Chemistry 448/548 Test 3 Name: _____
Fall 2025

Very Short Answer Questions: (3 points each)

1. The distance of closest approach between two unbound atoms of the same element is their _____.

2. In a complex, Δ (energy gap) generally _____ as elements progress down a group.

3. The transition metals are most frequently found in nature as their _____.

4. A defect caused by missing ions from the lattice is called a _____defect.

5. Of the high temperature superconductors, a major class are the "1-2-3 superconductors" which are so called because they have the general formula _____.

6. The distance component of London dispersion forces is directly proportional to _____.

7. Viscosity is _____ proportional to the strength of intermolecular forces.

8. The *d*-electron configuration in $Cr(CO)_6$ is _____.

9. What is the minimum number of electrons a stable, octahedral transition metal complex can be expected to have in its valence MOs? _____

10. State the Jahn-Teller theorem.

Discussion Questions: (You must show work to receive credit!)

1. Consider the square planar coordination complex MX_4. Ignoring π-bonding effects, its *d*-orbitals are ordered energetically $xz = yz < z^2 < xy < x^2\text{-}y^2$. If π-bonding is introduced, which metal orbitals will be involved and give the relative order of interaction. Justify your predictions. Are Jahn-Teller distortions for such complexes likely? Why or why not? (*Hint*: Assume the bond axes = xy axes.) (10 points)

2. Discuss n- and p-type semiconductors. (10 points)

3. Boron nitride, $(BN)_n$, can have a structure similar to that of graphite. Which would conduct electricity better and why? Would the difference in conductivities between the two be large or small and why? (10 points)

4. List the following in order of **<u>increasing</u>** melting point and briefly explain why each molecule was placed into the position that you chose. (i.e. Why does it melt at a higher temperature than the molecule preceding it and why does it melt at a lower temperature than the molecule following it?) AlN, diamond, H_2, H_2O, LiCl, NaCl, Ne, O_2, $SiCl_4$.

____ <____ <____ < ____ <____ <____ <____ <____ <____

5. Identify each element. (*Note*: Only 10 of the 11 elements are used.) (1 point each)

___ The high luster of this metal is noteworthy as is the colorful nature of its coordination compounds.

___ Its +4 oxidation state is unexpectedly its most stable. It is found in a variety of minerals and oil.

___ Forms a chloride that is a liquid at room temperature.

___ Bluish metal which frequently forms coordination compounds.

___ Soft and ductile; it is difficult to oxidize, but its oxide forms a distinctive green color.

___ Usually isolated by reduction of its oxide (found naturally) by chemical methods or of its sulfate electrochemically.

___ Chemically very similar to magnesium.

___ It is found naturally in the minerals haematite and magnetite, among others.

___ Very dense; pyrophoric when finely divided.

___ Reacts at room temperature with CO to form a liquid tetracarbonyl that is very toxic.

6. Which of the following would have the larger crystal field splitting energy (Δ_O)? Justify your answer. (10 points)

a) $[CoF_6]^{2-}$ or $[RhF_6]^{2-}$ -

b) $[Co(H_2O)_6]^{2+}$ or $[Co(NH_3)_6]^{2+}$ -

7. Methane has a boiling point of -182ºC, CF_4 has a bp of -184 ºC, and CCl_4 has a bp of -23 ºC. Why are the boiling points of the first two so close to each other and so far from the last compound? (10 points)