

Construct a regular expression defining each of the following languages over the alphabet  $\Sigma = \{a, b\}$ .

1. All words in which a appears tripled, if at all. This means that every clump of a's contains 3 or 6 or 9 or 12... a's.
2. All words that contain at least one of the strings  $s_1, s_2, s_3$  or  $s_4$ .
3. All words that contain exactly three b's in total.
4. All words that contain exactly two b's or exactly three b's, not more.
5. All strings that end in a double letter.
6. All strings that have exactly one double letter in them.
7. All strings in which the letter b is never tripled. This means that no word contains the substring bb.
8. All words in which a is tripled or b is tripled, but not both. This means each word contains the substring aaa or the substring bbb but not both.
9. All strings that do not have the substring ab.
10. All strings that do not have both the substrings bba and abb.
11. All strings in which the total number of a's is divisible by three, such as aabaabbaba.
12. All strings in which any b's that occur are found in clumps of an odd number at a time, such as abaabbbab.
13. All strings that have an even number of a's and an odd number of b's.
14. All strings that have an odd number of a's and an odd number of b's.