
Worksheet 4: Bohr Model of Atom, de Broglie, Heisenberg Uncertainty, Quantum Numbers

Concept questions: 7.67, 7.69**Bohr: 7.71, 7.73, 7.75, 7.81****deBroglie and Uncertainty: 7.51, 7.53, 7.55, 7.57,****Other problems: 7.100, 7.104**

- Without calculating any frequency values, predict which of the following transitions in the hydrogen atom is associated with radiation having the highest frequency:
 - from $n = 5$ to $n = 6$
 - from $n = 6$ to $n = 7$
 - from $n = 9$ to $n = 10$
 - from $n = 12$ to $n = 13$
- Without calculating any wavelength values, predict which of the following transitions in the hydrogen atom is associated with radiation having the shortest wavelength:
 - from $n = 1$ to $n = 2$
 - from $n = 2$ to $n = 3$
 - from $n = 3$ to $n = 4$
 - from $n = 4$ to $n = 5$
- What is the wavelength of the line in the hydrogen atomic spectrum corresponding to the transition from $n = 2$ to $n = 3$?
- Astronomers observing the constellation Bootes, which is 5.00×10^6 light-years from Earth, can see emission from the $n = 4$ to $n = 2$ transition of the H atom. What is the wavelength of this transition as viewed from Earth?
- For each of the following electronic transitions in the hydrogen atom, calculate the energy, frequency, and wavelength of the associated radiation and determine whether the radiation is emitted or absorbed during the transition:
 - from $n = 4$ to $n = 1$
 - from $n = 5$ to $n = 2$
 - from $n = 3$ to $n = 6$Do any of these transitions emit or absorb visible light?
- What are the wavelengths of the following objects:
 - an 85-kg person skiing at 50 km/hr
 - a 10.0 g-bullet fired at 250 m/s
 - a lithium atom moving at 2.5×10^5 m/s
- How rapidly would each of the following particles be moving if they all had the same wavelength as a photon of red light ($\lambda = 750$ nm)?
 - an electron
 - a proton (mass of proton = 1.67262×10^{-24} g)
 - a neutron (mass of neutron = 1.67493×10^{-24} g)
 - an α particle with a mass of 6.64×10^{-24} g
- Calculate the uncertainty in the position of
 - a 1.50-mg mosquito moving at a speed of 1.40 m/s if the speed is known to within ± 0.01 m/s
 - a proton moving at the speed of $(5.00 \pm 0.01) \times 10^4$ m/s
- How many orbitals are there in an atom with each of the following principal quantum numbers? 1, 2, 3, 4, and 5
- What are the possible values of the quantum number l when $n = 4$?
- What set of orbitals corresponds to each of the following sets of quantum numbers:
 - $n = 2, l = 0$
 - $n = 3, l = 1$

- c. $n = 4, l = 2$ d. $n = 1, l = 0$
12. How many electrons could occupy orbital(s) with the following quantum numbers?
- a. $n = 2, l = 0$ b. $n = 4, l = 2$
 c. $n = 3, l = 1, m_l = 0$ d. $n = 1, l = 0, m_l = 0$
13. Which of the following combinations of quantum numbers are allowed?
- a. $n = 1, l = 1, m_l = 0$ b. $n = 3, l = 0, m_l = 0$
 c. $n = 1, l = 0, m_l = -1$ d. $n = 2, l = 1, m_l = 2$

Key:

1. a 2. a 3. 656 nm
4. 486 nm
5. a. -2.04×10^{-18} J, 3.08×10^{15} Hz, 9.73×10^{-8} m, emit,
 b. -4.58×10^{-19} J, 6.91×10^{14} Hz, 4.34×10^{-7} m, emit,
 c. $+1.82 \times 10^{-19}$ J, 2.74×10^{14} Hz, 1.09×10^{-6} m, abs., Yes, b
- 6 a. 5.6×10^{-37} m b. 2.65×10^{-34} m c. 2.3×10^{-13} m
7. a. 9.70×10^2 m/s b. 5.28×10^{-1} m/s c. 5.27×10^{-1} m/s d. 1.33×10^{-1} m/s
8. a. $\Delta x \geq 4 \times 10^{-27}$ m b. $\Delta x \geq 3 \times 10^{-10}$ m
9. 1, 4, 9, 16, 25
10. 0, 1, 2, 3
11. a. 2s b. 3p c. 4d d. 1s
12. a. 2 b. 10 c. 2 d. 2
13. b