Exercise 9.1. Describe a polynomial-time alternating Turing machine solving EXACT INDEPENDENT SET:

Input: Given a graph $G$ and some number $k$.
Question: Does there exists a maximal independent set in $G$ of size exactly $k$?

Find a level of the polynomial hierarchy where this problem is contained in.

* Exercise 9.2. Show that $\Sigma_i \text{QBF}$ is complete for $\Sigma_i \text{P}$.

Exercise 9.3. Show $\text{AExpTime} = \text{ExpSpace}$.

Exercise 9.4. Show that if $P = NP$, then $P = PH$.

Exercise 9.5. Show $NP^{SAT} = \Sigma_2 \text{P}$.

* Exercise 9.6. Let $A$ be a language and let $F$ be a finite set such that $A \cap F = \emptyset$. Show that

$$P^A = P^{A \cup F} \quad \text{and} \quad NP^A = NP^{A \cup F}.$$ 

Infer that there exist infinitely many oracles $A$ and $B$ such that

$$P^A = NP^A \quad \text{and} \quad P^B \neq NP^B.$$