Directions

We are going to go through the demos in the lobby. Take turns within your group filling out this handout. This is not graded in any way, but a very important part of science is to make observations and record them carefully. The observations will be our evidence that allows us to draw conclusions.

It is certainly fun to play with the demos, but our goal here is to have fun **and** to learn some science, specifically about making observations and drawing conclusions. We live in an era where it is common place for everyone (teachers and students) to first try to look up the answer on the internet. Science is more than a collection of facts. It is an approach to understanding our world.

Thus, as you go through the lobby see what you can figure out yourselves. Try stuff! … and record what you do and think about it. You may not be able to understand everything that you see right now. The important thing is that you are thinking about your observations just like a scientist.

The demos have very nice posters. You will find the answers to some of the questions posed here in the posters so take time to look at them.

Stay on your group's demo until you are asked to rotate to the next demo.

Time permitting at the very end we will get together and discuss what you have seen.

<u>Your group number:</u>

Order of demos	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Whispering Gallery	1	6	4	3	2	5
Antigravity Mirror	2	7	5	4	3	6
Can you believe your eyes?	3	8	6	5	4	7
Pendulum Wave Machine	4	1	7	6	5	8
Chaotic Pendulum	5	2	8	7	6	1
Plasma Ball	6	3	1	8	7	2
Giant Guitar String	7	4	2	1	8	3
Spectra/Hologram	8	5	3	2	1	4

Whispering Gallery

1. Read the poster aloud together.

2. Follow the directions on the poster and make sure you can hear each other when one person is at the orange dish and one at the blue dish.

3. Here are some additional things you can try. Record your observations.

    1. Try moving away from the circular hole. At what point can you no longer hear the other person (while speaking softly)?

    2. Try speaking directly to the other person (not toward the dish). What do you observe?

    3. Try to block the sound by having some people stand in the middle between the two dishes. What do you observe?

    4. Think of some other experiments and try them out. List your experiments and your results.

4. How does the dish concentrate sound at the little circle in the center? Draw a picture showing how the sound travels between the two dishes.

5. The orange and blue dishes may be thought of as “sound mirrors”. They are concave and focus the sound from far away to a single point. What are other examples of concave mirrors either for sound or for light?

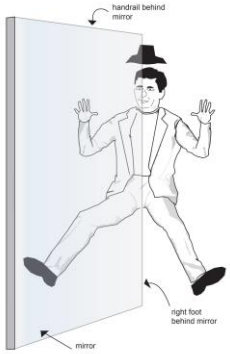
Antigravity Mirror

1. Read the poster aloud and follow the directions on the poster to try out this demo.

2. Let us think first about just a single mirror like you have at home in a bathroom. When you see something your eye detects light and sends a signal to your brain. Suppose you are looking at yourself in a mirror as shown below. Draw a path for how the light travels from your feet to your eye and from your nose to your eye?

3. If you didn't know there was a mirror, where would you think the person is standing? Draw this in the picture below.

4. The mirror set up of the demo is shown below. Draw the path that the light from your foot takes to get to your eye. Why do you appear to be flying?



5. Can you make it so that you appear to have three feet?

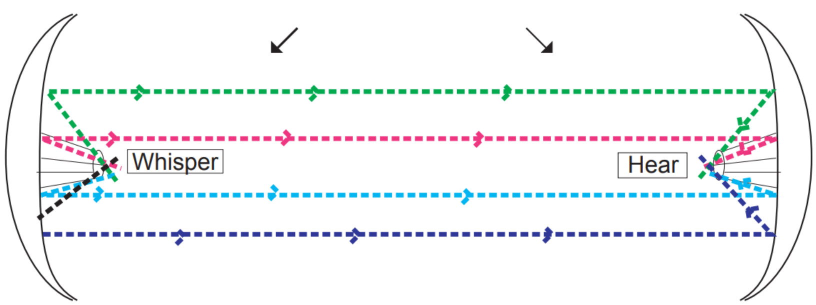
Can you believe your eyes?

1. Before you read the poster look through the hole. What do you see? Let each person in your group do it. Do you feel that you can touch the image? What happens when you move the rod in and out?

2. Now read the poster, perhaps as a group.

3. How is this demo related to the whispering gallery and the antigravity mirror? You should start to see a pattern for how you trace rays of light or sound.

4. Imagine that you were given a large piece of cardboard. How might you modify the whispering gallery so that you could hear the person speaking but not see them?



Pendulum Wave Machine

1. With all the pendulums stopped, press the button. Describe what happens.

2. You are given two strings with small weights on the bottom. When you hold one up, it will swing back and forth just like a playground swing. The period of oscillation is defined as the time it takes to come back to the starting point.

   Do a set of experiments to figure out what determines the period. Is it the length of the string? Is it the mass of the weight? Describe what you observed.

3. Try to make two pendulum with *slightly* different periods. One will be just slightly faster than the other. Test it out. Describe what you see.

4. Now go back to the pendulum wave machine and use what you have learned about pendulums to explain what is going on. Measure the period of the shortest length and the longest length pendulum.   You can do this by counting the number of times it goes back and forth in a time interval like 10 seconds. (This is also the way you can measure someone's pulse.)

Chaotic Pendulum

We have experienced a simple pendulum and a set of simple pendulums in the pendulum wave machine. This is more complicated. We have basically a bunch of pendulums connected together. Let us explore this.

1. Wait until everything is almost stopped. (It will take a long time to completely stop.) As gently as you can have the system perform small oscillations. This means turning the knob just a little. What do you see? Try this several times. Do your best to be reproducible. Do you see the same thing each time?

2. Again wait for everything to stop. Very slowly give the knob 1/4 of a turn and let go. Try to repeat this exactly several times. Do you see the same motion or does it differ?

3. The hallmark of chaos is that small differences in the initial condition can lead to big changes in the end result. Do the results from above indicate chaotic behavior?

4. What are some other examples of systems which might be chaotic?

5. Given what you have learned about chaotic behavior, why might it be very hard if not impossible to predict the weather several weeks in advance?

Plasma ball

1. Why does the plasma ball light up?   What are the blue zig zag lines that look like lightning? Hint: read the poster.

2. A plasma is one state of matter. What are three other major states of matter?

3. One at a time try touching the globe first in one place and then in multiple places. What do you find? Does it make sense based on what you read in the poster? Why?

4. Your teacher is going to have a few extra fun things to try to use with the plasma globe. Be gentle and careful! What do you observe? What do you think is going on?

5. With the light bulbs see if the orientation of the light bulbs matter and if you have to touch the bulb to get it to light. Can you identify the different types of light bulbs and how they work?

Giant Guitar String

Waves occur in many places in nature. Sound is a wave that travels through the air. Light and radio waves are examples of electromagnetic waves. You are familiar with water waves in a pool or at the beach. This is an example of a wave on a string, like those that occur in string instruments such as a guitar.

1. Wait until the string above has stopped moving and is completely straight. Now give the small string attached to the wall a big quick pull. Can you see the wave move along the big string? What happens when the wave reaches the end?

2. The string can also be driven by a motor. If you press the button on the wall, the motor will run for 5 minutes before turning. Start the motor with the frequency turned all the way down (smallest number). Slowly turn the frequency up until you reach the fundamental mode. It will look like this: What frequency does it occur at?

3. Continue to turn up the frequency until you reach the second mode. It will look like this: What frequency does it occur at?

4. Continue in this manner. Can you find the third mode? What frequency is it at?

5. You can't hear this string because it has a very low frequency (lower than what humans can hear). But if this were a guitar string, the second wave (4.) would be one octave higher than the first one. Do any of you play musical instruments?
How is the frequency changed (different notes) in your musical instrument?

Spectra

1. Read and follow the directions on the poster under “Things to do and see”.

2. List the different light sources and describe what you see for each.

3. There is a lot of detailed information in the rest of the poster. These are the most important points to take away.

    - Light comes in different wavelengths. Our brain interprets this as colors, but they correspond to different wavelengths of the light. Smaller wavelengths mean higher energy. Thus, violet and ultra-violet (UV) have higher energy. That is why you need to put sunscreen on to protect yourself from UV light from the sun.

    - Each source of light combines these colors in different ways. For example, light from outside or from the incandescent bulb has every color in the rainbow. The colors (or as we say spectra) are continuous. On the other hand some sources show only lines - only very specific colors. These lines tell you what the source is.

    - The fact that one source has this “finger print” (or spectra) of color lines lets you determine what the source is - even if you can not get to the source. This allows you to determine what is on distant stars and planets.

Hologram

1. Observe the dinosaur hologram. It should appear to be three dimensional. How big is the dinosaurs head?

2. Move your head up and down. What happens to the hologram? Next move right to left being careful not to raise or lower your head. What happens to the hologram?