(1) Show that if \( L \) is PSPACE-complete, then \( L \) is NP-hard. Show that the converse is not true.

(2) Show that \( \text{ALL}_{NFA} = \{ \langle M \rangle : L(M) = \Sigma^* \} \) for the NFA \( M \) whose input alphabet is \( \Sigma \) is in PSPACE.

(3) A string \( w = w_1, \ldots, w_n \) with \( w_i \in \Sigma \) for \( 1 \leq i \leq n \) yields
   
   (a) the string \( w_1, \ldots, w_{i-1}, a, w_{i+1}, \ldots, w_n \) with \( a \in \Sigma \) by a substitution, and
   (b) the string \( w_1, \ldots, w_{i-1}, w_{i+1}, \ldots, w_n \) by a deletion.

   (You can substitute or delete any single symbol \( w_i \).) Let \( L \subseteq \Sigma^* \) be an arbitrary language and suppose that \( w, w' \in \Sigma^* \). We say that there is a deletion-substitution chain in \( L \) from \( w \) to \( w' \) if there is a finite integer \( \ell \) so that there exist strings \( (z_0, \ldots, z_\ell) \) with each \( z_i \in L \) for which \( z_0 = w \), \( z_\ell = w' \), and \( z_i \) is obtained from \( z_{i-1} \) by a deletion or substitution for each \( 1 \leq i \leq \ell \).

   Show that, when \( L \) is regular, \( DSC_L = \{ \langle w, w' \rangle : \exists \) a deletion-substitution chain from \( w \) to \( w' \) in \( L \} \) is in PSPACE.

(4) We say that language \( \overline{L} \) is in coNP if and only if language \( L \) is in NP. By direct analogy with the definition of NP-completeness, precisely define coNP-completeness. (Use polynomial-time reducibility.)

   A tautology is a logical formula that is always true. Show that \( \{ \langle \psi \rangle : \psi \text{ is an unquantified boolean formula that is a tautology} \} \) is coNP-complete.

(5) A boolean formula is in disjunctive normal form (DNF) if it is the disjunction of clauses, where each clause is the conjunction of literals (variables or their negations). We consider totally quantified boolean formulas of the form \( Q_1 x_1 \cdots Q_m x_m [\psi] \) where \( \psi \) is in disjunctive normal form. Show that the language of true TQBFs in DNF is PSPACE-complete.