KWANTLEN UNIVERSITY COLLEGE
CHEMISTRY 1110 R11 Spring 2004
Dr. Jennifer Wolf
EXAM No. 2
Wednesday, March 24, 2004

Name: _____

Student Number_____

Instructions: Ensure that this exam contains all **ten** questions. Read the exam carefully and judge your time accordingly. Show your work where space is provided. If you need extra space, use the back of a preceding page and clearly indicate the question number. Rough work and work for short-answer questions may also be done on the back of a preceding page. A periodic chart is supplied with this exam.
Maximum Score: 70 marks

Question	Marks
1	/10
2	/4
3	/8
4	/6
5	/4
6	/8
7	/5
8	/9
9	/7
10	/9
TOTAL	/70

Question 1 (10 marks)
What is the maximum number of electrons that can have the following quantum numbers, and what are the possible orbital designations?

	# of electrons	possible orbital designations: (3p, 2s, etc.)
(a) n = 2, m_ℓ = +1/2	**4**	**2s, 2p**
(b) n = 3, ℓ = 2	**10**	**3d**
(c) n = 2, ℓ = 2	**0**	**-**
(d) n = 6, ℓ = 3	**14**	**6f**
(e) n = 3 m_ℓ = 0	**6**	**3s, 3p, 3d**

Question 2 (4 marks)
Give the electron configurations of the following (do not use noble gas core abbreviations for this question):

(a) Mo^{2+} **$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 4d^4$**

(b) Br **$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$**

(c) Pb^{2+} **$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6\ 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10}$**

(d) Cu **$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$**

Question 3 (8 marks)
Circle the correct choice(s) (may be more than one or none):

Isoelectronic with O^{2-}	S^{2-} O^+ **N^{3-}**
Isolelectronic with Fe^{3+}	**Mn^{2+}** Cr Ru^{3+}
Has 4 unpaired electrons	O Ti **Cr^{2+}**
Is diamagnetic	**Ar** **Ca** O
Most electronegative	**Cl** C Br
Has no d-electrons	As **P** **Ti^{4+}**

Question 4 (6 marks)
Match the following:

(a) Atomic radius (pm)

117	71	F
121	121	As
99	99	Cl
71	117	Si

(b) Ionic radius (pm)

99	**171**	N^{3-}
171	**140**	O^{2-}
59	**99**	Na^{+}
140	**59**	Li^{+}

(c) 2^{nd} ionization energy (kJ/mol)

4562	**2912**	Cl
2297	**2297**	P
1451	**4562**	Na
2912	**1451**	Mg

Question 5 (4 marks) (No need to show work)
(a) Order the following molecules in increasing polarity:

HCN H_2CO CH_3F CH_3Br CF_4

lowest CF_4 CH_3Br = HCN H_2CO CH_3F highest

(b) Order the following molecules or ions in order of increasing C-O bond length:

CO CO_2 CO_3^{2-} CH_3OH

Lowest CO CO_2 CO_3^{2-} CH_3OH highest

Question 6 (8 marks)
In the following pairs of molecules or ionic compounds, one is real and the other does not exist. Circle the **incorrect** one **giving your reasoning**.

(a) K_3N **Mg_3N**

Mg_3N is incorrect because Mg forms Mg^{2+} ions, and N forms N^{3-} ions.

(b) IF_3 **FI_3**

FI_3 is incorrect, because F cannot have an expanded octet while I can.

(c) PF_5 **NF_5**

NF_5 is incorrect because N cannot have an expanded octet, while P can.

(d) XeO_2 **NeO_2**

NeO_2 is incorrect, because Ne cannot have an expanded octet, while Xe can.

Question 7 (5 marks)

(a) Sketch a 2s and the three 2p orbitals:

-- see orbital handout, or figure 12-5 in book --

(b) Describe (with diagrams if necessary) the sp^2-hybridization scheme:

-- see figure 12-8 on page 442 --

Question 8 (9 marks)
Draw Lewis structures for the following molecules or ions, and indicate the geometry predicted by VSEPR theory:

(a) SF_4

-- Lewis structure has one lone pair on S, therefore geometry is see-saw (see table 11.1)

(b) BrF_5

-- Lewis structure has one lone pair on Br, therefore geometry is square pyramidal (see table 11.1)

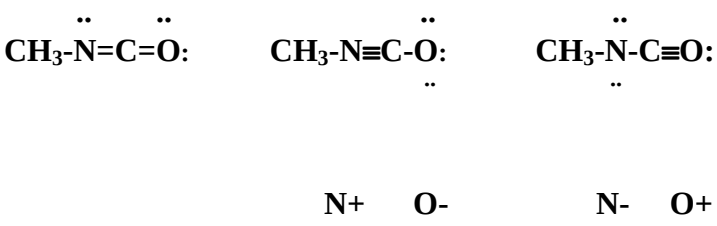
(c) $SOCl_2$

-- Lewis structure has one lone pair on S, therefore geometry is trigonal pyramidal

Question 9 (7 marks)
Methyl isocyanate is a toxic chemical used in the production of many pesticides. Methyl isocyanate has the formula CH_3NCO (the methyl group is attached to the nitrogen and the order of the N, C, and O atoms is as shown).

(a) Draw Lewis structures for methyl isocyanate, including all correct resonance forms.

Partial Lewis structures (formal charges are shown below structures).



(b) Indicate all non-zero formal charges on your resonance structures above.

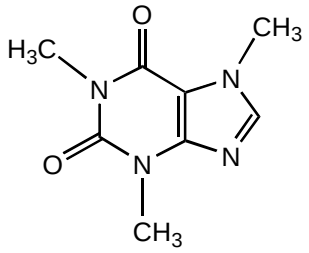
(c) Based on your resonance structures above, what would you expect the C-N-C bond angle to be? Explain.

The C-N-C bond angle should be 120º. The first resonance structure is the best one; therefore the geometry around the nitrogen should be triogal planar electron geometry and a bent 120º structure.

(d) Based on your resonance structures above, which C-N bond would you expect to be longer? Explain and be specific!

The CH_3-N bond should be longer; this will be a single bond, whereas the second will be closer to a double bond.

Question 10 (9 marks)
The following is a partial Lewis structure of caffeine:



(a) (i) How many lone pairs are there in the complete Lewis structure? **8**

(ii) How many sp^3-hybridized carbons are there? **3**

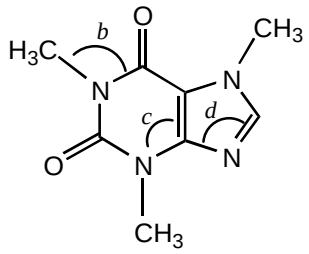
(iii) How many sp^2-hybridized carbons? **5**

(iv) How many sp-hybridized carbons? **0**

(v) How many sp^3-hybridized nitrogens? **3**

(vi) How many sp^2-hybridized nitrogens? **1**

The partial Lewis structure of caffeine is given again below, this time including labels for some bond angles. Give the approximate bond angles indicated below:



(b) **109.5°** (c) **120°** (d) **120°**