

Comparing The Difference In Sound Inputs

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Introduction

The main aim of this experiment is to compare the difference in sound inputs. Sound is to be input to a speaker, and the sound produced by the speaker is detected by a microphone. The sounds injected into the speaker and those detected by the microphone are to be compared. An oscilloscope is to be used to measure the levels of the two and compare them. A tube is used to confine the sound waves that travel from the speaker to the microphone.

The tube here acts like a container with air particles in it. The air particles are made to vibrate by the sound, producing regions of compressions and rarefactions as shown below:

These regions enable the sound to propagate from one end of the tube to another. This phenomenon is called air resonance [1]. Another good example of air resonance is when one blows air into an empty bottle with one of its ends closed. When one blows air into the mouth of the bottle, a pressure wave is set just at the top of the mouth. The pressure wave enables air particles present to vibrate uniformly, hence producing a sound. If one blows harder, the sound becomes louder. However, the frequency of sound produced only depends on the size of the container and its shape.

Historically, the acoustic resonator was created in the 1850s using the air resonance principle. Herman Helmholtz, a scientist from Germany, what is currently considered a powerful scientific instrument. The acoustic resonator uses the principle of using pressure to move air. However, instead of producing sound, this instrument detects it. The design by the scientists was such that it was able to detect a specific frequency as desired by the one operating it. The sound on that frequency could then be amplified greatly. Another important feature of the instrument was that it was able to extend the time period of a tone that had been produced by a sound source so that it could be heard for longer if the frequency was detectable by the ear.

The concepts above form part of a wide range of other concepts known as Acoustics. This field has enabled the building of spherical resonators that can be used in various applications. One such application is for the modeling of the hydrogen atom. Hydrogen is considered the most basic atom, and if modeled and studied through experiments, it can be used to predict the behaviors of other elements. This is because it contains all the basic parts of an atom, which are the electron, proton, and neutrons. The study of the hydrogen atom has led to the discovery of nuclear power. Splitting an atom causes the release of a vast amount of energy, whereas combining atoms needs a lot of energy [3]. Since it is difficult to split a hydrogen atom physically in a normal lab, it is easier to model an atom using a resonator and split the resonator.

It should be noted that both the wave function and wave sound of the electron give the solutions of the wave equation to describe a delocalized object (Lloyd, 1996). However, the aspect that is described is different.

There is also a software program that uses quantum analog apparatus to measure spectra. The program is based on the sound card. It helps in measuring spectra in all amplitude and resonators in the “molecule” and the “atom” (*Experimentalphysik II – Oberflächenphysik: SpectrumSLC*, 2018).

Theory

As noted, resonance only occurs whenever one manages to develop a standing wave inside a closed tube. A standing wave is formed when two waves of similar frequency travel in opposite directions and interfere both constructively and destructively. Within a closed tube, the sound wave sent inside is reflected back by the closed end, and hence, the wave is the same, which means it has the same frequency. However, other conditions have to be satisfied. One of them is that the length of the tube has to be an integer factor of the wavelength of the sound wave. This means that;

Where f is frequency and $n = 1, 2, 3, 4, \dots$ L is the length of the tube. This way, the reflected wave will interfere with the incident one to form nodes and antinodes, as shown below:

At the nodes, the two waves completely interfere destructively, whereas, at the antinode, they interfere constructively. A standing wave is called that way because it is stationary. As noted above, the incident wave should start exactly at the opening of the tube. Another thing to note is that the diameter of the opening matters a lot. The smaller, the better.

The wave equation can be modeled and used to describe a standing wave. A one-dimensional wave equation can be sufficient. The equation below shows the one-dimensional wave equation.

If this equation is solved, one can effectively determine how the disturbance or air particles propagate outwards from their original positions outwards. The propagation occurs at a fixed speed but is possible in all directions in space. However, the one-dimensional wave equation only considers a specific direction. A three-dimensional wave equation was formulated by Euler 10 years after the formation of the one-dimensional equation. Euler figured out a way to solve for all wave parameters in all spatial directions.

Most people are in a position to manipulate concrete solutions instead of just equations, encouraging explorations and, at the same, enhancing conceptual understanding. The experiment manipulates equations that affect the location changes of a semiconductor (Wertz, 2012). Having the capacity to differ the area or state of a physical object and look at the band-gap changes encourages a more extensive scope of experimentation and may even prompt a sort of “instinct” that is normally accessible just to those for whom conditions have their very own existence.

Experimental Method

Experiment 1: Standing sound Waves in a Tube

Tube pieces are connected to add to the length of the tube. Each time a tube piece is added, the speaker and microphone are put at each end, and the readings on the oscilloscope are taken. The frequency of the sound is varied at the speaker for a wide range, starting from a low frequency of 100 Hz. It is expected that the readings are not the same due to the change in the length of the tube and the frequency of the sound. Each length has a different resonance frequency. The resonance frequency for a certain length would not be the same for another length of the tube. As the frequency is increased, the wavelength of the wave changes (decreases). To tell that resonance has been reached, the amplitude of the sound wave, as shown by the oscilloscope, should be zero, showing that destructive interference has occurred.

Experiment 2: Modeling a hydrogen atom with a spherical resonator

The equipment has been set up in a manner that allows us to use the spherical resonators that represent hydrogen atoms to determine resonance frequencies [2]. Data about the angular momentum quantum numbers of the resonators can be found, too. We do this by starting from a low frequency of around 100 Hz, which is increased step by step to 8 kHz. The change in amplitude is then observed, as is the change in sign. From this, we can determine the angles where the amplitude is observed to be zero and those where the amplitude is maximum.

Experiment 3: Broken Symmetry in the Spherical Resonator and Modeling a Molecule

This experiment tries to examine the impact of the splitting of quantum states. The spherical cavity of the modeled molecule will be split symmetrically, and the results will be studied.

References

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