

Problem 1.55. The pumping lemma says that every regular language has a pumping length p , such that every string in the language can be pumped if it has length p or more. If p is a pumping length for language A , so is any length $p' \geq p$. The minimum pumping length for A is the smallest p that is a pumping length for A . For example, if $A = 01^*$, the minimum pumping length is 2. The reason is that the string $s = 0$ is in A and has length 1 yet s cannot be pumped; but any string in A of length 2 or more contains a 1 and hence can be pumped by dividing it so that $x = 0$, $y = 1$, and z is the rest. For each of the following languages, give the minimum pumping length and justify your answer.

Part a. 0001^*

Part d. $0^*1^+0^+1^* \cup 10^*1$