# CHM151 Exam 4 100 Pts Spring 2015 Name:(1 Pt)\_\_\_

# Tutors and Instructors, DO NOT HELP WITH THIS EXAM.

## Take home exam Due any time Tuesday May 12th.

1. (4 Pts) Which pair is geometrically similar? You must show the Lewis and VSEPR structures to justify your answer.

(A)  $SO_2$  and  $CO_2$  (B)  $CO_2$  and  $OF_2$ 

(C)  $PH_3$  and  $BF_3$  (D)  $SO_2$  and  $O_3$ 

2. (4 Pts) Explain why BCl<sub>3</sub> is a planar molecule while NCl<sub>3</sub> is pyramidal.

3.(4 Pts) NH<sub>3</sub> (pyramidal geometry) reacts with BF<sub>3</sub> (planar geometry) to form the addition compound, H<sub>3</sub>NBF<sub>3</sub>. What is the geometry around the nitrogen and boron centers in the addition compound? Explain in terms of the hybrid orbitals involved. (Hint: Show the Lewis structure of the new molecule. Both N and B are centers of this molecule.)

4. (3 Pts) The ammonium ion is symmetrical, with the nitrogen at the center of a tetrahedron of four equivalent

hydrogens. What hybridization of nitrogen orbitals is used to represent the bonding in the ion?

5. (3 Pts) Which type of hybrid orbital is used by carbon in CO<sub>2</sub>?

6. (3 Pts) Which compound would be expected to have the largest dipole moment? Explain why.

 $(A) CO_2 \qquad (B) \qquad BF_3 \qquad (C) SO_2 \qquad (D) \qquad CF_4$ 

Reason:

7. (3 Pts) The molecule : O=C=N−H has been detected in gas clouds between stars. What is the predicted
C−N−H bond angle? \_\_\_\_\_\_

8. (4 Pts) Provide estimates of each of the following bond angles?

- (A) angle O–S–O in  $SO_4^{2-}$  (B) angle Cl–C–Cl in  $HCCl_3$
- (C) angle F–Be–F in BeF<sub>2</sub>\_\_\_\_ (D) angle H–O–H in  $H_2O$ \_\_\_\_\_

- 9. (4 Pts) Knowing that F is more electronegative than either B or P, what conclusion can be drawn from the fact that BF<sub>3</sub> has no dipole moment but PF<sub>3</sub> does?
- 10. (3 Pts) A compound consisting of an element having a low ionization potential and a second element having a high electron affinity is likely to have
  - (A) covalent bonds. (B) metallic bonds. (C) coordinate covalent bonds,

(D) ionic bonds.

- 11. (3 Pts) In which pair do both compounds exhibit predominantly ionic bonding?
  - (A)  $SO_2$  and HCl (B) NaF and MgO (C) KNO<sub>3</sub> and  $CH_4$  (D) KCl and  $CO_2$
- 12. (3 Pts) What forces hold the elements together in an ionic compound?
- 13. (3 Pts) Which is most likely to be formed by electron transfer and be ionic?

	Main Groups							
				IV	V	VI	VII	(O)
First Period								
Second Period	X	Υ	Ζ	Ρ		Q	S	U
Third Period	W					R	Т	Μ

(A) a compound of **U** and **S** (B) a compound of **P** and **S** 

(C) a compound of Z and P

- (D) a compound of **Y** and **T** (E) a compound of **Q** and **T**
- 14. (3 Pts) What is the explanation for the fact that the bonding in  $SnI_4$  is more covalent than the bonding in  $SnF_4$ ?

- 15. (3 Pts) Which characteristic is generally true of nonmetallic oxides?
  - (A) They are in general ionic compounds.
  - (B) They are in general covalent compounds.
  - (C) They react with water to form bases.
  - (D) They cannot be prepared directly from the elements.
  - (E) They react with acids to form a salt and water.
- 16. (4 Pts) Use structural formulas to show how hydrogen bonding occurs in liquid methanol, CH<sub>3</sub>OH. (Use at least 2 molecules.)

17. (3 Pts) Consider the boiling point of a series of hydrogen compounds.

		bp	H <sub>2</sub> O H <sub>2</sub> S H <sub>2</sub> S	Se H <sub>2</sub> Te			
Explain the abnormally high boiling point for water.							
18. (3 Pt	ts) Of these met	als, interatomic forces are	e probably weakest in				
(A)	Ag (B) A	u (C) Zn (D	D) Hg Support your answ	ver:			
19. (3 P	19. (3 Pts) How many sigma ( $\sigma$ ) and pi ( $\pi$ ) bonds are found in the ethylene molecule H <sub>2</sub> C=CH <sub>2</sub> according to modern bonding						
theo	ory? Sigma	pi					
20. (3 Pt	ts) An acceptable	E Lewis dot structure for N	N <sub>2</sub> O is				
(A)	:Ö- <u>Ň</u> -Ň	(B) :Ö−N≡N:	:				
(C)	∶Ö=N⊨Ä	(D) ∶Ö <b>= N= N</b> :	:				
21. (4 Pts) Which has a Lewis (electron dot) structure with the greatest number of unshared pairs on the central atom?							
(A)	NH <sub>3</sub>	(B) IF <sub>3</sub>	(C) SeCl <sub>2</sub>	(D) ICl <sub>2</sub>			

22. (4 Pts) Draw Lewis dot representations of all reasonable contributing structures to the resonance hybrid of the nitrate ion.

23. (4 Pts) Which substance has the highest boiling point? Explain why.

(A)  $CH_4$  (B) He (C) HF (D)  $Cl_2$ 

### 24. (3 Pts) Consider the phase diagram of a pure compound. Which statement applies?



- (A) The path  $A \rightarrow C$  represents sublimation.
- (B) Following the path  $A \rightarrow B \rightarrow C$  the compound would first liquefy and then vaporize.
- (C) If the compound is in state A, continued reduction of the pressure (at constant temperature) will cause it to melt.
- (D) None of these statements is correct
- 25. (3 Pts) A crystal of anhydrous KNO<sub>3</sub> is made up of
  - (A) molecules of KNO<sub>3</sub>.
  - (B) atoms of potassium, nitrogen, and 3 atoms of oxygen alternately spaced in the crystal.
  - (C) a geometrical pattern of potassium ions and nitrate ions in the crystal.
  - (D) potassium nitrate molecules alternately spaced with water molecules.
  - (E) molecules of KNO<sub>3</sub> and water combined into larger molecules.

26. (4 Pts) Which group of substances is correctly arranged in order from the highest to the lowest melting point? Also state the primary intermolecular forces for each compound.

(A) HF>H <sub>2</sub> >NaF	(B) NaF>H <sub>2</sub> >HF	(C) HF>NaF>H <sub>2</sub>	(D)	NaF>HF>H <sub>2</sub>
----------------------------	----------------------------	---------------------------	-----	-----------------------

Primary forces of each:\_\_\_\_\_

Primary intermolecular forces for each:\_\_\_\_\_

27. (3 Pts) Which has the highest molar heat of vaporization?

(A) a molecular liquid,  $S_8$  (B) a hydrogen-bonded liquid,  $H_2O$ 

(C) a monatomic liquid, Ar (D) an ionic melt,  $BaF_2$ 

28. (4 Pts) Which inert gas has the highest boiling point? \_\_\_\_\_ Explain why.

#### 29. (4 Pts) Draw the structures and determine the formal charge of each atom in