NAME:_____ Section:_____ Student Number:_____

Spring 2012 **Chemistry 2000 Practice Midterm #1A** ____/ 50 marks

INSTRUCTIONS:
1) Please read over the test carefully before beginning. You should have 4 pages of questions, a blank "overflow" page and a periodic table page.
2) If your work is not legible, it will be given a mark of zero.
3) Marks will be deducted for incorrect information added to an otherwise correct answer.
4) Calculators are not permitted.
5) You have 90 minutes to complete this test.

Confidentiality Agreement:
I agree not to discuss (or in any other way divulge) the contents of this exam until after 8pm Mountain Time on Monday, February 13th, 2012. I understand that breaking this agreement would constitute academic misconduct, a serious offense with serious consequences. The minimum punishment would be a mark of 0/50 on this exam and removal of the "overwrite midterm mark with final exam mark" option for my grade in this course; the maximum punishment would include expulsion from this university.

Signature: _____ Date: _____
Course: CHEM 2000 (General Chemistry II)
Semester: Spring 2012
The University of Lethbridge

Question Breakdown

Q1	/ 12
Q2	/ 4
Q3	/ 6
Q4	/ 6
Q5	/ 22

Total	/ 50

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1. As you know, the noble gases are very unreactive. There are, in fact, two distinct reasons why a substance might be unreactive:

   1. Molecules made from that substance might be unstable.
      e.g. In class, we saw the MO explanation for the nonexistence of Ne_2.
   2. Molecules made from the unreactive substance might be stable in complete isolation, but react with each other (or with other materials) in a thermodynamically favorable manner.
      In other words, reactions like $2\ NeX \rightarrow 2\ Ne + X_2$ might be favorable for any X.

   These two cases can be distinguished experimentally, because in the first case we can't make the molecule at all, while in the second we can make it in specially designed experiments in the gas phase at ultralow pressures and detect it spectroscopically. **[12 marks]**

(a) Using the data in the table, construct a valence MO energy level diagram for NeF. *[10 marks]*

Your diagram should include all valence electrons.
Label all orbitals, but you do not need to draw pictures of them.

Orbital energies (Ry)		
	2s	2p
F	-2.95	-1.37
Ne	-3.56	-1.59

(b) Based on your valence MO energy level diagram, state whether or not NeF is a stable molecule, and briefly justify your answer. Is Reason #1 or Reason #2 applicable to the lack of reactivity of Ne with F_2? *[2 marks]*

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2. Briefly explain how photoelectron spectroscopy works. What information does photoelectron spectroscopy give us about a molecule's orbitals? **[4 marks]**

3. Boron is an intrinsic semiconductor, while aluminium is a metal. **[6 marks]**

(a) Sketch the band diagrams implied by this information. Clearly label each band. *[4 marks]*

(b) Briefly discuss the feature(s) of these diagrams that cause the different electrical properties of boron and aluminium. *[2 marks]*

4. **[6 marks]**

(a) When valence bond theory is applied to OF_2, what is the hybridization of the central atom? *Show any work you do in arriving at your answer to this question.* *[3 marks]*

(b) Briefly explain what hybridization is and why it is necessary in valence bond theory. *[3 marks]*

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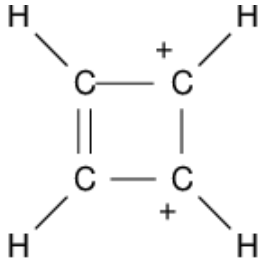
5. The following is a Lewis diagram for one resonance structure of the cyclobutenediylium dication ($C_4H_4^{2+}$): **[22 marks]**



(a) How many **valence** σ MOs and how many **valence** π MOs would this ion have? *[2 marks]*

_____ valence σ MOs _____ valence π MOs

(b) Draw all the π MOs. You can either sketch each MO, or you can use the symbols +/-/0 to describe the contributions of the p orbitals on each atom. *[4 marks]*

(c) Next to each MO that you drew in part (b), classify it as bonding, antibonding, or nonbonding. *[4 marks]*

(d) How many valence π electrons are there in the cyclobutenediylium dication? *[1 mark]*

(e) Sketch a valence π MO energy level diagram based on your classification of the MOs in part (b) of this question. Label each MO and populate your diagram with electrons. *[4 marks]*

question 5 is continued on the next page…

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5. *continued…*

(f) Calculate the carbon-carbon bond order in this ion (σ and π combined). *[2 marks]*

(g) Is this ion paramagnetic or diamagnetic? *[1 mark]*

(h) Would bonding be stronger, weaker, or about the same if the ion gained two π electrons? Explain. *Note that adding two electrons would give you a neutral molecule called cyclobutadiene.* *[3 marks]*

(i) What molecular property could you measure and compare in the dication and in the neutral molecule to confirm your theoretical prediction in part (h)? *[1 mark]*

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Overflow Page

If you use this page for any answers, please clearly indicate which question is being answered and make sure you note on the page for the question itself that the answer continues here.

Chem 2000 Standard Periodic Table

1												13	14	15	16	17	18
1.0079 **H** 1	**2**																4.0026 **He** 2
6.941 **Li** 3	9.0122 **Be** 4											10.811 **B** 5	12.011 **C** 6	14.0067 **N** 7	15.9994 **O** 8	18.9984 **F** 9	20.1797 **Ne** 10
22.9898 **Na** 11	24.3050 **Mg** 12	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	26.9815 **Al** 13	28.0855 **Si** 14	30.9738 **P** 15	32.066 **S** 16	35.4527 **Cl** 17	39.948 **Ar** 18
39.0983 **K** 19	40.078 **Ca** 20	44.9559 **Sc** 21	47.88 **Ti** 22	50.9415 **V** 23	51.9961 **Cr** 24	54.9380 **Mn** 25	55.847 **Fe** 26	58.9332 **Co** 27	58.693 **Ni** 28	63.546 **Cu** 29	65.39 **Zn** 30	69.723 **Ga** 31	72.61 **Ge** 32	74.9216 As 33	78.96 **Se** 34	79.904 **Br** 35	83.80 **Kr** 36
85.4678 **Rb** 37	87.62 **Sr** 38	88.9059 **Y** 39	91.224 **Zr** 40	92.9064 **Nb** 41	95.94 **Mo** 42	(98) **Tc** 43	101.07 **Ru** 44	102.906 **Rh** 45	106.42 **Pd** 46	107.868 **Ag** 47	112.411 **Cd** 48	114.82 **In** 49	118.710 **Sn** 50	121.757 **Sb** 51	127.60 **Te** 52	126.905 **I** 53	131.29 **Xe** 54
132.905 **Cs** 55	137.327 **Ba** 56	**La-Lu**	178.49 **Hf** 72	180.948 **Ta** 73	183.85 **W** 74	186.207 **Re** 75	190.2 **Os** 76	192.22 **Ir** 77	195.08 **Pt** 78	196.967 **Au** 79	200.59 **Hg** 80	204.383 **Tl** 81	207.19 **Pb** 82	208.980 **Bi** 83	(210) **Po** 84	(210) **At** 85	(222) **Rn** 86
(223) **Fr** 87	226.025 **Ra** 88	**Ac-Lr**	(261) **Rf** 104	(262) **Db** 105	(263) **Sg** 106	(262) **Bh** 107	(265) **Hs** 108	(266) **Mt** 109	(281) **Dt** 110	(283) **Rg** 111							

138.906 **La** 57	140.115 **Ce** 58	140.908 **Pr** 59	144.24 **Nd** 60	(145) **Pm** 61	150.36 **Sm** 62	151.965 **Eu** 63	157.25 **Gd** 64	158.925 **Tb** 65	162.50 **Dy** 66	164.930 **Ho** 67	167.26 **Er** 68	168.934 **Tm** 69	173.04 **Yb** 70	174.967 **Lu** 71
227.028 **Ac** 89	232.038 **Th** 90	231.036 **Pa** 91	238.029 **U** 92	237.048 **Np** 93	(240) **Pu** 94	(243) **Am** 95	(247) **Cm** 96	(247) **Bk** 97	(251) **Cf** 98	(252) **Es** 99	(257) **Fm** 100	(258) **Md** 101	(259) **No** 102	(260) **Lr** 103

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