ACTIVITY CHALLENGE

DIFFICULTY LEVEL: HARD

ACOUSTICS AND SOUND

XYLOPHONE: Play the tune *Spring* by Vivaldi. Notice the different notes that are written. The ones with a bar connecting them are called **Eighth Notes**. How many Eighth Notes are there in this piece of music?_____

Dynamics are what musicians call changes in volume. Forte(*f*) is the Dynamic marking for playing the music loud while Pianissimo (p) is the Dynamic marking for playing the music quietly. Play the song again but this time, try to observe the Dynamics. Where you able to? Yes or No.

For the Xylophone, what do you need to do in order to play the instrument Forte? What do you need to do in order to play the instrument Pianissimo?

BONGOPHONE AND BOOMWHACKERS: Try hitting different colored tubes with the mallet at the Bongophone station. The long red tube has a lower pitched sound than the short red one. Explain why in your own words:

A C Major scale is made up the following notes C-D-E-F-G-A-B-C. There are no sharps or flats in this Key Signature. The only other Key Signature without sharps or flats is A Minor. Using either the Bongophone tubes or the nearby Boomwhackers, arrange the tubes into the A Minor scale. Write the **color order** below:

ELECTRICITY AND MAGNETISM

MAGNETIC SCULPTURE: Use the small hex-nuts to build a bridge between the two magnets. Build a tower of hex-nuts from the middle of your bridge. As you tower gets taller, what happens to the magnetic force?

Look at the picture on the exhibit sign. Try to recreate the sculpture. How many hex nuts are you able to stack in this pattern?

If you weren't able to build it the first time, try it again without treating it like a pyramid.

CIRCUIT BENCH: Use the metal bars and cranks to power **one** of the devices or **one** row of lights. Draw the circuit you created below:

The word *circuit* is similar to the word *circle*, why?

What tiny particle is responsible for the electricity flowing?

On the side of the exhibit with just the light bulbs, build a new circuit to the bulbs without the black sockets. Keep building your circuit until it includes all rows of these bulbs. Can you get them all light up at once? **Yes or No?**

Do the same with the other type of bulbs. Was it **easier or harder** to light them all this time? (think about how much energy you are using to turn the crank to come to your answer)

Write a sentence describing why this is the case (HINT: to answer this question properly, go to the exhibit called "Light it Up.")

ENERGY FLOOR: Power the camera to take a selfie with one person. How many **Joules** did you generate?_____

Repeat with a group of friends. How many Joules did all of you generate?_____

At its simplest, a car requires **300 Joules** to start. Do you think you'd be able to start a car on your own? Why or why not?

PNEUMATIC TUBES: Place a ball in the opening of the tube and watch it travel to the other side. Why does covering the hold with your hand make the ball travel faster?

What is a real-world application of this air pressure concept?

PARACHUTE LAUNCHER: Launch a parachute and try to catch it was it falls down. Could you catch it? **YES or NO**

What is a parachute supposed to do?

Did your parachute fall **quickly** or **slowly?**

Place the parachute in the launcher in the following orientations. Circle the way(s) that work best. Working best means that the parachute opens the quickest and falls the slowest!

Parachute first

Weight first

Folded in half, parachute and weight first

Folded in half, parachute mesh first

FLIGHT ZONE, WIND TUBE: Build a paper flyer using the given instructions. Which flyer did you choose?

Was your flyer able to fly up and out of the tube? **Yes or No**.

Make changes to your design so that it flies differently and test it again. What did you change about your flyer?

Draw your design here:

FLIGHT ZONE PAPER AIRPLANES: Build a paper airplane. Using the launcher, try to get your airplane through one or more of the hoops. How far did your plane fly?

Try angling the launcher differently. Now how far did your plant fly?

Go back to the table and add some weight to your airplane. Test your plane again. How far did it fly this time?

Repeat all of the above with a new paper airplane using a different design. Which airplane did better, your **first** or your **second**?

WATER LAB: At the **Water Mushroom**, turn the crank until the water is completely off. Turn the water back on slowly until you see a mushroom-like shape. Touch the water gently with one finger moving from the bottom toward the spout. Describe what happens to the water:

What is a **Sluiceway**?

Build the following sluiceways based on the descriptions below. Draw your design and describe what happens to the water in each:

- A system that prevents all water from flowing past the first step.

- A system that utilizes at least one gate with openings.

- A system that allows water to flow down only the sides of the steps.

At the **Valve Play** exhibit, begin with all valves turned in the same direction (all horizontal or all vertical). Place a ball into the start and guide it through the tubes to the top of the Water Lab using the valves.

Did you need to try this more than once to make it? **Yes or No?**

LIGHT AND VISION

COLOR FILTERS: Start by holding the green disk up to your eyes at the Color Filter Exhibit. Look at each picture. What numbers do you see?

Now try it with the red filter. Was it easier to see with the **red** or **green**?

What is in the bottom right picture?

How does a filter work?

BENHAM DISK: Choose a disk and Velcro it to the spinner. Press the button and watch the center as it spins. What colors do you see on the black and white disk?**Red, Orange, Yellow, Green, Blue, Indigo, Purple**

Does speed affect what you see?**Yes or No**

Our eyes have cones for which color combination?**red, blue, and yellow** or **red, orange, yellow** or **red, blue, green?**

KALEIDOSCOPES: Step inside the Duck-Under Kaleidoscope. How many physical mirrors are there?

The mirrors are set up in what shape?**Square, Rectangle, Triangle, Octagon**

The mirrors are set up at what angle?**30º, 40º, 90º, 60º**

What type of angle is this?**Obtuse, Acute, Right**

Sit down in front of the **DISGUSTOSCOPE**. Press the button to turn on the light. Look into the small hole while putting **one thumb** into the larger end. How many of your thumb do you see?

MECHANICS AND MOTION

ROLLER COASTER: Build a roller coaster using any **six pieces** and at least one loop. Test your rollercoaster with one of the balls. Draw the roller coaster that you designed:

When you hold a ball at the start of the track, the ball is full of _____ energy.

A ball going around a loop is full of _____ energy.

SUPER BOUNCE: Gently **lift** all of the balls as high as you can and the drop them. Which ball goes the highest?

Now only lift three of the balls. What changed?

Try it again, now only lifting two of the balls. What changed?

NEWTON'S CRADLE: Lift the handle on one of the end balls and then release it. How many balls are pushed up on the opposite side?**1 2 3 4**

Now lift two balls and release.

How many balls are pushed up on the opposite side this time?**1 2 3 4**

Both the **Super Bounce and Newton's Cradle** exhibit behave similarly. Explain why:

CAN YOU LIFT 100 POUNDS?: Pull on each rope and try to lift the weights. Which rope(s) where you able to successfully lift 100lbs?**Red Yellow Green Blue**.

Look carefully at each rope system. Each one has a _____.

How many of these does each rope have?

- Red:
- Yellow:
- Green:
- Blue:

In order to lift the weights with the rope-system, you end up only needing to apply about 17lbs of force to the rope.

This is determined through the use of the following simplified formula: $\frac{weight}{mechanical\ advantage}$

In our exhibit, the weight is 100lbs and the mechanical advantage is the number of pulleys. For example, 100lbs/ 6 pulleys = 16.6666 ~ 17lbs.

Armed with this formula, determine how many pounds of force you much execute on each rope:

- Red:
- Yellow:
- Green:
- Blue:

If there was a system with 8 pulleys, how many pounds of force would you need to exert (show your ratio)?

What about 10 pulleys?

PENDULUM LAB: For this section of the Activity guide, you will be using the Scientific Method to answer a proposed question. The Scientific Method has six steps: Purpose, Research (if necessary), Hypothesis, Experiment, Analysis, and Conclusion.

Purpose: The purpose of this experiment is to determine what variable affects the swing rate of the pendulum.

Hypothesis: Write a hypothesis (good guess) using this outline:

- *I predict that the variable (circle one)* ***mass, pendulum length, angle of release*** *will cause the pendulum to swing faster or slower*.

Experiment: Test all three variables (mass, length, and angle) using the various pendulums in the lab.

Analysis: *Did the angle of release (what you tested using the Amplitude pendulum) affect the swing rate?* **Yes** or **No**

-Did the mass at the end of the pendulum (tested at the mass pendulum) affect the swing rate? **Yes** or **No**

- Did the length of the pendulum (tested at pendulum snake) affect the swing rate? **Yes** or **No**

Conclusion: Write a conclusion statement on your own. Be sure to include the **variable** which affected the swing rate and how it affected the swing rate (such as heavier made it slower).

CIRCLE PACKING: Arrange all the colored disks within the circle so that they all lay flat. Try drawing the arrangement once you've solved it.

What is a practical application of circle packing?

TOWER OF HANOI: Follow the Instructions at the puzzle. Time yourself with a watch or clock and record how long it takes you to solve the puzzle. _____

Try the puzzle a second time, moving the circles to a different peg. Record your second time. _____

Try it a third time. Record your third time. _____

Were you able to complete the puzzle faster each time? **Yes or No.**

MAGIC SQUARE: Order the numbers so that the sum is always 15 when you add each row, column, and diagonal.

The Magic Square can be solved by using a formula. Using the variable 'n' for number, fill in the formula on the grid below:

Using your formula, solve the following Magic Squares.

Sum of 18

Numbers to put in this Magic Square: 2, 3, 4, 5, 6, 7, 8, 9, 10

Sum of 24

The number in the center for this Magic Square is **8**

Sum of 96

In all four Magic Squares, what is the **least common** multiple of the value of the required sum?

List the **product** for the center number when multiplied by 3.

BLUE BLOCKS: Using the pictures on the wall as examples, build a Dwelling, a piece of Furniture, and either the **Playground Pinball** or the **Spinning Wheels** (circle one).

Engineers use blueprints in order to build bridges, houses, cars, and so one. Draw a design that you could build with the Blue Blocks and then build it.

SHAKE TABLE - BUILDINGS: Build a skyscraper like one of the ones in the pictures. Test your building on the shake tab Does your building shake?**Yes** or **No**.

-hat shape reinforcements will give your building stiffness?**Square, Hexagon, Triangle.**

What shape reinforcements will give your building flexibility?**Square, Hexagon, Triangle.**

Do we want our buildings to have some flexibility?**Yes** or **No.** Why or why not?

SHAKE TABLE – BRIDGES: Build a beam bridge and test it with cars, pedestrians, or trains. What do trusses do?

- Build an Arch Bridge and test it with cars, pedestrians, or trains. What presses into the curve of the arch into the supports?

-Draw a design for your own type of bridge, either using one of the pictures as reference or coming up with one entirely of your own. Build this bridge and test it with cars, pedestrians or trains. Does it hold up?**Yes** or **No**.

-Why or why not?

CATENARY ARCH: Follow the directions to build and raise your catenary arch. Does the arch stand?**Yes** or **No**.

If not, describe what went wrong.

What force keeps the pieces of an arch together?

GIANT ARTCH: With the help of some friends, follow the directions to build the Giant Arch. When finished let go. How long did your arch stand?**Yes or No.**