Fall 2007 CH301 Worksheet 2

1. A pool cue ball has a mass of 170 g. Assume that the position of the ball is known with an uncertainty of the width of a hydrogen atom, about 1.20 Å. What is the minimum uncertainty in its velocity?

2. Repeat the calculation, but this time with an electron, which has a mass of 9.11×10^{-31} kg. Does the uncertainty in the velocity become significant?

3. What is the de Broglie wavelength for the cue ball moving at a leisurely speed of 1 m/s?

4. What is the de Broglie wavelength of an electron moving at the not-so-leisurely speed of 100 km/s?

5. What is the de Broglie wavelength of a 70-kg person jogging at 2.5 m/s?

6. Stars can be treated as black-body radiators, so that their temperatures can be approximated from their spectra. The star Betelgeuse has a λ_{max} = 800 nm. What is the temperature of Betelgeuse, in degrees Celsius?

7. Given that Betelgeuse has a radius of 4.524×10^{11} m, how much power is emitted from Betelgeuse?

8. What is the minimum temperature at which a black body can be for its λ_{max} to be in the visible spectrum (400-700 nm)?

9. Explain briefly, in your own words, what is meant by "the ultraviolet catastrophe."

10. Which of the following sets of quantum numbers are valid of an electron? What is wrong with the ones that aren't?

(a) n = 1	l = 1	m_l = 0	m_s = ½
(b) n = 3	l = 1	m_l = -1	m_s = -½
(c) n = 2	l = 0	m_l = 0	m_s = 1
(d) n = 5	l = 2	m_l = -3	m_s = ½

11. Briefly explain the so-called “wave-particle duality.”

12. A scientist shines lights at a metal, but does not detect the release of any electrons. In classical theory, what should the scientist do to make some electrons be ejected?

13. What should the scientist actually do to get electrons to be emitted?

14. Once electrons are being emitted, what effect will increasing the intensity of the light have?

15. What effect will increasing the frequency have?

16. Calculate the energy of a photon with wavelength 550 nm.

17. What would be the wavelength of emission expected from the n = 4 to n = 2 transition for hydrogen?

18. What happens to the energy difference between levels as n increases for the particle in a box? What about for the hydrogen atom?

19. Why isn't the probability density for the electron in the hydrogen atom highest at the nucleus?

20. List the wavelengths of the wave functions for the first 3 energy levels of a particle in a box of length L.

21. What is the ground-state electron configuration for chlorine?

22. How many electrons go into each s orbital for n = 1 to 4? Each p orbital?

23. How many electrons can go into the n = 2 shell of an atom? The n = 3 shell?

24. List the following orbitals in order of increasing energy in the hydrogen atom: 3s, 2p, 5s, 3d, 4p, 4s

25. The Pauli exclusion principle states that no two electrons can have the same set of quantum numbers. What is the practical consequence of this when assigning electrons to orbitals?

26. What effect does shielding have on the energy of electrons in outer shells of a many-electron atom?

27. An atom has 4 electrons in its 2p subshell. In the boxes below, draw their configuration, using arrows to indicate the spins of the electrons.

28. How many electrons can go into the 3d subshell of an atom?

29. What is the ground state electron configuration of tungsten, W?

30. What is the meaning of "degenerate" with regard to atomic orbitals?

31. How many unpaired electrons are in the ground state of sulfur?

32. How many unpaired electrons are in the ground state of arsenic, As?

33. What is the ground-state electron configuration of Fe^{3+}?

34. An electron is located in a state with n = 5, l = 1,and m_l = 0. In what type of orbital is the electron located?

35. What would be the wavelength of emission expected from the n = 5 to n = 1 transition for hydrogen?

36. How many radial nodes are present in a 2s orbital?

37. How many electrons can go into the 2p subshell of an atom?

38. Give the principle and angular quantum numbers for (a) a 3d orbital and (b) a 4f orbital.

39. What physical characteristic of the orbital does l correspond to? What about m_l?

40. How many subshells are there in the electron shell with principle quantum number n = 6?