333 We defined **wait until** w $=$ $t{:=}\ t{\uparrow}w$ where t is an extended natural time variable, and w is an extended natural expression.

(a)√ Prove **wait until** w $\Leftarrow$ **if** $t{\ge}w$ **then** ok **else** $t{:=}\ t{+}1$. **wait until** w **fi**

(b) Now suppose that t is a nonnegative extended real time variable, and w is a nonnegative extended real expression. Redefine **wait until** w appropriately, and refine it using the real time measure (assume any positive operation time you need).

After trying the question, scroll down to the solution.

§(b) We need to account for the time to test $t \geq w$ and to make a conditional branch. If it's $\bot$, rather than branching to the recursive call, which then branches back to the test, the branch can be straight back to the test, so no further time is needed for the call. We can't say what the time is until we know the computing platform, but we can say it's 1 something. Where should we place $t:= t+1$? The usual place is before the **if** , but here the test $t \geq w$ uses t , and maybe it makes sense to say that it captures the value of t at the beginning of the interval that accounts for the comparison and conditional branch. So I'll have to put the time increase at the start of both branches. The refinement is

$$\textbf{wait until } w \;\Longleftarrow\; \textbf{if } t \geq w \textbf{ then } t:= t+1 \textbf{ else } t:= t+1.\ \textbf{wait until } w \textbf{ fi}$$

The definition is

$$\textbf{wait until } w \;=\; t:= t + ceil\,((w-t)\uparrow 0) + 1$$