

Inquiry Approaches

Initial Inquiry

What is electric current?

Current is a measure of the rate at which charge moves from one point to another; it is often described as the "flow of electrons". This is because an electron is the elementary negative charge.

What is a magnet?

A magnet is a material that produces a magnetic field. Magnets have a north and a south pole.

What causes sound?

A vibrating source creates a disturbance in the air particles that surround it. This disturbance then becomes a new vibrating source. The new source creates another disturbance, which eventually propagates from the original source to the listener's ears and causes his/her ear drums to vibrate.

What are the components of a speaker?

Speakers typically require a power supply, a source of audio input, a circuit board that will process and amplify the input signal, a coil of conducting wire, a magnet and a vibrating membrane.

Experimental Procedure Inquiry

What is an analogue signal?

In the context of this activity, an analogue signal is a voltage whose magnitude and polarity changes as time progresses.

Where does the analogue signal in this activity come from?

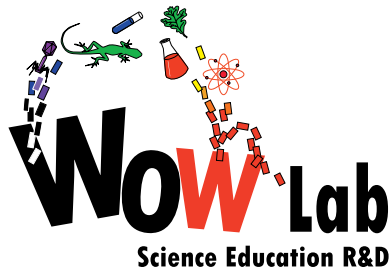
The music file stored on the computer hard drive is read and processed by several components of the computer in order to create a voltage that varies with time at the audio output port. This voltage is used to create a current in the solenoid.

How is the analogue signal at the computer's audio output converted to sound?

When the solenoid is connected to the audio output, a voltage is applied across the coil of wire creating a current. The current creates a magnetic field, effectively turning the solenoid into a bar magnet. The strength and polarity of this "simulated" magnet changes according to the signal voltage. Since the solenoid is placed over another magnet that is fixed in place, the solenoid will repeatedly move away and then towards the fixed magnet. This is how the plate, which is attached to the solenoid, vibrates. The frequency of this vibration is the frequency at which the signal voltage changes polarities. The amplitude of vibration changes as the magnitude of the voltage changes.

What happens to the magnetic field of the solenoid if the current in the wire is reversed?

The direction of the magnetic field is also reversed. Since the direction of the field corresponds to the north and south poles, reversing the current effectively reverses the poles.



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Styrofoam Plate Speaker - Inquiry Approaches

What happens to the magnetic field of the solenoid if the current is increased?

The strength of the field is also increased. Since the solenoid is effectively a bar magnet, increasing the current creates a stronger magnet. Its forces of attraction/repulsion will be stronger as well.

All speakers have a circuit board that contains an amplifier, among other things. What is being amplified and why is amplification necessary?

An amplifier amplifies the signal received at its input. In this activity, the signal is a time-varying voltage. Therefore, the speaker amplifiers amplify voltage. This is necessary because electronic engineers purposely make the voltage at the audio output port very small for safety reasons. Connecting the solenoid directly to the audio output will create a very small current in the coil and the amplitude of vibration will also be small. As a result, the ear will perceive a very quiet, essentially inaudible sound.

In-Depth Inquiry

What is a solenoid?

A solenoid is a cylindrical coil of conducting wire. When current flows through this coil, the magnetic field produced inside and around the solenoid is identical to that of a bar magnet. By convention, the field is said to flow out of the north pole and into the south pole.

What is the relationship between frequency and pitch?

In the context of sound, frequency counts the number of vibrations per second; its unit is Hertz (Hz). Sound at different frequencies is perceived differently by the human ear. Pitch represents how the ear perceives different frequencies. Low frequencies are perceived at low pitch while high frequencies are perceived at high pitch.

What is the relationship between amplitude and loudness?

When an object vibrates, the amplitude of the vibration is the maximum displacement of the object from its origin. The human ear is able to perceive amplitude. The loudness represents how the ear perceives different amplitudes. Small amplitudes are perceived as a quiet sound and large amplitudes are perceived as a loud sound.

How are magnetic fields and currents related?

A current produces a magnetic field around its conducting path. For example, a straight wire carrying a current will have a circular magnetic field around it. Furthermore, the current is directly proportional to the size (or strength) of the magnetic field. The direction of the current is also related to the direction of the magnetic field. If one looks straight down a wire and the current is moving towards the observer, then the magnetic field circulates in a counter clockwise direction around the wire. If the direction of the current is reversed, the magnetic field circulates in the clockwise direction. This phenomenon is described by Ampere's Law.

What causes current to flow in a wire?

Current is the movement of electrons. If a voltage is applied across a conducting wire, one end of the wire will have higher electric potential than the other. Electrons will move toward regions of lower potential. By analogy, a mass at a height will have higher gravitational potential than a mass on the ground. The mass at the height will move towards the region of lower gravitational potential. Therefore, an applied voltage causes current. Large voltages cause large currents.