**CUSP – Real-world Science Workshop I: Scientific Measurements and Observations**

**Fleet-work:**
In this workshop we have been examining the process of science. One of the critical features of scientific investigation is conducting valid and reliable measurements and observations.
A valid measurement refers to something that is considered accurate or "correct." For instance, if you measure the height of your instructor, Dr. Ed Price, you'd probably get 6' 2" tall. A measurement of 9 ft. tall is not valid. A reliable measurement is one that you can repeatedly or consistently achieve. If you were to measure his height to 6 significant figures (i.e. 6.13423 feet) it would be hard to get that consistently. Also it should be the case that you and a different person can repeatedly measure the same thing.

The exercises are designed to investigate the process of observation and measurement.

**Measurement** is the comparison of the known with the unknown. It involves a measurement device (known), interacting with the unknown, and an observation (detection).

**Observation** is the detection of an object (known or unknown) with a detector or detection system.

**I.** check out **Relative Motion Pendula.** Here two pendulums are running at the same time. First, convince yourself that you can trace out each of the four straight lines. Describe how you did this

***For the two lines that run along the axes (the + ) of the two pendula, push only one pedulum at a time***
***For the other two lines (the x ), push both pendula at the same time***

Next the circles:

***Push the two pedula, but off-set by 1/2 a swing—push the 2nd when the first has traveled out and back to the middle.***

You observe the circular path of the center pendulum. Does it really travel in a circular path? Explain.

***No only relative to the other pendulum (the base). Each travels in a straight line relative to the floor.***

Did you make an observation or a measurement?

***This is debatable, but presumably an observation… you see it traveling in a circle***

Label the known, unknown, detection system

***Known is your relative position, the stationary floor, shapes on the second pendulum; unknown may or may not be the movement of the pendula. The dection system is your eye observing the position of one pendulum relative to the shapes on the pendulum.***

Where (in this exhibit) would you have to place a camera to observe the center pendulum traveling in a circular path? Which part(s) of the measurement system are you changing?
***On the second (or flat pendulum)… or on the tip of the 1st pendulum. You are changing the detection system.***

**II.** Compare this to the **Silage beach.** This has to be done in pairs. Face your partner inside the tent. What do you observe (what / who appears to be moving)? What is your detector? What is known and unknown?
***The person you see seems to be moving…and you feel like you're moving. Your eyes and your sense of balance (inner ear) are the sensors. Known: your position. Unknown: ??? (how good your sense of balance is)***

**III.** Check out the **About Faces Exhibit**. Start with both images down. At first impression do the two pictures seem the same?
***yes***
Turn them upright. Do they appear the same?
***no***
What is changing, the known, unknown, or the detector?
***Your detector… your brain processes the visual stimulae differently.***

**IV** Spend time at the **Water Strobe.**
Draw a sketch of the path of the water with the strobe running at one frequency.

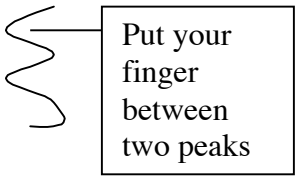
Draw a sketch of the path of the water with the strobe at a different frequency (faster or slower).

Press the button to turn on the incandescent (constantly illuminated) light.. Draw a sketch of the path of the water.

In each of these three scenarios has the water been changing its path? Explain.

***No… your detection system is changing… not the water path.***

Go back to the strobe scenario, Put your finger in between two of the side peaks of the vertical path of the water. Does it get wet? Explain.




**Your finger should get wet…. Your eye/strobe detector**

Doesn't detect the water, but your finger does

What is changing? The path of the water? Your eye? The Light? What is the detection system comprised of? Can your finger count as a detector?

***The detection system is changing -- it is comprised of your eye, and the illumination source (which is changing frequency, or constantly on). The finger can be a detector***

**V:** Try the same variations with the **Oscillinderscope**. Pluck one of the guitar strings the same way every time (hold it out the same amount). Change the speed of the drum behind it. What is going on? Explain this in terms of known, unknown, and detectors.

***Same scenario. The detection system changes with differing rates of "illumination" which is created by running the cylinder at different rates. You are taking "snapshots" of the string which makes the patterns you observe.***

**VI:** Lastly, Go to the **Fragment of ,Jericho**. Where was Jericho?

Draw a sketch of the system. Identify the measurement device, the known and unknown.

***The laser, optical detector and sound generator (and your ear) are the detectors. The rate of the spinning bowl should be known, the scratches/groves in the bowl are unknown.***

What would happen if the width of the laser beam were more than on groove on the pot? Explain.

***You would not be able to detect the variation in grooves (like trying to measure the width of a hair with a ruler that only has 1" markings on it).***

What if you changed the speed that the pot is turning? (think about a record player).
***Just like playing a 33 speed record at 45 rpm… do you know what a record is? Anyhow, the pitch or frequency would increase. People talking would start to sound like chipmunks.***

**VII:** identify **another exhibit** in the hall where you could explain what both OBSERVATION and MEASUREMENT are. Give a brief description of how you would explain this to someone who didn't know any science. Feel free to use analogies from your own life experience (for example, what you use a ruler for and how it is used, hint hint hint). Don't forget to include the known, the unknown, and the detection system.

***This is up to you… happy trails.***