THE KENNEDY CENTER

Connections:
MORE Science and Music

Thursday, March 4
11a.m.–12 p.m. ET
Grades 5–7

Curriculum Connections: Science
National Standards for Music: 6, 7, 8, 9

Photo by Carol Pratt.

About the Program

In this program National Symphony Orchestra members Yvonne Caruthers (cello), Natasha Bogachek (violin), and Stephen Dumaine (tuba) explore the connections between science and music. They identify real-life examples of concepts learned in science class and explain how musicians can perform better thanks to the discoveries and understandings of science.

What You'll Hear

- "Freq-y Wave" by Lynda Williams
- *Zigeunerweisen* (excerpt) by Pablo de Sarasate
- Etude No. 34 for Solo Violin by Rodoplhe Kreutzer
- Caprice No. 1 for Solo Cello by Alfredo Piatti
- Etude No. 8 for Solo Tuba by Phil Snedecor
- *Ziganotchka*, a traditional Ukrainian folk song

The Sounds of Science

Sound Waves

What is sound, anyway? Thanks to science, we know sound happens when an object vibrates (moves back and forth quickly). For example, when your finger plucks a string, the string vibrates and disturbs the air around it, making an invisible sound wave. You hear the sound when the wave travels through the air to your ear.

Different sounds have different wavelengths. A wavelength is the distance between the high point of one wave to the high point of the next wave. The number of high points per second is called the frequency. If many sound waves pass in one second, the frequency is high. If only a few sound waves pass in the same second, the frequency is low.

In music, we hear what happens at different frequencies. The pitch of a note—how high or low it sounds—depends on the frequency of the sound waves. The higher the frequency, the higher the pitch; the lower the frequency, the lower the pitch.

During the Program . . .

- Discover which has a greater range — light or sound;
- Learn the special technique of "buzzing";
- Learn about a surprising substitute for ivory;
- Listen carefully to see how fast the performers can play;
- See how long Stephen can play a note on the tuba.

Ahhh or Ouch?

Sound also varies by how loud or soft it is. Scientists measure that intensity in decibels, or dB. From studying the human ear, they can tell us how loud is *too* loud. When you speak in a normal voice to a friend, it is about 60 dBs. Sitting in the front row of a rock concert, you're likely hearing 110 dB, something that could hurt your hearing if you did it often. And hold it right there, because sound at 160 dBs (too loud!) could cause permanent damage to your ear.

Musicians must be extra careful, particularly if they are exposed to loud music on a regular basis. To protect their hearing, some even wear earplugs while they are performing.

The Construction of Instruments

String Instruments

String instruments like the violin and the cello are usually constructed of wood, with strings made of synthetic (man-made) materials and metal. The strings vibrate when they are plucked or when the musician draws a bow across a string. The bows are usually made of wood and horsehair. Old bows were often decorated with ivory.

A vibrating string does not produce much sound. The instrument's hollow body creates a resonating chamber that amplifies (enlarges) the sound waves of the vibrating strings.

Photo by Carol Pratt.

Brass Instruments

Instruments like the tuba are normally made from brass, a yellowish metal. To make a sound on a brass instrument, musicians "buzz" their lips against the instrument's mouthpiece.

Greener Instruments

Efforts to protect endangered or threatened species affect musicians. Take for example, the materials used to make bows. First, the tips of older bows feature ivory, a material banned to protect endangered African elephants. Second, deforestation (the widespread clearing of trees) has made the preferred wood—called pernambuco—for bows scarcer. Some bow makers have substituted carbon fiber, a synthetic material (thank you, chemistry!) twice as strong as steel. And some instrument makers discovered carbon fiber makes great instruments, too.

Instructional Activities

Experiment

Test your own resonating chamber. Take a rubber band and a small plastic water bottle with a cap. First, fill the bottle with water and close the cap. Stretch the band around the bottle and pluck the band with your finger. Then remove the cap, empty the water, and reattach the cap. Pluck the band again. Is the sound different? If so, how? What does your experiment tell you about resonating chambers?

Research

Musicians must teach their muscles to hold and play their instruments. And just like a runner training for a race, musicians must practice hard to train their arms, hands, and fingers—and even their lips and tongues—to play better and faster. Choose an instrument and find exercises that would help a musician play it. Share your findings with the class.

Resources

BTW
International Noise Awareness Day is April 28, 2010

Internet Resources:

Kennedy Center NSO Education:
https://www.kennedy-center.org/nso/nsoed/onlineresources.html

Yvonne Caruthers' Web Site: www.yvonnecaruthers.com

NSO Ensemble—Science and Music Cuesheet 2005-2006:
http://www.kennedy-center.org/education/cuesheets/single_cuesheet.cfm?asset_id=59311

Federal Resources for Educational Excellence—Physical Sciences:
http://www.free.ed.gov/subjects.cfm?subject_id=58&toplvl=56

Print Resources

Richard, Jon. *Sound and Music (Science Factory)*. Mankato, MN: Stargazer Books, 2004.

Macaulay, David. *The New Way Things Work*. Boston: Houghton Mifflin, 1998

Wood, Robert W. *Sound Fundamentals: Funtastic Science Activities for Kids*. Philadelphia, PA: Chelsea House, 1998.