wide array of career opportunities available. I also invited a professor who leads research at WPI to the classroom. This visitor provides students with a real-life example of a career in STEM and research.

Assessment

Students will summarize their research by creating a hospital poster on how the sensor works.

Link to Assignment: [Medical Poster Project](#)

Link to Rubric: [Inside the Sensor: How Physics Powers Blood Oxygen Rubric](#)

