LAST Name: ____

FIRST Name: ____

Student #: ____

CHM2132
Midterm #1
Fall 2013

This is a closed book exam with no notes allowed.
Non-graphing, non-programmable calculators are permitted.
An equation sheet with constants and conversion factors are provided on the last page.
You may rip this page off of the exam and use it for rough work.

You must show all work to receive partial credit.

Remember to include units in all your calculations**.**
Marks will be deducted if units are not shown in your final answer.
Marks will be deducted if an unreasonable number of sig figs is shown in final answer.
If data calculated in previous sections of a multi-part question and used for subsequent calculations is incorrect, no additional mark deductions will be applied.

You have 75 minutes to complete this test.

Q1: __________**/8** **Q2:** __________**/13** **Q3:** __________**/14** **Q4:** __________**/10**

Total = __________**/45**

Question 1. The following statements are **FALSE**. **Choose 4 of the 5 statements below** and:

(i) Change the sentence so that it becomes a correct statement.

(ii) In one sentence explain why the statement was incorrect. (8 marks)

a) The entropy of any isothermal process can be experimentally determined by measuring the heat of the process and dividing this number by the temperature.

We have not covered this yet.

b) Oil and water undergo spontaneous phase separation because of favorable hydrophobic interactions between oil molecules.

We have not covered this yet.

c) If $\Delta S_r^o < 0$ for the isothermal transition of a protein from the unfolded to the folded state then we know that this process will not be spontaneous.

We have not covered this yet.

d) For an isothermal chemical reaction run at constant pressure, $\Delta_r U_m$ is always less than $\Delta_r H_m$.

e) If a cup of water containing some ice is put into a freezer held at -20^{o}C, the chemical potential of the ice will be constant.

We have not covered this yet.

Question 2. Answer the questions below, using the data acquired at 298 K shown in the tables.

	$\Delta H^o_{r,m}$ (kJ/mol)
B_2H_6 (g) +3 O_2 (g) → B_2O_3 (s) + 3 H_2O (g)	-2036
2 B (s) + 3/2 O_2 (g) → B_2O_3 (s)	-1274
H_2 (g) + ½ O_2 (g) → H_2O (g)	-241.8

	S^o_m (J/K/mol)	$C^o_{p,m}$ (J/K/mol)
H_2 (g)	130.7	28.8
O_2 (g)	205.1	29.4
B (s)	5.90	11.1
B_2O_3 (s)	54.0	62.8
B_2H_6 (g)	233.1	56.0

a) Determine $\Delta H^o_{f,m}$ for B_2H_6(g) at 298 K. (3 marks)

b) Based on your answer in a), state whether the formation reaction is exothermic or endothermic. (1 mark)

c) Determine $\Delta H^o_{f,m}$ for B_2H_6(g) at 310 K. (3 marks)

d) Find $\Delta U^{o}_{f,m}$ for B_2H_6 (g) at 298 K. (3 marks)

e) What is the maximum work that could be done in the formation of 1.00 mol of B_2H_6 at 298 K? (3 marks)

We have not covered this yet.

Question 3.

A 2.15 mol sample of an ideal gas with $C_{v,m}$ = 3/2 R, for which p = 2.50 atm and T = 465 K is expanded adiabatically against an external pressure of 0.613 atm until the final pressure is 0.613 atm.

a) What is the final temperature of the gas? (4 marks)

b) How much work is done? (3 marks)

c) What is the total entropy change for the gas? (4 marks)

We have not covered this yet.

d) Is this a spontaneous process? Prove your answer with a calculation. (3 marks)

We have not covered this yet.

Question 4. Answer the following short questions:

a) Write down the van der Waals equation, and circle the term(s) that account for the attractive interaction between gas molecules. (1 mark)

b) On a pressure *versus* volume diagram, draw an isothermal expansion against constant pressure, and shade in the portion that corresponds to the work of this process. Be sure to label the initial and final volume on the graph axis. (3 marks)

c) For the process in b), what is doing the work, the system or the surroundings? (1 mark)

d) Given that $\beta = \frac{1}{VT}\left(\frac{\partial V}{\partial T}\right)_p$, find $\frac{V_i}{V_f}$. You must show your work to get marks in this question. (3 marks)

e) Suppose, two copper bars $\left(C^o_{p,m} = 24.4 \text{ J K}^{-1} \text{ mol}^{-1}\right)$, one initially at 80°C and the other initially at 20°C, are brought into contact with each other in a thermally insulated compartment and then allowed to come to equilibrium. (Assume no volume change.) What is ΔU^o_m and ΔH^o_m for this process? (2 marks)