Review Material for Exam #3

1. Radio waves for Rocket 101 are emitted at a frequency of 100.9 MHz. Calculate the wavelength, in m, of this radiation.

2. The green line in the atomic spectrum of thallium has a wavelength of 535 nm. Calculate the energy of a photon of this light.

3. Light with a wavelength of 465 nm lies in the blue region of the visible spectrum. Calculate the frequency of this light. What is the energy associated with this wavelength?

4. An electron in the 5th energy level of Be\(^{3+}\) goes down to the first level. Calculate:
   a. The change in energy (J) of the electron.
   b. The frequency of light emitted (s\(^{-1}\)).
   c. The wavelength of light emitted, in m and nm.

5. Calculate the frequency of electromagnetic radiation emitted by the hydrogen atom in the electron transition from \(n = 4\) to \(n = 3\). What is the wavelength (in nm) emitted?

6. State whether the following are valid sets of quantum numbers and if not why:

<table>
<thead>
<tr>
<th>(n)</th>
<th>(\ell)</th>
<th>(m_\ell)</th>
<th>(m_s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>+1/2</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>-1</td>
<td>-1/2</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>-2</td>
<td>+1/2</td>
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<tr>
<td>2</td>
<td>1</td>
<td>0</td>
<td>-1/2</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>-1/2</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>-3</td>
<td>+1/2</td>
</tr>
<tr>
<td>-4</td>
<td>1</td>
<td>0</td>
<td>+1/2</td>
</tr>
</tbody>
</table>

7. Draw the shapes (including the orientation) of all the s, p and d orbitals.

8. Give the ground state electron configuration for the following: S\(^{2-}\), Te\(^+\), V\(^{5+}\), Nb\(^{2+}\), Cu, Zn\(^+\), Cl\(^-\), Ba, Re, F, As\(^{3-}\), Cr

9. What is the atomic number and the complete electron configuration of the yet undiscovered element directly below Fr in the periodic table?

10. Which of the following atoms, Na, Mg, S, or K has the
    a. smallest atomic radius
    b. lowest ionization energy
11. Which of the following atoms, Ca, As, Br, or Rb has the
   a. largest atomic radius
   b. highest ionization energy

12. Which of the following are larger than an N atom?

13. On the basis of their position on the periodic table, select the atom with the larger atomic
    radius in each of the following pairs:
   a. Na, Cs   e. Ne, Xe
   b. Be, Ba   f. Na, P
   c. N, Sb   g. K, Ge
   d. F, Br   h. Al, Cl

14. Explain why it is unusual for IE\(_1\) of S to be lower than IE\(_1\) of P. Give a possible
    explanation.

15. Identify each ion:
   a. 3+ ion: \(1s^22s^22p^6\)
   b. 3+ ion: \(1s^22s^22p^63s^23p^63d^3\)
   c. 2+ ion: \(1s^22s^22p^63s^23p^64s^23d^{10}4p^65s^24d^{10}\)
   d. 2− ion: \(1s^22s^22p^63s^23p^64s^23d^{10}4p^6\)

16. Write the reaction of each of the oxides with water: K\(_2\)O, MgO, P\(_2\)O\(_5\), SO\(_2\), CO\(_2\).

17. Use a Born-Haber Cycle to calculate the missing energy (bold) of the following:

   a. \(\Delta H^{\circ}_f\) BeI\(_2\)(s) = \(-208\) kJ/mole BeI\(_2\)
      \(\Delta H_{\text{sublimation}}\) Be(s) = +302 kJ/mole
      Be(g) IE\(_1\) = +903 kJ/mole
      IE\(_2\) = +1757 kJ/mole
      \(\Delta H_{\text{dissociation}}\) I\(_2\)(s) = +107 kJ/mole I
      EA I(g) = -295 kJ/mole
      \(\Delta H_{\text{lattice}}\) BeI\(_2\)(s) = ? kJ/mole BeI\(_2\)

   b. Li(g) \(\rightarrow\) Li\(^+\)(g) + e\(^-\)   IE\(_1\) = +540 kJ/mole
      Li(s) \(\rightarrow\) Li(g)
      \(\frac{1}{2}\) O\(_2\)(g) \(\rightarrow\) O(g)   \(\Delta H_{\text{dissociation}}\) = ? kJ/mole O
      O(g) + 2 e\(^-\) \(\rightarrow\) O\(^2^-\)(g)
      2 Li\(^+\)(g) + O\(^2^-\)(g) \(\rightarrow\) Li\(_2\)O(s)
      2 Li(s) + \(\frac{1}{2}\) O\(_2\)(g) \(\rightarrow\) Li\(_2\)O(s)   \(\Delta H_{\text{lattice}}\) = -2800 kJ/mole Li\(_2\)O
      \(\Delta H^{\circ}_f\) = -554 kJ/mole Li\(_2\)O
c. \( \Delta H^o_{f \text{ MnS(s)}} \) = \(-212\) kJ/mole MnS

\( \Delta H_{\text{sublimation Mn(s)}} \) = ? kJ/mole

\( \text{Mn(g)} \)

\( \text{IE}_1 \) = +721 kJ/mole

\( \text{IE}_2 \) = +1509 kJ/mole

\( \Delta H_{\text{sublimation S(s)}} \) = +264 kJ

\( \text{S(g)} \)

\( \text{EA}_1 \) = -200 kJ/mole

\( \text{EA}_2 \) = +446 kJ/mole

\( \Delta H_{\text{lattice MnS(s)}} \) = \(-3176\) kJ/mole MnS

d. \( \Delta H^o_{f \text{ Th}_2\text{S}_3(s)} \) = ? kJ/mole

\( \Delta H_{\text{sublimation Th(s)}} \) = +528 kJ/mole

\( \text{Th(g)} \)

\( \text{IE}_1 \) = +590 kJ/mole

\( \text{IE}_2 \) = +1110 kJ/mole

\( \text{IE}_3 \) = +1930 kJ/mole

\( \text{IE}_4 \) = +2780 kJ/mole

\( \Delta H_{\text{dissociation S}_8(s)} \) = +279 kJ/mole S

\( \text{S(g)} \)

\( \text{EA}_1 \) = -200 kJ/mole

\( \text{EA}_2 \) = +589 kJ/mole

\( \Delta H_{\text{lattice Th}_2\text{S}_3(s)} \) = \(-10397\) kJ/mole

18. Draw the best Lewis structure of each of the following. Include all lone-pair electrons and non-zero formal charges on each atom:

\( \text{CCl}_4, \text{PH}_3, \text{O}_3, \text{CO}_3^{2-}, \text{NO}_3^-, \text{H}_2\text{CO}, \text{C}_2\text{H}_4, \text{N}_2, \text{SiF}_4, \text{HCN}, \text{NH}_4^+ \)