INORGANIC CHEMISTRY CUMULATIVE EXAM
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Oxidation, reduction in inorganic chemistry

Oxidation and reduction are fundamentals part of chemistry, including in inorganic chemistry. They are associated with empirical phenomena (such as electron transfer) and concepts (such as oxidation state).

1. (10 points) The terms "oxidation" and "reduction" are, in their origin, derived from particular kinds of chemical transformation. Why is oxidation called oxidation? Why is reduction called reduction? Your answer should include a *specific experimental situation* that justifies the terms, with at least two chemical reactions that justify the observation and your answer should *not* use the term or concept of oxidation number or oxidation state.

2. (10 points) Define the term "oxidation state." Your definition should include two examples of specific chemical substances.

3. (10 points) Calculate the oxidation state for carbon in the compound glucose ($C_6H_{12}O_6$). Compare it to the oxidation number of carbon in graphite (C). (HINT: You should find that these are the same). Does glucose contain the same kind of carbon as graphite? Explain your answer.

4. (10 points). The Pauling Electroneutrality Principle stands as a powerful argument against the over-application of oxidation state as a concept. What is the Principle, and how does it differ from oxidation state? Give specific chemical examples.

5. (15 points). Assigning the oxidation state—and therefore the *d*-electron count—of transition metal ions in complexes is an important skill in inorganic chemistry. Determine the oxidation state and the *d*-electron count of the transition metal atom in the following complexes or substances.

(a) $CpFe(CO)_2$

(b) $Li_3Fe(CN)_6$

(c) Fe(TPP)Cl (TPP = tetraphenylporphyrin)

6. (15 points). Strong debates can arise around oxidation states. For each of the following complexes, indicate how particular issues with the *ligands* can affect a calculation of the transition metal oxidation state. Which oxidation state would *you* prefer, and why?

(a) $Co(CO)_3NO$

(b) $CpCo(\eta^4\text{-}C_4Ph_4)$

7. (15 points) π-acceptor ligands are most commonly found with metals in low oxidation states. Why is this so?

8. (15 points). One of the remarkable features of the lanthanides is the preponderance of the +3 oxidation state. Yet, some lanthanides also have significant chemistry with other oxidation states. Examples include cerium (atomic number 58, oxidation state +3 or +4), samarium (atomic number 62, atomic number oxidation state +2 or +3) and ytterbium (atomic number 70, oxidation state +2 or +3). Explain the preponderance of the +3 oxidation state with the lanthanide elements and also why these three lanthanides can vary from the +3 state. (NOTE: you do not need a periodic table for this. If you need to think about the electron configuration of the element, work it out from the atomic number).