Waves & Particles – Ch. 5

1. In the diagrams below, which wave has the higher frequency? Explain.

Higher frequency because more waves pass through the point in a second.

2. Briefly describe what Planck and Einstein contributed to the concept of Quantum Theory.

Planck's, Einstein E=hν, photoelectric effect to say e⁻ behave as particles.

From this, we have wave-particle duality.

3. One of the lines in the emission spectrum of sodium has a wavelength of 590 nm. What is the frequency of this line?

\[ V = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \text{ m/s}}{590 \times 10^{-9} \text{ m}} = 5.1 \times 10^{14} \text{ Hz} \]

4. A radio station broadcasts at a frequency of 91.3 MHz (9.13 \times 10^7 \text{ Hz}). What is the wavelength of this EM wave?

\[ \lambda = \frac{c}{V} = \frac{3.00 \times 10^8 \text{ m/s}}{9.13 \times 10^7 \text{ Hz}} = 3.29 \text{ m} \]

5. Calculate the energy of a gamma ray photon with a frequency of 6.0 \times 10^{22} \text{ Hz}.

\[ E = hν = (6.626 \times 10^{-34} \text{ J s})(6.0 \times 10^{22} \text{ Hz}) = 3.98 \times 10^{-11} \text{ J} \]

6. When an electron in a hydrogen atom drops from the fifth to the second energy level, 4.58 \times 10^{-19} \text{ J} of energy is released. Find the frequency of the photon that is produced.

\[ V = \frac{E}{h} = \frac{4.58 \times 10^{-19} \text{ J}}{6.626 \times 10^{-34} \text{ J s}} = 6.93 \times 10^{14} \text{ Hz} \]

7. Order the following regions of the EM spectrum from lowest to highest energy: infrared, microwaves, ultraviolet, visible red, visible green, X-rays.

Microwaves, infrared, visible red, visible green, UV, X-ray
## Electron Configuration – Ch. 5

### Part A – Orbital Diagrams & Longhand Electron Configuration

Use the patterns within the periodic table to draw orbital diagrams and write longhand electron configurations for the following atoms.

<table>
<thead>
<tr>
<th>Symbol</th>
<th># e⁻</th>
<th>Orbital Diagram and Longhand Electron Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mg</td>
<td>12</td>
<td>![Mg diagram] (1s^2 2s^2 2p^6 3s^2)</td>
</tr>
<tr>
<td>2. P</td>
<td>15</td>
<td>![P diagram] (1s^2 2s^2 2p^6 3s^2 3p^3)</td>
</tr>
<tr>
<td>3. V</td>
<td>23</td>
<td>![V diagram] (1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3)</td>
</tr>
<tr>
<td>4. Ge</td>
<td>32</td>
<td>![Ge diagram] (1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^2)</td>
</tr>
</tbody>
</table>

### Part B – Shorthand Electron Configuration

Use the patterns within the periodic table to write the shorthand electron configurations for the following elements.

<table>
<thead>
<tr>
<th>Symbol</th>
<th># e⁻</th>
<th>Shorthand Electron Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Ca</td>
<td>20</td>
<td>([\text{Ar}]4s^2)</td>
</tr>
<tr>
<td>6. Pb</td>
<td>82</td>
<td>([\text{Xe}]6s^2 4f^{14} 5d^{10} 6p^2)</td>
</tr>
<tr>
<td>7. F</td>
<td>9</td>
<td>([\text{He}]2s^2 2p^5)</td>
</tr>
<tr>
<td>8. Pd</td>
<td>46</td>
<td>([\text{Kr}]5s^2 4d^8)</td>
</tr>
</tbody>
</table>
Name: ___________ Period: ____ Date: ____ Teacher: Ms. Wagner

Problem Set #3
Electrons in Atoms 5: Chemistry
Show ALL Work! Use Significant Figures!

Calculate the wavelength from the following frequencies:
1. \(0.91 \text{ m} \quad 3.3 \times 10^8 \text{ Hz}\)
2. \(1.2 \times 10^7 \text{ m} \quad 23.1 \text{ Hz}\)

Calculate the frequency from the given wavelengths:
3. \(6.09 \times 10^{16} \text{ Hz} \quad 4.93 \times 10^{-9} \text{ m}\)
4. \(9.23 \times 10^4 \text{ Hz} \quad 325 \text{ nm}\)

5. According to the Bohr model, where are electrons found? \(\text{In fixed positions (orbits)}\)
6. Be able to define the following:
   a. Energy level-
   b. Quantum-
   c. Atomic orbital-
   d. Atomic Emission Spectra-
   e. Hund’s rule-
   f. Pauli Exclusion Principle-
   g. Aufbau Principle-

7. Arrange the following waves in order of increasing wavelength:
   a. Microwaves, gamma rays, x-rays, visible light, infrared

8. What is the maximum number of electrons that can go into each of the following sublevels?
   a. \(8\) second principal energy level
   b. \(2\) 2s
   c. \(6\) 3p
   d. \(10\) 5d
   e. \(14\) 4f

9. Write the electron configurations for the following compounds
   (You may use the noble gas configurations)
   a. \(\text{He} \quad [\text{Ne}]^{2}\) or \([\text{He}]^2\)
   b. \(\text{Ag} \quad [\text{Kr}] 5s^2 4d^9\)
   c. \(\text{Si} \quad [\text{Ne}] 3s^2 3p^2\)
   d. \(\text{Ni} \quad [\text{Ar}] 4s^2 3d^8\)
   e. \(\text{K} \quad [\text{Ar}] 4s^1\)
   f. \(\text{S} \quad [\text{Ne}] 3s^2 3p^4\)
10. Which element corresponds to each of the following electron configurations?
   a. $\text{Na} \quad 1s^2 2s^2 2p^6 3s^1$
   b. $\text{Mn} \quad 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$
   c. $\text{F} \quad 1s^2 2s^2 2p^5$

11. Draw orbital diagrams for the following elements and state how many unpaired electrons are present:
   a. $\text{N}$
   b. $\text{Mg}$

12. What is the difference between classical mechanics and quantum mechanics?

   Classical — everyday life
   Newton's laws

   Quantum — explain the ways subatomic particles behave
Problem Set #3
Electrons in Atoms 5: Honors Chemistry
Show ALL Work! Use Significant Figures!

Calculate the wavelength from the following frequencies:
1. \( 0.91 \text{ m} \) 3.3 \( \times \) 10\(^{8} \) Hz
2. \( 1.28 \times 10^{-1} \text{ m} \) 23.1 Hz

Calculate the frequency from the given wavelengths:
3. \( 6.09 \times 10^{16} \text{ Hz} \) 4.93 \( \times \) 10\(^{-9} \) m
4. \( 9.23 \times 10^{5} \text{ Hz} \) 325 nm

5. According to the Bohr model, where are electrons found? __in fixed positions called energy levels__

6. **Be able to define the following:**
   a. Energy level-
   b. Quantum-
   c. Atomic orbital-
   d. Atomic Emission Spectra-
   e. Hund’s rule-
   f. Pauli Exclusion Principle-
   g. Aufbau Principle-

7. Arrange the following waves in order of increasing wavelength:
   a. Microwaves, gamma rays, x-rays, visible light, infrared
   \[ \text{gamma, x-ray, visible, IR, microwave} \]

8. What is the maximum number of electrons that can go into each of the following sublevels?
   a. 8 second principal energy level
   b. 2 2s
   c. 6 3p
   d. 10 5d
   e. 14 4f

9. Write the electron configurations for the following compounds
   (You may use the noble gas configurations)
   a. He \([He] \) or \( 1s^2 \)
   b. Ag \([Kr]5s^24d^9 \)
   c. Ni\(^{2+}\) Ni \([Ar]4s^23d^8 \rightarrow [Ar]3d^8 \)
   d. K\(^{+}\) \([Ar] \)
10. Which element corresponds to each of the following electron configurations?
   a. Na \( 1s^2 2s^2 2p^6 3s^1 \)
   b. Mn \( 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5 \)

11. Draw orbital diagrams for the following elements and state how many unpaired electrons are present:
   a. N
     \( \begin{array}{c}
     1s \\
     2s \\
     2p
     \end{array} \)
     \( 3 \) unpaired e-
   b. Mg
     \( \begin{array}{c}
     1s \\
     2s \\
     2p
     \end{array} \)
     \( 0 \) unpaired e-

12. What is the difference between classical mechanics and quantum mechanics?
   Classical = Newton, quantum = subatomic particles

13. Write all the quantum numbers of all the electrons in the following atoms:
   a. Helium
     \( n=1, l=0, m_e=0, m_s=+\frac{1}{2}, -\frac{1}{2} \)
   b. Oxygen
     \( n=2, l=0, m_e=0, m_s=+\frac{1}{2}, -\frac{1}{2} \)
   c. Lithium
     \( n=2, l=0, m_e=0, m_s=+\frac{1}{2}, -\frac{1}{2} \)

14. What are the possible values of \( l \) for an electron with \( n=3 \)?
   \( l=0, 1, 2 \)

15. What are the possible values of \( m_l \) for an electron with \( l=2 \)?
   \( m_l=-2, -1, 0, 1, 2 \)

\( E=nh \) (h=Planck’s constant of \( 6.63 \times 10^{-34} \text{ J}\cdot\text{s} \))

16. \( 2.9 \times 10^{-32} \) The prominent yellow line in the spectrum of a sodium vapor lamp has a frequency of 43 Hz. What energy will be emitted?

17. \( 3.697 \times 10^{-31} \) What wavelength is required in order to have photochemical dissociation of \( \text{O}_2 \) with \( E=538 \times 10^3 \text{ J} \)?

\[ E=nhv = \frac{hc}{\lambda} \]
\[ \lambda = \frac{hc}{E} = \frac{(6.63 \times 10^{-34} \text{ J}\cdot\text{s})(3 \times 10^8 \text{ m/s})}{538 \times 10^3 \text{ J}} \]