Exam 4 Chm 203 (Dr Mattson) 11 November 2013

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:

Circle your Folder group:

H He Li Be B C N O F Ne Na Mg Al Si

Instructions: Show all work whenever a calculation box is provided! 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 and purses must be closed and stored on the floor under the table. Cell phones must be OFF and placed in your backpack/purse – not in your pocket.

1. (1 pt) The bond dissociation energy for hydrogen is 436 kJ/mol. What does this mean? (Only one answer.)

   A. 436 kJ are consumed forming one mole of H_2.

   B. Forming hydrogen from its atoms is endothermic.

   C. It takes 436 kJ to break one mole of H-H bonds.

   D. 436 kJ are required to break the bonds in one mole of hydrogen atoms.

2. (5 pts) These statements regard chemical bonds in general. Indicate which are true and which are false.

   T F Bond dissociation energies are always positive.

   T F Double bonds are stronger than single bonds.

   T F Bond forming from atoms is always exothermic.

   T F All elements form bonds.

   T F Covalent bonds are formed between two atoms of similar electronegativies.

3. (4 pts) Circle the most polar bond of each pair. (Circle 4 choices)

   A. N-O or N-F B. C-O or N-O

   C. C-F or C-Cl D. C-O or Si-O

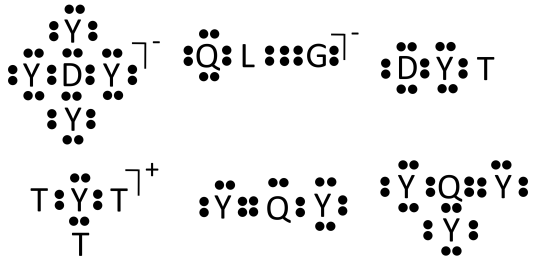
4. (3 pts) Sketch the Lewis dot structure for the nitrite ion and assign formal charges to each atom.

5. (3 pts) Sketch the Lewis dot structure for carbon dioxide and assign formal charges to each atom.

6. (6 pts) Following up with the two previous questions, complete the following table:

	Nitrite	Carbon dioxide
ABE formula		
Hybridization on central atom		
Shape		

7 – 13. Consider these molecules and ions to answer the next seven questions.



7. (2 pts) Which is/are linear? Circle your choice(s).

   DY_4^- QLG^- DYT YT_3^+ QY_2 QY_3

8. (2 pts) Which has/have sp^2 hybridization? Circle your choice(s).

   DY_4^- QLG^- DYT YT_3^+ QY_2 QY_3

9. (2 pts) Which has/have resonance? Circle your choice(s).

   DY_4^- QLG^- DYT YT_3^+ QY_2 QY_3

10. (2 pts) Which has/have an AB_3E structure? Circle your choice(s).

    DY_4^- QLG^- DYT YT_3^+ QY_2 QY_3

11. (2 pts) Which has/have an at least one π bond? Circle your choice(s).

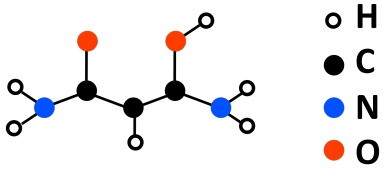
    DY_4^- QLG^- DYT YT_3^+ QY_2 QY_3

12. (3 pts) Make a key. Fill in the second row with **D**, **Y**, **Q**, **L**, **G**, and **T** so that they match the identity of each of the elements listed.

Key	H	C	N	O	Cl	S

13 – 17. Refer to figure.

13. (3 pts) Complete the figure of the molecule by adding multiple bonds and E groups as needed.



14. (2 pts) How many total σ and π bonds are in this molecular structure?

15. (1 pt) What is the hybridization of either nitrogen?

16. (1 pt) What is the ABE formula for the oxygen atom bonded to both H and C?

17. (2 pts) What is the hybridization and bond angle for the middle C atom?

18. (4 pts) Complete this table for expanded octet species.

	Geometry name	Circle all angles
AB_5		90^o 109^o 120^o 180^o
AB_4E		90^o 109^o 120^o 180^o
AB_6		90^o 109^o 120^o 180^o
AB_5E		90^o 109^o 120^o 180^o

19. (3 pts) Consider this reaction:

$Fe_3O_4(s) + 4\ H_2(g) \rightarrow 3\ Fe(s) + 4\ H_2O(g)\ \ \Delta H^o = +150\ kJ$

How much heat, q, is required to produce 1.00 kg Fe?

Answer with units:_____

20. (4 pts) Which of the following has/have ΔH_f^o equal to 0? Circle all that apply.

A. $H_2O(g)$ B. $H_2O(l)$ C. $H_2(g)$ D $O_2(g)$

21. (1 pt) What is the chemical equation that corresponds to the heat of formation of ammonium nitrate.

A. $NH_4^+(g) + NO_3^-(g) \rightarrow NH_4NO_3(s)$

B. $2\ N_2(g) + 4\ H_2(g) + 3\ O_2(g) \rightarrow 2\ NH_4NO_3(s)$

C. $NH_4NO_3(g) \rightarrow NH_4NO_3(s)$

D. $N_2(g) + 2\ H_2(g) + {}^3/_2\ O_2(g) \rightarrow NH_4NO_3(s)$

22. (4 pts) Given ΔH_f^o = +33 kJ/mol for $NO_2(g)$ and -242 kJ/mol for $H_2O(g)$, what is ΔH_{rxn}^o for the reaction:

$2\ NO_2(g) + 4\ H_2(g) \rightarrow N_2(g) + 4\ H_2O(g)\ \Delta H^o = ?$

Answer with units:_____

23. (3 pts) How much heat is required to warm 250 g water from 25 ^{o}C to 100 ^{o}C? (Given: Specific heat of water = 4.184 J/g deg)

Answer with units:_____

24. (3 pts) Given ΔH_{vap} = 40.68 kJ/mol H_2O, how much heat is required to vaporize 250.0 g H_2O at 100 ^{o}C?

Answer with units:_____

25 - 26. When 0.100 mol HCl(aq) and 0.100 mol NaOH(aq) are reacted in a total volume of 100.0 mL in a coffee cup calorimeter, the solution warms by 13.4 degrees. Use this information to answer the next two questions. Given: density of the solution is 1.00 g/mL.

25. (3 pts) Calculate q for this process. (Given: Specific heat of solution = 4.184 J/g deg)

Answer with units:_____

26. (3 pts) Use your value for q to calculate ΔH^o for:

$NaOH(aq) + HCl(aq) \rightarrow H_2O(l) + NaCl(aq)\ \ \Delta H^o = ?$

Answer with units:_____

27. (3 pts) Given these two equations, calculate ΔH^o for the third one.

$CH_4(g) + H_2O(g) \rightarrow 3\ H_2(g) + CO(g)\ \ \Delta H^o = +206\ kJ$

$H_2(g) + CO_2(g) \rightarrow H_2O(g) + CO(g)\ \ \Delta H^o = +41\ kJ$

$CH_4(g) + 2\ H_2O(g) \rightarrow 4\ H_2(g) + CO_2(g)\ \Delta H^o = ?$

28. (3 pts) Estimate ΔH^o for the reaction:

$N\text{-}O(g) + Br\text{-}Br(g) \rightarrow Br\text{-}N\text{-}O(g) + Br(g)\ \ \Delta H^o = ?$

Table of Bond Dissociation Energies

kJ/mol	N	O	Br
N	240	200	240
O	200	180	210
Br	240	210	193

Answer with units:_____

Subtotal from exam: _____

Folder work: (20 max) _____

Total:

Answers

1. C

2. T T T F T

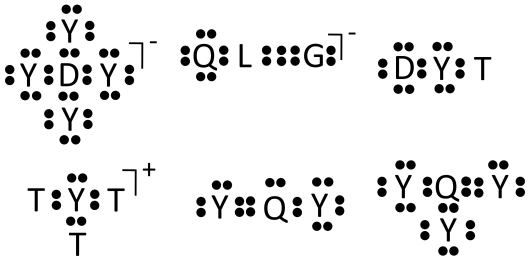
3. A. N-F B. C-O C. C-F D. Si-O

4 and 5.

6.

	Nitrite	CO_2
ABE formula	AB_2E	AB_2
Hybridization on central atom	sp^2	sp
Shape	Bent	linear

7 – 13. Consider these molecules and ions to answer the next seven questions.



7. QLG^-

8. QY_2 QY_3

9. QY_2 QY_3 (Note: QLG^- also has resonance: one triple + one single bond can be written as two double bonds.)

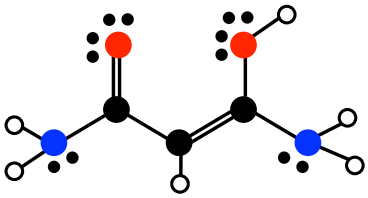
10. YT_3^+

11. QLG^- QY_2 QY_3

12.

Key	H	C	N	O	Cl	S
	T	L	G	Y	D	Q

13.



14. 12 σ and 2 π bonds

15. sp^3

16. AB_2E_2

17. sp^2 and 120^o

18.

	Geometry name	Circle all angles
AB_5	Trigonal bipyramid	90^o 109^o 120^o 180^o
AB_4E	See saw	90^o 109^o 120^o 180^o
AB_6	Octahedral	90^o 109^o 120^o 180^o
AB_5E	Square pyramid	90^o 109^o 120^o 180^o

19. q = 895 kJ

$Fe_3O_4(s) + 4\ H_2(g) \rightarrow 3\ Fe(s) + 4\ H_2O(g)$ $\Delta H^o = +150$ kJ

20. C and D

21. D

22. $\Delta H_{rxn}^o = -1034$ kJ

23. 78.5 kJ

24. $\Delta H = 565$ kJ

25 - 26. When 0.100 mol HCl(aq) and 0.100 mol NaOH(aq) are reacted in a total volume of 100.0 mL in a coffee cup calorimeter, the solution warms by 13.4 degrees. Use this information to answer the next two questions. Given: density of the solution is 1.00 g/mL.

25. $q_{cal} = 5610$ J

26. $\Delta H^o = -56.1$ kJ

27. $\Delta H^o = 165$ kJ

28. $\Delta H^o = -47$ kJ