Chapter 2 Homework Problems

1. Electromagnetic waves A, B, and C are represented:

   Rank them (by letter) in order of
   __ < __ < __  (a) increasing frequency
   __ < __ < __  (b) increasing photon energy
   __ < __ < __  (c) increasing intensity (amplitude)
   __ < __ < __  (c) increasing wavelength
   — (d) If wave B just barely fails to cause a current when shining on metal, is wave A or C more likely to do so?
   — (e) If wave B represents visible radiation, is wave A or C more likely to be IR radiation?

2. An FM station broadcasts at 90.3 MHz (megahertz, or \(10^6\) s\(^{-1}\)). Find the wavelength (in m) of these waves.

3. An x-ray has a wavelength of 0.13 nm. Calculate the energy (in J) of one photon of this radiation.

4. Use either the Bohr equation or the Rydberg equation to calculate the wavelength (in nm) of the least energetic visible spectral line in the H atom.
5. An alpha particle (mass = $6.6 \times 10^{-24}$ g) emitted by radium travels at $3.4 \times 10^7 \pm 0.1 \times 10^7$ mi/h. Given the uncertainty in its velocity, what is the uncertainty in its position (in m)?

6. What is the de Broglie wavelength (in m) of a mosquito weighing 1.55 mg and flying at 1.38 m/s?

7. Are the following quantum number combinations allowed? If not, explain why not.
   
   (a) $n = 1$, $\ell = 0$, $m_\ell = 0$
   (b) $n = 2$, $\ell = 2$, $m_\ell = +1$
   (c) $n = 7$, $\ell = 1$, $m_\ell = +2$
   (d) $n = 3$, $\ell = -2$, $m_\ell = +2$

8. For each of the following sets of quantum numbers, give the sublevel designation, the allowable $m_\ell$ values, and the maximum number of electrons allowed to have that combination in an atom:

   Example: $n = 2$, $\ell = 0$
   
<table>
<thead>
<tr>
<th>Sublevel</th>
<th>$m_\ell$</th>
<th>max. # e$^-$</th>
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</thead>
<tbody>
<tr>
<td>2s</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
   
   (a) $n = 5$, $\ell = 1$
   (b) $n = 3$, $\ell = 2$
   (c) $n = 4$, $\ell = 3$
9. Given the following sets of quantum numbers, set up the orbital notation (labeled with the sublevel designation) for the indicated sublevel of electrons and circle the indicated orbital. Assume that electrons fill from more negative to more positive \( m_l \) values.

Example: \( n = 5, \ell = 1, m_l = 0 \) 
Answer: \( \bigcirc \)

\( \text{(a)} \) \( n = 3, \ell = 0, m_l \) = 0

\( \text{(b)} \) \( n = 2, \ell = 1, m_l = -1 \)

\( \text{(c)} \) \( n = 4, \ell = 3, m_l = -2 \)

\( \text{(d)} \) \( n = 4, \ell = 2, m_l = 0 \)

10. What is the maximum number of electrons in an atom that can have each of the following sets of quantum numbers or sublevel designations?

\( \text{(a)} \) \( n = 2, \ell = 1, m_l = 0 \)

\( \text{(b)} \) \( 5f \)

\( \text{(c)} \) \( n = 5, m_l = +1 \)

\( \text{(d)} \) \( n = 3, \ell = 2 \)

11. Write a full set of quantum numbers for the following. Assume that orbitals fill from more negative \( m_l \) values to more positive \( m_l \) values, and that spin up \( (m_s = +\frac{1}{2}) \) fills before spin down.

\( \text{(a)} \) The outermost electron in a Li atom

\( \text{(b)} \) The electron gained when a Br atom becomes a \( \text{Br}^- \) ion

\( \text{(c)} \) The electron lost when a Cs atom ionizes

\( \text{(d)} \) The highest energy electron in the ground state B atom

12. Write the complete electron configuration for each ground state atom.

\( \text{(a)} \) S

\( \text{(b)} \) Kr

\( \text{(c)} \) Hg
13. Write the noble gas electron configuration, draw the valence level orbital notation, and indicate whether each of the following are paramagnetic or diamagnetic atoms in the ground state. 

**Note:** silver has the same exception as copper

(a) Ba

(b) Co

(c) Ag

14. Valence level orbital notations for four ions are shown below. Identify the elements from which the ions are derived, and write the formula of the oxide each ion forms.

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<tr>
<td>5s</td>
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<tr>
<td>4s</td>
<td>3d</td>
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2+ ion 3+ ion 1+ ion 4+ ion

a) b) c) d)

15. How many core, outer, and valence electrons are present in an atom of each of the following elements?

<table>
<thead>
<tr>
<th>Core e^-</th>
<th>Outer e^-</th>
<th>Val. e^-</th>
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<tbody>
<tr>
<td>(a) Br</td>
<td>(b) Cd</td>
<td>(c) Cr</td>
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<tr>
<td>(d) Sr</td>
<td>(e) F</td>
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