

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Thermodynamics of Materials

3.00 Fall 2000

W. Craig Carter

Department of Materials Science and Engineering

Massachusetts Institute of Technology

77 Massachusetts Ave.

Cambridge, MA 02139

Exam 2: Friday November 17, 2000 (11:05-11:55AM)

NAME: _____

This exam is composed of three questions. Please read them carefully and thoughtfully before you answer.

Your answers should fit in the space provided in the exam. If you find that the provided space is insufficient, use the back of the previous page and clearly indicate that your answer continues.

You may wish to work your answer out on scratch paper before writing on the exam. Your answers will be graded on their accuracy, physical insight, and clarity. A concise clear answer will get a better score with a longer answer with the same content. You may supplement your answer with a figure, a plot, or equations. Your answers will be graded in their entirety—extraneous or irrelevant equations or remarks may reduce the clarity or accuracy of your answer.

The questions are not necessarily ordered according to their difficulty—it would be prudent to read them all before you start. Finally, each question is not weighted equally in the grading; the weights are given below.

Question 2.1: 30 points possible _____

Question 2.2: 40 points possible _____

Question 2.3: 30 points possible _____

Total: 100 points possible _____

Exam Question 2.1

Read *carefully* and determine whether the following statements are true or false and indicate your thermodynamic reasoning. If you claim that a statement is false, you may state which of the laws of thermodynamics that it violates or you may employ a physical counter-example. If the statement is false, you may wish to amend the statement with a clarifying phrase that makes the statement true.

2-1-i A body in equilibrium and in thermal and mechanical contact with a reservoir at constant pressure and temperature will have the lowest possible value of Gibbs Free energy for that body.

2-1-ii The entropy of a material can never decrease.

2-1-iii If two phases that are composed of the same kind of pure material are in equilibrium at constant pressure, then they must have the same value of Gibbs free energy.

2-1-iv The internal energy of a system and its surroundings is not conserved during an irreversible process.

2-1-v Melting of a fixed amount of a pure material at constant pressure is an endothermic process when the entropy of a liquid is greater than the entropy of a solid.

2-1-vi For a system composed C components with chemical potentials μ_i for the i -th component and N_i is the number of molecules of the i -th species, $\sum_{i=1}^C \mu_i N_i$ will always have its smallest possible value.

Exam Question 2.2

One mole of pure substance at constant pressure is observed to melt at T_m and boil at T_v . For a temperature range $T_{low} < T_m < T_v < T_{high}$ and constant pressure, sketch plots of the following (for molar quantities, draw curves for stable and unstable phases; label relevant points and curves):

2-2-i \bar{H} versus T .

2-2-ii G_{total} versus T and \bar{G} versus T .

2-2-iii Phase fractions versus H_{total} .

2-2-iv \bar{G} versus H_{total} .

