(Q3) Prove that the language $L = \{0^n \mid n$ is perfect cube$\}$ is not regular. Construct the CFG for the regular expression $(0+1)^*$

Sol^n) 1. Let us assume L is regular, let p be a constant provided by the pumping lemma.
2. Let w be the string 0^3. This string is in L, and is of length at least p. So w can be written as xyz with $|xy| \leq p$ and y not ε.
3. Pumping lemma state that if $xyz \in L$ then xy^kz also is L y contain at least one 0 in y since y is not ε.
4. Let us assume for $k = 2$, the resulting string is $xyyz$.
5. So it suffices to show that $p^3 < p^3 + p < (p+1)^3$.
The first inequality holds since $q > 0$.

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6. The claim is established, so xyyz is not in L.

7. This contradicts the pumping lemma, so our orignal assuption, that L was regul[ar] is not incorrect.

~~CFG CFG for~~ CFG for $(0+1)^*$

The CFG can be given by,

Production rule

(P):

$S \rightarrow 0S \mid 1S$

$S \rightarrow \varepsilon$

The rules are in the combination of 0's & 1's with the start symbol. Since $(0+1)^*$ indi[cates] {ε, 0, 1, 01, 10, 00, 11, ...}. In this set, ε is a string, so in the rule, we can set the rule $S \rightarrow \varepsilon$.