**Viewing the Unseen Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Stations: Go to a station. Perform activities as instructed and answer all questions associated with the station. At signal, move to next station and repeat.

1. Now Hear This!

Open the Exploratorium “Sound Uncovered” App. Adjust the slider.

What is the lowest frequency you can hear? \_\_\_\_\_\_\_\_ Hz

What is the highest frequency you can hear? \_\_\_\_\_\_\_\_ Hz

Did everybody in your group have the same answers? \_\_\_\_\_\_\_\_

Name an animal that would likely hear a lower range of frequencies than you: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name an animal that would likely hear a higher range of frequencies than you: \_\_\_\_\_\_\_\_\_\_\_\_\_

Describe a way in which humans use sound waves outside of the normal range of audible frequencies for a practical purpose: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(Use the iPad to help you answer the last three questions if necessary.)

1. What a Smart Phone!

Look at the labeled end of the television remote. Click buttons on the remote. Is there a visible signal coming from the end? \_\_\_\_\_\_\_\_

What do you see when you click buttons on the remote while viewing the end through the camera of a smart phone? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Based on the evidence from this station, is there a signal coming from the end of the remote even though you can’t see it with your eyes? \_\_\_\_\_\_\_\_

Name another tool that scientists use to collect data that cannot be observed with the unaided eye: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What does a television remote sound like?

When you use a television remote, a signal is transmitted to the television. Can you see the signal with the unaided eye? \_\_\_\_\_\_

Turn on the amplifier provided at this station. Aim the television remote at the photovoltaic panel attached to the amplifier and press a button on the remote. Repeat with a different button. What do you hear as you push the buttons? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Are the sounds the same or are they different? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Note that what you are observing at this station is actually similar to the functioning of a radio when you are grooving to a funky tune. Instead of an IR signal, the signal reaches the antenna of the radio as a \_\_\_\_\_\_\_\_\_\_\_\_\_ wave, is converted to an \_\_\_\_\_\_\_\_\_\_\_\_\_ signal, and then converted to the \_\_\_\_\_\_\_\_\_\_\_\_\_ that reaches your ear.

The diagram below shows the transmission of the audial signal between your ear and your brain. Pressure differences vibrate the eardrum, which moves the three bones of your middle ear. These bones (hammer, anvil, and stirrup) act as a lever system, which amplifies the tiny pressure differences and allows them to be transmitted into the cochlea. Within the cochlea, the pressure differences get converted into what is essentially an electrical signal that is transmitted by a nerve to your brain and interpreted as sound.

For more information on this process, view \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is the name of the window that connects the middle ear and the inner ear?

1. Oval window B. Rear window C. Round window D. Square window



1. Let it GLOW!

Look at the plastic ring labelled “non-scintillator”. Hold it in the cardboard box and look through the viewing hole. What do you see? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hold the ring in front of the UV lamp. What do you see? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Look at the plastic stick labelled “scintillator”. Hold it in the cardboard box and look through the viewing hole. What do you see? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hold the scintillator in front of the UV lamp. What do you see? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Note that when the scintillator is struck by high energy radiation (UV light in this case) the organics within the scintillator give off visible \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. “Cannon” you “air” me now?

Create a tower of cups as a target. Aim the large vortex cannon at the cups and try to knock them all down. Who can knock them all down from the farthest distance? Can you see the vortex as it moves from the cannon to the cups? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Now slide the switch of the little vortex cannon to turn it on and wait a moment until condensation begins to emerge from the opening of the cannon. Shoot a vortex from the cannon and study it carefully. Sketch the vortex in the space below:

If you have time, go to <http://youtu.be/jfVXKWqlJRc> to see a HUGE vortex ring!

1. Holy smokes!

Look carefully at the cloud chamber. Do you notice anything unusual? (Be patient. You may need to wait for a while before you see anything happen.) Are the tracks that form in the cloud chamber oriented in a certain direction, or do they form randomly?

Notice that there is a radiation source in the corner of the cloud chamber.

How does this affect the number of tracks you see in that area? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Do tracks form in other parts of the cloud chamber? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What might create those tracks? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. You can count on me!

Open the program labeled Data Studio (if it is not already open). Create a “Counter” experiment and hit “start”. Hold the Geiger Muller tube at various distances from the radiation source. What happens to the count rate as you get closer to the radiation source? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Does the count rate drop to zero when you are far from the source? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What does this imply? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Homework -

<http://www.fordham.edu/images/whats_new/magazine/fall11/cosmicconnections.pdf>

Experiment:

Problem statement - What will happen to trigger rate as paddle overlap is increased?

Hypothesis - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Data –

1. Dimensions of each counter: \_\_\_\_\_\_\_\_\_\_\_\_ cm x \_\_\_\_\_\_\_\_\_\_\_\_ cm

|  |  |  |
| --- | --- | --- |
| Percent overlap | Overlap Area (cm2) | Trigger Frequency (Hz) |
| 0 |  |  |
| 25 |  |  |
| 50 |  |  |
| 75 |  |  |
| 100 |  |  |

Graph –



Calculate flux at earth’s surface.

Muon flux = \_\_\_\_\_\_\_\_\_\_\_\_ muons/s/cm2

What other cosmic ray investigations could you do with this equipment? (Give a SHORT description of one of them.)

Connect to CERN (Detectors are essentially multiple variations of the CRD counters), neutrino detectors, and the Standard Model.

Assessment

Station lab questions, article questions, overlap lab