1. (48 points) Complete and balance each reaction shown below. Use smallest integer values possible for coefficients. Assume the requisite temperature for those that need it.

\[
\begin{align*}
\text{NH}_3(g) + \text{O}_2(g) & \rightarrow \\
\text{NO}(g) + \text{O}_2(g) & \rightarrow \\
\text{NO}_2(g) + \text{H}_2\text{O}(l) & \rightarrow \\
\text{NaNH}_2(s) + \text{NaNO}_3(s) & \rightarrow \\
\text{NaN}_3(s) + \text{heat} & \rightarrow \\
\text{NH}_4\text{NO}_3(aq) + \text{heat} & \rightarrow \\
\text{Cu(NO}_3)_2(s) + \text{heat} & \rightarrow \\
\text{TiO}_2(s) + \text{C(s) + Cl}_2(g) & \rightarrow \\
\text{TiCl}_4(l) + \text{Mg(s)} & \rightarrow \\
\text{TiCl}_4(l) + \text{O}_2(g) & \rightarrow \\
\text{Na}_2\text{Cr}_2\text{O}_7(s) + \text{S(s)} & \rightarrow \\
\text{MnO}_2(s) + \text{HCl(aq) } & \rightarrow \\
\text{Fe}_3\text{O}_4(s) + \text{CO(g) } & \rightarrow \\
\text{CuFeS}_2(s) + \text{O}_2(g) & \rightarrow \\
\text{Cu}_2\text{S(s) + O}_2(g) & \rightarrow \\
\text{Cu}_2\text{S(s) + Cu}_2\text{O(s) } & \rightarrow
\end{align*}
\]

2. (10 points) Give the name (not the symbol) of the element with the atomic number shown.

39:                       40:
41:                       42:
43:                       44:
45:                       46:
47:                       48:
3. (9 points) Name the following complexes.

   a) [Zn(en)$_2$]Br$_2$
   b) Na[Fe(H$_2$O)$_2$(C$_2$O$_4$)$_2$]
   c) [Co(en)$_2$Cl$_2$]

4. (9 points) Write the chemical formulae for the following complexes. (The abbreviation “en” may be used for ethylenediamine.)

   a) pentaaquabromomanganese(III) nitrate
   b) potassium hexacyanoferrate(II)
   c) sodium tetrachloro(ethylenediamine)cobaltate(III)

5. (8 points) Ortho-phenanthroline, C$_8$H$_6$N$_2$, is a bidentate ligand, commonly abbreviated “phen”. Use a d-orbital diagram to explain why [Fe(phen)$_3$]$^{2+}$ is diamagnetic while [Fe(phen)$_2$(H$_2$O)$_2$]$^{2+}$ is paramagnetic.

6. (8 points) Between the two complexes, hexacyanoferrate(III) and tetrachloroferrate(III), which is more likely to be high-spin and which is more likely to be low-spin? Explain your answer.

7. (8 points) Hydrogen azide reacts with diiodine in a 2:1 molar ratio. Deduce the products and give a complete and balanced reaction.