Kinetic-Molecular Theory

1. Consider separate 1.0 liter gaseous samples of H₂, Xe, Cl₂, and O₂, all at 1 atm and 0°C. (a) Rank the gases in order of increasing average kinetic energy. (b) Rank the gases in order of increasing average velocity. (10 pts)

   a. increasing average kinetic energy: _______________________________________

   b. increasing average velocity: _______________________________________

2. Which gas effuses faster, and by how much: SF₆ or He? (10 pts)

Wavelength and Frequency

3. (a) How long (in minutes) does it take light to reach the Earth from the Sun? (Light travels at 3.00×10⁸ m/s. The distance from the Earth to the Sun is 93.0 million miles.) (b) The starship Enterprise receives a distress call from the civilian vessel Kobayashi Maru, which has struck a gravitic mine near the Neutral Zone. What is the distance (in km) between the vessels if it takes 2.00 minutes for the Enterprise to reach the Kobayashi Maru, traveling at Warp 1 (the speed of light)? (10 pts)
4. An FM station broadcasts classical music at 93.5 MHz. Find the wavelength (in m) of these radio waves. (10 pts)

5. What is the frequency (in Hz) of a photon of radiation with a wavelength of $2.00 \times 10^{-6}$ m? (10 pts)

The Energy of a Photon

6. What is the energy (in kJ/mol) of X-ray radiation having a wavelength of $2.00 \times 10^{18}$ Hz? (10 pts)

7. Ultraviolet radiation and radiation of shorter wavelengths can damage biological molecules because they carry enough energy to break bonds within the molecules. A carbon-carbon bond requires 348 kJ/mol to break. What is the longest wavelength (in nm) of radiation with enough energy to break carbon-carbon bonds? (10 pts)
The Quantum Mechanical Model of the Atom

8. The Quantum Numbers (10 pts)
   a. What are the possible values of the angular momentum quantum number, \( l \), when the principal quantum number, \( n \), is 3?
   b. What are the possible values of the magnetic quantum number, \( m_l \), when the angular momentum quantum number, \( l \), is 2?
   c. What are the possible values of the spin quantum number, \( m_s \), when the magnetic quantum number, \( m_l \), is 1?
   d. How many orbitals are there in an atom with the quantum numbers \( n = 5 \)?
   e. How many orbitals are there in an atom with the quantum numbers \( n = 4, l = 1 \)?

9. Orbitals (10 pts)
   a. How many orbitals are there in the 5\( d \) subshell? _____
   b. What is the maximum number of electrons that can be held in a set of 7\( s \) orbitals? _____
   c. Match each of the drawing below to the correct type of orbital (s, p, d, or f):
   
   
   ____  ____  ____  ____  ____
**Electron Configurations**

10. Write a complete electron configuration and orbital diagram for an atom of **sulfur**. Is a sulfur atom diamagnetic or paramagnetic? (10 pts)

   electron configuration: ________________________________

   orbital diagram:

   diamagnetic or paramagnetic?: __________

11. **Bonus.** Use the Rydberg equation to calculate the wavelength (in nm) of a photon emitted when a hydrogen atom undergoes a transition from $n=6$ to $n=3$. What part of the electromagnetic spectrum does this radiation correspond to? (+5 pts)