Your assignment is to present the following paper to your inorganic chemistry class: “Band Gap Narrowing in a High-Entropy Spinel Oxide Semiconductor for Enhanced Oxygen Evolution Catalysis” (<https://pubs.acs.org/doi/10.1021/jacs.2c12887>). Use the questions below as a guide to construct your presentation. Make sure that you provide a background on the field generally. The questions below may be useful for guiding your thinking, but they may not be comprehensive (i.e., you may need to delve into areas not directly addressed by the questions). The questions may not necessarily be in the order in which you choose to present topics. When you present a technique or measurement that is new to you, assume that it is new to the rest of the class as well, and briefly explain it. You are encouraged to use figures. You may copy/paste figures from the materials provided, or from other sources. Ensure that any figure not generated by you or from this manuscript has a citation. You are encouraged to reach out to your instructors for help. However, you should first put a reasonable amount of effort into answering your questions yourself by doing your own research.

1. The compound prepared and studied in this article, (Fe0.2Co0.2Ni0.2Cu0.2Zn0.2)Al2O4 is described as a “high entropy oxide”, or HEO, with the “spinel” crystal structure. Explaining what all of that means to your audience will go a long way toward providing sufficient background. Here are some suggestions for how to do that:
   1. Within the context of solids and crystal structures,
      1. What is a metal oxide?
      2. What is the spinel crystal structure? Describe this structure using your knowledge from inorganic chemistry, and for a reference on spinel, see <https://en.wikibooks.org/wiki/Introduction_to_Inorganic_Chemistry/Ionic_and_Covalent_Solids_-_Structures#_8.6_Spinel,_perovskite,_and_rutile_structures>) You can check your understanding: what element(s) reside on the A- and B-sites in (Fe0.2Co0.2Ni0.2Cu0.2Zn0.2)Al2O4? And what is the coordination geometry of the A- and B-sites?
   2. The ΔH for the formation of HEOs is positive, and thus, unfavorable. That is because it is enthalpically favorable (ΔH < 0) for a HEO to phase segregate (decompose) into its simpler, constituent, “end-members”. For example, phase segregation of (Fe0.2Co0.2Ni0.2Cu0.2Zn0.2)Al2O4 into FeAl2O4, CoAl2O4, ZnAl2O4 and other simpler compounds would be exothermic. The stable formation of HEOs is ***possible*** (ΔG < 0) because of a large, positive ΔS. Think about the equation ΔG = ΔH – TΔS. Keeping all of that in mind:
      1. Within the context of HEOs, what is entropy?
      2. Where does the entropy in HEOs come from?
   3. High-entropy materials are currently an intense area of scientific research. Give a few examples (2 or 3) of why so much attention is being paid to HEOs. Do they have enhanced or unexpected properties? What do the authors of this article mean by “synergistic effects”?
   4. State the central, primary finding in this article.
2. Describe the approaches the authors used to synthesize and characterize (Fe0.2Co0.2Ni0.2Cu0.2Zn0.2)Al2O4 and any other compounds relevant to this work.
   1. How did the authors prepare (Fe0.2Co0.2Ni0.2Cu0.2Zn0.2)Al2O4? (Keep this brief)
   2. Powder X-Ray Diffraction (PXRD) is one of the most common techniques for analyzing solids. What information is obtained by PXRD? Give a brief description of how PXRD works. Present the authors’ PXRD data and explain its meaning. Excellent tutorial videos about PXRD can be found at [youtube.com/@patsperovskites4733](mailto:youtube.com/@patsperovskites4733). (Diffraction Lectures 13, 23 and 24 are particularly relevant to PXRD). *Note*: *you may exclude the advanced topic of Rietveld refinement from your explanation.*
   3. Describe two other pieces of experimental evidence the authors used to support that (Fe0.2Co0.2Ni0.2Cu0.2Zn0.2)Al2O4 was prepared as intended. Present the authors’ data and explain.
3. Describe the central, primary findings in this article:
   1. Figure 5 summarizes the most important findings in this article. Pay particular attention to explaining Figure 5 and the corresponding in-text discussion on pages 6756-6757. Figure 5 features quite a few topics that you are familiar with from inorganic chemistry, and consequently, you should discuss the relevance of
      1. Electronegativity (χ)
      2. Crystal field theory
      3. Δ (tetrahedral)
      4. Band theory, including Eg
   2. The authors demonstrate the implications of Figure 5 by using (Fe0.2Co0.2Ni0.2Cu0.2Zn0.2)Al2O4 as an electrocatalyst for the oxygen evolution reaction (OER):
      1. What is an electrocatalyst?
      2. What is OER and why is it an important reaction to develop catalysts for?
      3. Present the authors’ electrochemistry data (linear sweep voltammetry) and explain its significance. *Note*: *linear sweep voltammetry is similar to the cyclic voltammetry* *from this course and the lab. The big difference is that the potential is changed in only one direction while current is monitored.*
4. Conclude with some big picture take-aways from this paper.
   1. What is the big achievement that warrants publication in *Journal of the American Chemical Society*, a prestigious journal?