This homework is concerned with the practice of program verification according to Hoare logic. Please refer to the Huth & Ryan chapter for background and terminology. As a primer, try the practice exercises at http://www.cs.bham.ac.uk/research/projects/lics/tutor/chap4/questions.html (solutions provided on the web site).

1. (H & R, 1st ed., Ex. 4.3.1.) Use the proof rule for assignment and logical implication as appropriate to show the following partial correctness proofs:
   (a) $\vdash_\text{par} (x > 0) \ y = x + 1 \ (y > 1)$
   (b) $\vdash_\text{par} (\top) \ y = x; y = x + x + y \ (y = 3 \cdot x)$
   (c) $\vdash_\text{par} (x > 1) a = 1; y = x; y = y - a \ (y > 0 \land x > y)$

2. (H & R, 1st ed., Ex. 4.3.2.) Write down a program $P$ such that
   (a) $\langle \top \rangle \ P \ (y = x + 2)$
   (b) $\langle \top \rangle \ P \ (z > x + y + y)$
   and prove it.

3. (H & R, 1st ed., Ex. 4.5.2(b).) Write code for $P$ for the following specification and prove the correctness of the input/output behavior:
   $\langle \top \rangle \ P \ (z = \max(w, x, y))$
   where $\max(w, x, y)$ denotes the largest of $w, x,$ and $y$. Show your program and the proof that it satisfies the given post condition using a proof tableaux.

4. (H & R, 1st ed., Ex. 4.6.1.) Show that $\vdash_\text{par} (x \geq 0) \ \text{Copy1} \ (x = y)$ where $\text{Copy1}$ is the following code:

   ```
   a = x;
   y = 0;
   while (a != 0) {
       y = y + 1;
       a = a - 1;
   }
   ```