

Exam 4 Chm 203 (Dr Mattson) 13 November 2017

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: _____

One point bonus for correctly completing all three items: printed name, signature, and chemistry student number.

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 periodic table" in the answer box — then write your name on the periodic table and turn it 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. (5 pts) In each set, circle the most electronegative element.

- a. O Cl Kr
- b. C O F
- c. S Cl Ar
- d. N P As
- e. Cl Sn Sb

2. (5 pts) In each set, circle the most polar bond.

- a. O – Br O – Cl O – F
- b. C – N C – O C – F
- c. H – B H – C H – O
- d. F – S Cl – O As – F
- e. I – I I – F F – F

3. (5 pts) Molecular hydrogen, H_2 , has a bond length of 74 pm and a bond strength of 436 kJ/mol. Answer these T/F questions about H_2 .

- T F The H – H bond is a π -bond.
- T F The bond strength would decrease if the hydrogen atoms were stretched apart.
- T F The bond strength would increase if the hydrogen atoms were forced closer together.
- T F In H_2 the bond is formed by the overlap of two 1s orbitals from the hydrogen atoms.
- T F Breaking the H – H bond would have $\Delta E = -436$ kJ/mol ($H_2 \rightarrow 2 H \quad \Delta E = -436$ kJ/mol)

4. (8 pts) Sketch the best Lewis dot structures for these ions, none of which actually exist. Answer the questions that follow.

a. FO_3^+	b. NO_2^+
c. OCl_3^+	d. FO_3^-

4b. (4 pts) Circle all ions with resonance (ignoring those with unacceptable formal charges):

- a. FO_3^+ b. NO_2^+ c. OCl_3^+ d. FO_3^-

4c. (2 pts) Circle two isostructural ions.

- a. FO_3^+ b. NO_2^+ c. OCl_3^+ d. FO_3^-

4d. (4 pts) Circle all ions with E groups in their ABE formulas.

- a. FO_3^+ b. NO_2^+ c. OCl_3^+ d. FO_3^-

4e. (4 pts) Circle all ions with a trigonal planar shape.

- a. FO_3^+ b. NO_2^+ c. OCl_3^+ d. FO_3^-

4f. (4 pts) What is the hybridization of the central atom in each structure?

a. FO_3^+	b. NO_2^+
c. OCl_3^+	d. FO_3^-

5a. (4 pts) The azide ion, N_3^- , is used in the form of NaN_3 in automobile airbags. Assign formal charges below each atom in these two possible structures.



5b. (1 pt) Which is the most important structure? Circle your choice.

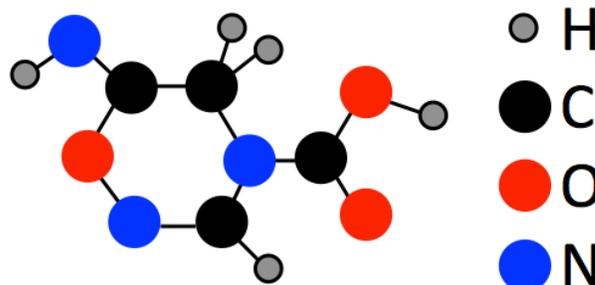
Left or Right

5c. (1 pt) What is the hybridization of the central nitrogen atom?

5d. (2 pts) How many σ -bonds and π -bonds are in the azide ion?

____ σ -bonds
____ π -bonds

6. (5 pts) Add double bonds as necessary to this organic structure. Add electron pairs as necessary throughout. Dots and lines must be bold enough for me to see.



7a. (4 pts) Sketch the structures of these molecules.

a. SF ₆	b. PF ₅
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7b. (2 pts) What is the geometry name for each?

a. SF ₆	b. PF ₅
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7c. (2 pts) Are these molecules polar?

a. SF ₆ Yes or No	b. PF ₅ Yes or No
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7d. (4 pts) What are the approximate bond angles within the molecule? Circle all that apply.

- a. SF₆ 90° 109° 120° 180°
 b. PF₅ 90° 109° 120° 180°

$$q = c \times m \times \Delta T$$

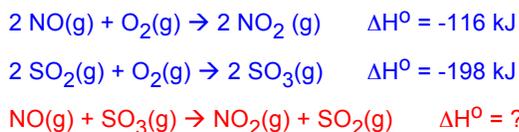
Specific heat for water, $c_{\text{water}} = 4.184 \text{ J g}^{-1} \text{ deg}^{-1}$

8. (5 pts) Suppose 97 g water, initially at 24.0 °C, absorbs 1750 J heat. What is the final temperature of the water?

You must show work for credit.

Answer with units: _____

9. (4 pts) Given the following information, calculate ΔH for the third equation.



You must show work for credit.

Answer with units: _____

10. (2 pts) Write the equation for the standard heat of formation of potassium phosphate. Include states of matter, (s), (l), or (g).

No partial credit.

11. (5 pts) Referring to the second equation in Question 9, calculate q if 215 g SO₂(g) is reacted with excess O₂.

You must show work for credit. Mind the sign of your answer.

Answer with units: _____

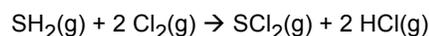
12. (5 pts) When 3.090 g CaO(s) is added to 100.0 g water at 24 °C in a calorimeter, the temperature of the water increases to 34.6 °C. Estimate ΔH for the reaction below.



You must show work for credit. Mind the sign of your answer.

Answer with units: _____

13. (3 pts) Estimate ΔH for the following reaction given these bond dissociation energies (kJ/mol): Cl-Cl: 243; S-H: 340; S-Cl: 250; and H-Cl: 432



Answer with units: _____

14. (10 pts) Naming. Complete the formula or name for each pair of the following. **Nom. Certified: Skip this.**

A.	dinitrogen trioxide
B.	vanadium(III) perchlorate
C.	hydrofluoric acid
D.	iodic acid
E.	lead(IV) sulfide
F.	CoSO ₃
G.	HClO ₂ (aq)
H.	(NH ₄) ₂ SO ₃
I.	SF ₆
J.	XeF ₄

Total score (out of 100): _____

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

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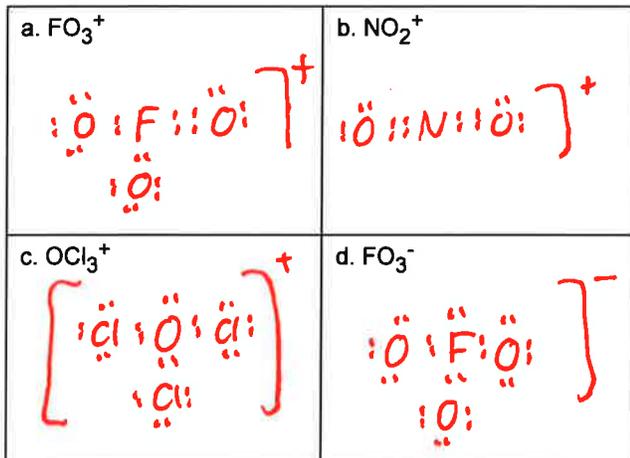
- a. O-Br O-Cl O-F
 b. C-N C-O C-F
 c. H-B H-C H-O
 d. F-S Cl-O As-F
 e. I-I I-F F-F

3, 5
2, 5

3. (5 pts) Molecular hydrogen, H₂, has a bond length of 74 pm and a bond strength of 436 kJ/mol. Answer these T/F questions about H₂.

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 T F Breaking the H-H bond would have ΔE = -436 kJ/mol (H₂ → 2 H ΔE = -436 kJ/mol)

4. (8 pts) Sketch the best Lewis dot structures for these ions, none of which actually exist. Answer the questions that follow.



4b. (4 pts) Circle all ions with resonance (ignoring those with unacceptable formal charges):

- a FO₃⁺ b. NO₂⁺ c. OCl₃⁺ d. FO₃⁻

4c. (2 pts) Circle two isostructural ions.

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- a FO₃⁺ b. NO₂⁺ c. OCl₃⁺ d. FO₃⁻

4f. (4 pts) What is the hybridization of the central atom in each structure?

a. FO ₃ ⁺	<u>sp²</u>	b. NO ₂ ⁺	<u>sp</u>
c. OCl ₃ ⁺	<u>sp³</u>	d. FO ₃ ⁻	<u>sp³</u>

5a. (4 pts) The azide ion, N₃⁻, is used in the form of NaN₃ in automobile airbags. Assign formal charges below each atom in these two possible structures.



5b. (1 pt) Which is the most important structure? Circle your choice.

Left or Right

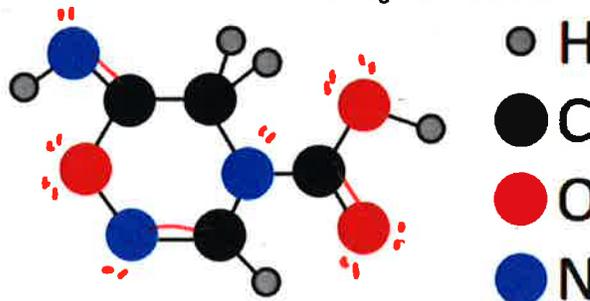
5c. (1 pt) What is the hybridization of the central nitrogen atom?

sp

5d. (2 pts) How many σ-bonds and π-bonds are in the azide ion?

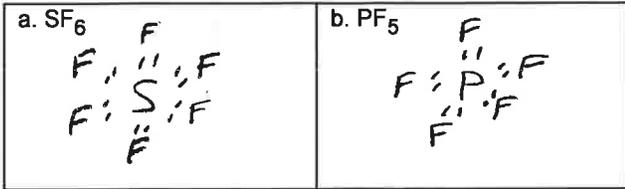
2 σ-bonds
2 π-bonds

6. (5 pts) Add double bonds as necessary to this organic structure. Add electron pairs as necessary throughout. Dots and lines must be bold enough for me to see.

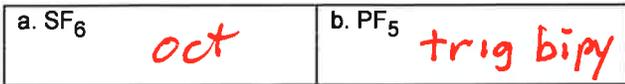


Key

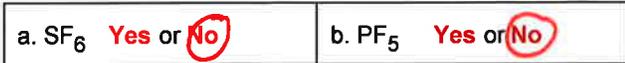
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7b. (2 pts) What is the geometry name for each?



7c. (2 pts) Are these molecules polar?



7d. (4 pts) What are the approximate bond angles within the molecule? Circle all that apply.

- a. SF₆ 90° 109° 120° 180°
- b. PF₅ 90° 109° 120° 180°

$q = c \times m \times \Delta T$

Specific heat for water, $c_{\text{water}} = 4.184 \text{ J g}^{-1} \text{ deg}^{-1}$

8. (5 pts) Suppose 97 g water, initially at 24.0 °C, absorbs 1750 J heat. What is the final temperature of the water?

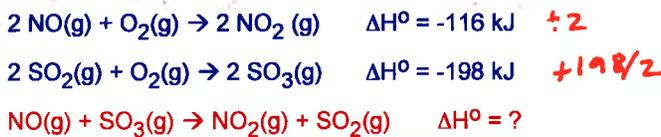
You must show work for credit.

$$1750 = 4.184 \times 97 \times \Delta T$$

$$\Delta T =$$

Answer with units: 28.3°C

9. (4 pts) Given the following information, calculate ΔH for the third equation.



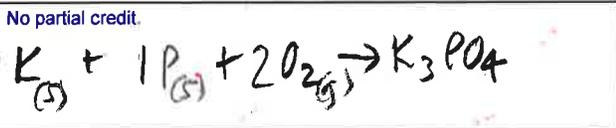
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$$\text{NO} + \frac{1}{2} \text{O}_2 \rightarrow \text{NO}_2 \quad \Delta H = -58 \text{ kJ}$$

$$\text{SO}_3 \rightarrow \text{SO}_2 + \frac{1}{2} \text{O}_2 \quad \Delta H = +99 \text{ kJ}$$

Answer with units: 41 kJ

10. (2 pts) Write the equation for the standard heat of formation of potassium phosphate. Include states of matter, (s), (l), or (g).



11. (5 pts) Referring to the second equation in Question 9, calculate q if 215 g SO₂(g) is reacted with excess O₂.

You must show work for credit. Mind the sign of your answer.

$$q = \frac{-198 \text{ kJ}}{2 \text{ mol SO}_2} \times \frac{215 \text{ g}}{64 \text{ g}} = -333 \text{ kJ}$$

Answer with units: -333 kJ

12. (5 pts) When 3.090 g CaO(s) is added to 100.0 g water at 24 °C in a calorimeter, the temperature of the water increases to 34.6 °C. Estimate ΔH for the reaction below.



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$$q_{\text{cal}} = 4.184 \times 103.09 \times 10.6 \text{ deg}$$

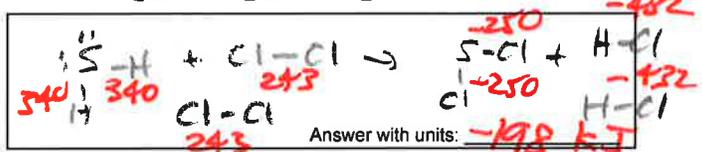
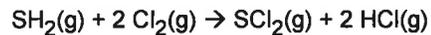
$$= 4.57 \text{ kJ} \quad q_{\text{cal}} = -q_{\text{rxn}}$$

$$\Delta H = \frac{-4.57 \text{ kJ}}{3.090 \text{ g}} \times \frac{56 \text{ g}}{\text{mol}}$$

$$= -83 \text{ kJ/mol CaO}$$

Answer with units: _____

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D. iodic acid	
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G.	HClO ₂ (aq)
H.	(NH ₄) ₂ SO ₃
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A+ > 95% A > 90% B+ > 85% B > 80% C+ > 75% C > 70% D > 60%