Atomic Structure

1. For a hydrogen atom which electron transition requires the largest amount of energy?

   A. n = 4 to n = 10
   B. n = 3 to n = 2
   C. n = 3 to n = 4
   D. n = 1 to n = 3
   E. n = 2 to n = 4

2. Which of the following do we use to understand quanta of light?

   I. The wavelength of a photon is directly proportional to its frequency;
   II. The frequency of a photon is directly proportional to its energy;
   III. A photon of light is released when an electron undergoes a transition from a low energy level to a level of higher energy.

   A. I only
   B. II only
   C. II and III
   D. I and III
   E. I, II and III

3. One of the emission lines in the spectrum of a hydrogen atom has a frequency of 7.40×10^{13} s^{-1}. Calculate the wavelength of this line in nanometers.

   A. 4.90×10^{-20} nm
   B. 4.90×10^{-11} nm
   C. 4.06×10^{-6} nm
   D. 4.06 nm
   E. 4.06×10^{3} nm

4. Which of the following is the best explanation for why the 3rd ionization energy in calcium is significantly greater compared to the first ionization energy in calcium.

   A. for a given element each successive ionization energy is significantly larger;
   B. the third electron is removed from n = 3 shell where the effective nuclear charge is six times higher compared to the effective nuclear charge on an electron in the n = 4 shell;

C. since the inner core electrons in each shell form a spherical shape, removing an electron will always be significantly greater compared to removing electrons from non-spherical orbitals;
D. electron-electron repulsions decrease for each successive inner shell of electrons, lower electron-electron repulsions means higher ionization energy;
E. in calcium since the 3d orbital's are empty, the first ionization energy is significantly smaller than usual, making the third ionization energy appears significantly larger.

5. The effective nuclear charge on an electron in n = 3 shell in a copper atom is,

A. +1
B. +11
C. +17
D. +19
E. +27

6. When an electron occupies the n = 4 shell in a hydrogen atom
A. the energy required to ionize the atom from the n = 4 level is less than the energy required to ionize the atom when the electron is in the n = 1 level;
B. energy will have to be gained for the electron to get to the n = 1 shell;
C. the electron must go to n = 0 level to be ionized;
D. energy will have to be lost to ionize the electron;
E. the atom must absorb a photon for the electron to move to the n = 3 level or any other level below the n = 4 level.

7. How many unpaired electron does the element iron, Fe, have?

A) 0
B) 2
C) 4
D) 5
E) 6

8a. Write the complete electron configuration and indicate the number of unpaired electrons for each of the following species in their ground state,

i. Si ——— unpaired electrons

ii. I

_____ unpaired electrons

iii. Pm

_____ unpaired electrons

b) Show the orbital diagram (clearly labeled) for the valence electrons for Cl.

9. Briefly explain each of the following statements.

a) the first ionization energy for sodium is very much smaller than the second ionization for sodium; (8)

b) the atomic radius for potassium is larger than the atomic radius for Ca; (NOTE: Be sure to include both species in your explanation.) (8)

c) Given the following first ionization energies (in units of kJ mol^{-1}) (9)

Li	Be	B	C	N	O	F
520	899	801	1086	1402	1314	1681
Na	Mg	Al	Si	P	S	Cl
496	?	578	786	1012	1000	1251

Estimate the first ionization energy for magnesium and describe, at least, three different ionization energy trends, from the periodic table, you used to arrive at your estimate.

Use these responses for Questions 10 - 12. (A response can be used more than once or not at all.)

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$
D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3d^3$
E. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

10. a Group II metal;

11. a transition metal ion.

12. a noble gas.

13. The wavelength of a photo of light emitted by fireworks is 650 nm. Calculate the frequency of this light.

A) $4.31 \times 10^{-31}\ s^{-1}$
B) $4.62 \times 10^{5}\ s^{-1}$
C) $1.95 \times 10^{11}\ s^{-1}$
D) $2.17 \times 10^{-15}\ s^{-1}$
E) $4.62 \times 10^{14}\ s^{-1}$

14. The energy of a photon of light released from a hydrogen atom is 2.04×10^{-18} J. If the electron is originally in the n = 4 level, what level does the electron occupy after emitting the photon?

A) n = 1
B) n = 2
C) n = 3
D) n = 4
E) n = 5

Use the following choices to answer Q15 and Q16. (A response can be used more than once or not at all.)

A. O
B. Mg
C. Si
D. P
E. Cl

15. Has valence electrons that experience an effective nuclear charge of +6.

16. Has electrons in the second level that experience an effective nuclear charge of +13.

17. When an electron occupies the n = 6 shell in a hydrogen atom
A. energy will have to be lost to ionize the electron;
B. energy will have to be gained for the electron to get to the n = 1 shell;
C. the electron must go to n = 0 level to be ionized;
D. the energy required to ionize the atom from the n = 6 level is less than the energy required to ionize the atom when the electron is in the n = 1 level;
E. the atom must absorb a photon for the electron to move to the n = 5 level or any other level below the n = 6 level.