Prove that each of the following languages is not regular.

1. $\{0^{2^n} \mid n \geq 0\}$

2. $\{0^{2n}1^n \mid n \geq 0\}$

3. $\{0^m1^n \mid m \neq 2n\}$

4. Strings over $\{0, 1\}$ where the number of $0$s is exactly twice the number of $1$s.

5. Strings of properly nested parentheses $(\), brackets [\], and braces {\}. For example, the string $(([])){}$ is in this language, but the string $([)]$ is not, because the left and right delimiters don’t match.

6. Strings of the form $w_1^1w_2^2\cdots w_n^2$ for some $n \geq 2$, where each substring $w_i$ is a string in $\{0, 1\}^*$, and some pair of substrings $w_i$ and $w_j$ are equal.

Work on these later:

7. $\{0^n2^1 \mid n \geq 0\}$

8. $\{w \in (0 + 1)^* \mid w$ is the binary representation of a perfect square\}$