Exam 5 Chm 203 (Dr Mattson) 16 November 2015

Academic Integrity Pledge: *In keeping with Creighton University's ideals and with the Academic Integrity Code, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.*

Signature:

Name:

Chemistry Student Number: _____

Instructions: <mark>Show all work whenever a calculation box is provided!</mark> Write legibly. Include units whenever appropriate. 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 the periodic table provided — Write: "See PT" in the answer box and then hand the periodic table in with your exam. On your desk you are allowed only pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks, bags, and purse-like items must be stored in the rear section of the room. Cell phones must be silent and placed in your backpack/bag/purse – not in your pocket.

1. (1 pt) I have printed my name and correct student number and signed the Academic Integrity Pledge.

2. (5 pts) The H – H bond length in H_2 is 74 pm and its bond dissociation energy is 436 kJ/mol. Mark these statements as true or false.

   T F At least 436 kJ/mol are required to form H_2 from H atoms.

   T F H_2 is a covalent molecule.

   T F The bond between H atoms is formed by overlapping 1s orbitals.

   T F If the H – H bond could be stretched to more than 74 pm, the bond dissociation energy would also increase.

   T F For $H(g) + H(g) \rightarrow H_2(g)$ ΔE = -436 kJ/ mol H_2.

3. (4 pts) In each case, indicate the polar nature of each bond by writing δ^+ and δ^- by the two atoms. Draw a circle around example(s) of non-polar bonds.

   N – B   C – O   F – F   N – P

4. (8 pts) None of the following fluorine-containing species actually exists. Nevertheless, you can sketch reasonable Lewis dot structures for them. Do so in the space provided.

(a) FO^+	(b) FO_2^-
(c) FO^-	(d) FO_2^+

5a. Sketch reasonable Lewis dot structures for ClO_2 and OCl_2 and answer the questions that follow.

(2 pts) ClO_2	(2 pts) OCl_2

5b. (1 pt) Which is paramagnetic?

   A. ClO_2 B. OCl_2 C. Both   D. Neither

5c. (1 pt) Which has resonance?

   A. ClO_2 B. OCl_2 C. Both   D. Neither

5d. (3 pts) Which of these is predicted to be possible?

   Cl_2O_4 with Cl – Cl bond O_2Cl_4 with O – O bond

   Support your answer with a Lewis dot sketch.

6. (3 pts) Imidazole consists of H, C, and N atoms arranged as shown. Add double bonds as needed to make carbon and nitrogen obey the octet rule.

○ H
● C
● N
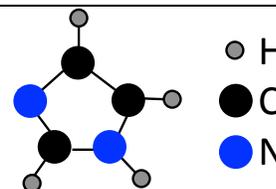
7. (12 pts) Sketch Lewis dot structures for the following molecules, making all atoms obey the octet rule. Add the ABE formula to each.

(a) SO_2	(b) SO_3
ABE formula: _____	ABE formula: _____
(c) SCl_2	(d) PF_3
ABE formula: _____	ABE formula: _____
(e) CS_2	(f) CCl_4
ABE formula: _____	ABE formula: _____

7b. (6 pts) Match the structures you drew in 7a with the shape names.

   ____ (a) SO_2 A. Bent 109°

   ____ (b) SO_3 B. Bent, 120°

   ____ (c) SCl_2 C. Linear

   ____ (d) PF_3 D. Tetradhedral

   ____ (e) CS_2 E. Trigonal plane

   ____ (f) CCl_4 F. Trigonal pyramid

7c. (3 pts) Which of the molecules sketched in 7a is/are polar?

(a) SO_2 (b) SO_3 (c) SCl_2 (d) PF_3 (e) CS_2 (f) CCl_4

7d. (6 pts) Circle the hybridization of each central atom.

(a) SO_2 **sp sp^2 sp^3**   (b) SO_3 **sp sp^2 sp^3**

(c) SCl_2 **sp sp^2 sp^3**   (d) PF_3 **sp sp^2 sp^3**

(e) CS_2 **sp sp^2 sp^3**   (f) CCl_4 **sp sp^2 sp^3**

8. (5 pts) What sort of intermolecular forces are present in… (LDF = London dispersion forces, D-D = dipole-dipole. Circle all that apply in each case)

(a) imidazole (Question 6) **LDF   D-D   H-bonding**

(b) OCl_2 (Question 5)   **LDF   D-D   H-bonding**

(c) SO_2 (Question 7)   **LDF   D-D   H-bonding**

(d) SO_3 (Question 7)   **LDF   D-D   H-bonding**

(e) CH_3OH **LDF   D-D   H-bonding**

9. (5 pts) Which of these events are exothermic (EXO) and which are endothermic (ENDO)? Circle your choice.

EXO or **ENDO**   Melting snow on a warm day

EXO or **ENDO**   Boiling water on the stove

EXO or **ENDO**   Candle flame

EXO or **ENDO**   Forming covalent bond from atoms

EXO or **ENDO**   Water vapor condensing into raindrops

10. (5 pts) Consider the formation of ammonia from its elements:

$N_2(g) + 3 H_2(g) \rightarrow 2 NH_3(g)$ $\Delta H^O = -92.2$ kJ
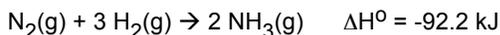
How much heat, q, is associated with the reaction of 25.0 g hydrogen with excess nitrogen?

Show work for credit!

Answer with units: _____

11. (5 pts) Consider the reaction shown below. If 1.00 mol ammonia is dissolved in 200.0 g water at 25.0 ^{O}C, what is the final temperature of the solution? [Given: specific heat for the solution = 4.18 J/g deg]

$NH_3(g) \rightarrow NH_3(aq)$ $\Delta H^O = -34.2$ kJ
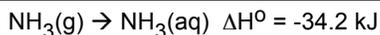
Answer with units: _____

12. (5 pts) Calculate ΔH^O for the reaction shown below, given these ΔH_f^O values:

ΔH_f^O for $N_2O(g)$ = 82 kJ/mol;

ΔH_f^O for $NH_3(g)$ = -46 kJ/mol;

ΔH_f^O for $H_2O(g)$ = -242 kJ/mol.

$3 N_2O(g) + 2 NH_3(g) \rightarrow 4 N_2(g) + 3 H_2O(g)$ $\Delta H^O = ?$

Answer with units: _____

13. (3 pts) Write the equation that is defined as ΔH_f^O for $N_2O(g)$.

14. (5 pts) Use the first two equations to calculate ΔH^O for the third equation.

$CH_4(g) + O_2(g) \rightarrow CH_2O(g) + H_2O(g)$ $\Delta H^O = -276$ kJ

$CH_4(g) + 2 O_2(g) \rightarrow CO_2(g) + 2 H_2O(g)$ $\Delta H^O = -803$ kJ

$CH_2O(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$ $\Delta H^O = ?$
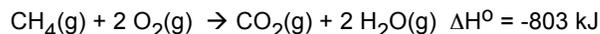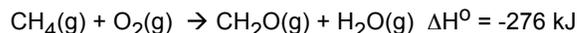
Show work for credit!

Answer with units: _____

9. (10 pts) Nomenclature. Complete the following table. (If you are nomenclature certified, skip this question.)

sulfur hexafluoride	
nitrogen monoxide	
phosphorus pentafluoride	
carbon disulfide	
tetraphosphorus hexoxide	
	ClO_2
	N_2O_4
	BrF_3
	NH_3
	Br_2

Total score (out of 100):   _____

A+ > 95% A > 90% B+ > 85% B > 80% C+ > 75% C > 70% D > 60%

Answers

2. F T T F T

3. $\delta^- N - B \; \delta^+$ $\delta^+ C - O \; \delta^-$ (Non-polar: F – F) $\delta^- N - P \; \delta^+$

4.
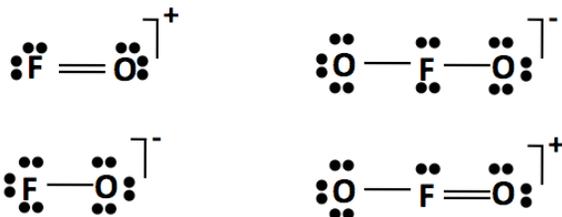
5a.

5b. A. ClO_2 5c. D. Neither   5d. Cl_2O_4 with Cl – Cl as shown:
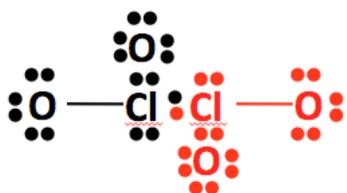
6.
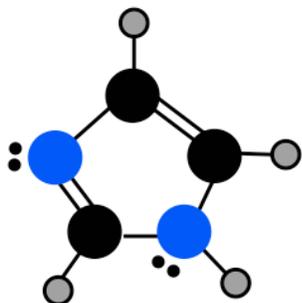
7.
(a) SO_2 is AB_2E (b) SO_3 is AB_3 (c) SCl_2 is AB_2E_2 (d) PF_3 is AB_3E (e) CS_2 is AB_2 (f) CCl_4 is AB_4
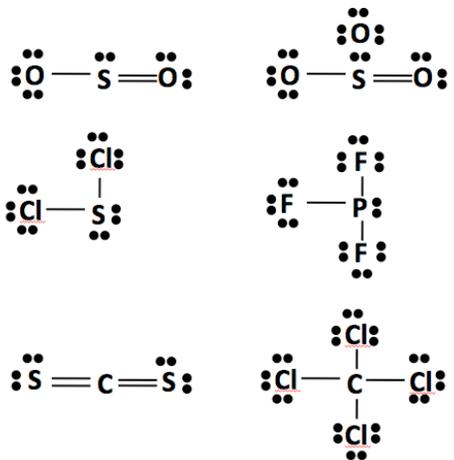
7b. B E A F C D

7c. A C D

7d. (a) SO_2 **sp^2** (b) SO_3 **sp^2** (c) SCl_2 **sp^3** (d) PF_3 **sp^3** (e) CS_2 **sp** (f) CCl_4 **sp^3**

8.

  (a) imidazole (Question 6) **LDF H-bonding**

  (b) OCl_2 (Question 5) **LDF D-D**

  (c) SO_2 (Question 7) **LDF D-D**

  (d) SO_3 (Question 7) **LDF**

  (e) CH_3OH **LDF D-D H-bonding**

9. **ENDO ENDO EXO EXO EXO**

10. q = -381 kJ

11. 62.7 ^{o}C

12. (5 pts) Calculate ΔH^o = -880 kJ

13. $N_2(g) + \frac{1}{2} O_2(g). \rightarrow N_2O(g)$

14. ΔH^o = -527 kJ

9.

sulfur hexafluoride	SF_6
nitrogen monoxide	NO
phosphorus pentafluoride	PF_5
carbon disulfide	CS_2
tetraphosphorus hexoxide	P_4O_6
chlorine dioxide	ClO_2
dinitrogen tetroxide	N_2O_4
bromine trifuloride	BrF_3
ammonia	NH_3
bromine	Br_2