Chemistry II Study Guide over Atomic Structure and Periodicity (focus on book Chapters 5, 6, and 10)
4 points

Name: _____

Date: _____ Hour: _____

Topics/people to be covered on the December 4, 2009 test:

wavelength	frequency	$c=\lambda\nu$
ideas of Max Planck	$E=h\nu$	quanta
photons	relationship between E and λ	spectra
wave-particle duality of nature	de Broglie equation	Bohr model
ground state	relationship between E and energy level	degenerate
excited state	Heisenberg Uncertainty Principle	orbital shapes
Erwin Schrödinger	Pauli Exclusion Principle	Hund's rule
quantum numbers	history of the periodic table	periodic trends
Johann Döbereiner	Dmitri Mendeleev	John Newlands
orbital diagrams	Aufbau principle	valence e^-
chemical families	ionization energy	atomic radius
first ionization energy	electromagnetic radiation	e^- affinity

Practice questions:

1) What type of relationship (direct or indirect) exists between wavelength, frequency, and photo energy?

2) Microwave radiation has a wavelength on the order of 1.0 cm. Calculate the frequency and energy of a single photon of this radiation. [$\nu=3.0 \times 10^{10}$ Hz, $E = 2.0 \times 10^{23}$ J]

3) A photon of ultraviolet light has enough energy to mutate a strand of human DNA. What is the frequency and energy of a single UV photon with a wavelength of 25 nm? [$\nu=1.2 \times 10^{16}$ Hz, $E=8.0 \times 10^{-18}$ J]

4) One type of electromagnetic radiation has a frequency of 107.1 megahertz, another type has a wavelength of 2.12×10^{-10} m, and a third type has photons with energy equal to 3.97×10^{-19} J each. Identify each type of electromagnetic radiation and place them in increasing order of photon energy and frequency.

5) Calculate the de Broglie wavelength for a 55-gram tennis ball served at 35 m/s (~80 mph). [$\lambda=3.4 \times 10^{-34}$ m]

6) A particle has a velocity of 90.% of the speed of light and a wavelength of 1.5×10^{-15} m. What is its mass? [$m=1.6 \times 10^{-27}$ kg]

7) Calculate the wavelength of light emitted from each of the following transitions in a hydrogen atom AND identify the type of EMR emitted in each transition:

(a) from n=3 to n=2 [656.7 nm, red visible light]

(b) from n=4 to n=2 [486.4 nm, green visible light]

(c) from n=5 to n=3

8) Does a photon of visible light have sufficient energy to excite an electron in a hydrogen atom from the n=1 ground state to the n=5 excited state? [no]

9) An excited hydrogen atom in the n=5 state emits light having a frequency of 6.90×10^{14} Hz. Determine the energy level for the final state of the electron transition. [n=2]

10) What are the possible values for the four quantum numbers?

11) Which of these are incorrect: 1s, 1p, 7d, 9s, 3f, 4f, 2d?

12) Which of the following sets of quantum numbers is/are NOT allowed?

(a) $n = 3, \ell = 3, m_\ell = 0, m_s = +1/2$
(b) $n = 4, \ell = 3, m_\ell = 2, m_s = -1/2$
(c) $n = 4, \ell = 1, m_\ell = 1, m_s = +1/2$
(d) $n = 2, \ell = 1, m_\ell = -1, m_s = -1$
(e) $n = 5, \ell = -4, m_\ell = 2, m_s = +1/2$
(f) $n = 3, \ell = 1, m_\ell = 2, m_s = -1/2$

13) Give the maximum number of electrons in an atom that can have these quantum numbers:
(a) n = 4

(b) n = 5, $m_\ell = +1$

(c) n = 5, $m_s = +1/2$

(d) n = 3, $\ell = 2$

(e) n = 2, $\ell = 1$

14) (a) Draw orbital diagrams (arrows) for the elements Na, Co, and Kr.
(b) How many unpaired electrons are present in each element?

15) For elements 1-36, there are two exceptions to the filling order as predicted by the periodic table. Draw the orbital diagrams of the two exceptions and indicate how many unpaired electrons are present.

16) The elements Si, Ga, As, Ge, Al, Cd, S, and Se are all used in the manufacture of various semiconductor devices. Write the expected noble gas electron configuration for these atoms.
ex> lithium is [He] $2s^1$

17) Write the electron configuration for the following:
(a) The element with one unpaired 5p electron that forms a covalent compound with fluorine
(b) The as-yet-undiscovered alkali earth metal after radium
(c) the noble gas with electrons occupying 4f orbitals
(d) the first-row transition metal with the most unpaired electrons

18) In mercury,
(a) How many electrons occupy atomic orbitals with n = 3?
(b) How many electrons occupy d atomic orbitals?
(c) How many electrons have spin up?

19) Which of the following represent(s) an excited state? Write the ground state configuration for any that are excited. Indicate how many unpaired electrons are present in each of the ground state configurations.
(a) $1s^2 2s^2 3p^1$

(b) $1s^2 2s^2 2p^6$

(c) $1s^2 2s^2 2p^4 3s^1$

(d) $[Ar] 4s^2 3d^5 4p^1$

20) Arrange the following groups of atoms in order of increasing atomic radius (size):
(a) Te, S, Se

(b) K, Br, Ni

(c) Ba, Si, F

21) Arrange the elements in question 20 in order of increasing first ionization energy.

22) In each of the following, indicate which would have a smaller radius:
(a) H or He (b) Cl, In, or Se (c) Nb, Zn, or Si (d) Na^-, Na, or Na^+

23) Rank the elements, Be, B, C, N, and O in order of increasing first ionization energy. Explain your reasoning.

24) Compare the electron affinities of sulfur and oxygen. What accounts for the difference?

25) Barium emits photons of light with energies of 3.59×10^{-19} J. What color is that? [554 nm, yellow]