Lesson plan for *Resonance*: High School Version

http://phet.colorado.edu

Learning Goals: Students will be able to:

- Describe what resonance means for a simple system of a mass on a spring.
- Identify, through experimentation, cause and effect relationships that affect natural resonance of these systems.
- Give examples of real-world systems to which the understanding of resonance should be applied and explain why.

Learning Goals: (from the design document)

- What is resonance?
- What affects the resonance frequency of a system? (mass and spring constant for this system, in general "material" and mass.)
- How does the frequency of a driver interact with the natural resonance of a system?
- What is damping? What effect does damping have?
- What effect does gravity have?

Background: Demonstrations might help the student's interest in the spring/mass systems. These systems are used are to be simplified examples to help them understand complex systems. Some simple demos could be

- Rubbing a wet finger around a glass; if you put different heights of liquid in the glass students should be able to hear different tones.
- Plucking a string and varying the length of it. I use a rubber band on a tissue box, but if you have a real string instrument, the real-world context would be more obvious.
- Blowing over a container with a small opening like a soda bottle with varying amount is liquid is nice.
- You can make several "flutes" by cutting straws to different lengths. The mouth piece end should be cut to have a tip 
- Striking pieces of metal of different materials and size.

Resonance **Introduction:**

This sim was designed for college level students so it might be helpful to read the Tips for Teachers for this sim. Three things that might be especially helpful are:

1. Tell students to use the frequency dial slowly
2. Explain that since this sim shows real-life behavior, they may have to make observations over a period of time before they change variables. ie. Changes are transient, so if they expect to see instantaneous results, they will miss key ideas.
3. It may be helpful to have used Waves on a String and Masses and Springs prior to this sim or tell students who feel like they need help to check these more simple sims to help them.

Lesson: Students could do this in pairs or as homework.

Post-Lesson: Clicker questions