1. What is the principal quantum number of the lowest energy d subshell?
   A. 1
   B. 2
   C. 3
   D. 4
   E. 5

2. How many unpaired electrons are in the ground state of Fe?
   A. 0
   B. 1
   C. 2
   D. 3
   E. 4

3. Which of the following ions has the largest ionic radius?
   A. \( \text{Cl}^- \)
   B. \( \text{Al}^{3+} \)
   C. \( \text{Mg}^{2+} \)
   D. \( \text{Na}^+ \)
   E. \( \text{H}^+ \)

4. Which of the following statements is true?
   A. \( ^{19}_{\text{F}}F^- \) has more protons than neutrons.
   B. \( ^{2}_{\text{H}}H^+ \) has more electrons than protons.
   C. \( ^{12}_{\text{C}}N \) has more neutrons than \( ^{12}_{6}C \).
   D. \( ^{20}_{10}Ne \) has the same number of protons and neutrons.
   E. \( ^{19}_{5}F^- \) has fewer electrons than \( ^{20}_{10}Ne \)

5. What is the frequency associated with green light that has \( \lambda = 532 \) nm?
   A. \( 5.64 \times 10^5 \) Hz
   B. \( 1.74 \times 10^{-15} \) Hz
   C. \( 1.74 \times 10^6 \) Hz
   D. \( 5.64 \times 10^{14} \) Hz
   E. 532 Hz

6. Which of the following shows an incorrect set of quantum numbers for an electron in the given orbital?

<table>
<thead>
<tr>
<th>Orbital</th>
<th>n</th>
<th>l</th>
<th>m_l</th>
</tr>
</thead>
</table>
   A. 2s    | 2 | 0 | 0   |
   B. 1s    | 1 | 0 | 0   |
   C. 2p    | 2 | 1 | 0   |
   D. 3p    | 3 | 1 | -1  |
   E. 4d    | 4 | 0 | 0   |
7. Which of the following represents an orbital in which a 3d electron could be found?

![diagram]

A. 1 only  
B. 2 only  
C. 4 only  
D. 1 and 4 only  
E. 3 and 5 only

8. Rank the following in order of increasing polarity.


A. Cl – Cl < K – F < C – F < C – O  
B. Cl – Cl < C – F < C – O < K – F  
C. Cl – Cl < C – O < C – F < K – F  
D. K – F < Cl – Cl < C – O < C – F  
E. C – O < C – F < K – F < Cl – Cl

9. Which one of these molecules does NOT have a lone pair on the central atom?

A. NH₃  
B. H₂O  
C. PO₄³⁻  
D. ICl₄⁻  
E. XeF₂

10. How many valence electrons are there in the carbonate ion (CO₃²⁻)?

A. 20  
B. 22  
C. 24  
D. 26  
E. 28

11. Which one of the following has the strongest H — X bond?

A. H—Cl  
B. H—Br  
C. H—F  
D. H—I  
E. H—S—H
12. An unknown liquid has a density of 2.14 g/mL. How many mm$^3$ would a 6.42 mg sample of this liquid occupy if dispensed into a 10 mm$^3$ test tube? Remember that 1 mL = 1 cm$^3$.

A. 3.00 mm$^3$
B. 1.37 mm$^3$
C. $3.00 \times 10^{-2}$ mm$^3$
D. $3.32 \times 10^{-3}$ mm$^3$
E. $1.37 \times 10^{-2}$ mm$^3$

13. The average atomic mass of copper, which has only two naturally occurring isotopes is 63.5 amu. One of the isotopes, $^{63}$Cu, has an atomic mass of 62.9 amu and 69.1% abundance. What is the atomic mass of the second isotope?

A. 63.2 amu
B. 63.8 amu
C. 64.1 amu
D. 64.8 amu
E. 65.1 amu

14. List the following electromagnetic waves in the order of increasing wavelength.

Microwave, UV, Visible light, IR, X-ray

A. Microwave < X-ray < UV < Visible light < IR
B. X-ray < Microwave < UV < Visible light < IR
C. UV < Visible light < IR < Microwave < X-ray
D. Visible light < IR < UV < Microwave < X-ray
E. X-ray < UV < Visible light < IR < Microwave

15. Which of the following electronic transitions of a H atom results in the emission of light with the shortest wavelength?
16. [Kr] 5s\(^1\)5p\(^1\) is an excited state electron configuration for which neutral atom?

A. Ga  
B. Rb  
C. Sr  
D. Y  
E. In

17. What is the electron configuration of the cobalt ion in Co(NO\(_3\))\(_3\)?

A. [Ar] 4s\(^2\)  
B. [Ar] 4s\(^1\)3d\(^5\)  
C. [Ar] 4s\(^2\)3d\(^4\)  
D. [Ar] 3d\(^6\)  
E. [Ar] 3d\(^7\)

19. Which of these is an incorrect Lewis structure?

A. i only  
B. ii only  
C. iii only  
D. i and ii  
E. all three are incorrect

20. Which of the following can have three equivalent resonance structures?

I. NO\(_2\)\(^-\)  II. NO\(_3\)\(^-\)  III. SO\(_2\)  IV. BrO\(_3\)\(^-\)

A. I and II  
B. I, II and IV  
C. III and IV  
D. II and IV  
E. II only
21. Which one of the following molecules obeys the octet rule?

A. ClO₂  
B. CF₄  
C. SF₄  
D. ICl₄⁻  
E. KrF₂

22. The isotope of an unknown element, X, has a mass number of 33. The most stable ion of the isotope has 18 electrons and forms a binary compound with sodium having a formula of Na₂X. Which of the following statements is true?

A. The binary compound formed between X and fluorine will be a covalent compound.  
B. The isotope of X contains 20 protons.  
C. The isotope of X contains 15 neutrons.  
D. The identity of X is chlorine, Cl.  
E. All of the above.

23. Which of these electrostatic interactions has the lowest potential energy?

A. an electron 5.5 nm from an anion with a charge of −1  
B. an electron 4.2 nm from an anion with a charge of −2  
C. an electron 3.7 nm from an anion with a charge of −1  
D. an electron 4.2 nm from an anion with a charge of −1  
E. an electron 5.5 nm from an anion with a charge of −2

24. How many photons are contained in a 0.200 mJ burst of light shown below?

A. 4.99 × 10¹⁴  
B. 4.99 × 10²³  
C. 6.08 × 10²⁶  
D. 1.82 × 10¹⁵  
E. 1.82 × 10⁴⁴
25. An electron is excited from the n=1 ground state to the n=3 state in a hydrogen atom. Which of the following statements is false?

A. It takes less energy to ionize (completely remove) the electron from n=3 state than from ground state.
B. The electron is farther from the nucleus on average in the n=3 state than in the n=1 state.
C. The wavelength of light emitted if the electron drops from n=3 to n=2 will be shorter than the wavelength of light emitted if the electron falls from n=3 to n=1.
D. The wavelength of light emitted when the electron returns to the ground state from n=3 will be the same as the wavelength of light absorbed to go from n=1 to n=3.
E. For n=3, the electron is in the second excited state.

26. What is the wavelength of light emitted from an H atom upon the electronic transition of n_i=3 to n_f=1 according to the Bohr model?

A. $1.37 \times 10^{-7}$ m
B. $1.03 \times 10^{-7}$ m
C. $3.42 \times 10^{-16}$ m
D. $1.14 \times 10^{-24}$ m
E. $1.28 \times 10^{-51}$ m

27. Which ground state electron configuration shown below belongs to the atom with the highest (most positive) second ionization energy?

A. $1s^2 2s^2 2p^6 3s^1$
B. $1s^2 2s^2 2p^6 3s^2$
C. $1s^2 2s^2 2p^6 3s^2 3p^1$
D. $1s^2 2s^2 2p^6 3s^2 3p^4$
E. $1s^2 2s^2 2p^6 3s^2 3p^5$

28. If the minimum energy required to break the oxygen-oxygen bond in O_2 is 495 kJ/mole, what is the longest wavelength of radiation that possesses the necessary energy to break the bond in one molecule?

A. 242 nm
B. 125 nm
C. 454 nm
D. 655 nm
E. 283 nm
CHEMISTRY 110 EXAM 1
SEPTEMBER 19, 2011
Answer Key

FORM A
1. C
2. E
3. A
4. D
5. D
6. E
7. D
8. C
9. C
10. C
11. C
12. A
13. D
14. E
15. D
16. C
17. D
18. D
19. D
20. E
21. B
22. A
23. A
24. A
25. C
26. B
27. A
28. A