Fall 2008 CH301--The TA's gift to you—a practice exam 1

1. What is the energy (E) of a photon that has a wavelength (λ) of 70 nm?
    A. 2.84×10^{-18} J
    B. 6.51×10^{-19} J
    C. 7.52×10^{-19} J
    D. 1.28×10^{-18} J
    E. 3.27×10^{-17} J

2. Which if the following statement(s) is/are true?
    I.   Since it is observed experimentally that blackbody radiators emit less power at higher frequencies, the power radiated must be inversely proportional to the square of the frequency.
    II.   The failure of classical mechanics to predict the behavior of blackbody radiators is called the photoelectric effect.
    III.   After the threshold frequency is reached, further increasing the frequency of light would increase the velocity of ejected electrons.
    IV.   The quantized energy levels of electrons result in the continuous absorption/emission spectra of gases.

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

3. For the hydrogen atom, emitted light with a frequency of 2.35×10^{14} Hz corresponds most closely to an electronic transition between which two energy levels?
    A. 2 and 3
    B. 1 and 2
    C. 1 and 3
    D. 3 and 5
    E. 4 and 5

4. Which of the following statement(s) is/are true regarding Particle in a Box?
    I.   The Energy of the particle is nonzero and continuous.
    II.   The number of possible wavelengths is limited by boundary conditions
    III.   Within a given energy level, as the length of the box increases, the energy of the particle decreases
    A.   I, II, and II
    B.   I only
    C.   II only
    D.   I and II
    E.   II and III

5. If we know the position of an electron (mass: 9.1×10^{-31} kg) with an uncertainty of 10^{-7} m, what would be the minimum uncertainty in the electrons's velocity?

    A. 580 m·s^{-1}
    B. 610 m·s^{-1}
    C. 670 m·s^{-1}
    D. 750 m·s^{-1}
    E. 800 m·s^{-1}

6. What is the deBroglie wavelength (λ) of an 800g object traveling at 30.0 $m \cdot hr^{-1}$?
   - A. 5.25×10^{-32} m
   - B. 9.94×10^{-32} m
   - C. 6.23×10^{-32} m
   - D. 7.59×10^{-32} m
   - E. 8.37×10^{-32} m

7. Which of the following statement(s) is/are true regarding the Schrödinger and wave equations?
   - I.   The exact location of the electron can be calculated using the Schrödinger equation.
   - II.   Three dimensional solutions to the Schrödinger equation are done using polar coordinates because it simplifies the math.
   - III.   Every solution to the Schrödinger equation contains at least one repulsive potential energy term.

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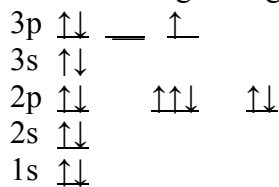   - D.   I and III
   - E.   II and III

8. Which of the following is not a possible set of quantum numbers?
   - A. $n = 4$, $l = 3$, $m_l = -1$, $m_s = \frac{1}{2}$
   - B. $n = 1$, $l = 0$, $m_l = 0$, $m_s = \frac{1}{2}$
   - C. $n = 3$, $l = 1$, $m_l = -1$, $m_s = -\frac{1}{2}$
   - D. $n = 5$, $l = 4$, $m_l = -5$, $m_s = -\frac{1}{2}$
   - E. $n = 9$, $l = 8$, $m_l = 6$, $m_s = \frac{1}{2}$

9. Which of the following is not a possible set of quantum numbers?
   - A. $n = 3$, $l = 2$, $m_l = -2$, $m_s = -\frac{1}{2}$
   - B. $n = 2$, $l = 1$, $m_l = -1$, $m_s = \frac{1}{2}$
   - B. $n = 5$, $l = 0$, $m_l = 2$, $m_s = 1$
   - C. $n = 7$, $l = 5$, $m_l = -5$, $m_s = -\frac{1}{2}$
   - D. $n = 8$, $l = 0$, $m_l = 0$, $m_s = \frac{1}{2}$

10. The following configuration violates which rule(s)?
    3p ↑↓ __ ↑
    3s ↑↓
    2p ↑↓   ↑↑↓   ↑↓
    2s ↑↓
    1s ↑↓

    - I.   Aufbau Principle
    - II. Pauli Exclusion Principle
    - III. Hund's Rule

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

11. The electron configuration $[Ar]4s^23d^{10}4p^4$ could be the electron configuration of which of the following?
    1. Se
    2. As^{2-}
    3. S
    4. Te
    5. None of them

12. The electron configuration $[Ar]4s^23d^9$ could be the electron configuration of which of the following?
    D. Ag
    E. Ni
    F. Cu
    G. Zn
    H. None of them

13. The electron configuration $[Kr]5s^14d^5$ could be the electron configuration of which of the following?
    1. Nb
    2. Tc
    3. Mo
    4. Cr
    5. None of them

14. Which of the following correctly describes period(s) and group(s) in the periodic table?
    III.   Periods are the eighteen columns, groups are the seven rows.
    IV.   Groups are the eighteen columns, periods are the seven rows.
    V.   Groups and periods are synonyms for the columns.
    VI.   Groups and periods are synonyms for the rows.
    VII.   The group is the main block of the period table while the period includes only the lanthanide series and actinide series.

15. What best explains the increase in ionization energy up and to the right of the periodic table?
    1. Increasing effective nuclear charge.
    2. Decreasing electron affinity.
    3. Increasing electronegativity.
    4. Increasing atomic radius.
    5. Decreasing shell stability.

16. Rank the following species from least to greatest ionization energy: Oxygen (O), Potassium (K), Sulfur (S) and Sodium (Na).
    J. $S < O < Na < K$
    K. $Na < K < O < S$
    L. $K < Na < O < S$
    M. $K < Na < S < O$
    N. $O < S < K < Na$

17. Rank the following from least to greatest ionization energy: C, N, O
    1. $O < C < N$
    2. $O < N < C$
    3. $C < N < O$
    4. $C < O < N$
    5. $N < C < O$

18. Which of the following is the correct lewis structure for NH₄Cl?

1.
```
     H
     |   +           ..  ‾
H—N—H ,      [:Cl:]
     |               ..
     H
```

2.
```
     H
     |  +           ..  ‾
H—N      ,     [ H-Cl:]
     |               ..
     H
```

3.
```
     H
     |  +           ..  ‾
H—N:     ,     [H-Cl:]
     |               ..
     H
```

4.
```
     H
     |  2+          ..       2-
    :N:      ,   [H—Cl—H ]
     |            ..
     H
```

5.
```
     H
     |      2-            2+
H—:N:—H ,      [:Cl:]
     |
     H
```

19. Using charge density, rank the lattice energy of the following compounds from least to greatest: KF, BeO, MgS, MgBr₂.
   A. BeO < MgS < MgBr₂ < KF
   B. KF < BeO < MgS < MgBr₂
   C. BeO < KF < MgBr₂ < MgS
   D. MgBr₂ < MgS < BeO < KF
   E. KF < MgBr₂ < MgS < BeO

20. Which of the following species would have three resonance structures?
   1. CH₃COO‾
   2. NO₂‾
   3. NO₃‾
   4. HCN
   5. SO₂

21. How many single and double bonds are in the correct Lewis structure methanol (CH₃OH)?
   1. 5 single bonds and 0 double bonds.
   2. 3 single bonds and 1 double bond.
   3. 4 single bonds and 1 double bond.
   4. 6 single bonds and 0 double bonds.
   5. 5 single bonds and 1 double bond.

22. Based on their Lewis structures, which of the following atoms would be considered radicals?
   I.   C
   II.   N
   III.   O
   IV.   F
   1. II and IV
   2. I and III
   3. I, II and III
   4. II, III and IV
   5. II and III
   6. I and IV

23. Which group on the periodic table contains at least one element likely to form stable covalent compounds that have fewer than 8 valence electrons on their central atom?
   1. Group 4
   2. Group 7
   3. Group 6
   4. Group 3
   5. Group 5

24. How many double bonds area found in the Lewis structure of ethanoic acid (CH_3COOH)?
   1. 6
   2. 0
   3. 2
   4. 5
   5. 1

25. Which of the following electronic geometries is reserved for hypervalent compounds?
   1. linear
   2. trigonal planar
   3. trigonal bipyramidal
   4. tetrahedral
   5. dodecahedral
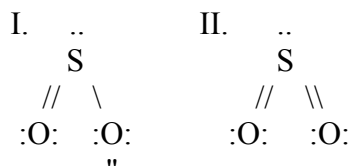
26. What would be the electronic geometry of Br_3^-?
   1. trigonal bipyramidal
   2. square pyramidal
   3. octahedral
   4. tetrahedral
   5. icosohedral

27. What is the formal charge on the Xenon atom (Xe) in XeF_2?
   1. -2
   2. 2
   3. 0
   4. 6
   5. -4

28. Based on formal charge considerations, which of the following is a better Lewis structure for sulfur dioxide (SO_2)?

    I.   ..   II.   ..
       S   S
      // \\   // \\
   :O: :O: :O: :O:
        "

1. Structure 2 is better based on formal charge considerations.
2. Structure 1 is better based on formal charge considerations.
3. Both structure are equivalent based on formal charge considerations.
4. Neither structure is a correct Lewis structure for SO_2.

29. Rank the following diatomic molecules in terms of decreasing electronegativity difference (ΔEN): HI, HF, HBr, HCl,

1. HI < HF < HCl < HBr
2. HI < HBr < HCl < HF
3. HCl < HBr < HI < HF
4. HF < HCl < HBr < HI
5. all have the same electronegativity difference.

30. Which of the bonds below is not correctly paired with its electronegativity difference (ΔEN)?

1. C-H ; 0.3
2. B-F ; 2.5
3. C-O ; 0.5
4. N-N ; 0
5. Si-Si ; 0