COMP 280 : Assignment 1

due: Thursday, January 27, 2000

1. (4 pts) Prove or provide a counterexample for each of the following statements about sets:

   (a) (2 pts) $(A \cap B) \cup C = A \cap (B \cup C)$ if and only if $C \subset A$.

   (b) (2 pts) $A \cap (B \cup C) = (A \cup B) \cap (A \cup C)$

2. (6 pts) We have discussed the following two implementations of multisets:

   A multiset is either
   - *empty*, or
   - (*cons E MS*), where E is an element and MS is a multiset

   An elementRec is a structure (*make-elt elt count*) where *elt* is an element and *count* is a number.
   A multiset is either
   - *empty*, or
   - (*cons ER MS*), where ER is an elementRec and MS is a multiset that does not have an elementRec for the element in ER.

   For each representation:

   (a) Write a Scheme program to compute the union of two multisets.

   ; union : multiset multiset → multiset

   (b) (3 pts) Provide and prove a statement that your union program is correct.

3. (10 pts) Rice University maintains information about the assignments of students to its eight colleges. Each college can accommodate a large but limited number of students. The university performs several queries on this information:

   - How many students are assigned to a given college?
   - Which students are assigned to a given college?
   - How many spaces are available in a given college?

   (a) (4 pts) Provide two different data models for the housing information. Briefly discuss the advantages and disadvantages of each model. *Warnings*:
   - Your two models should not be simple variations of one another.
   - Describe models, not implementations.

   (b) (6 pts) Assume you are using the following data definitions for the housing information:

   A RiceCollege is one of 'Baker, 'Brown, 'Hanszen, 'Jones, 'Lovett, 'SidRich, 'Weiss, 'WillRice

   A StudentRec is a structure (*make-student name college*)
   where name is a symbol and college is a RiceCollege.

   A HousingInfo is either
   - *empty*, or
   - (*cons SR HI*) where SR is a StudentRec and HI is a HousingInfo.

   The program for computing the students in a given college has the following contract:

   ; InCollege : HousingInfo RiceCollege → (listof StudentRec)
   ; returns a list of records of all students assigned to the named college

   Provide two Scheme implementations of InCollege, one using structural recursion and one using an accumulator. Prove that the two programs produce the same lists of student records; the statement that you prove should be as precise as possible. Clearly state and prove all intermediate results required for your proof.