For instructor's use only

1	2	2d bonus	3	4	Si. D.	**Total: /16**

Name: **Student ID:**

UNIVERSITY OF MANITOBA, DEPARTMENT OF CHEMISTRY
Chemistry 2290, Winter 2011, Dr. H. Georg Schreckenbach

First Midterm Examination February 9, 2011

This exam has **4** (four) pages. *READ the question carefully*! Answer **ALL** questions, except possibly 2d, which is a bonus question that may earn you one extra mark. Most questions have *multiple* parts. Note that the questions aren't necessarily ordered by difficulty or by any other criteria.

If you use *pencil*, your exam will not be remarked! For numerical problems, all mathematical steps must be shown. Please answer all questions *on* the question sheets. Use *reverse* side or extra paper if more space is needed. On any extra sheet, please indicate your name and student ID number, please.

[Comment 2012: Of course, I do provide enough space for the answers in an actual exam.]

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1. Concepts: state functions **3 marks**

(a) In the context of thermodynamics, what is a state function? (Definition.)
(b) Given an example of a property that is *not* a state function.
(c) In the context of thermodynamics, define "system".

2. The laws of thermodynamics **3 marks (a-c); 1 bonus mark (d)**

(a) Provide a concise verbal statement of the First Law of Thermodynamics.
(b) Provide a concise verbal statement of the Zeroth Law of Thermodynamics.
(c) What if any is the connection between the Zeroth Law and the temperature?
Note: It is not sufficient to simply copy the respective equation(s) from the formula sheet.
(d) Bonus: Show the logical connection (equivalence) between the fact that the entropy is a state function and the formulation of the 2nd Law involving the 'perpetual motion machine of the second kind'.

3. Ideal Gas and Real Gases **(4 marks)**

Consider 5.00g of N_2 gas (molar mass 28.0134 g mol^{-1}) at 300.0K occupying a volume of 0.800 L. Calculate the compression factor Z for **(a)** the ideal gas law, and **(b)** the van der Waals equation of state.
(van der Waals parameters of N_2: a = 1.370 bar L^2 mol^{-2} and b = 0.0387 L mol^{-1}.)
(c) For the van der Waals equation of state, have both attractive and repulsive forces been considered in the model? (Yes/No – Explain!)

4. Entropy change **6 marks**

Two pieces of iron metal with equal masses of m = 200.0 g each and temperatures T_1 =15.0 °C and T_2 = 45.0 °C, respectively, are brought into close, direct contact. Assuming (i) that they are

completely isolated from their surroundings, and (ii) that the volume does not change, calculate the change in entropy (ΔS_{system}) associated with their heat exchange. Also determine $\Delta S_{Surroundings}$ and ΔS_{Total}.

You may need some or all of the following information:

$M = 55.847$ g mol^{-1}; $C_{V,m} = 25.1$ J K^{-1} mol^{-1}, assumed independent of temperature.

Total marks in this exam: 16 (regular questions); bonus marks: 1 (question 2d)

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