CH 221 Fall 2025:
"Valence Bond and Molecular Orbitals" *Lab Instructions*

Step One:

Get a printed copy of this lab! You will need a printed (hard copy) version of pages I-7-3 through I-7-12 to complete this lab. If you do not turn in a printed copy of the lab, there will be a 2-point deduction.

Step Two:

Watch the **video introduction** for this lab **here: http://mhchem.org/w/7.htm**
The video introduction will help prepare you for the lab and assist you in completing the work before turning it in to the instructor.
There are no PreLab questions for this lab.

Step Three:

Bring the printed copy of the lab with you on Monday, November 3 (section L1), Tuesday, November 4 (section L2), Wednesday, November 5 (section L3) *or* **Friday, November 7 (section L4))** During lab in room AC 2507, you will use these sheets (with the valuable instructions!) to gather data, all of which will be recorded in the printed pages below.

Step Four:

Complete the lab work and calculations on your own, then **turn it in** (pages I-7-5 through I-7-12 *only* to avoid a point penalty**) at the beginning of recitation to the instructor on Monday, November 10 (section L1), Thursday, November 13 (section L2, Veterans Day), Wednesday, November 12 (section L3)** *or* **Friday, November 14 (section L4)**
The graded lab will be returned to you the following week during recitation.

If you have any questions regarding this assignment, please email (mike.russell@mhcc.edu) the instructor! Good luck on this assignment!

VALENCE BOND (VB) THEORY

and

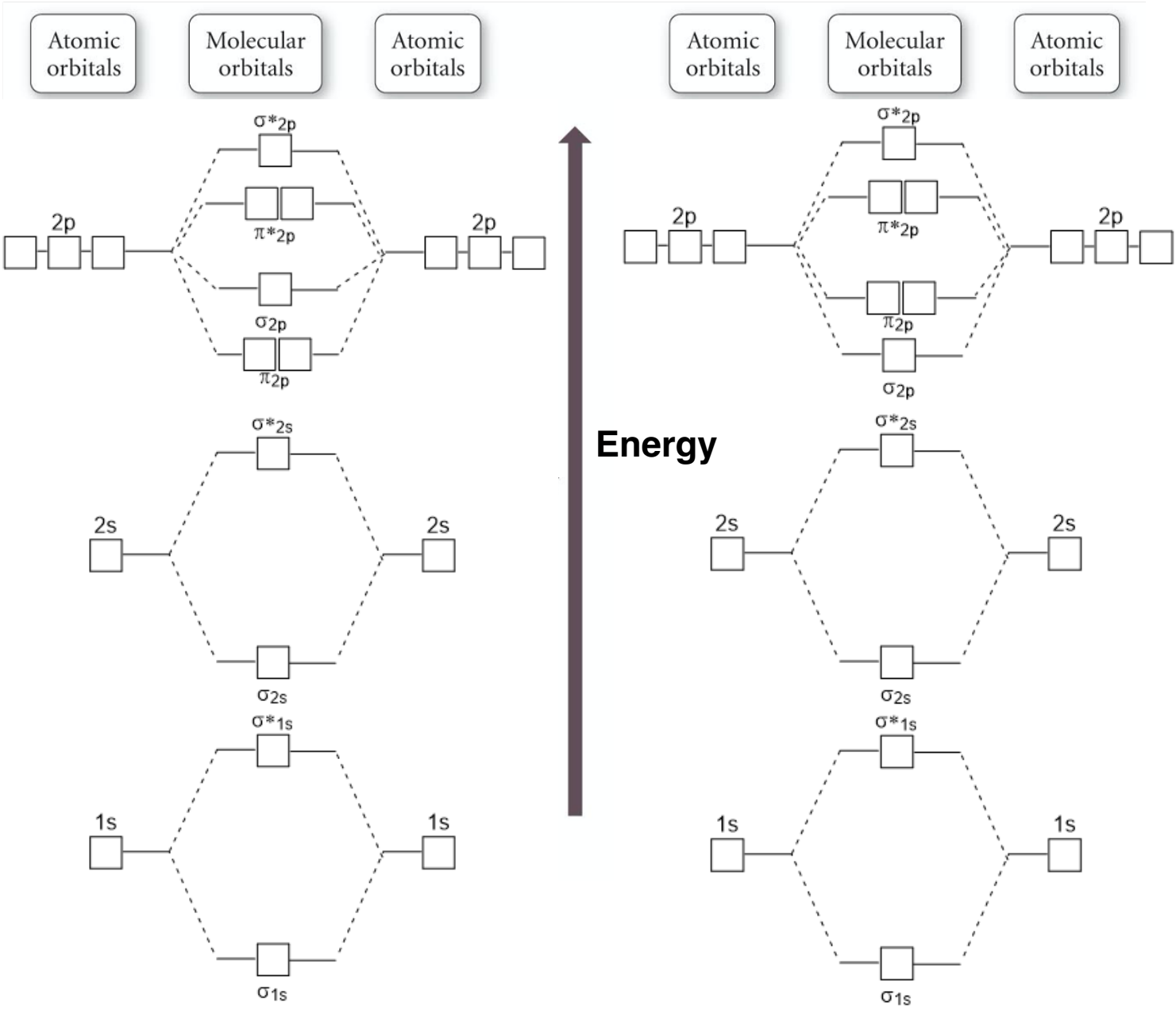
MOLECULAR ORBITAL (MO) THEORY

LAB

This lab contains a series of handouts that you should complete. Neatness counts!

Useful handouts from the Chemistry 222 website (http://mhchem.org/222):

- Geometry and Polarity Guide (http://mhchem.org/geopo/)
- MO Diagram - B_2 through N_2 (http://mhchem.org/MO)
- MO Diagram - O_2 through Ne_2 (http://mhchem.org/MO)



*Molecular orbital diagrams for **B, C, N (left)** and **O, F and Ne (right)**.*
Use [core electrons] *if not showing the 1s interactions in your molecular orbital diagram.*

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VALENCE BOND THEORY and MOLECULAR ORBITAL THEORY LAB - *Worksheet* **Name:**
Hand drawn versions only, no computer generated structures *first and last name*
Complete the sections below by providing the appropriate information in the spaces provided. *Neatness counts!*

Part One: Valence Bond Theory *Complete the following sections using Valence Bond Theory.*

Molecule/Ion	Lewis Structure (& Isomers, if any)		
SeI_2		***Electron Pair Geometry:*** ***Molecular Geometry:*** ***Polar or Nonpolar:***	***Hybridization:*** ***Bond Order:*** ***Resonance Forms? (Y/N)***

Molecule/Ion	Lewis Structure (& Isomers, if any)		
$AsCl_5$		***Electron Pair Geometry:*** ***Molecular Geometry:*** ***Polar or Nonpolar:***	***Hybridization:*** ***Bond Order:*** ***Resonance Forms? (Y/N)***

Molecule/Ion	Lewis Structure (& Isomers, if any)		
CO_3^{2-}		***Electron Pair Geometry:*** ***Molecular Geometry:*** ***Polar or Nonpolar:***	***Hybridization:*** ***Bond Order:*** ***Resonance Forms? (Y/N)***

Molecule/Ion	Lewis Structure (& Isomers, if any)		
ClO_3^{1-}		***Electron Pair Geometry:*** ***Molecular Geometry:*** ***Polar or Nonpolar:***	***Hybridization:*** ***Bond Order:*** ***Resonance Forms? (Y/N)***

Molecule/Ion	Lewis Structure (& Isomers, if any)		
ClO_4^{1-}		***Electron Pair Geometry:*** ***Molecular Geometry:*** ***Polar or Nonpolar:***	***Hybridization:*** ***Bond Order:*** ***Resonance Forms? (Y/N)***

Molecule/Ion	Lewis Structure (& Isomers, if any)		
$XeOF_4$		***Electron Pair Geometry:*** ***Molecular Geometry:*** ***Polar or Nonpolar:***	***Hybridization:*** ***Bond Order:*** ***Resonance Forms? (Y/N)***

Part Two: Molecular Orbital Theory *Complete the following sections using Molecular Orbital Theory. Draw a complete Molecular Orbital diagram to answer these questions (include all 1s and 2s interactions, no short hand notation) and provide the missing information.*

Molecule / Ion: **Li_2**

Molecular Orbital Diagram:

Bond Order: _____ Number of sigma bonds: _____ Number of pi bonds: _____

(Circle) **Paramagnetic** *or* **Diamagnetic** Should this molecule exist? *(Circle)* **Yes** *or* **No**

Molecule / Ion: **Be_2**

Molecular Orbital Diagram:

Bond Order: _____ Number of sigma bonds: _____ Number of pi bonds: _____

(Circle) **Paramagnetic** *or* **Diamagnetic** Should this molecule exist? *(Circle)* **Yes** *or* **No**

Molecule / Ion: **B_2**

Molecular Orbital Diagram:

Bond Order: _____ Number of sigma bonds: _____ Number of pi bonds: _____

(Circle) **Paramagnetic** *or* **Diamagnetic** Should this molecule exist? *(Circle)* **Yes** *or* **No**

Molecule / Ion: **N_2**

Molecular Orbital Diagram:

Bond Order: _____ Number of sigma bonds: _____ Number of pi bonds: _____

(Circle) **Paramagnetic** *or* **Diamagnetic** Should this molecule exist? *(Circle)* **Yes** *or* **No**

Molecule / Ion: **F_2**

Molecular Orbital Diagram:

Bond Order: _____ Number of sigma bonds: _____ Number of pi bonds: _____

(Circle) **Paramagnetic** *or* **Diamagnetic** Should this molecule exist? *(Circle)* **Yes** *or* **No**

Molecule / Ion: **Ne_2**

Molecular Orbital Diagram:

Bond Order: _____ Number of sigma bonds: _____ Number of pi bonds: _____

(Circle) **Paramagnetic** *or* **Diamagnetic** Should this molecule exist? *(Circle)* **Yes** *or* **No**

Part Three: Theory Comparison *Complete the following sections using both Valence Bond (VB) Theory and Molecular Orbital (MO) Theory.* ***Shorthand notation for MO Diagrams is recommended****, include 1s and 2s interactions.*

Molecule / Ion: **CN^{1-}** *(Use the MO Diagram for B, C and N on this problem)*

Valence Bond Lewis Structure:	Bond Order (VB): _____
	Bond Order (MO): _____
	Number of sigma bonds (VB): _____
Molecular Orbital Diagram:	Number of sigma bonds (MO): _____
	Number of pi bonds (VB): _____
	Number of pi bonds (MO): _____
	(VB) Paramagnetic? *(circle)* **Yes No**
	(MO) Paramagnetic? *(circle)* **Yes No**

Molecule / Ion: **NO^{1+}** *(Use the MO Diagram for O, F and Ne on this problem)*

Valence Bond Lewis Structure:	Bond Order (VB): _____
	Bond Order (MO): _____
	Number of sigma bonds (VB): _____
Molecular Orbital Diagram:	Number of sigma bonds (MO): _____
	Number of pi bonds (VB): _____
	Number of pi bonds (MO): _____
	(VB) Paramagnetic? *(circle)* **Yes No**
	(MO) Paramagnetic? *(circle)* **Yes No**

Molecule / Ion: **NO** *(Use the MO Diagram for O, F and Ne on this problem)*

Valence Bond Lewis Structure:	Bond Order (VB): _____
	Bond Order (MO): _____
	Number of sigma bonds (VB): _____
Molecular Orbital Diagram:	Number of sigma bonds (MO): _____
	Number of pi bonds (VB): _____
	Number of pi bonds (MO): _____
	(VB) Paramagnetic? *(circle)* **Yes No**
	(MO) Paramagnetic? *(circle)* **Yes No**

Molecule / Ion: **O_2**

Valence Bond Lewis Structure:	Bond Order (VB): _____
	Bond Order (MO): _____
	Number of sigma bonds (VB): _____
Molecular Orbital Diagram:	Number of sigma bonds (MO): _____
	Number of pi bonds (VB): _____
	Number of pi bonds (MO): _____
	(VB) Paramagnetic? *(circle)* **Yes No**
	(MO) Paramagnetic? *(circle)* **Yes No**

Molecule / Ion: **OF^{1-}**

Valence Bond Lewis Structure:	Bond Order (VB): _____
	Bond Order (MO): _____
	Number of sigma bonds (VB): _____
Molecular Orbital Diagram:	Number of sigma bonds (MO): _____
	Number of pi bonds (VB): _____
	Number of pi bonds (MO): _____
	(VB) Paramagnetic? *(circle)* **Yes No**
	(MO) Paramagnetic? *(circle)* **Yes No**

Molecule / Ion: **Ne_2^{2+}**

Valence Bond Lewis Structure:	Bond Order (VB): _____ Bond Order (MO): _____ Number of sigma bonds (VB): _____
Molecular Orbital Diagram:	Number of sigma bonds (MO): _____ Number of pi bonds (VB): _____ Number of pi bonds (MO): _____ (VB) Paramagnetic? *(circle)* **Yes No** (MO) Paramagnetic? *(circle)* **Yes No**