MIND TREKKERS
Chladini Plates Lesson Plan

Amount of time Demo takes: 1-5 min

Materials:
1. Frequency generator
2. Motor
3. Various shaped plates
4. Sand
5. Salt shaker (filled with sand)
6. Wire leads to attach components

Set up instructions:
1. Thoroughly clean plates with a paper towel
2. Plug the motor in to the frequency generator using the red and black cables, plug in power supply
3. Place the motor inside the plastic bin (so sand is easy to clean up)
4. Attach the Chladini Plate of choice

SAFETY!
1. 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.
2. Sand spilled on the ground could make the area slippery, sweep up any spilled sand.

What is the demo/lessons objective or big idea briefly?
- Chladini plates demonstrate how sound travels and the resonance of the material it is moving through. The sand will move to the areas on the plate that are not vibrating, and will show you where the nodes 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, and a chladini plate has been selected and sand is added. Turn on the frequency 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?
4. **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 node 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. 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.

**Vocabulary:**

*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.

http://en.labs.wikimedia.org/wiki/FHSST_Physics/Print_version

**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 up between demonstrations if needed. When completely finished gather all materials listed for this demonstration and make sure everything is accounted for. If something was used up, broken or damaged, let someone know so it can get replaced or fixed. All items in materials list should be back in the kit for this demo.

Clean plates between demos 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://en.wikipedia.org/wiki/Ernst_Chladni
http://www.physicsclassroom.com/class/sound/u11l2a.cfm

National Standards
K-12 Content Standard G, History and Nature of Science (If you talk about Ernst Chladini)
K-12 Content Standard B, Physical Science

Chladini Plates lesson plan bullet points
- Chladini plates demonstrate how sound travels and the resonance of the material it is moving through. The sand will move to the areas on the plate that are not vibrating, and will show you where the nodes are for that frequency. This allows us to compare and measure the nodes at 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. The sand will settle on the nodes, and the anti nodes will be clear of sand.