

Information in Radio Waves



Name: _____ Class: _____ Date: _____

Identify Me: A Practice in Spectroscopy

Introduction -

All things in the universe have their characteristic “signatures”. People on TV have their catch-phrases, you have your DNA, and atoms / molecules have their specific emission / absorption spectrums. By observing and knowing which wavelengths of energy specific elements interact or resonate with in the lab, astronomers can use these signatures to identify those same things up in space.

This activity focuses on giving students an understanding on how the techniques used by spectroscopy can be used to identify many different things. Students will build their own simple spectrometer and use it to look at various sources of light. They will make simple illustrations of what they see and discuss what principles are at work. After his discussion, students will investigate the process of spectroscopy using an online (and downloadable) flash program developed by the SIRTf Science Center at Cal. Tech, under the funding of NASA’s EPO (education and public outreach) programs.

Objectives -

- Demonstrate pattern recognition using spectral lines
- Understand the processes behind diffraction
- Recognize the uses and information gathered by the process of spectroscopy

Materials -

- Part 1:

- scissors
- CDs (hopefully not ones you want)
- empty cereal boxes
- tin-foil
- tape
- 60° angle templates

■ (http://coolcosmos.ipac.caltech.edu/cosmic_games/spectra/angle60.gif)

-Part 2:

- computers
- internet
- colored pencils (1 set of colors per pair of students is optimal)

Time required - 1 block period (~ 90 minutes)

Previous knowledge needed -

- The Electromagnetic spectrum
- Prisms and Diffraction of light

Preparations before lab: (20 minutes)

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Part 1:

- obtain enough materials for each student (1 box, 1 CD, and enough tin-foil to go around)
- prepare any light sources to be observed before class
 - ex: fluorescent bulbs, candles, chemical samples to burn, etc.
- print sets of instructions and worksheets

Part 2:

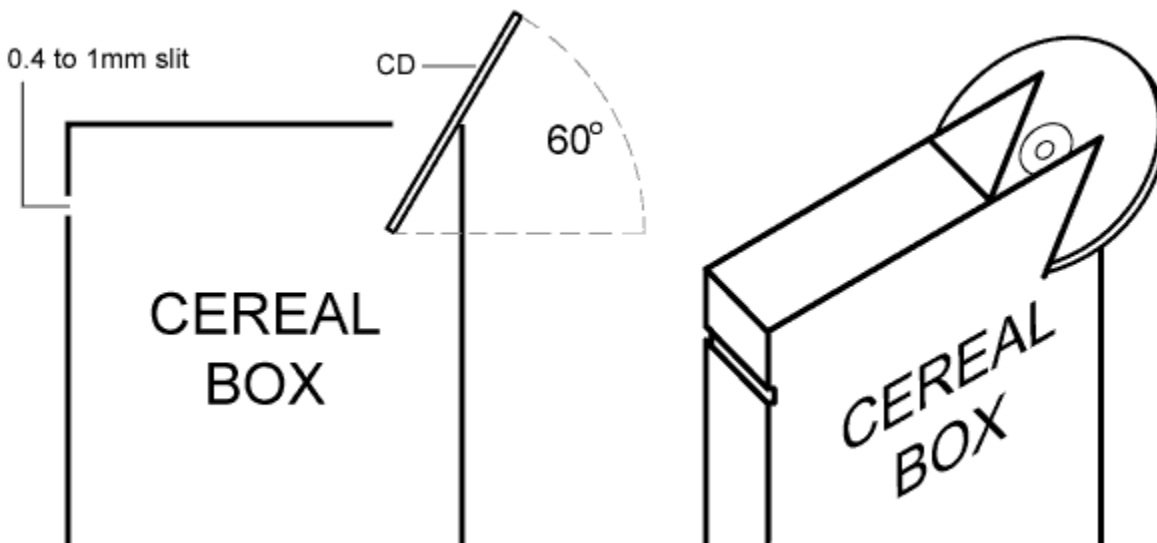
- Ensure all computers have flash installed, otherwise the activity will not work

Methods -

Part 1:

- Instructions for building the spectrometer can be found at:
http://coolcosmos.ipac.caltech.edu/cosmic_games/spectra/makeGrating.htm

What you'll be making:



Instructions:

1.) On the top of the box, measure in 1.5 inches and make a mark.



2.) Using the 90 degree edge of the triangle...draw a guideline across the width of the box.



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3.) Cut along the guideline, then unfold the flaps you just made. Cut off the flaps.



4.) Place the short edge of the triangle along the top edge of the box and draw a 3 inch line towards the center of the box: Using those lines as guides...cut two 3" slits on both sides of the cereal box as shown.



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5.) Flip the box over and do the same thing on the other side.



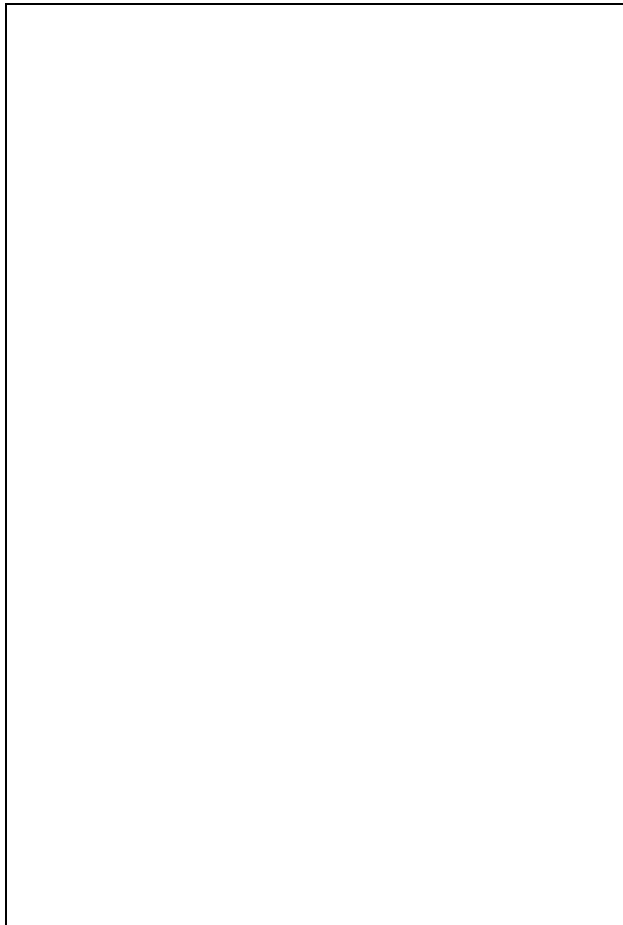
6.) Slide the cd into the slits as shown



7.) Now you're going to cut a rectangle out on the opposite long side of the box as shown. The rectangle should be the width of the box and one inch high. The top of the rectangle should be about half an inch from the top of the box.

To cut it, first poke a hole towards the top of the box with a pen. Then, cut a rectangle using the hole as a starting point.





8.) Take enough aluminum foil to cover the hole and fold it in half. place the creased side towards the middle of the hole and tape it in place.



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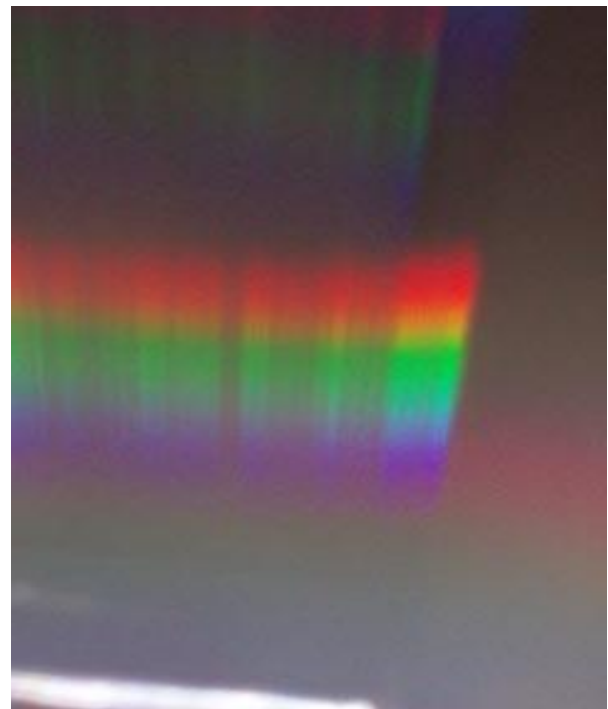
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9.) Take a second piece of foil and cover the bottom half of the hole. You want to leave a gap between the two pieces of foil. This gap should be between .4 and 1mm. Too wide and the spectra gets blurry. Too narrow then not enough light gets in.



10.) Tape the top of the box closed.

11.) Point the slit at a bright light bulb, and look into the square hole. You should see something like this:



12.) Look at various sources of light and copy down the resulting spectrum that you see in the table provided in your "Student Answer Worksheet"

- **DO NOT LOOK DIRECTLY AT THE SUN.** Point your spectrometer to a white wall in sunshine or at some clouds instead!!!!

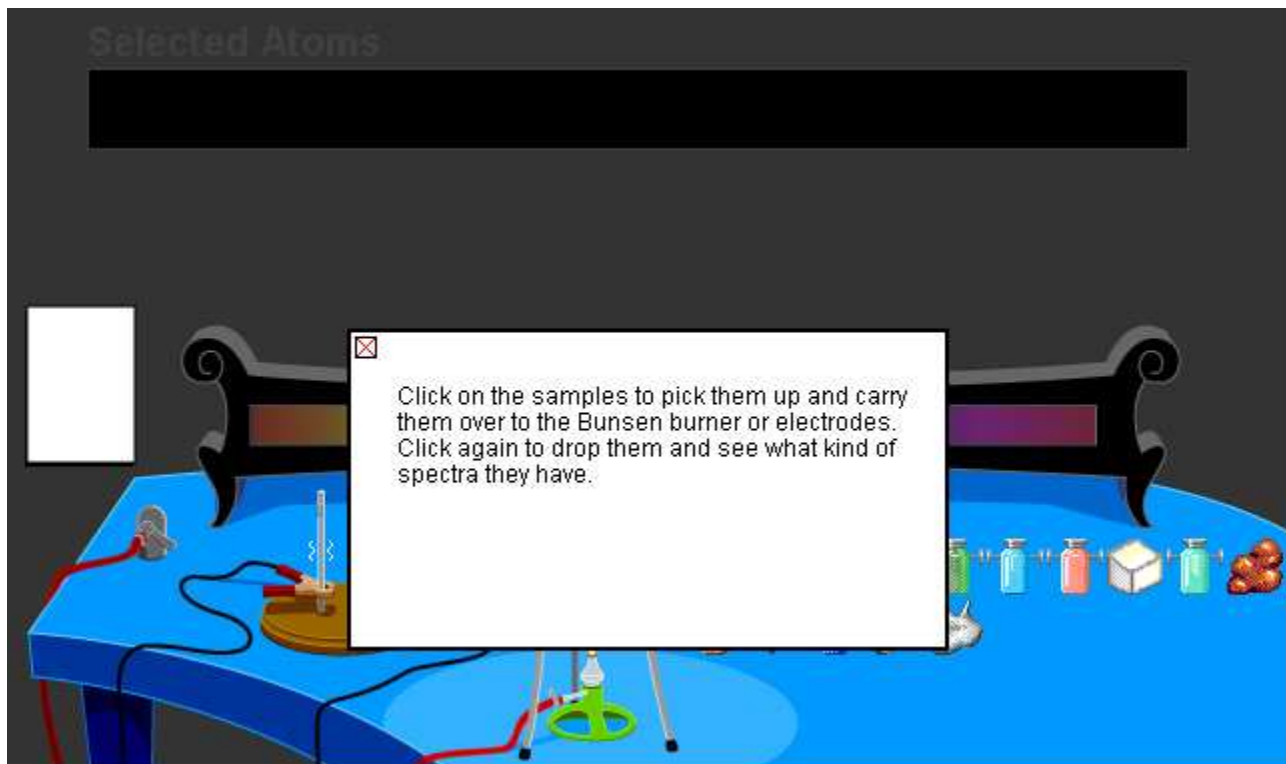
Recommended viewing sources:
- Incandescent bulbs
- Fluorescent bulbs
- Spectrum Gas Tubes

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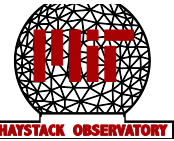
Part 2: Done in Partners

- 1.) Open up your internet browser, and type into the address bar:
http://coolcosmos.ipac.caltech.edu/cosmic_games/spectra/spectrometerTutorial.htm
- 2.) Read through the instructions, then click on the link at the bottom titled “Explore the Whyville Spectrometer”
- 3.) If the area where the application should show appears white, click in the white area and the application should appear with a message in the middle.

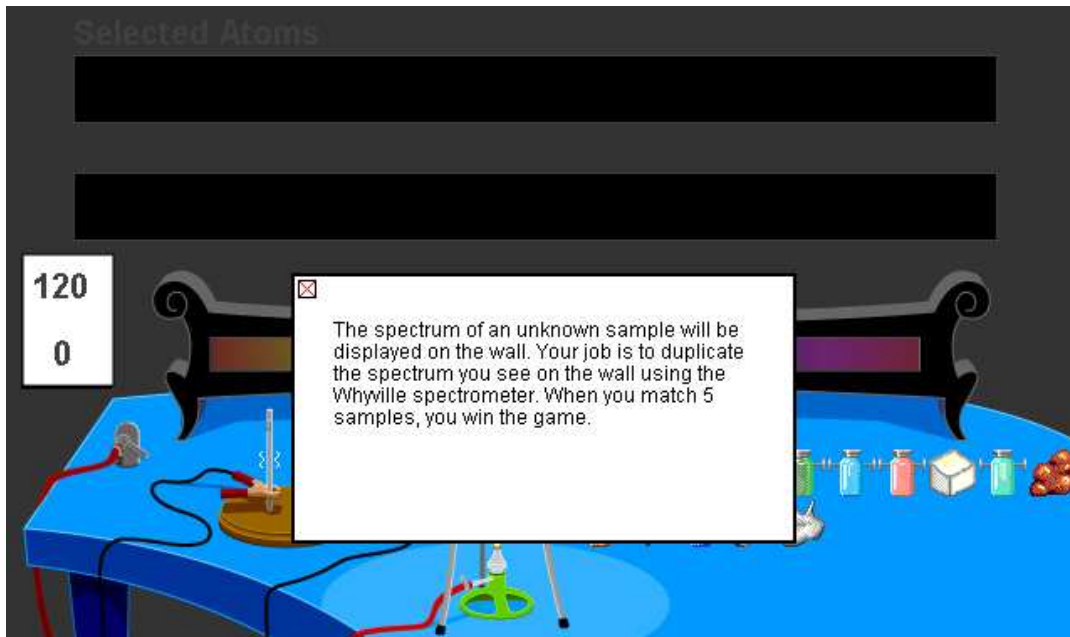


- 4.) Click the Red [x] in the top left of the message box and play around with the options. Get used to them.
- 5.) For each element, copy down the spectral lines shown on your “Spectral Lines Reference” worksheet to the best of your ability. Your teacher should have provided coloring utensils of some sort. (Note: make sure to remove elements from the apparatus before placing another. If you don't remove them their spectral lines combine together.)

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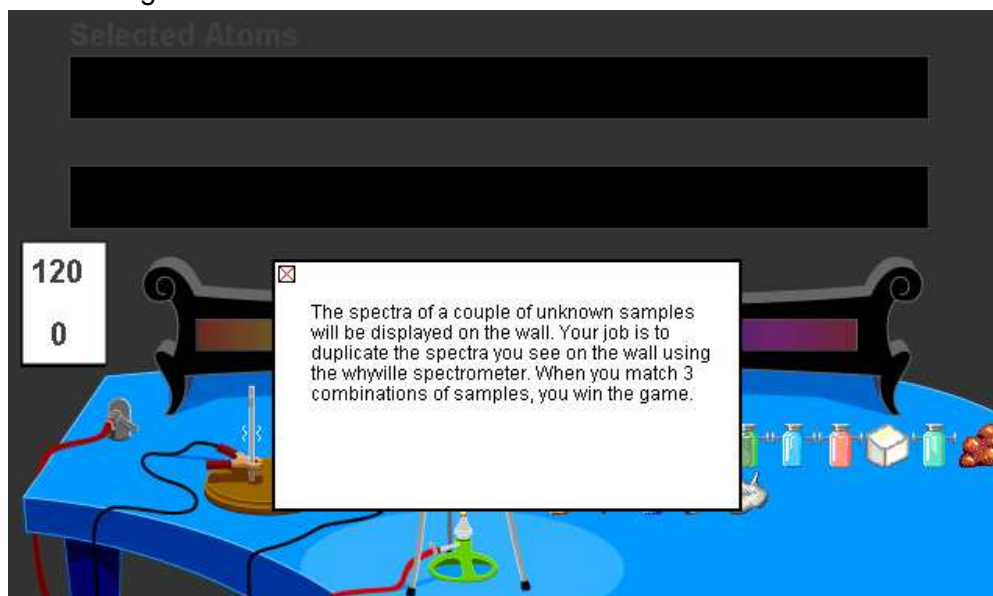


6.) When you are finished click the link under the application titled: “level 1”. The application should look like this:



7.) Each time you get one correct, make note of which element it was and write down the message the game gives you about that element.
(Note: you have only 120 seconds to match 5 elements, if you don't succeed in one attempt just refresh the browser until you have successfully matched 5 different elements)

8.) After you have done 5 individual elements, click the link under the application titled: “Next Level”. The resulting screen should look like this:



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9.) This level is similar to the first level where you will need to match up spectral lines. This time you need to add multiple elements together to achieve the matching spectral line. (Note: one partner should keep track of the element combinations on a scrap piece of paper, after its matched it will automatically make it impossible to check which elements they were)

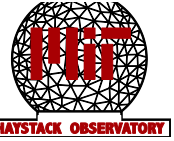
10.) Make 3 matches and record your results on your worksheets.

11.) If you have extra time, feel free to play with the application some more.

Credit:

“Cool Cosmos” EPO coordinated and managed by the SIRTf Science Center, based at the Infrared Processing and Analysis Center on the campus of the California Institute of Technology in Pasadena.

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Name: _____ Date: _____

Spectral Lines References:

Hydrogen:

Helium:

Boron:

Carbon:

Nitrogen:

Oxygen:

Neon:

Sodium:

Argon:

Copper:

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Krypton:

Strontium:

Xenon:

Tungsten:

Mercury:

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Student Answer Worksheet

Part 1:

Light source:	What it looked like:
1.)	
2.)	
3.)	
4.)	
5.)	

Part 2:

Level 1 -

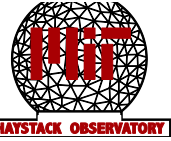
1.) Element Name:
Description:

2.) Element Name:
Description:

3.) Element Name:
Description:

4.) Element Name:
Description:

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5.) Element Name:

Description:

Level 2 -

(cross out the elements that don't match up and circle the ones that do. **USE PENCIL!! You might run out of time!**)

1.) Elements:

H He Bo C N O Ne Na Ar Cu Kr Sr Xe W Hg

2.) Elements:

H He Bo C N O Ne Na Ar Cu Kr Sr Xe W Hg

3.) Elements:

H He Bo C N O Ne Na Ar Cu Kr Sr Xe W Hg

Answer the following questions:

1.) Explain how your self-made spectrometer works.

2.) Why do different element's show up at different frequencies? What causes the "gaps"?

3.) Why does light from the sun practically cover the entire spectrum?

