Exercise 42
Determine whether Player 2 has a winning strategy in the PSPACE game
\[ G = (\phi, \{p_0, p_2\}, \{p_1, p_3\}, <) \]
with
\[ \phi = (\neg p_0 \rightarrow p_1) \land ((p_0 \land p_1) \rightarrow (p_2 \lor p_3)) \land (\neg p_1 \rightarrow (p_3 \rightarrow \neg p_2)) \]
and \( p_i < p_j \) iff \( i < j \).

Exercise 43
A quantified Boolean formula is of the form \( \phi = Q_1 p_1 \ldots Q_n p_n \psi \) where \( Q_1, \ldots, Q_n \in \{\forall, \exists\} \) are quantifiers, \( p_1, \ldots, p_n \) are propositional variables, and \( \psi \) is a propositional formula containing only the variables \( p_1, \ldots, p_n \).

Validity of such formulae is defined as follows:
- For \( n = 0 \), the formula \( \phi \) does not contain variables, and thus is a Boolean combination of 0 and 1. Then \( \phi \) is valid iff it evaluates to 1.
- For \( n > 0 \), we consider:
  \[ \phi_0 := Q_2 p_2 \ldots Q_n p_n \psi[p_1 := 0], \]
  \[ \phi_1 := Q_2 p_2 \ldots Q_n p_n \psi[p_1 := 1]. \]

If \( Q_1 = \exists \), then \( \phi \) is valid iff one of \( \phi_0 \) and \( \phi_1 \) is valid.
If \( Q_1 = \forall \), then \( \phi \) is valid iff both \( \phi_0 \) and \( \phi_1 \) are valid.

QBF denotes the set of all valid quantified Boolean formulae. Prove that the problem of deciding the existence of winning strategy for Player 2 in PSPACE games is PSPACE-complete.

Exercise 44
Determine whether Player 2 has a winning strategy in the \( \text{EXPTIME} \) game \( G = (\phi, \Gamma_1, \Gamma_2, t_0) \) with
- \( \phi = (p_1 \land p_2 \land p_3 \land \neg q) \lor (\neg p_1 \land \neg p_2 \land \neg p_3 \land q) \),
- \( \Gamma_1 = \{p_1, p_2, p_3\} \),
- \( \Gamma_2 = \{q\} \),
- \( t_0(p_1) = t_0(p_2) = t_0(p_3) = t_0(q) = 0. \)