An article in *Inorganic Chemistry*, “η2-SO2 Linkage Photoisomer of an Osmium Coordination Complex,” by Cole *et al.* (*Inorg. Chem.* **2018**, *57*, 2673-2677) showed the irradiation of a osmium pentaamine coordination complex, [Os(NH3)5(SO2)] [Os(NH3)5(HSO3)]Cl4 (**1**), with 505 nm light at low temperature results in η1-to-η2 linkage photoisomerization of the SO2. This represents a rare example of a solid-state photo-switch based on osmium.

1. The crystal structure for **1** has two different cations: [Os(NH3)5(SO2)]2+ and [Os(NH3)5(HSO3)]+. Give the oxidation state and d electron count for each Os.
2. Draw the Lewis structures for SO2 and HSO3-.
3. Why is the Os-S bond length to HSO3- much longer than that to SO2 (2.2513 vs. 2.0965 Å)?
4. What orbitals/electrons on the SO2 are used to make the η1-SO2bond? What orbital(s) on the Os are used to make the η1-SO2bond?
5. What orbitals/electrons on the SO2 are used to make the η2-SO2bond? What orbital(s) on the Os are used to make the η2-SO2bond?
6. Define panchromatic.
7. Compare the UV/Vis absorption characteristics of the single crystal **1** versus that of [Os(NH3)5(CF3SO3)]2+, as seen in figure S.3 in the Supporting Information. What are the implications of this in terms of the utility of **1** as an optical switch?
8. It has been shown in previous work with [Ru(NH3)4(SO2)X]2+ complexes that the σ-donor ability of the ligand *trans* to SO2, X, correlates to the stability of the η2-SO2 linkage isomer (see references 10-17), where stronger sigma donors are more stabilizing and lead to slower isomerization back to the η1 form. Given this trend, arrange the series of potential *trans* ligands in terms of stability of the η2-SO2: NH3, H2O, Cl-, TFA, pyridine.
9. In these ruthenium complexes, the η2 complex returns to the η1 isomer within minutes of returning to room temperature. In contrast, **1** has not fully reached its dark state after 15 h. The authors state that the longevity of the Os-η2 isomer upon returning to room temperature is due to the fact that osmium is in the third row of transition metals. Explain why this may be.