Exam Five **CHM 203 (Dr. Mattson)** **17 November 2004**	***Academic Integrity Pledge:*** *In keeping with Creighton University's ideals and with the Academic Integrity Code adopted by the College of Arts and Sciences, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.* *Signature:*

Instructions: Show all work whenever a calculation is required! You will receive credit for how you worked each problem as well as for the correct answer. This exam is worth 50 points. BOX YOUR ANSWERS!

1. (2 pts) Sketch one of the resonance structures for the carbonate ion. Assign formal charges to each atom.

2. (2 pts) (a) Sketch the Lewis dot structure of the nitrite ion. Include resonance forms.

(b) (1 pt) What is the N-O bond order?

3. (3 pts) Sketch the Lewis dot structure for the three nitrogen compounds N_2H_4, N_2H_2, and N_2.

(b) (3 pts) Use the information obtained to complete the following table. Circle your choice in each cell.

	N_2H_4	N_2H_2	N_2
N-N bonding	single double triple	single double triple	single double triple
Hybridization on N	sp sp^2 sp^3	sp sp^2 sp^3	sp sp^2 sp^3
N-N bond strength (dissociation energy) (kJ/mol)	160 418 941	160 418 941	160 418 941

4. (1 pts) Which of these bonds is the most polar?

O-O O-S O-Se S-S S-Se

5. (1 pts) Circle your choices. Electronegativity as a periodic trend [increases/decreases] across the periodic table from left to right and [increases/decreases] from top to bottom.

6. (2 pts) Circle all of the covalent molecules.

NaCl O_2 SO_2 $CaCl_2$ Fe_2O_3 CH_4

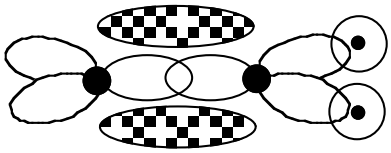
7 (8 pts) Matching. Use the spaces provided here to show whatever work you think is necessary to complete the matching below. (Suggest you draw Lewis structure and write ABE formula, however your drawings will not be graded.) Then match the structure with the phrase that describes one unique property of that species.

(A) OH_2	(B) SO_4^{-2}
(C) SO_2	(D) NH_3
(E) NO_2	(F) SO_3
(G) N_2	(H) SF_4

Match the structures above with the descriptions below. Enter "A", "B" etc. Each structure is used ONCE.

_____	1. the only paramagnetic example	
_____	2. the only example with trigonal pyramid structure, AB_3E	
_____	3. the only tetrahedral example	
_____	4. diatomic, triple bond	
_____	5. bent; σ-bonds formed from overlap of sp^3 and two 1s orbitals	
_____	6. bent, 3s and 3p orbitals hybridized to make central atom sp^2	
_____	7. sp^2, trigonal plane; resonance forms	
_____	8. the only expanded octet molecule	

8. (5 pts) Inspect the hybridization drawing below for OCH_2. Note that O is on the left and C is on the right and the electrons are not shown. The black dots represent the nuclei of atoms. The shaded parts are from the overlap of two p-orbitals.



What is the hybridization on the O atom?
What is the hybridization on the C atom?
What is the carbon-oxygen bond order?
How many (TOTAL) σ-bonds are in molecule?
How many π-bonds are in the molecule?

9. (1 pt) When ΔH is < 0, the reaction is called [exothermic/endothermic].

10. (3 pts) A 5.7 g chunk of porcelain is heated to 100 ^oC by placing it in boiling water. The porcelain is then transferred to a coffee cup calorimeter containing 45.0 g water at 25.0 ^oC. If the final temperature of porcelain and water is 31.0 ^oC, what is the specific heat of porcelain? [Given: specific heat of water is 4.184 J/g deg]

11. (3 pts) Heat capacity (also called molar heat capacity) and specific heat are related entities. Heat capacity has units of J/mol deg and specific heat has units of J/g deg. Sodium has a molar heat capacity of 28.2 J/mol deg. Convert this into the specific heat with units of J/g deg.

12. (3 pts) Write the chemical reaction that defines the heat of formation for ammonium carbonate.

13. (3 pts) When 1.045 g CaO is added to 50.0 g water at 25.0 ^oC in a coffee cup calorimeter, the temperature of the water increases to 32.3 ^oC. Assuming the specific heat of the solution is 4.184 J/g deg, calculate ΔH for the reaction:

$$CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2 \qquad \Delta H=?$$

14. (3 pts) Calculate ΔH_{rxn} for the combustion of ammonia according to the following equation [Given: ΔH_f(kJ/mol): NH_3 = -46; NO_2 = +33; H_2O =-286]

$$4\ NH_3(g) + 7\ O_2\ (g) \longrightarrow 4\ NO_2(g) + 6\ H_2O(g)$$

b. (3 pts) Calculate q_{rxn} when 30.0 g ammonia is burned in excess oxygen.

15. (3 pts) Estimate ΔH for this gas-phase reaction using bond energies. [Given: bond dissociation energies in kJ/mol): N-H: 390; N-Br: 240; Br-Br: 193; H-Br: 366]

$$NH_3 + Br_2 \longrightarrow NH_2Br + HBr$$

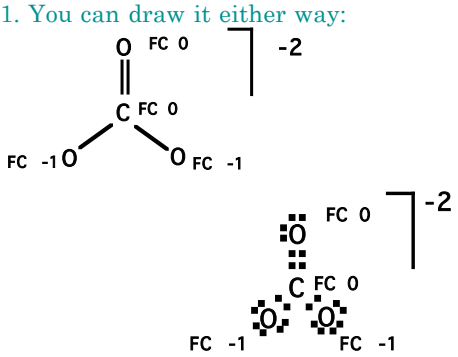
16. (1 point) Print your name here:

(For DocM's use)
Your exam score (50 possible): _____
On-line bonus work adjustment: _____
Chem Show attendance bonus: _____
Your total exam score (50 max): _____

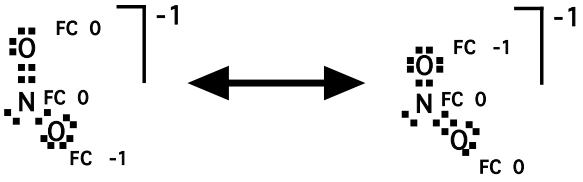
Determine your grade:
A ≥ 46.5; B+ ≥ 43.5; B ≥ 41.0;
C+ ≥ 37.5; C ≥ 34.00; D ≥ 30.00

Answers.

1. You can draw it either way:



2.



(b) 1.5

3.

(b)

	N_2H_4	N_2H_2	N_2
N-N bonding	single	double	triple
Hybridization on N	sp^3	sp^2	sp
N-N bond strength	160	418	941

4. O-Se

5. (1 pts) Circle your choices. Electronegativity as a periodic trend [increases/decreases] across the periodic table from left to right and [increases/decreases] from top to bottom.

6. O_2 SO_2 CH_4

7 1. E; 2. D; 3. B; 4. G; 5. A; 6. C; 7. F, 8. H

8.

What is the hybridization on the O atom? sp^2

What is the hybridization on the C atom? sp^2

What is the carbon-oxygen bond order? 2

How many (TOTAL) σ-bonds are in molecule? 3

How many π-bonds are in the molecule? 1

9. exothermic

10. 2.87 J/g deg

11. 1.23 J/g deg.

12.

$N_2(g) + 4\ H_2(g) + C(s) + 3/2\ O_2(g) \longrightarrow$

$1\ (NH_4)_2CO_3$ $\Delta H = \Delta H_f$

13. $CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2$ $\Delta H = -82$ kJ

14. $\Delta H_{rxn} = -1400$ kJ

b. $q_{rxn} = -618$ kJ

15. $\Delta H = -23$ kJ