Sound Waves and the Doppler Effect

Introduction

The Doppler effect is the change in frequency of a wave for an observer moving relative to its source. It is commonly heard when a vehicle sounding a siren or horn approaches, passes, and moves away from an observer. The received frequency is higher during the approach, it is identical at the instant of passing by, and it is lower while it moves away.

Aim

Draw pictures of high and low-frequency wave fronts.
Explain why the pitch of a car horn changes as it approaches and then drives past an object
Explain the Doppler effect, with diagrams, and give examples of where it can be heard.

Vocabulary

Include these terms in your written responses
Pitch – How low or high a tone sounds to a person. Sound waves move closer together as pitch increases, therefore so does the frequency and hertz measurement.

Frequency – Wiggles per second (sound waves move back and forth). Measured in Hertz (Hz). High frequency sounds are perceived as 'high pitched' sounds.

Amplitude - How loud or quiet a sound is received by a person. It is a measurement of how forceful a sound wave is in air pressure and is recorded in decibels dBA. A normal conversation voice is approximately 65 decibels.

Doppler Effect – As the source of a wave (sound or light) approaches an observer, the observer sees/hears a higher frequency than the source actually is emitting. As the source moves away from an observer, the observer sees/hears a lower frequency wave than the source actually is emitting.

Materials

- Tuning Fork (with a string tied to the handle)
- Internet connection
-PhET simulation website
-YouTube

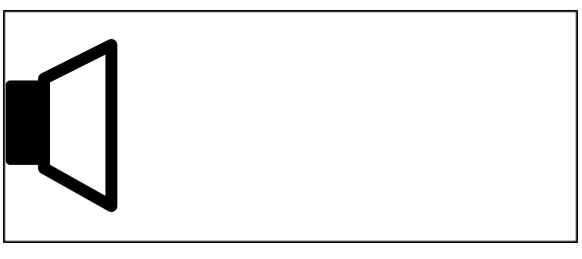
Experiment One

Go to the PhET simulation entitled Sound at the website:
https:/phet.colorado.edu/sims/html/sound-waves/latest/sound-waves all.html

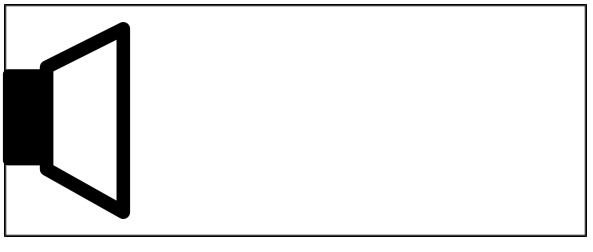
Choose "Listen to A Single Source", check Enable Audio, and alter the frequencies.

Draw a picture of a low pitch sound wave and high pitch sound wave as fronts.

Low Pitch Sound Wave Front



High Pitch Sound Wave Front



Experiment Two

Go to the following website: http://www.youtube.com/watch?v=a3RfULw7aAY ,
which is an example of Doppler Shift using a car horn.

Describe what you heard using some of the key vocabulary terms in your response.

_____

_____

_____

Draw a picture (with wave fronts) illustrating the Doppler Effect of the car and horn as it **approaches** and **moves** away in the video.

Experiment Three

BEING CAREFUL, take the Tuning Fork with string tied to it and tap the fork with a mallet while it is dangling. Then, swing the tuning fork in a circular motion (in front of you or above your head) , being sure that you do not hit anything or anyone.
https://www.youtube.com/watch?v=5xsPnlRpucc

Describe what you heard using some of the key vocabulary terms in your response.

_____

_____

_____

10. Draw a picture (with wave fronts) illustrating the Doppler Effect of the Tuning Fork being swung around your head.

Analysis & Conclusions

1. When an automobile moves towards a listener, the sound of its horn seems relatively:

a. low pitched b. high pitched c. normal

2. When an automobile moves away from a listener, its horn seems relatively:

a. low pitched b. high pitched c. normal

3. The changed pitch of the Doppler Effect is due to changes in:

a. wave speed b. wave frequency c. wave amplitude

4. Describe (in your own words) how the Doppler Effect works.

_____

_____

_____

5. Which of the following scenarios would produce the Doppler Effect? *Check all that apply.*

☐ A moving sound source (such as an airplane passing overhead)

☐ A moving observer of a source (such as a person running past a loud stereo)

☐ A moving source and moving observer (such as kids chasing an ice cream truck that is playing music)

☐ A non-moving source and non-moving observer (such as person watching television on a couch)