EXAM FIVE **CHM 203 (Dr. Mattson)** **14 NOVEMBER 2008**	***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. If you need more space, you may use the back of your periodic table — Write: "See PT" in box and then attach the periodic table. BOX YOUR ANSWERS! Write legibly.

1. (2 pts) The element silicon has the following ionization energies (all in kJ/mol) for the first three ionizations: E_{i1} = 787, E_{i2} = 1577, E_{i3} = 3231. Which set contains the most reasonable values for the next three ionization energies of silicon, E_{i4}, E_{i5}, and E_{i6}?

   A. 4356, 16091, and 19784 kJ/mol

   B. 4217, 8099, and 20724 kJ/mol

   C. 4420, 6119, and 7762 kJ/mol

   D. 15843, 19188, and 21979 kJ/mol

   E. 4294, 17209, and 0 kJ/mol

2. (6 pts) Write the electron configuration for the following metal ions. Use core notation.

Mn^{+2}
Ni^{+2}
Mo^{+3}

3. (5 pts) Consider the following pairs of atoms. Do you expect the bond between the two to be ionic (I), polar covalent (PC) or non-polar covalent (NPC)?

A. F, F	I	PC	NPC
B. C, O	I	PC	NPC
C. Na, Cl	I	PC	NPC
D. H, H	I	PC	NPC
E. H, C	I	PC	NPC

4. (3 pts) In the molecule nitrogen monoxide, the basic structure is N—O. Add δ^+ and δ^- labels to the molecule to show the polar nature of the NO bond.

N — O

5. (3 pts each) Do the following ions have resonance? Explain using structures.

(a) nitrite

(b) sulfate

6. (18 pts) Sketch the best possible Lewis dot structures for each of the following compounds and ions, none of which actually exists.

SO_2^{+2}	ClO_3^{+}
PO_2^{-1}	$SiCl_2^{-2}$
AlI_4^{-1}	ArF_4

7. (6 pts) What is the ABE formula for each of your sketches above?

SO_2^{+2}	ClO_3^{+}
PO_2^{-1}	$SiCl_2^{-2}$
AlI_4^{-1}	ArF_4

8. (6 pts) What is the geometry name for ABE formulas determined above?

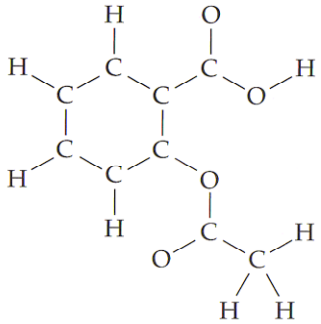
SO_2^{+2}	ClO_3^{+}
PO_2^{-1}	$SiCl_2^{-2}$
AlI_4^{-1}	ArF_4

9. (5 pts) The ion CNO^- can be sketched a number of ways. Suppose it is sketched with nitrogen in the middle so that every atom obeys the octet rule. Create this sketch and assign formal charges to assess if your structure is good or not.

10(a). (4 pts) Sketch the Lewis dot structure of the carbonate ion, CO_3^{-2}. What is the hybridization for the carbon atom?

10(b) (3 pts) How many σ and π bonds are contained within the carbonate ion?

11(a) (5 pts) The following is the structure of aspirin. It is missing some bonds. Add them where appropriate.



Aspirin

11(b) (2 pts) What is/are the hybridization(s) for the carbons in the 6-membered ring?

12. (5 pts) Ammonia is formed from its elements:

$$3\ H_2(g) + N_2(g) \rightarrow 2\ NH_3(g) \qquad \Delta H^o = -92\ kJ$$

Calculate a value for q when 85 g H_2 is reacted with excess N_2.

13. Suppose a chunk of calcium metal with a mass of 0.882 g was dropped into 50.0 g water. It immediately reacts accordingly:

$$Ca(s) + 2\ H_2O(l) \rightarrow Ca(OH)_2(s) + H_2(g) \qquad \Delta H^o = ?$$

13(a) (5 pts) As it reacts, the temperature of the water increases from 22.8 °C to 64.9 °C. Calculate q_{cal} for this experiment. [Given: Spec heat = 4.18 J/g deg]

13(b) (3 pts) Use q_{cal} to calculate q_{rxn}.

13(c) (5 pts) Use q_{rxn} to calculate ΔH^o for the reaction as it is shown above. Provide proper units on ΔH!

14. (5 pts) Use ΔH_f^o values to estimate ΔH^o for the reaction. [Given ΔH_f^o: $AlCl_3(s)$ = -704 kJ; $H_2SO_4(l)$ = -814 kJ; $Al_2(SO_4)_3(s)$ = -3435 kJ; HCl(g) = -92 kJ]

$$2\ AlCl_3(s) + 3\ H_2SO_4(l) \rightarrow Al_2(SO_4)_3(s) + 6\ HCl(g)$$

15. (5 pts) Use the bond energy values given to estimate ΔH for the reaction:

kJ/mol	H	N	Cl
H	436	390	432
N	390	240	200
Cl	432	200	243

$$NH_3(g) + Cl_2(g) \rightarrow NH_2Cl(g) + HCl(g)$$

(1 pt) Print your name here.

Answers:

1. A

2. [Ar] $3d^5$, [Ar] $3d^8$, [Ar] $4d^3$

3. (A) NPC, (B) PC, (C) I, (D) NPC, (E) PC

4. δ^+ N — O δ^-

5. (a) nitrite, NO_2^-, YES, AB_3, with three σ bonds and one π bond giving 3 resonance structures
(b) sulfate, SO_4^{-2}, AB_4, with four σ bonds and zero π bonds NO resonance

6. Description of your structure (every atom has 8 electrons except as noted):

   SO_2^{+2} AB_2 with two double bonds, Structure: linear
   ClO_3^+ AB_3 with two single bonds and one double bond, Structure: trigonal plane
   PO_2^{-1} AB_2E with one single bond and one double bond, Structure: bent or angular
   $SiCl_2^{-2}$ AB_2E_2 with two single bonds, Structure: bent or angular
   AlI_4^{-1} AB_4 with four single bonds, Structure: tetrahedral
   ArF_4 AB_4E_2 with four single bonds (Ar has an expanded octet to 12 electrons), Structure: square plane

7. See answer to previous question

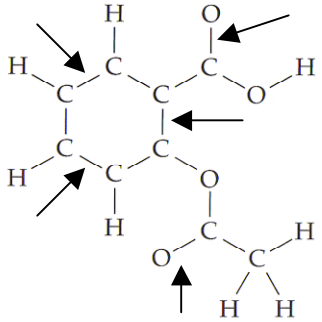
8. See answer to Question 6

9. There were two ways that you may have sketched this: (a) If you sketched C double bond N double bond O, you formal charges would have been –2, +1 and 0 for C, N and O, respectively. The formal charge of –2 is not good (formal charges ideally fall between –1 and +1) (b) If you sketched C triple bond N single bond O, you formal charges would have been –1, +1 and –1 for C, N and O, respectively. This one has more acceptable formal charges.

10(a). AB_3 therefore sp^2.

10(b) 3 σ and one π bonds

11(a) The arrows point to the locations where double bonds should have been placed. (The 3 arrows around ring could be shifted over – there are two resonance forms.)



Aspirin

11(b) sp^2

12. q = -1293 kJ

13. Suppose a chunk of calcium metal with a mass of 0.882 g was dropped into 50.0 g water. It immediately reacts accordingly:

$$Ca(s) + 2\ H_2O(l) \rightarrow Ca(OH)_2(s) + H_2(g) \quad ?$$

13(a) q_{cal} = 8.95 kJ

13(b) $q_{rxn.}$ = –8.95 kJ

13(c) ΔH = –406.9 kJ

14. ΔH^o = –137 kJ

15. ΔH = +1 kJ