0. Having survived (I hope) one or more semesters, what is your current major? ______________

1. Write the molecular formula of a compound whose empirical formula is C₄H₃N and whose molecular weight is 195.223 g/mol. (6 points)

2. Complete the following table of ionic compounds and empirical formulas and determine whether each compound is soluble in H₂O (16 points):

<table>
<thead>
<tr>
<th>Empirical Formula</th>
<th>Name</th>
<th>Solubility</th>
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</thead>
<tbody>
<tr>
<td>NH₄CN</td>
<td></td>
<td></td>
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<tr>
<td>NaClO₂</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>lithium nitrate</td>
<td></td>
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<tr>
<td></td>
<td>lead (II) iodide</td>
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</tr>
</tbody>
</table>

3. Determine the number of moles of beryllium in 53.123 kg of beryllium fluoride. (6 points)

4. Write the complete atomic symbols for two different isotopes of $^{34}_{16}S$. (6 points)
5. Balance the following equation without adding any additional elements or compounds and determine how many grams of Cr may be produced from 11.3 g of Zn and excess Cr(NO\textsubscript{3})\textsubscript{2}. (10 points)

\[ \text{_____ Zn (s) + _____ Cr(NO_3)_2 (s) \rightarrow _____ Cr (s) + _____ ZnNO_3 (s)} \]

6. Balance the following reduction/oxidation reactions in acidic conditions using the half-reaction method, remember to add H\textsubscript{2}O and H\textsuperscript{+} to these equations as needed. (20 points)

\[ \text{_____ Al (s) + _____ Sn^{4+} (aq) \rightarrow _____ Al^{3+} (aq) + _____ Sn^{2+} (aq)} \]

\[ \text{_____ Na (s) + _____ IO_3^- (aq) \rightarrow _____ Na^+ (aq) + _____ I^- (aq)} \]

7. Calculate the total heat (in kJ) needed to heat 0.245 L of ethylene glycol from 25.3 °C to 213.0 °C which freezes at -77.0 °C and boils at 285.0 °C. The heat of fusion is -452.5 J/g, the heat of vaporization is 893.2 J/g, the specific heat is 2.420 J/g K and the density is 2.4511 g/ml. (16 points)
8. Calculate the DeBroglie wavelength of a neon atom moving at 1340 m/s. (10 points)

9. Determine the energy (in J) of a single photon of red light with a wavelength of 925 nm. (10 points)

10. Balance the following chemical equation and calculate the number of grams of disulfur dichloride that can be produced from 32.0 g of S\textsubscript{8} and 71.0 g of Cl\textsubscript{2} in this process. (8 points)

\[ \text{___ S}_8 \text{(l)} + \text{___ Cl}_2 \text{(g)} \rightarrow \text{___ S}_2\text{Cl}_2 \text{(g)} \]

11. Draw the ground state electron box notation and rare gas electron configuration for titanium, Ti. (8 points)
12. A compound containing only chromium, Cr, and oxygen was created by burning 51.31 g of Cr in exactly 63.14 g of oxygen. Write the empirical formula for this compound. (8 points)

13. Draw the Lewis dot structure for ICl$_3$ and describe both the structural pair and molecular geometries for this molecule. (12 points)

14. Give a complete valence bond description of the bonding in CO$_2$. Include hybridization of each atom and total number and location of sigma and pi bonds formed. (16 points)

15. Show the molecular orbital electron configuration for NO and NO$^+$. State whether these are paramagnetic or diamagnetic (12 points)
16. Arrange N, O, F, Ne, Na, Cs in order of electronegativity from highest (on the left) to lowest (on the right). (6 points)

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</thead>
<tbody>
<tr>
<td>Highest</td>
<td>Electronegativity</td>
<td>Lowest</td>
<td></td>
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17. Determine the final hydrogen ion concentration (in mol/L) in a solution prepared by diluting 33.23 ml of 15.332 M HNO$_3$ to 250.0 ml. (10 points)

18. Draw the Lewis dot structure for IO$_4^-$ and determine the oxidation number for each atom. (10 points)

19. Calculate the concentration of a NaOH solution when 35.32 ml are needed to titrate 25.00 ml of 0.1033 M HCl to the equivalence point. (10 points)

20. Bonus Question: Write the net ionic equation for a reaction when an aqueous solution of BaCl$_2$ is added to an aqueous solution of Na$_2$CO$_3$. (10 points)