

PHYSICS CONNECTIONS

Lesson 1: The Physics Of Music

Vocal music is an excellent way to illustrate aspects of the laws of physics and also help us gain insight into why humans respond to music. In the last Unit of Study we explored the aspects of the upper respiratory system to produce sound. This unit will examine the science of making music.

Vocabulary:

Vibration: is caused by an exciting force of energy. This starts the repetitive motion of an object.

Frequency: the rate of energy that makes things vibrate. Everything has a frequency, so everything moves.

Pitch: the effect of raising or lowering the speed of vibration.

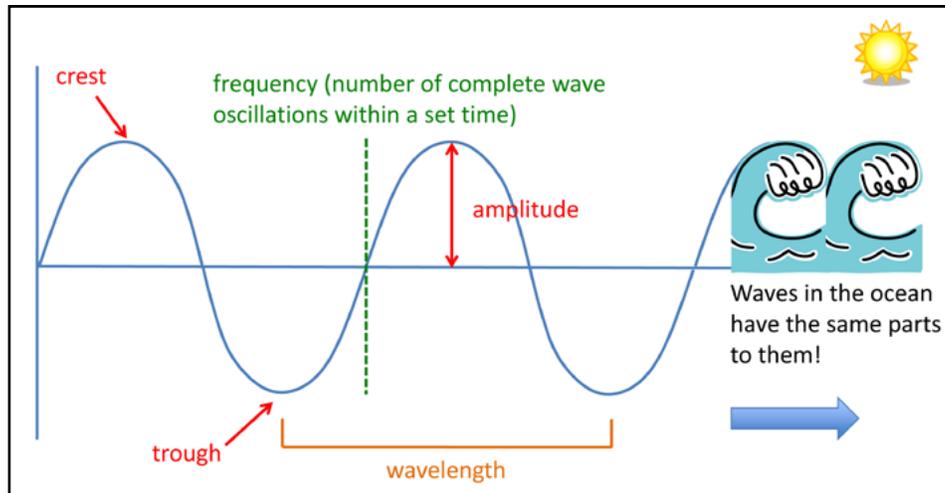
Chest voice: the lower part of the voice.

Head voice: the mid to higher part of the voice.

Sound waves: the length of vibrations that occur when sound passes through something: air, water, earth and humans.

Big Idea:

When the voice **vibrates** it moves air particles; the particles hit other particles and they also start to vibrate. This action creates **sound waves**. The vibration continues until the energy stops. The faster the vibration, the higher the **pitch**, because the particles are hitting each other very quickly creating a higher **frequency** of sound waves! The slower the vibration, the lower the pitch, because the particles are hitting each other very slowly creating a lower frequency of sound waves. Sound is energy activated by vibration.



Two basic physics equations that describe waves:

1) $E = hf$

Where:

E = energy

h = planck's constant ($6.62606957 \times 10^{-34}$ Joule-seconds;
represents the constant proportionality between energy
of a photon and the frequency of its wave.)

f = frequency

2) $\lambda = v/f$

Where:

λ = wavelength

v = velocity (of wave)

f = frequency

Lesson:

Not all sound is at the same pitch. Why is the sound coming from the **chest voice** lower than sound coming from the **head voice**? The vibrations from the chest voice have more room to vibrate so they are lower. When vibrations go into the head, there is less room so the pitch goes up!

Try This!

Stretch the flat side of a rubber band between your fingers and blow directly on it to make it vibrate. As you stretch the rubber band tighter, the pitch goes up, relax it a little and the pitch goes down. Relax it completely and the sound stops.

The amount of air coming from your lungs is fairly constant so the vibration happens when the band is stretched tighter. The same thing happens with the vocal cords; as sound is produced the cords begin to vibrate. As pitch goes up the cords stretch more tightly. There is less surface where the air and rubber band meet. The tension on the rubber band makes it tighter and faster, for a higher pitch.

Let's see how it works inside the singer's body. Phonate in the lowest register of the voice for a lower pitch and feel how many different places in your body begin to vibrate. As long as you keep the air moving, the vibration (repetitive motion) will continue. Draw your attention to how many places you feel vibration in your chest and back. Now phonate again in the higher register of your voice. The vibration goes into your face and particularly to your nose. As your voice goes up in pitch the frequency of the vibration is faster. Your chest area has more space for sound so the pitch is lower, as the vocal cords stretch tighter into a smaller part of your body, the frequency of the sound becomes faster and the pitch goes up as well.

Wrap up:

We have explored the physics of making sound, next let's turn up the volume and check out the notion of intensity and its relationship to physics and the human voice!