1. Justify the following strategy for establishing the NP-completeness of a language $L$ in terms of reductions.

1. For membership, $L$ is reduced to another NP-complete language $L_1$.
2. For hardness, an NP-complete language $L_2$ is reduced to $L$.

What can be said about the complexity of $L$ if any of the objectives fails?

2. The classification of CAUTIOUS involved two reductions:

\[ \langle P, a \rangle \notin \text{CAUTIOUS} \iff R_1(P, a) = P \cup \{ f \leftarrow a, \sim f. \} \in \text{STABLE} \]

\[ P \in \text{STABLE} \iff R_2(P) = \langle P \cup \{ f \leftarrow f. \}, f \rangle \notin \text{CAUTIOUS} \]

In both cases, the atom $f$ introduced by the reduction is new, i.e., $f \notin \text{Hb}(P)$. Prove the correctness of the reductions $R_1$ and $R_2$.

3. Analyze the computational time complexity of decision problems STABLE, BRAVE, and CAUTIOUS in the case of positive programs.

4. Given a normal program $P$, the transfinite iteration sequence of $\Gamma_P^2$ is defined for all ordinals $\alpha$ as follows:

(i) \( \Gamma_P^2 \uparrow 0 = 0 \).

(ii) \( \Gamma_P^2 \uparrow \alpha + 1 = \Gamma_P^2(\Gamma_P^2 \uparrow \alpha) \) for a successor ordinal $\alpha + 1$.

(iii) \( \Gamma_P^2 \uparrow \alpha = \bigcup_{\beta < \alpha} \Gamma_P^2 \uparrow \beta \) for a limit ordinal $\alpha$.

Prove in detail that $\Gamma_P^2 \uparrow \alpha \subseteq M \subseteq \Gamma_P(\Gamma_P^2 \uparrow \alpha)$ for any $\alpha$ and any stable model $M \in \text{SM}(P)$.

5. Determine $\text{SM}(P)$ and $\text{WFM}(P)$ for normal programs $P$ consisting of

(a) \( a \leftarrow \sim b. \ b \leftarrow \sim c. \ c \leftarrow \sim a. \)

(b) \( a \leftarrow \sim b. \ b \leftarrow \sim c. \ b \leftarrow \sim d. \ c \leftarrow \sim a. \ e \leftarrow \sim a. \ e \leftarrow \sim c. \ f \leftarrow \sim e. \)

(c) \( a \leftarrow \sim b. \ b \leftarrow \sim a. \ c \leftarrow a. \ d \leftarrow a. \ d \leftarrow b. \ e \leftarrow d, \sim c. \)