1. The enthalpy change, $\Delta H$, for the gas-phase reaction: $M^{2+} + D \rightarrow [MD]^{2+}$ is negative for all combinations of $M = \text{Mg or Cd}$ and $D = \text{H}_2\text{O}$ or $\text{CH}_3\text{SH}$. The ratio of $\Delta H_{\text{H}_2\text{O}}/\Delta H_{\text{CH}_3\text{SH}}$ is larger when $M = \text{Mg}$ than when $M = \text{Cd}$. Explain the difference in ratios. 2 pts

2. Identify the products of the following reactions or write "NR" if no reaction occurs. 3 pts
   a) $\text{BCl}_3 + \text{Me}_2\text{NBR}_3 \rightarrow$
   b) $\text{MgI}_2 + \text{HgO} \rightarrow$
   c) $\text{AuCl} + \text{NaSCN} \rightarrow$

3. Give the ionization isomers that are possible for the formula $\text{Pt(NH}_3)_2\text{BrNO}_2$. 1 pt

4. One isomer of the complex $[\text{PtCl}_2(\text{NH}_3)_2]$ reacts with $\text{Ag}_2\text{O}$ to give the complex ion, $[\text{Pt(EN)}_2(\text{OH})_2]^{2+}$. When this was treated with 1,2-diaminoethane, no complex with one molecule of en could be isolated. What is the geometric structure of the $[\text{PtCl}_2(\text{NH}_3)_2]$ initially used? Defend your structure. 2 pts
5. Sketch clearly all the stereoisomers possible for the octahedral complex ion, \([\text{CoBr}_2(\text{en})\text{(NH}_3)_2]^+\), where \text{en} = 1,2\text{-diaminoethane}. Do not repeat equivalent isomers. Show mirror image pairs if any chiral isomers are possible. Use as many of the templates below as you need. 3 pts

6. How many stereoisomers are possible for the complex \(\text{mer-}[\text{Co(Br}_3\text{(NH}_3)(\text{H}_2\text{O})(\text{py})}\), where \(\text{py} = \text{pyridine}\)? Answer ____. (You may ask for any character table to be put on the board.) 1 pt
7. How many unpaired electrons would be expected for each of the following complexes or ions? 3 pts
   a) \([\text{Rh(CN)}_2]^+\) (assume a linear structure) answer ______

   b) \([\text{CoL}_2]^{2-}\) (octahedral, \(L\) is a weak field ligand) answer ______

   c) What is the crystal field stabilization energy for the complex in b) above? answer ______

8. You are given a small bar of an unknown metal, \(X\). You find the density of the metal to be 10.5 g/cm\(^3\). An X-ray diffraction experiment measures the edge of the unit cell as 4.09 angstroms. Assuming that the metal crystallizes in a face-centered cubic lattice, what is \(X\) most likely to be? (Circle the best choice.) 2 pts

   A. Ag       B. Rh       C. Pt       D. Pb       E. None of these could be \(X\).

9. Check the following statement(s) that is (are) FALSE? 1 pt
   ___ 1. The hexagonal closest-packed structure can be represented as ABABAB....
   ___ 2. A body-centered cubic unit cell has four atoms per unit cell.
   ___ 3. For unit cells having the same edge length, a simple cubic structure would have a smaller density than a body-centered cube.
   ___ 4. Atoms in a solid consisting of only one element would have six nearest neighbors if the crystal structure was a simple cubic array.
10. The unit cell in this two-dimensional crystal contains _______ X's and _______ O's. 1 pt

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X X X X X X X
O O O O O O O
X X X X X X X
O O O O O O O
X X X X X X X
O O O O O O O
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11. In a certain ionic compound which can be represented as $M_pX_\alpha(s)$, the anions, X, form a face-centered cubic lattice. Within that, the cations, M, occupy 100% of the tetrahedral holes. Answer the following questions about $M_pX_\alpha$. 3 pts

a) What are the coordination numbers of M ____ and X ____?

b) What is p? _______

The sketch shows the positions of the tetrahedral holes in a cubic cell.
12. a) If CuBr adopts a zinc blende lattice (A = 1.638, Born exponent, n = 10), what is its lattice energy in kJ? The cell edge distance, d = 273 pm. 2 pt

b) Describe how the lattice energy of CuBr could be determined experimentally. Be specific and write any expressions that would need to be evaluated. 2 pt

c) Explain whether the calculated lattice energy from part a) likely to be fairly close to or considerably different from the real value. 1 pt

13. The ionic radius of Ag⁺ is 115 pm and that of F⁻ is 133 pm. What type of ionic lattice do you expect for AgF(s)? Name and sketch the AgF unit cell. 2 pt