

Name _____ KEY _____ Lab Section _____ Date _____

Pre-Lab: Crystal Violet and Quantum Theory

For this lab you will need a **calculator**, plus:

1. **Computer.** Any desktop or laptop with an Internet connection can be used to complete this lab. Bring your laptop to lab if you wish. Laptops will also be available in lab.

Using a **mouse** is recommended for technical computing.

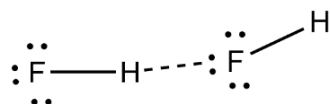
2. **Internet connection.** If you are using your laptop in the Reichardt Bldg, check the **wifi** settings.
3. **UA username and password.** These are required to log in to the UAF WebMO website.
4. **Chem106 group password.** Your TA or professor will announce this in class or online.

To do:

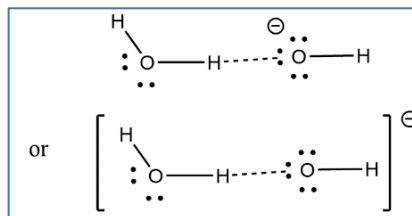
1. Read and study the lab handout and worksheet.
2. Review in your textbook some topics from C105 and C106 such as: electromagnetic spectrum (Sect. 3.2 in Burdge, 4th Ed.), atomic spectroscopy (Sect. 3.4), electronegativity (6.2), Lewis formulas (6.3), resonance (6.5), hydrogen bonds (7.3), molecular orbitals (7.7), visible spectroscopy (9.5), enthalpy (10.3), energy of activation (14.6), and transition states (14.7).

Also **google** "khan academy representing endothermic and exothermic processes"

3. The Lewis structure of a hydrogen fluoride dimer $[\text{FH}\cdots\text{FH}]$ is shown below. The dashed line represents a hydrogen bond, which is a weak connection between the electron-rich F atom and the partially-positive H atom.



In a similar manner, OH^- ion is stabilized in water by hydrogen bonds. A small model would be a OH^- ion stuck to a water molecule: $\text{HOH}\cdots\text{OH}^-$. Draw a Lewis structure for this complex containing one hydrogen bond. Make it look about like the HF dimer.



(The reversed isomer is 9 kcal/mol less stable.)

4. Write a balanced chemical equation for formation of the hydroxide ion-water-complex ($\text{H}_2\text{O}\cdots\text{OH}^-$) from H_2O and OH^- . Do not include Lewis formulas.



5. The table on the right lists hypothetical energy values (E) for the above species. Use these to calculate ΔE for the formation reaction.

The energies in the table are **highly negative** because in quantum theory the energy of a molecule is compared to the energies of the constituent particles, that is, several nuclei and all the core and valence electrons.

	E (kcal/mol)
H ₂ O	-47,937.8
HO ⁻	-47,599.3
HOH...OH ⁻	-95,556.4
$\Delta E =$ kcal/mol	

$$\Delta E = \sum E_{\text{products}} - \sum E_{\text{reactants}}$$

$$\Delta E = E_{\text{HOH-OH}} - (E_{\text{OH}} + E_{\text{H}_2\text{O}})$$

$$\Delta E_{\text{rxn}}^{\circ} = \sum E_{\text{products}} - \sum E_{\text{reactants}} = -95556.4 - (-47599.3 + (-47937.8)) \text{ kcal/mol}$$

$$\Delta H_{\text{rxn}}^{\circ} = -19.3 \text{ kcal/mol}$$

(c) Is this reaction exothermic ☒ or endothermic ☐? Check one. (**Hint:** Check the **sign of ΔE .**)
(Google “deltaH is negative - is this exothermic?”)

6. **Peruse** the Wikipedia article on “Computational chemistry”. Read about Nobel prizes in the History section. Follow links to “activation energy” in the Catalysis section and “HOMO and LUMO” in the Drug Development section.

7. Log in to WebMO (chem106 group) as described in the Appendix of the lab handout. Calculate the energy of a **single carbon atom** using the default settings invoked when you log in:

Under the **New Job** menu, select **Create New Job**. Left click once on the workspace to insert a C atom. **Continue** (right arrow at the bottom of the screen). **Continue**. **Continue**.



The WebMO Job Manager page should now be displayed.

Record the **Number** of **your** C job here: _____ (No need to report the energy value.)

WebMO Job Manager			
Status jwkeller chem106 unlimited 0 jobs Folders Inbox Trash	<< New Job Refresh Download Move		
	Show all Show all		
	<input type="checkbox"/>	Number	Name Description
	<input checked="" type="checkbox"/>	37753	C Molecular Energy - 106 - ORCA
	<input type="checkbox"/>	37746	C25H31ON3 Molecular Energy - 106 - ORCA
	<input type="checkbox"/>	37695	C25H30N3(+1) Molecular Orbitals - Gaussian