Problem 1
Let $\Delta = \text{NP} \cap \text{coNP}$. Prove $\Delta = P^\Delta$, where $P^\Delta = \bigcup_{L \in \Delta} P^L$.

Problem 2
Prove that $\text{Space}(n) \notin \text{NP}$.

Problem 3
Suppose there exists constant $q$ such that $\text{SAT} \in \text{PCP}_{1,2-q}(\log(n), q)$. Prove $P = \text{NP}$.

Problem 4
Let $f : \{0,1\}^n \rightarrow \{0,1\}$ be the majority function, i.e. $f(x) = 1$ iff $\sum_i x_i > n/2$. Prove that $f$ can be computed by a family of circuits of $O(\log n)$ depth, poly($n$) size, where the gates consists of not gates, 2-input or gates, and 2-input and gates.

Problem 5
Using Grover’s algorithm, show that 3-coloring can be solved on a quantum computer in $O(2^{n/2} \cdot n^{O(1)})$ time, where $n$ is the number of vertices.