SOCIETY OF PHYSICS STUDENTS
An organization of the American Institute of Physics

NIST Summer Institute
for Middle School Science Teachers

Get Ready to SOCK!

Hannah Pell
Shauna LeFebvre

Meet the SOCK Interns

Hannah Pell

- Lebanon Valley College ’16
- B.S. Physics
- B.A. Music – Oboe Performance and Theory
- Hometown: Hershey, PA

Shauna LeFebvre

- Union College ‘16
- B.S. Physics
- Mathematics and Ancient Greek Minors
- Hometown: Cheshire, MA

SOCK Background

Science

Outreach

Catalyst

Kit

- Started in 2001 by Gary White
- Created annually
- Contains materials and lessons for outreach
  - Use it for visiting classrooms, STEM fairs, etc.
- Given to 25 SPS chapters for their outreach efforts
- Manual is available online

Our Process

- What did we look for?
  - Reliability
  - Versatility
  - Inexpensive
  - Simplicity

2015 SOCK

- **Theme:** Sound Waves and Acoustics
- Main Activities, Demonstrations, and Lessons
  - **Introduction to Sound Waves:**
    - Visualizing Waves
    - Fun with Tuning Forks
    - Speed of Sound Lab
  - **Strings:**
    - The Physics of the Acoustic Guitar
  - **Winds:**
    - Straw Pan Pipes
  - **Percussion:**
    - Boomwhackers!
  - **Vocals**
    - Sound at a Distance
    - Doppler Effect

Demonstrations: *Fun with Tuning Forks*

All ages
Estimated Time: 10 minutes (per demo)

Motivation:
- To reinforce the idea that music and physics are related through sound

Objectives:
- Students will explore the concepts of resonance and interference using tuning forks
- Students will understand that oscillations and vibrations are the source of sound waves

Materials:
- Set of 13 Tuning Forks
- Rubber Mallet
- Smallest Boomwhacker©
- 8-Ohm Mini Speaker (not included)
- Cup of Water (not included)
- Oscilloscope (not included)

Sinusoidal Motion of Tuning Fork

Vocabulary:
- Tuning fork, oscillations, vibrations, resonance, interference, sinusoidal motion, harmonic, fundamental, overtones

Introduction: Physics with Tuning Forks!
Tuning forks are most commonly known for their musical use: tuning an instrument. But what can their behavior teach us about the physics of sound? In this series of demonstrations, students will understand that the nature of a sound wave is due to vibrations and oscillations, the concepts of resonance and interference, and visually see the sinusoidal motion of a tuning fork when struck.

Demonstration One: ***Is it really doing anything?***
Note – When striking a tuning fork, use a soft surface, such as a rubber mallet or the sole of your shoe. Do not strike the tuning fork on a hard surface. Tuning forks are a laboratory instrument and this demonstration will allow the students to get used the handling them properly.

- When a tuning fork is struck, it begins to oscillate back and forth. These oscillations serve as the source for the sound wave that is produced.

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Motivation

Objectives

Materials

Vocabulary

Introduction

Demonstration

New Manual Content!

Contents Summary

Title: "Visualizing Waves"

- **Suggested Outreach:** Any
- **Type:** Demonstration
- **Motivation:** To serve as an introductory visualization of the properties of waves and their behavior
- **Summary:** "Visualizing Waves" provides a visual exploration of different types of waves, their properties, and general characteristics using a Slinky. Best if used for starting or reviewing a lesson on waves in any kind of outreach setting.

- Suggested Outreach
- Type
- Motivation
- Summary

Outreach Reflections: *Elementary School*

Hannah: "Kids love science; even saying the word physics grabs their attention. But more importantly, kids love **interactive** science. Given the task of teaching physics to nearly 120 third-graders (a group of 48 and group of 66), we decided to divide and conquer. Shauna and I planned three stations exploring different concepts in our musical SOCK: sound at a distance, percussion and wind instruments, and tuning forks. It was a win-win situation: the students were allowed the opportunity for more interaction while we could test more of our SOCK ideas. Thanks to the help of our fellow ACP interns, we introduced basic acoustics to nearly 120 third-graders, and it was exactly as awesome as it sounds. When working with younger students, I would suggest that your presentation alludes to **more questions and conversation** than anything. Avoid the quantitative stuff; kids are intuitive and visual learners. They like hands-on science. I would also advise having **extra staff and support available** to help manage the kids. Keep things light, and be sure to get the kids talking. Allow the outreach event to serve as an opportunity for the kids to **discuss their observations** and **ask questions**. Any of the demos in the SOCK can be used for elementary school when approached in this way."

Shauna: "If you can get enough volunteers, stations are great if you are presenting to a large group of students. Stations allow you to present more **hands-on activities** to smaller sub-groups and make it easier to have more activities in a short amount of time. Presenting material in this way does prevent you from going as in-depth as you would like for older students, though, so I find that this presentation works best with elementary-aged students. The most effective way to present in stations is to make sure that the **activity at each station feeds into the next**. It's easier for students to understand what you're teaching them if they can apply what they are learning at one station to the next station. There will be multiple volunteers from your chapter presenting, the students will be asking questions and interacting, and their teachers will be talking to their students. On top of that, most of the activities from this year's SOCK make their own noise. Make sure everyone is paying attention as you explain everything so you don't have go through an activity multiple times."

Thank you to Tuckahoe Elementary School, Theresa Coffman, and all of the third-grade staff!

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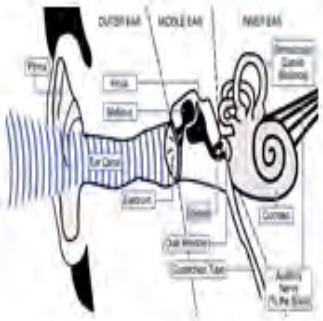
Outreach Reflections

New Manual Content!

Did You Know? Mechanics of the Eardrum



Sound waves enter the ear canal and vibrate the ear drum. Our hearing range is limited by the length of the ear canal, which is roughly 2.5 cm. The frequencies allowed in a tube with one closed end are $f_n = n \cdot \frac{v}{4 \cdot L}$. Human ears are most sensitive to sound frequencies around 2000-8000 Hz. Only 0.12% of the sound wave is transmitted by the ear drum because it transitions from travelling through air to travelling through muscle. The bones amplify the sound that does get through and then vibrate a membrane called the oval window, which then vibrates the liquid-filled cochlea tube. Since muscle and water are similar, 99% of the sound wave is transmitted from the oval window to the cochlea. The basilar membrane is vibrated, which excites fine hair sensors in our ears. Depending on the location of the sensors that get excited, a signal is sent to the brain which identifies the sound.

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Did You Know?

More Fun Things to Explore!

- *Ultrasound and Sonography*
  - **Ultrasound** is an oscillating pressure wave with a frequency greater than the upper limit of the human hearing range; this is usually around 20 kHz, but can vary from person to person.
  - Ultrasonic devices are used in many different fields to detect objects and measure distances. Ultrasonic imaging (or sonography) is used in both veterinary medicine and human medicine. It is safe and painless procedure, and produces pictures of the inside of the body using sound waves.
  - *For more info:*
    - http://www.radiologyinfo.org/en/info.cfm?pg=genus
    - http://www.livescience.com/38426-ultrasound.html
- *Acoustic Levitation*
  - **Acoustic Levitation** is a method for suspending matter by sending intense sound waves through the medium, sometimes on the order of ultrasonic frequencies. Acoustic levitation has progressed from motionless levitation to controllably moving hovering objects, which has many uses in the pharmaceutical and electronics industries.

  - *For more info:*
    - https://www.youtube.com/watch?v=669AcEBpdsY
    - http://www.aip.org/publishing/journal-highlights/acoustic-levitation-made-simple
- *Sonic Boom*
  - A **sonic boom** is attained when an object travels through air faster than the speed of sound. As an aircraft passes through air, it creates pressure waves surrounding it. As the aircraft speeds up, the pressure waves become more closely compacted, eventually merging into one: the sonic boom. Sonic booms generate enormous amounts of sound energy, sounding much like an explosion. The ratio between the velocities of the sound wave to the object travelling is given by the *Mach number*.

  - *For more info:*
    - http://science.howstuffworks.com/question73.htm
- *Useful Phone Apps (free unless noted otherwise)*

Apple	Both	Android
Sonar Ruler® ($.99) Science Learning Hub®	NoiseTube® iSeismometer®	Acoustic Frequencies®

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More Fun Things to Explore!

Demonstrations

Why is Outreach so Important?

- **Good for the Public**
  - Makes science fun
  - Promotes curiosity, the desire to learn, and science literacy
  - Gives teachers resources for their classrooms
- **Good for the SPS Chapters**
  - Helps SPS members network and make connections
  - SPS members gain teaching skills
  - Opens up leadership opportunities

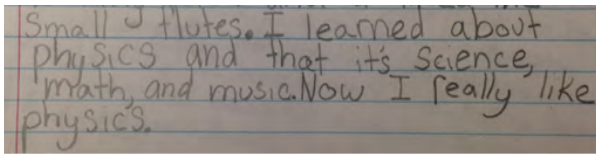
Outreach Events

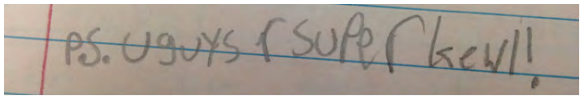
- **HOCO STEM Festival**
  - Location: Howard County Community College
  - 2014 SOCK “Light: A Spectrum of Utility”
  - Polarization, diffraction, and fluorescence

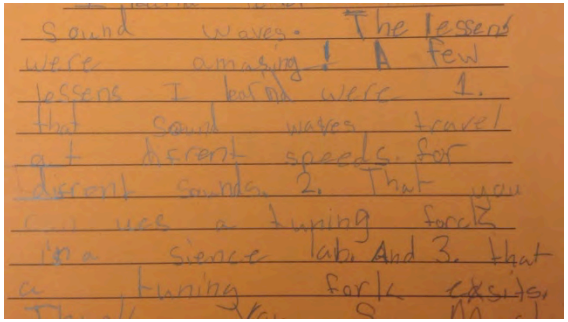
- **Yorktown High School**
  - Location: Arlington, VA
  - Four junior-level honors physics classes
  - Lesson in student engagement

Outreach Events cont.

- **Tuckahoe Elementary School**
  - Location: Arlington, VA
  - **Stations**
    - Fun with Tuning Forks!
    - Acoustics of Musical Instruments
      - Boomwhackers and Mini Pan Pipes
    - Sound at a Distance
      - String and Cup Telephones







- **UMD Girls Physics Camp**
  - Location: University of Maryland, College Park, MD
  - 24 girls with interest in physics
  - Pan Pipes for Middle School

National Institute of Standards and Technology

- Non-regulatory agency within the U.S. Department of Commerce
- Provides standards for industry
- User facilities

NIST Summer Institute
for Middle School Science Teachers

NIST Summer Institute for Middle School Teachers

- 21 teachers from all over the nation
- Presenters from NIST and other organizations
- Connects teachers with scientists

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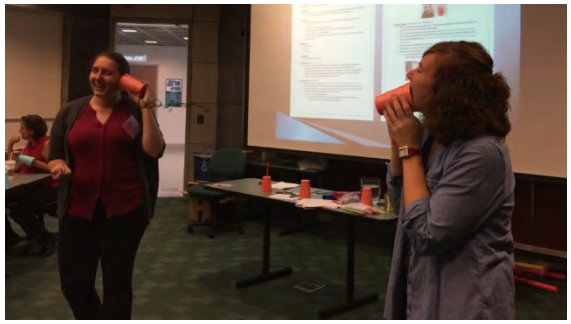
My Role at the Summer Institute

- Set up the activities
- Help out during the activities
- Present the SOCK to the teachers

Conclusion



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