



## Doppler Effect

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Students experience the Doppler effect by watching videos and teacher demonstrations of how pitch changes followed up with a whole class discussion.

Science Topics	Process Skills	Grade Level
Doppler Effect	Scientific Inquiry Observing Comparing Predicting Communicating	6-12

Time Required			
Preparation	Set-Up	Activity	Clean-Up
None	5 minutes	25 minutes	5 minutes

### Learning Goals

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

### Materials

In the Kit	Not in the kit	Optional
Worksheet – 1 per student Tuning Fork with string tied to handle	Computers*	

Worksheet – 1 per student  
Tuning Fork with string tied to handle

Computers\*

\*If there aren't enough computers for every student it's possible for the sound simulation activity to be done as homework or a teacher demonstration.

### Set-Up

Gather materials and set up computers with the PhET simulator "Sound" and YouTube videos:

- "The Sound of Audi" <http://www.youtube.com/watch?v=sY7KhvdtB9I> (first 10 seconds)
- "Doppler Effect" <http://www.youtube.com/watch?v=a3RfULw7aAY>

### Introduce the Activity

Students will investigate the "Sound" simulation and explore how the waves change as the parameters are adjusted, then they will answer questions 1 and 2 of their worksheet.

### Doing the Activity

#### Video Demonstrations

1. Show the first ten seconds of "The Sound of Audi" video. Ask the students what they observe about the sound.

2. Show the excerpt several times until the class comes to the idea that pitch is higher as the car heads towards you, and lower as it drives away. Students may mention that the car is loudest when it's right in front of the man with the microphone, but the Doppler effect deals with pitch change, not volume.
3. Show the "Doppler Effect" video and discuss what is heard. This doesn't need to be shown as many times as the first video because most of the observing was done the first time around.

### **Tuning Fork Demonstration**

1. Hold the string of the 883 Hz tuning fork and swing it around your head. It should vibrate loud enough for the class to hear.
2. Students will answer questions 3 and 4 of their worksheet.
  - a. Question 3 asked them to describe what was heard – this was already answered as class discussion, but is here to reinforce the idea for every student.

### **Drawing Wave Fronts**

1. Draw wave fronts for a high frequency wave and for a low frequency wave on the board. (The high frequency wave fronts should have waves closer together than the low frequency wave front.)
2. Ask students to think about the car moving and try to come up with a theory as to why the pitch sounds higher as the car approaches and lower as it drives away.
3. Have the class report their theories.

### **Class Discussion and Explanation**

1. Discuss the previous demonstrations and how they are called the "Doppler Effect." Explain the concepts to the students.
2. Students will answer question 5.

### **Explanation**

In-depth background information for teachers and interested students.

When drawing a wave front one can see that if the source is moving towards the observer, the source is closer each time it emits a new wave front. That brings the wave front closer to the previous wave front than it would have been if the source were stationary. So you can see that the wave fronts are closer together as they reach the listener so they are arriving at a higher frequency.

### Key Lesson Terminology

- 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.

### **Modifications**

- This activity could be done as homework and then reviewed in class the next day. The teacher should have the simulator running in the front of the class to get students thinking about what they had experienced.
- This activity can be done as a teacher demonstration, but our experience has been if you put the simulator up and give directions students don't get very much – they need to explore it at their own pace.

### **Extensions**

- As homework or as a whole class, students could go outside and listen for signs of Doppler effect.

### **Supplemental Materials**

Worksheet below.

## Doppler Effect

Name: \_\_\_\_\_

1. Look at the "Sound" simulation on the PhET.colorado.edu site. Investigate how the wave changes as you adjust the various parameters. Draw a picture of a sound wave below. Draw a wave that is a low sound and one that is a high sound. What is different between the two?
2. If a tuning fork is sounding and then swung over a person's head, how do you think it will sound?

### Demonstration

3. After listening to the demonstrations, describe what you heard.
4. *Prediction:* Draw a picture or pictures that show how wave fronts (like shown in the Sound sim) might look while a speaker is moving towards you. Draw how it would look if the speaker were moving away from you.

### Class Discussion and Explanation

5. Describe in your own words as you might to other students, how the Doppler effect works.