Chladini Plates Lesson
Plan

Amount of time Demo takes: 1-5 mins.
Don’t try this at home!

Materials
● Frequency generator
● Motor
● Various shaped plates
● Sand
● Salt shaker (filled with sand)
● Wire leads to attach components
● Needs electricity

Set-up Instructions
1. Thoroughly clean plates with a paper towel and rubbing alcohol.
2. Plug the motor in to the frequency generator using the red and black cables; plug into the wall.
3. Place the motor inside the plastic bin (so sand is easy to clean up).
4. Attach the Chladini Plate of choice.

SAFETY!
● Very young students are more sensitive to high-pitched sounds than older kids/adults. Be careful to keep the amplitude down when changing frequencies so as not to hurt their ears.
● Sand spilled on the ground could make the area slippery, sweep up any spilled sand.

Lesson’s Big Ideas
● Chladini plates provide a model for how sound travels. They do this because when the plate is shaken by the generator, the material vibrates to make a sound -- we call this resonating. Sound waves travel through materials in a similar way, but we can’t see them. That’s why we say we can model it with Chladni Plates.
● The sand will move to the areas on the plate that are not vibrating. No vibration takes place where the waves are interacting destructively (cancelling each other out). Lots of vibration is taking place where the
waves interact constructively or haphazardly. So, the places where sand falls will show you where the nodes (calm spots) are for that frequency. This allows us to compare and measure the nodes at different frequencies.

**Instructional Procedure**

1. Once the equipment is set up, turn on the frequency generator. See what happens as you change the frequency of the generator.
2. Change the frequency and observe the patterns.
3. Have the people observing predict how the pattern will change if you have a higher or lower frequency. Were they correct?

**Background Information**

- Chladini plates named after Ernst Chladni, a 1700’s physicist. He used a cello bow to rub the edge of a wooden or metal plate to excite the plate. It was not easy to vary the frequency with the tools he had. We use an electric frequency generator that changes frequencies and can easily demonstrate different frequencies. Chladini studied this to better understand the resonance in instruments. Chladini was able to record the patterns at different frequencies, the nodal patterns at lower frequencies were simpler than ones at higher frequencies. This simple experiment allowed Chladini to study sound waves.
- When the plate is resonating, the sand will naturally move towards the lower energy level (simply: they’re not being thrown off). The lower energy level is a node, this is where the sand will collect. The sand lines show the lower energy areas that are not vibrating. This allows you to measure and compare the nodes between different frequencies.
- **Frequency** is the speed of the wave, **pitch** is used to describe how we hear the frequency. If we hear a high pitch, we are describing hearing a high frequency.
- **Nodes** are where the wave is not moving, **anti-nodes** are where the wave is moving. Here are some diagrams to help visualize some of these terms.
Assessment/sample questions you can ask
1. What do the lines in the sand show us?
2. How do the lines in the sand change with the frequency?

Conclusion
- Review concepts covered and ask if they have any other questions.
- Frequency, nodes and anti nodes, resonance.
- The Chladini plates resonating allow us to see the sound waves that we can hear.

Clean Up
- Clean plates occasionally through the day with alcohol. Try to keep the sand in the plastic bin and off the table or floor. If you run out of sand, let someone know so it can get refilled.

References
- http://blog.teachersource.com/2010/05/21/chladni-plates/
- http://www.physicsclassroom.com/class/sound/u11l2a.cfm

Next Generation Science Standards
- K-5
  - 1-PS4-1
- 6-8
  - MS-PS4
- 9-12
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