EXAM FOUR **CHM 203 (Dr. Mattson)** **11 NOVEMBER 2009**	***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. (5 pts) T/F In our first discussion of covalent bonds, we learned that the hydrogen-hydrogen bond has a dissociation energy of 436 kJ/mol.

   T F 436 kJ are released when two moles of H atoms make one mole of H_2

   T F It takes 436 kJ to make one mole of H_2 from H atoms.

   T F To break one mole of H_2 into H atoms, one needs to provide 436 kJ

   T F The H-H bond is stronger than a C-H bond (dissociation energy = 410 kJ/mol)

   T F One mole of H_2 breaks into H atoms with the release of 436 kJ

2. (6 pts) T/F In our second discussion of covalent bonds, we learned that some bonds are polar and others are not.

   T F Bond polarity is predicted by using the electronegativities of the elements involved.

   T F Electronegativity is a periodic trend that decreases from left to right across the periodic table, excluding the noble gases.

   T F Electronegativity is a periodic trend that decreases from top to bottom down the periodic table.

   T F Non-polar bonds are predicted when both atoms have the same electronegativity.

   T F Bonds between two atoms that are several rows apart on the periodic table but in the same period, are expected to be polar.

   T F The C-F bond is expected to be less polar than a O-F bond.

3. (4 pts) Phosphine is a compound that exists between phosphorus and hydrogen. It occurs in swamps and ignites upon exposure to air creating eerie "willo-the-wisps." Given that phosphine has one phosphorus, predict its formula using a Lewis dot structure and show your work.

4. (6 pts) Which of these compounds are expected to be covalent molecular? Circle all that are.

   a. BF_3 b. NH_3 c. F_2

   d. NaI e. C_3H_6O f. $CaCl_2$

5a. (3 pts) Methyl amine smells like rotted fish and has formula CH_3NH_2. Sketch the Lewis dot structure for this molecule and answer the following questions about it.

5b. (2 pts) What is the ABE formula for C? For N?

C	N

5c. (1 pt) Is the carbon-nitrogen bond single, double or triple? Circle: **Single Double Triple**

5d. (1 pt) What is the hybridization of nitrogen?

6a. (3 pts) The molecule CHOCl has carbon as the central atom. Sketch its Lewis dot structure.

Answer 6b – 6e in boxes after 6e.

6b. (1 pt) What is the ABE formula for C?

6c. (1 pt) Predict the H-C-Cl bond angle.

6d. (1 pt) What is the hybridization of carbon?

6e. (2 pts) What is the total number of σ and π bonds in the molecule?

6b.	6c.
6d.	6e.

Print your name here and sign Academic Integrity Statement.

7a. (3 pts) Sketch the Lewis dot structure for the nitrate ion, NO_3^-.

Answer 7b – 7g in boxes after 7g.

7b. (1 pt) What is the ABE formula for N?

7c. (1 pt) What is the name of the geometry?

7d. (1pt) Is there resonance?

7e. (1 pt) What is the formal charge on nitrogen?

7f. (1 pt) What is the hybridization for nitrogen?

7g. (2 pts) What is the total number of σ and π bonds in the molecule?

7b.	7c.	7d.
7e.	7f.	7g.

8a. (3 pts) Sketch the Lewis dot structure for SO_2.

8b. (1 pt) What is the ABE formula for S?

8c. (1 pt) What is the name of the geometry?

8d. (1 pt) Is there resonance?

8e. (1 pt) What is the hybridization for sulfur?

8b.	8c.	8d.	8f.

9. (12 pts) Match ABE formula and geometry.

_____	AB_2	A. Bent (109º)
_____	AB_3	B. Bent (120º)
_____	AB_2E	C. Linear (expanded octet)
_____	AB_4	D. Linear (sp-hybridization)
_____	AB_3E	E. Octahedral
_____	AB_2E_2	F. See-saw
_____	AB_5	G. Square pyramid
_____	AB_4E	H. Tetrahedral
_____	AB_3E_2	I. Trigonal bipyramid
_____	AB_2E_3	J. Trigonal plane
_____	AB_6	K. Trigonal pyramid
_____	AB_5E	L. T-shaped

10. (3 pts) Write the equation that defines the heat of formation of aluminum trichloride.

→ ΔH_f^o = -704 kJ

11. The combustion of acetylene is:

$2\ C_2H_2 + 5\ O_2 \rightarrow 4\ CO_2 + 2\ H_2O\ \Delta H^o = -2511$ kJ

11a. (5 pts) How much heat is produced if 85 g C_2H_2 is combusted with excess O_2?

11b. (1 pt) Is the reaction exothermic? YES or NO

11c. (1 pt) If this reaction were performed in a calorimeter, would the water warm up? Circle either YES or NO

12a. (5 pts) When 1.375 g CaO is added to 50 mL water at 25.0 ºC, the temperature of the water increases to 34.6 ºC. Given the specific heat is 4.184 J/g deg, how much heat is absorbed by the calorimeter?

12b. (5 pts) Continuing with the experiment described in 12a, calculate ΔH^o for the reaction:

$CaO + H_2O \rightarrow Ca(OH)_2$ ΔH^o = _____ kJ

13. Given:

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

13a. (2 pts) Determine ΔH^o for the reaction:

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

13b. (3 pts) Determine ΔH_f^o for ammonia.

14. (5 pts) Given these two reactions, calculate ΔH^o for the third one. *Show your work!*

$P_4(s) + 6\ Cl_2(g) \rightarrow 4\ PCl_3(g)\ \Delta H^o = -1148$ kJ

$P_4(s) + 10\ Cl_2(g) \rightarrow 4\ PCl_5(g)\ \Delta H^o = -1500$ kJ

$PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)\ \Delta H^o$ = ?

15. (5 pts) Calculate ΔH^o for the reaction below.

[Given: ΔH_f^o(kJ/mol): $H_2S(g)$ = -21; $S(s)$ = 0; $SO_2(g)$ = -297; $H_2O(g)$ = -242]

$2\ H_2S(g) + SO_2(g) \rightarrow 2\ S(s) + 2\ H_2O(g)\ \Delta H$ = ?

Answers

1. T F T T F

2. T F T T T F

3. PH_3 (must also show Lewis dot which is AB_3E)

4. a. BF_3; b. NH_3; c. F_2; e. C_3H_6O

5a. Carbon should feature three bonds to H and one to N. Nitrogen is bonded to two H atoms in addition to being bonded to the C and has an electron pair.

5b. C: AB_4; N: AB_3E

5c. single

5d. sp^3

6a. Carbon is single bonded to the H and Cl atoms and double bonded to oxygen. The oxygen has two electron pairs, E groups.

6b. AB_3

6c. 120^o

6d. sp^2

6e. three σ and one π bonds

7a. Your structure should show nitrogen single bonded to two O atoms and double bonded to one O atom. The single bonded O atoms also have three E groups and the double-bonded oxygen atom has two E groups. Nitrogen has no E group.

7b. AB_3

7c. trigonal plane

7d. yes

7e. +1

7f. sp^2

7g. three σ and one π bonds

7a. Your structure should show sulfur single bonded to one O atom and double bonded to the other O atom. The single bonded O atom also has three E groups and the double-bonded oxygen atom has two E groups. Sulfur has one E group.

8b. AB_2E

8c. bent or angular

8d. yes

8e. sp^2

9. D J B H K A I F L C E G

10. $Al(s) + 3/2\ Cl_2(g) \rightarrow 1\ AlCl_3(s)$ $\quad \Delta H_f^o = -704$ kJ

11. $q_{rxn} = -4104$ kJ

11b. YES; 11c. YES

12a. $q_{cal} = 2064$ J

12b. $\Delta H^o = -84$ kJ

13. $\Delta H^o = +92$ kJ

13b. $\Delta H_f^o = -46$ kJ

14. $PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$ $\Delta H^o = -88$ kJ

15. $2\ H_2S(g) + SO_2(g) \rightarrow$
$2\ S(s) + 2\ H_2O(g)$ $\Delta H = -145$ kJ