Chemistry 2500 Final Exam **Name** _____

1. (36 points) Complete and balance each reaction shown below. Use smallest integer values possible for coefficients. Assume the requisite temperature for those that need it.

$Li_3N(s) + H_2O(l) \rightarrow$

$NaHCO_3(aq) + HC_2H_3O_2(aq) \rightarrow$

$CaC_2(s) + H_2O(l) \rightarrow$

$CaCN_2(s) + H_2O(l) \rightarrow$

$H_3BO_3(s) + \text{heat} \rightarrow$

$CH_4(g) + H_2O(g) \rightarrow$

$PbO(s) + C(s) \rightarrow$

$NO_2(g) + H_2O(l) \rightarrow$

$Li(s) + N_2(g) \rightarrow$

$TiO_2(s) + C(s) + Cl_2(g) \rightarrow$

$ZrCl_4(s) + Mg(s) \rightarrow$

$Na_2Cr_2O_7(s) + S(s) \rightarrow$

2. (30 points) Fill in the blank periodic table with the symbols of elements 1-86, exclusive of the f-block elements.

3. (12 points) The O–N–O bond angles in NO_2^+, NO_2, and NO_2^- are 180º, 134º, and 115º, respectively. Explain why.

4. (12 points) Concentrated nitric acid has a density of 1.44 g/mL and is a 70.0% mixture by weight. What is its molarity?

5. (12 points) Explain the chelate effect.

6. (12 points) Which is the weaker base, NF_3 or NH_3? Explain why.

7. (12 points) Describe the industrial production of sulfuric acid. Include balanced chemical reactions.

8. (12 points) Hydrofluoric acid is a weak acid in aqueous solutions with a pK_a of 4.1. What will be the pH of a 1.00 L aqueous solution that contains 10.0 g of the acid?

9. (16 points) Predict the geometries of the following molecules or polyatomic ions.

a) PCl_3

b) XeF_3^+

c) SF_4

d) ICl_2^-

10. (10 points) Give the two half-reactions that occur in your lead-acid storage battery when you start your car.

11. (12 points) Diagram the d orbitals of a transition metal in a square planar complex. Label all the orbitals. Assume the square plane is in the xy-coordinate plane.

12. (12 points) Give the coordination number for a metal atom in the following environments.

a) cubic closest packing

b) body-centered cubic

c) simple cubic

13. (12 points) Explain why $B(OH)_3$ is acidic but $Ga(OH)_3$ is basic.

Extra Credit (no more than 12 points) Nickel forms an anion $[NiCl_4]^{2-}$ that is square planar while the analogous zinc anion, $[ZnCl_4]^{2-}$ is tetrahedral. Explain the difference.