**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**In Class Activity – Symmetry and Point Groups**

**April 15th, 20145**

Before coming to class, I asked you to watch the TED talk by Marcus duSautoy. Here’s the link if you would like to check it out again later.

Link: <http://www.ted.com/talks/marcus_du_sautoy_symmetry_reality_s_riddle>

As I previously stated, the last 4 minutes of this video is not as relevant to our class, but the video itself provides a nice introduction to the topic of symmetry.

**Overview**

For the first 1/3 to 1/2 of the class, we will go over symmetry elements and point groups. For the remaining time, we will perform this in-class activity on the computers. You will turn in this activity sheet at the end of class and it will be part of your participation grade (similar to the first day activity). You can discuss with your neighbors, but please do your own work and look at each structure. You can use the flowchart to help you assign point groups. We will be using an online resource called “Symmetry @ Otterbein” that you can go back and use later to practice. If you want to look back at this sheet, it will be posted on D2L.

**Goals for this in-class activity:**

* Visualize chemical species as 3-dimensional objects
* Practice identifying symmetry elements of chemical species
* Practice determining point groups of chemical species
* Practice recognizing molecules of low and high symmetry

**Steps to in-class activity:**

1. Go to the “Symmetry @ Otterbein” site. Link: <http://symmetry.otterbein.edu/>

-At the top of the page, select the “*Challenge*” tab.

1. Let’s start by examining molecules of **low symmetry**. Then we will look at more complex species. Select ethane-Br2Cl2 on the menu to the left.

-What symmetry elements does it possess?

-What is its point group?

1. Now look at ethylene-BrCl on the menu to the left.

-What symmetry elements does it possess?

-What is its point group?

1. Check those answers to #2 and #3 by going to the “*Gallery*” tab up at the top of the screen and looking at the two species described above.

-Did you get the assignments right? If not, what did you miss? Visualize the symmetry elements you missed.

1. Now we will examine species of more complex symmetry. Return to the “*Challenge*” tab and select cyclohexane (*boat* conformation), on the menu to the left.

-What symmetry elements does it possess (and how many?):

-What is its point group?

1. Now look at cyclohexane in the *chair* conformation of cyclohexane.

-What symmetry elements does it possess (and how many?):

-What is its point group?

1. Let’s check those cyclohexane answers by going to the “*Gallery*” tab up at the top of the screen and looking at the boat and chair conformations of cyclohexane.

-Did you get the symmetry elements and point groups right? If not, what symmetry elements did you miss?

-If you missed any symmetry elements, visualize them by selecting them to the right side of the screen.

1. Now go back to the “*Challenge*” tab, and select [Re2Cl8]2−.

-What symmetry elements does it possess (and how many?):

-What is its point group?

1. Now select [Os2Cl8]2−.

-What symmetry elements does it possess (and how many?):

-What is its point group?

1. Again, go to the “*Gallery*” tab and check your answers for the Re and Os compounds.

-Did you get the symmetry elements and point groups right? If not, what symmetry elements did you miss?

-If you missed any symmetry elements, visualize them by selecting them to the right side of the screen.

1. Now go back to the “*Challenge*” tab. Look at boric acid and then look at triphenylphosphine.

-What symmetry elements do they have in common?

-What symmetry elements are unique to just one of the species (and which one has them?)

-What are the point groups of the two compounds?

1. Still in the “*Challenge*” area, examine 12-crown-4 and tetrabromoneopentane.

-What symmetry elements do these species possess?

-What are their point groups?

1. Check your answers to #11 and # 12 by going to the “*Gallery*” tab.
2. Now let’s look at some species of **high symmetry**. Stay in the “*Gallery*” tab for the following sections. You do not need to write down answers for #15−#18.
3. Look at methane (Td) *or* adamantine (also Td).

-Visualize a C3 axis and a C2 axis.

-Can you see how if you perform a C3 operation, you move the C2 axis to a new position? That is also a C2 axis for these molecules!

1. Look at Cr(CO)6 (Oh), cubane (also Oh), *or* sulfur hexafluoride (also Oh).

-Visualize a S6 axis.

-Can you see how it can have a S6 but not have a C6 symmetry element?

1. Look at dodecaborate (Ih) *or* buckyball (also Ih).

-Visualize a S10 axis.

-Can you see how it can have a S10, but *not* a C10 symmetry element?

1. Think look back at the Td, Oh, and Ih species and see if you can think of a way to clearly identify them as high symmetry species and tell them apart from each other.

**That’s the end of the exercise, but I recommend continuing to examine various species in the “*Challenge*” tab and then checking your answers in “*Gallery”*. You can always go back to this website and practice identifying symmetry operations and point groups.**

**What do you think about this exercise? Did it help you with figuring out symmetry elements and point groups compared to a normal lecture on a whiteboard? Any comments you have can be put in the space below and I will take them into consideration:**