

**Chem 360 Problems**  
**Due 20<sup>th</sup> February 2007**

Do not write in pencil or red pen (if you do there will be no grade).

You can e-mail a “.pdf” file to me – [arb@rice.edu](mailto:arb@rice.edu)

Answer all questions.

1. Why does Zn have a smaller atomic volume than Ca (5 points)
2. Which atom in the following pairs has the higher ionization potential: (a) S or P, (b) K or Cu, (c) Al or Mg (2 points each). Why? (3 point each)
3. Predict the shape (including estimating angles) of (a) H<sub>3</sub>NO and (b) SF<sub>4</sub> by VSEPR (10 points)
4. Draw the important resonance structures for (a) the allyl radical (H<sub>2</sub>CCHCH<sub>2</sub>) and (b) F<sub>2</sub>SO (10 points)
5. HOCN and OCN<sup>-</sup>, how do you expect the OC and CN bonds to differ between these species? (10 points)
6. Which of the pair has a larger bond angle? (a) CH<sub>4</sub> or NH<sub>3</sub>, (b) NO<sub>2</sub><sup>-</sup> or O<sub>3</sub>? (10 points)
7. Which of each pair would you expect to show the most ionic character in its bonding? (a) CaCl<sub>2</sub> or ZnCl<sub>2</sub>, (b) ZnO or ZnS, (c) MgCl<sub>2</sub> or BeCl<sub>2</sub> (15 points).
8. Interpret the finding that the boiling points of the following compounds are in the order shown. (a) H<sub>2</sub>O > NH<sub>3</sub>, (b) CH<sub>3</sub>OH > CF<sub>3</sub>CH<sub>2</sub>OH > (CF<sub>3</sub>)<sub>2</sub>CHOH > (CF<sub>3</sub>)<sub>3</sub>COH. (10 points)
9. Predict the structure for B<sub>2</sub>H<sub>5</sub>Me (10 points)
10. How would you prepare DCl<sub>(g)</sub> starting from D<sub>2</sub>O? (10 points).
11. Covalent hydrides can be made by the following routes (a) direct combination, (b) reduction, (c) hydrolysis. If I make the following hydrides, which would I make from which route? (a) SiH<sub>4</sub>, HCl, PH<sub>3</sub> (10 points)
12. Hydrides of Group 13 elements are potentially suitable for use as rocket fuels because they produce a large amount of energy from combustion. How much energy is available from the complete of 1 mole of B<sub>6</sub>H<sub>10</sub>? Enthalpies of formation: ΔH<sub>f</sub> B<sub>6</sub>H<sub>10</sub> = +7.74 kJ.mol<sup>-1</sup>, B<sub>2</sub>O<sub>3</sub> = -1273 kJ.mol<sup>-1</sup>, and H<sub>2</sub>O = -286 kJ.mol<sup>-1</sup>. (10 points)
13. The reaction of PhC(O)D with OH<sup>-</sup> yields PhCO<sub>2</sub><sup>-</sup> and PhCD<sub>2</sub>OH + H<sub>2</sub>O. Why? (15 points)

14. Go to [http://www.rita.dot.gov/agencies\\_and\\_offices/research/hydrogen\\_portal/](http://www.rita.dot.gov/agencies_and_offices/research/hydrogen_portal/) and after reading it, suggest a key technical challenge that must be overcome in order to use hydrogen. (10 points)