Due: Thursday, 3/20/2008 before class

1. Let a k-PDA be a pushdown automaton with k stacks. Thus a 0-PDA is an NFA, and a 1-PDA is a standard PDA. We know that 1-PDAs are more powerful than 0-PDAs.
   (a) Show that 2-PDAs are more powerful than 1-PDAs.
   (b) Show that 3-PDAs are no more powerful than 2-PDAs.

   (Hint: Show that 2-PDAs are equivalent to Turing machines!)

2. A Turing machine with doubly infinite tape is similar to an ordinary Turing machine, but its tape is infinite to the left as well as to the right. The tape is initially filled with blanks except for the portion that contains the input. The tape head initially points to the leftmost symbol of the input string. Computation is defined as usual, except that the head never encounters an end to the tape as it moves leftward. Show that this type of Turing machine recognizes exactly Turing-recognizable languages.

3. Show that if a single-tape Turing machine cannot write on the portion of the tape containing then the language it recognizes is regular.