Name _____

SSN _____

CHEM 121a Exam 4 Fall 1998

This exam consists of 8 true-false questions (each worth 2 pts), 20 multiple choice questions (each worth 3 pts), and 3 short problems (each worth 8 pts). There are a total of 100 possible points.

True-False

If the statement is true, do nothing. If the statement is false, write a replacement for the underlined word, phrase, or number to make the statement true.

1. The bonds between hydrogen and oxygen atoms in a water molecule can be characterized as <u>polar covalent</u> bonds. _____

2. The strongest interactions between molecules in liquid water are best characterized as <u>London dispersion forces</u>. _____

3. Liquids with large intermolecular forces tend to have <u>low</u> viscosities. _____

4. The <u>lattice energy</u> is the change in energy when separated gaseous ions are packed together to form an ionic solid. _____

5. An antibonding molecular orbital is <u>higher</u> in energy than the atomic orbitals from which it is composed. _____

6. Larger bond order means <u>greater</u> bond strength. _____

7. Breaking a bond is an <u>exothermic</u> process. _____

8. The molecule HCN has two π bonds and <u>one</u> σ bond(s). _____

Multiple Choice

Please print your name and the "Test Color" on your Scantron sheet. Carefully mark the appropriate answer to each question on the Scantron sheet, and show any work in the space provided. Please hand in <u>both</u> the Exam and the Scantron sheet.

1. In which pair do both compounds exhibit predominantly ionic bonding?

   a. PCl_5 and HF
   b. Na_2SO_3 and BH_3
   c. KI and O_3
   d. NaF and H_2O
   e. RbCl and CaO

2. Which of the following bonds is the most polar?

   a. H−Cl
   b. H−S
   c. H−C
   d. H−F
   e. H−O

3. Which of the following molecules has a dipole moment?

a. CH_4
b. CCl_4
c. CO_2
d. H_2S
e. H_2

4. Consider the following:

I. Al, Si, P, S
II. Be, Mg, Ca, Sr
III. I, Br, Cl, F
IV. Na^+, Mg^{2+}, Al^{3+}, Si^{4+}

Which of these is an isoelectronic series?

a. IV
b. III
c. II
d. I
e. none of these

5. Which of the following has the smallest ionic radius?

a. Ca^{2+}
b. Cl^-
c. Li^+
d. O^{2-}
e. Be^{2+}

6. In the Lewis structure for elemental nitrogen there is (are)

a. a single bond between the nitrogens.
b. a double bond between the nitrogens.
c. a triple bond between the nitrogens.
d. three unpaired electrons.
e. none of these.

7. The bond angles about the carbon atom in the formaldehyde molecule, $H_2C{=}O$, are about:

a. 120°
b. 60°
c. 109°
d. 180°
e. 90°

8. Which of the following has an incomplete octet in its Lewis structure?

a. SO_2
b. ICl
c. CO_2
d. F_2
e. NO

9. Which of the following molecules contains an $sp^2{-}sp^2$ σ bond?

a. CH_4
b. C_2H_2
c. C_2H_4
d. C_2H_6
e. none of these

10. In the BeF_2 molecule the Be valence orbitals are:

a. sp hybrids
b. sp^2 hybrids
c. sp^3 hybrids
d. dsp^2 hybrids
e. none of these

11. The hybridization of the central atom in NO_3^- is

a. p^3
b. sp^2
c. sp^3
d. sp^2d
e. sp

12. Which of the following substances contains two π bonds?

a. C_2H_4
b. C_3H_8
c. C_2H_2
d. C_2H_6
e. CH_4

13. Which of the following diatomic molecules has a bond order of 2?

a. B_2
b. C_2
c. P_2
d. F_2
e. Na_2

14. Which of the species below would you expect to show the least hydrogen bonding?

a. NH_3
b. H_2O
c. HF
d. CH_4
e. all the same

15. Which of the following is the correct order of boiling points for KNO_3, CH_3OH, C_2H_6, Ne?

a. $Ne < CH_3OH < C_2H_6 < KNO_3$
b. $KNO_3 < CH_3OH < C_2H_6 < Ne$
c. $Ne < C_2H_6 < KNO_3 < CH_3OH$
d. $Ne < C_2H_6 < CH_3OH < KNO_3$
e. $C_2H_6 < Ne < CH_3OH < KNO_3$

16. The elements of group 5A, the nitrogen family, form compounds with hydrogen having the boiling points listed below:

. SbH_3 −17 °C, AsH_3 −55 °C, PH_3 −87 °C, NH_3 −33 °C

The first three elements illustrate a trend where the boiling point decreases as the mass decreases; however, ammonia (NH_3) does not follow the trend because of

a. dipole-dipole attraction.
b. metallic bonding.
c. hydrogen bonding.
d. London dispersion forces.
e. ionic bonding.

17. The unit cell in a certain lattice consists of a cube formed by an anion at each corner, an anion in the center, and a cation at the center of each face. The unit cell contains a net:

a. 5 anions and 6 cations.
b. 5 anions and 3 cations.
c. 2 anions and 3 cations.
d. 3 anions and 4 cations.
e. 2 anions and 2 cations.

18. The freezing point of helium is −270 °C. The freezing point of xenon is −112 °C. Both of these are in the noble gas family. Which of the following statements is supported by these data?

a. Helium and xenon form highly polar molecules.
b. As the molecular weight of the noble gas increases, the freezing point decreases.
c. The London dispersion forces between the helium molecules are greater than the London dispersion between the xenon molecules.
d. The London dispersion forces between the helium molecules are less than the London dispersion forces between the xenon molecules.
e. none of these

19. Which substance can be described as cations bonded together by mobile electrons?

a. Ag(s)
b. S_3(s)
c. Kr(l)
d. KCl(s)
e. HCl(l)

20. First order diffraction (n = 1) is observed from the closest-packed planes of nickel metal at an angle of $\theta = 20.9\ °$. If 1.54 Å X-rays were used in the diffraction study, determine the spacing between the closest-packed planes. The Bragg equation is: $n\lambda = 2d \sin\theta$.

a. 198 Å
b. 2.16 Å
c. 1.54 Å
d. 1.11 Å
e. 0.357 Å

Written Problems

Write out the solutions to the written problems. Please <u>show</u> all of your work.

1. Given the following information, calculate the enthalpy of sublimation of lithium in kJ/mol. Make sure you write out the chemical equation for each step and indicate the energy involved. (8 pts)

Enthalpy of formation for LiCl(s) = −408 kJ/mol
Lattice energy for LiCl(s) = −834 kJ/mol
Electron affinity for Cl(g) = −349 kJ/mol
First ionization energy for Li(g) = +520 kJ/mol
Bond dissociation energy for Cl_2(g) = +243 kJ/mol

2. For each of the following compounds, draw out the Lewis dot structure (2 pts ea) and using VSEPR, predict the shape (2 pts ea).

A. $[ClO_4]^-$

B. TeF_4

3. Draw and completely label the molecular orbital energy level diagram for the diatomic molecule F_2 (difluorine). Please include all valence electrons (those in the 2s and the 2p orbitals), indicate if the molecule is paramagnetic or diamagnetic, and calculate the bond order. (8 pts)

True-False	(16)	_____
Multiple Choice	(60)	_____
Written Problems	(24)	_____
Exam 4 Total	(100)	_____