1. Give an example of a timed automaton whose underlying graph is connected, but no accepting state is reachable.

2. Can you give an example of a timed automaton whose underlying graph is connected, but no accepting state is reachable, and whose only guards are upper bound guards: that is guards of the form $x < c$ with $c > 0$ or $x \leq c$ with $c \geq 1$? Note that there could be multiple upper bound guards with different constants.

3. The same question as above but now assume that the automaton has only lower bound guards: that is, guards of the form $x \geq c$ or $x > c$, with $c \geq 0$.

4. Let Z be the zone defined by $-3 \leq y - x \leq 4$. Can you construct an automaton whose zone graph contains a node (q, Z)?

5. For two zones Z_1, Z_2 define a *difference* operation as follows:

$$Z_1 - Z_2 := \{ \ v \in Z_1 \mid v \notin Z_2 \}$$

   Is $Z_1 - Z_2$ a zone? If yes, give a proof. If not, give a counterexample.

6. Provide an example of an automaton with a single state, $n \geq 2$ clocks and with $M = 1$, such that the zone graph along with the simulation relation $\preccurlyeq_M$ gives at least 2^n nodes.

7. Which of the following two zones can be obtained during reachability analysis of some timed automaton? For this zone, provide a timed automaton path that leads to this zone.

$$\begin{aligned} y - x &\leq 3 \\ x - y &\leq -1 \\ x &\geq 2 \\ y &\geq 4 \end{aligned} \qquad\qquad \begin{aligned} y - x &\leq 3 \\ x - y &\leq 1 \\ x &\geq 2 \\ y &\geq 4 \end{aligned}$$

8. Let $\mathcal{A}$ be an automaton with a single clock. Are simulation relations necessary? Is there an example of such an automaton for which the naïve zone enumeration without simulations does not terminate?