Chemistry 112
Non comprehensive part of Final Exam

8 points for your name          All problems worth 16 points

Section I .  New Material - You may NOT skip any questions from this section.

1A. Order the following atoms from largest to smallest atomic radius

    Na, Rb, Si  Largest _____Rb, Na, Si________Smallest

1B. Order the following atoms from largest to smallest ionization energy

    Ba, Si, Pb   Largest _____Si, Pb, Ba______Smallest

1C. Order the following atoms from least exothermic to most exothermic electron affinity

    Br, Cl, I    Least_____I, Br, Cl________Most

1C. Order the following atoms from most electronegative to least electronegative

    C, Ge, O     Most ______O, C, Ge________Least

2. For each of the following pairs of ionic compounds choose the ionic compound with the highest lattice energy

    NaCl, KBr    NaCl (Smaller ions)

    NaCl, MgS    MgS (more highly charged ions)

    LiF, RbI    LiF (Smaller ions)

    GaN, InN    GaN (Ga smaller than In)
3. Below are several reactions we have seen in this term. Write a chemical equation for each reaction:

First Ionization Energy
\[ X(g) \rightarrow X^+(g) + e^- \]

Second Ionization Energy
\[ X^+(g) \rightarrow X^{2+}(g) + e^- \]

Electron affinity
\[ X(g) + e^- \rightarrow X^-(g) \]

Lattice Energy
\[ X(g) + Y(g) \rightarrow XY(s) \]

Sublimation
\[ X(s) \rightarrow X(g) \]

Bond Energy
\[ X_2(g) \rightarrow 2X(g) \]

Reduction
\[ X(aq) + e^- \rightarrow X^-(aq) \]

Oxidation
\[ X(aq) \rightarrow X^+(aq) + e^- \]

4. Ammonia (NH\(_3\)) may be synthesized in the following reaction:

\[ N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) \quad \text{(reaction by bonds: N=N + 3 H-H \rightarrow 6 N-H)} \]

Determine the \(\Delta H_{rxn}\) using the following bond energy table

<table>
<thead>
<tr>
<th>Bond</th>
<th>Energy (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-H</td>
<td>432</td>
</tr>
<tr>
<td>H=H</td>
<td>850</td>
</tr>
<tr>
<td>N-H</td>
<td>391</td>
</tr>
<tr>
<td>N=H</td>
<td>800</td>
</tr>
<tr>
<td>N-N</td>
<td>160</td>
</tr>
<tr>
<td>N=N</td>
<td>418</td>
</tr>
<tr>
<td>N\equiv N</td>
<td>941</td>
</tr>
</tbody>
</table>

Note: This table contains some fake bonds to make the problem more interesting. You may have to make some Lewis structures to figure out which bonds you actually need to use.

Reactant bonds - product bonds
\[
(941 + 3(432)) - 6(391) \]
\[= 2237 - 2346 \]
\[= -109 \text{ kJ/mol} \]
5. For each of the following compounds give
a. A Lewis Structure
b. The electron arrangement around the central atom
c. The molecular arrangement around the central atom
d. Bond angles
e. Are the bonds in the molecule polar or non-polar
f. Is the molecule polar or non-polar

A. NF₃

5+21 = 26 electrons or 13 pairs

b. Tetrahedral

c. Trigonal pyramid

d. <109

e. Bonds polar

B. XeO₄

8+24 = 32 electrons or 16 pairs

b. Tetrahedral

c. Tetrahedral

d. 120 & 90

e. Polar bonds

C. OCl₂

6+14 = 20 electrons or 10 pairs

b. Tetrahedral

c. V-shaped

d. <109

e. Polar bond

D. SF₅⁺

6 + 35 -1 = 40 electrons

b. Trigonal bipyramid

c. Trigonal bipyramid

d. 120 & 90

e. Polar bonds

f. Nonpolar molecule
6. A. Nitrous oxide (N₂O) has three possible Lewis structures, find these three structures (In these structures N is the central atom)

\[
\begin{align*}
\text{Left} & : \text{N} \equiv \text{N} \equiv \text{O} \\
\text{Center} & : \text{N} \equiv \text{N} \equiv \text{O} \\
\text{Right} & : \text{N} \equiv \text{N} \equiv \text{O}
\end{align*}
\]

B. Using Formal charge decide which is the best structure

<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Center</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Left</td>
<td>5-6=-1</td>
<td>5-5=0</td>
<td>5-7=-2</td>
</tr>
<tr>
<td>N Center</td>
<td>5-4=+1</td>
<td>5-4=+1</td>
<td>5-4=+1</td>
</tr>
<tr>
<td>O right</td>
<td>6-6=0</td>
<td>6-7=-1</td>
<td>6-5=+1</td>
</tr>
</tbody>
</table>

Best 1 atom 0 Formal charge

O has a - formal charge

C. Given the following bond lengths, predict the bond lengths you should observe in this compound: N-N 167 pm, N=N 120 pm, N≡N 110 pm, N-O 147 pm, N≡O 115 pm, N=O 105pm

N≡N should be 110 pm - actual is 112 so is just about right

N-O should be 147 pm - actual is 119 so is much shorter (more like a double bond) than predicted