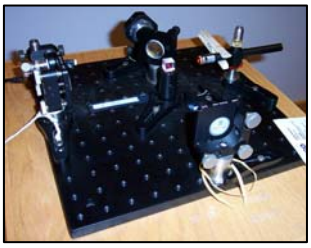
LIGO Explorer Name _____

Have fun exploring the science of LIGO!

1. The Little Michelson Interferometer

Location: In the auditorium



Procedure: Try to figure out the path of the laser light through the interferometer. Observe the interference pattern that the device makes. Gently pull the string to move the mirror by a tiny amount.

Questions: Answer the following

1. What do you see when the interferometer's mirrors move by tiny amounts?

2. Why is this model an important exhibit to have here at LIGO?

*EALR 2.1.4 Analyze how models are used to investigate objects, events, systems, and processes.

2. Interferometer Simulator

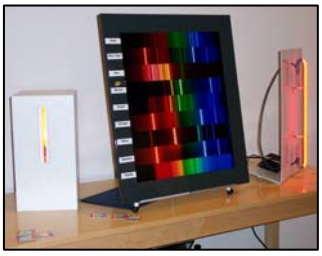
Location: Auditorium

Procedure: The wood blocks in the simulator represent the mirrors in a real interferometer. Slide the wood blocks back and forth while you keep tension on the strings. The strings represent the laser light. Watch the pattern change at the location of the photodetector.

1. In what way does the pattern at the 'photodetector' change when the 'mirrors' (the wood blocks) move?

* EALR: 2.1.4 Analyze how models are used to investigate objects, events, systems and processes

3. Scoping the Stars



Location: Auditorium

Procedure: Use either a grating or a spectroscope (box) to look at the light sources. Observe the pattern that each light produces. Try to match the pattern that you see with the patterns that are shown on the framed poster. There may or may not be a match.

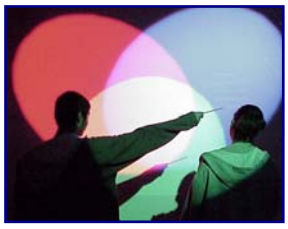
The name of the red-orange light is _____

The name of the yellow light is _____

Extra: Use the spectroscope to look at one of the white lights in the auditorium or the lobby.

* EALR: 1.1.3 Understanding the properties of sound, water, and light waves.

4. A Shadow- More Than Meets the Eye



Location: Auditorium

Procedure: Stand next to the front wall of the auditorium so that you can cast a shadow on the wall. Use your hands to cast shadows on the wall. Try overlapping shadows. Note: Thank you for not touching the wall. It is a projection screen and works best when it is clean.

Questions:

1. All the colors on the wall are created by what three (3) colors?

2. Explain how to produce a green shadow on the white section of the wall.

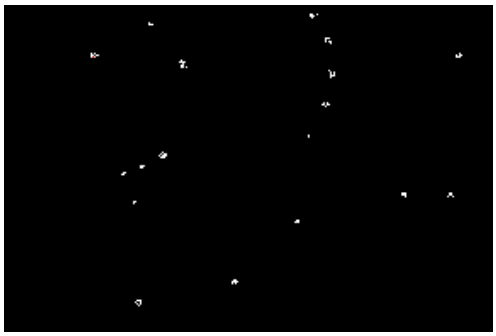
* EALR: 1.1.3 Understanding the properties of sound, water, and light waves.

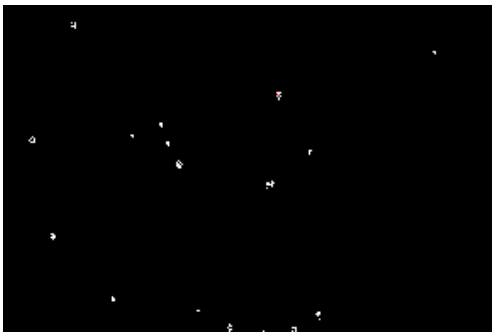
5. Search for the Stars

Location: The computer tutorial is on a computer at the rear of the auditorium.

Procedure:

A. Log on to http://www.stikky.com/0001-nightskies/0001-fulldetails.html on the computer. Click the 'sample pages' link.
B. Spend a few minutes learning how to locate the star **Betelgeuse** in the constellation **Orion**.
C. Locate and circle the star **Betelgeuse** in each of the diagrams below.





6. Gravity Well

Location: Lobby, opposite the main entry

Procedure: Pull out the drawer at the bottom of the well. Find a round object and roll it around in the well.

Questions:

1. The ball's orbit becomes smaller as it travels around the funnel. Why?

2. Is this exhibit a good model for the earth's orbit of the sun? Why or why not?

*EALR 1.1.2 Understand the positions, relative speeds, and changes in speed of objects.
1.2.5 Understand the structure of the Solar System.
1.3.2 Understand how balanced and unbalanced forces can change the motion of objects.

7. Simple Pendulum

Location: The back of the auditorium.

Investigate this question: "Does a heavier object swing at a different rate than a lighter object?"

1. What is your prediction?

Procedure: Perform a test using the objects at this exhibit by determining the number of swings the pendulum will make in 15 seconds.

Color of Bag	Weight of Bag	Number of swings in 15 seconds

2. What did you learn as a result of this experiment? Use your data to support to support your answer.

*EALR 2.1.2 Understand how to plan and conduct scientific investigations.

8. Journey to the Stars

Location: The galaxy model is outside

Procedure: Go outside for the "space walk"

Your mission will be to determine the distances from the earth to 6 prominent stars in the **Milky Way Galaxy**. Go to the earth's **Solar System Indictor** located outside at the front corner of the building. We have carefully plotted points on the LIGO grounds to represent 6 stars and their relative distances from the earth. But how will you measure these distances?

Starting at the earth's **Solar System Indicator**, carefully count the number of steps it takes you to walk to the star **Merek** located in the **Big Dipper**. You are now using the length of your step as a unit of measure. Make sure each step is the same length.

Total number of steps to **Merek** _____

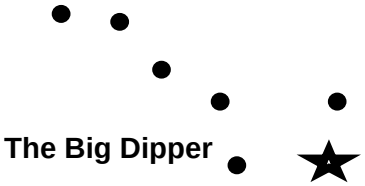
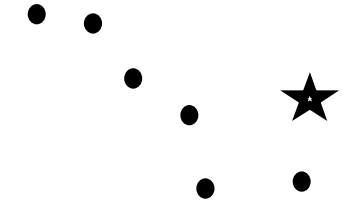
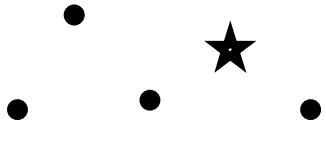
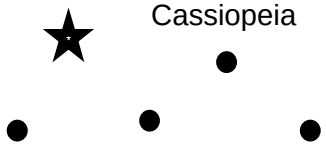
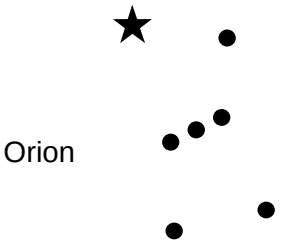
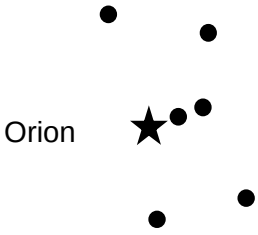
The distances to the stars are enormous. Listing these distances in miles or kilometers give us huge numbers. For example, Merek is 475,000,000,000,000 miles from earth! It is much easier to measure such distances in **light years**. A light year is the distance light travels in one year at a speed of 186,000 miles per second.!

If **Merek** is 80 light years away, and it took _____ steps to get there from earth, then how many light years equals one of your steps?

80 light years divided by ____ number of steps equals ____ light years per step.

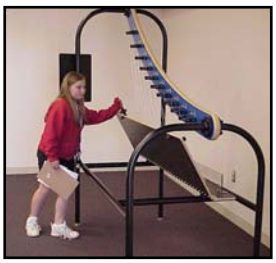
Now determine the estimated distance to each of the 5 remaining stars by counting the number of steps it takes you to walk from the earth's Solar System Indicator to the stars in each constellation.

Complete the table on the following page.

Constellation or "group of stars"	Star	Facts about the star	Number of your steps	Number of light years
 **The Big Dipper**	Merak	Hot white star. The light you see from this star took 80 years to reach the Earth.		80
 **The Big Dipper**	Dubhe	Is orbited by another less massive star. Along with Merak has been used for centuries to help people find the north star.		
 Cassiopeia	Ruchbah	About 4 times as big as our sun		
Cassiopeia 	Schedar	A very young star, about 200,000,000 years old. Helps point the way to the Andromeda Galaxy.		
 Orion	Betelgeuse	Red super giant. If Betelgeuse replaced our sun, the surface of the star would extend almost to the orbit of Jupiter!		
 Orion	Alnitak	Left-most of 3 stars that make up Orion's belt.		

*EALR 1.1.2 Understand positions, relative speeds, and changes in speed of objects.

9. Pendulum Snake



Location: In the corner station

Procedure: Grab the red handle and lift the board. Set the board down quickly. Watch the pendulums.

Questions:

1. Why do the pendulums swing at different rates?

2. Describe or draw the different patterns that you observe.

*EALR 2.1.1 Understand how to generate a question that can be answered through scientific investigation.
2.1.4 Analyze how models are used to investigate objects, events, systems, and processes.

10. Vibrating String

Location: In the corner station

Procedure: With the motor on, pull tightly on the string and watch the wave patterns that it forms.

Questions:

1. This exhibit makes waves called "standing waves". Why do you think that they are called standing waves?

2. How many standing wave patterns can you make?

*EALR 1.2.2 Understand how various factors affect energy transfers and that energy can be transformed from one form of energy to another.
1.1.3 Understand sound, water, and light waves; their properties, behaviors, etc.
2.1.4 Analyze how models are used to investigate objects, events, systems, and processes.

11. Pencil Waves

Location: In the corner station

Procedure: With your hand, press down on the pencils on one end of the exhibit. Quickly remove your hand. Watch the pencils.

Questions:

1. What happens to a wave when it reaches the end of the string?

2. Make waves on the device. Watch just one pencil. Describe the pencil's motion

*EALR 1.2.2 Understand how various factors affect energy transfers and that energy can be transformed from one form of energy to another.
1.1.4 Understand sound, water, and light waves; their properties, behaviors, etc.
2.1.5 Analyze how models are used to investigate objects, events, systems, and processes.

12. Giant Slinky

Location: In the corner station

Procedure: Grab the handle that comes from the blue can and push it back and forth or swing it side to side.

Questions:

1. What happens to a wave when it reaches the end at the wall?

2. What happens when waves collide with each other?

3. What must you do to make waves on the Slinky that look like the standing waves that you make on the vibrating string?

*EALR 1.2.2 Understand how various factors affect energy transfers and that energy can be transformed from one form of energy to another.

13. Sound Waves

Location: In the corner station

Procedure: Using the tuning forks, your voice and other noisemakers, make waves on the computer monitor by making noise in the microphone.

Question:

1. What differences do you see between the computer wave patterns made by different tuning forks?

*EALR 1.1.3 Understand sound, water, and light waves: their properties, behaviors, etc.

14. Waves in Time and Frequency

Location: In the corner station

Procedure: Watch and listen. The function generator (middle unit) makes electrical waves. These waves are graphed in time on the oscilloscope (right-side unit). The frequency of the waves appears on the signal analyzer (left-side unit). You also can hear the frequency (pitch) of the waves coming out of the speakers.

Question:

1. When the pitch (frequency) of the sound changes, how do the graphs change?

*EALR 1.1.3 Understand sound, water, and light waves: their properties, behaviors, etc.

15. Gravity Racer

Location: In the corner station

Procedure: Place three golf balls behind the starting gate at the top of the ramps. MAKE A PREDICTION OF WHICH BALL WILL WIN THE RACE TO THE BOTTOM. Now let the balls go. Was your prediction correct? Release the balls from other positions on the ramps by letting them go by hand.

Question:

1. Was your prediction correct?

2. What is your guess about the way this device works? Why does the ball that travels farther reach the bottom first?

*EALR 1.1.3 Understand sound, water, and light waves: their properties, behaviors, etc.