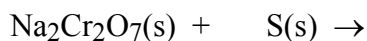
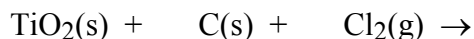
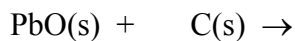
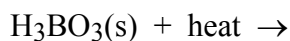
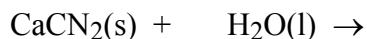


1. (36 points) Complete and balance each reaction shown below. Use smallest integer values possible for coefficients. Assume the requisite temperature for those that need it.



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  $\text{NO}_2^+$ ,  $\text{NO}_2$ , and  $\text{NO}_2^-$  are  $180^\circ$ ,  $134^\circ$ , and  $115^\circ$ , 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,  $\text{NF}_3$  or  $\text{NH}_3$ ? 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.