Created by Meghan R. Porter, Indiana University (<a href="mmulcron@indiana.edu">mmulcron@indiana.edu</a>) and posted on VIPEr (<a href="mmulcron@indiana.edu">www.ionicviper.org</a>) on May 15, 2020, Copyright Meghan R. Porter 2020. This work is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (CC BY-NC-SA 4.0). To view a copy of this license visit <a href="mailto:http://creativecommons.org/about/license/">http://creativecommons.org/about/license/</a>.

## **Active Learning Lesson Plan (Example)**

**Topic:** Crystal Field Theory (CFT) and *d*-splitting diagrams

**Learning Objective:** Students should be able to predict and draw *d*-splitting diagrams for an octahedral transition metal complex geometry using the principles of crystal field theory

## **Previous Knowledge of Student:**

Students should be familiar with:

- *d*-orbital orientations and phases
- Basics of crystal field theory (no specific splitting patterns, just an understanding of why the dorbitals split in the first place

Just in Time Teaching Activity (to be completed shortly before/at the beginning of the class period)

Create one sentence (in *your own words*), explaining why the *d*-orbitals are no longer degenerate when ligands are bound to a metal center, regardless of the geometry.

## **Active Learning Activity (group activity)**

Work in your groups to complete the following questions

1. Draw a generic octahedral molecule (ML<sub>6</sub>) and analyze whether the ligands are interacting with the metal center on or off-axis.

2. For each *d*-orbital listed below, examine how much interaction (i.e. overlap) it experiences with the incoming ligands. Consider items like number of ligands an orbital interacts with and how strong/weak (i.e. direct/indirect) that interaction is.

 $d_{xy}$ 

 $d_{zx}$ 

[Type to	ext]										
	$d_{z^2}$										
	$d_{yz}$										
	,										
	1										
	$d_{x^2-y^2}$										
3.	Consider	that th	e five	<i>d</i> -orbitals	of an	octahedral	molecule	split in	nto two	sets.	Apply you

3. Consider that the five *d*-orbitals of an octahedral molecule split into two sets. Apply your answer to the JIT question and reasoning in Question 2 in order to create the CFT *d*-splitting diagram for ML<sub>6</sub>. Provide 1–2 sentences describing how your group used your answers in the previous question to determine your orbital ordering.

Transfer your splitting diagram to your group whiteboard to share with the class.

## **Assessment of Learning**

Each member of your group should answer the assessment question *individually* on your notecard.

Predict how the octahedral splitting diagram changes when the bonds along the z-axis are lengthened (i.e. tetragonal elongation)? Your answer should include:

- Evaluation of how the interaction of each orbital with the ligands changes relative to an octahedral molecule. How does this change in interaction alter the energies in your diagram?
- A splitting diagram showing the ordering and energy of each orbital relative to your octahedral diagram