Problem 1 (Oracles and NP). Show that $\text{NP}^A = \text{NP}$ if and only if $A \in \text{NP} \cap \text{coNP}$.

Problem 2 (Circuits). Show that any boolean function $f : \{0, 1\}^n \rightarrow \{0, 1\}$ can be computed by a circuit of size $O(2^n)$.

**Bonus:** Improve this bound to $O\left(\frac{2^n}{n}\right)$.

Problem 3 (Sparse languages and $\text{P/poly}$). Recall that a language $A \subseteq \{0, 1\}^*$ is said to be sparse if there is a polynomial $p(n)$ such that $|L \cap \{0, 1\}^n| \leq p(n)$ for all positive integers $n$.

Show that $\text{P/poly} = \bigcup_{A \text{ sparse}} \text{P}^A$. 