**The Doppler Effect**

**I. Background**

 The Doppler effect is the change in [frequency](http://en.wikipedia.org/wiki/Frequency) of a [wave](http://en.wikipedia.org/wiki/Wave) for an [observer](http://en.wikipedia.org/wiki/Observer_%28physics%29) moving relative to its source. It is commonly heard when a vehicle sounding a [siren](http://en.wikipedia.org/wiki/Siren_%28noisemaker%29) 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.

**II. Objectives**

 Students will be able to :

 - 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.

 - Explain the Doppler effect, with diagrams, and give examples of where it can be heard.

**III. Materials**

 - Tuning Fork (with a string tied to the handle)

 - Internet connection

**IV. Key Terms**

 Pitch – How low or high a tone sounds to a person

 Frequency – wiggles per second (moves back and forth)

 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.

**V. Procedure**

 1. Go to the PhET simulation entitled Sound at the website : <http://phet.colorado.edu/en/simulation/sound> .

 2. Choose “Listen To A Single Source”, check Enable Audio, and alter the frequencies.

 3. Draw a picture of a low pitch sound wave and high pitch sound wave.

 Low Pitch Sound Wave High Pitch Sound Wave

 4. Go to the following website : <http://www.youtube.com/watch?v=a3RfULw7aAY> ,

 which is an example of Doppler Shift using a car horn.

 5. Describe what you heard.

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 6. Below is a picture of high frequency and low frequency wave fronts.



 7. Draw a picture (with wave fronts) illustrating the Doppler Effect of the car and horn

 as it approaches and moves away in the video.

 8. 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.

 9. Describe what you heard.

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 10. Draw a picture (with wave fronts) illustrating the Doppler Effect of the Tuning Fork

 being swung around your head.

**VI. 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.

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 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)