4. (17 points) Consider the following PCFG with S as the root; probabilities are given in parentheses:

Non-terminal productions:
(1.0) S → PRP VP
(1.0) VP → V NP
(1.0) NP → J N

Pre-terminal productions:
(1.0) PRP → I
(0.5) V → like
(0.5) V → eat
(0.25) J → green
(0.25) J → red
(0.25) J → verde
(0.25) J → roja
(1.0) N → salsa
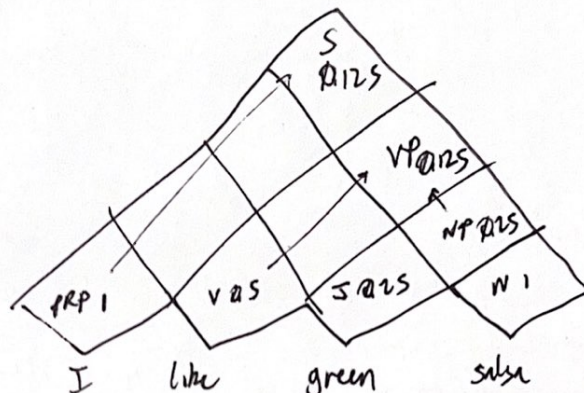
Note that *roja* and *verde* (both Spanish) mean *red* and *green*, respectively. *salsa* is originally a Spanish word but we will consider it as both English and Spanish for the purposes of this problem.

a. (4 points) Give the parse for the sentence *I like green salsa*. (We strongly prefer if you can draw the tree, but if you prefer you can write it with brackets.)
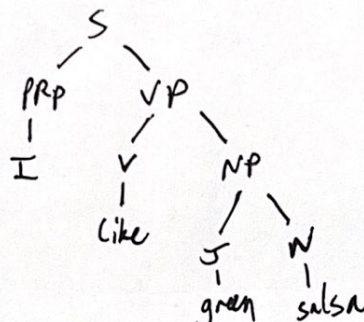
b. (3 points) What probability does the grammar assign to this parse? You should give either a fraction or a decimal as the answer. **Box your final answer.**

$$\boxed{\dfrac{1}{8}}$$

c. (3 points) Add one rule to the grammar that allows you to parse the sentence *I like salsa verde*. You should add a **nonterminal** production, not a pre-terminal production (i.e., do not add a rule that ends in a word). You do not need to update probabilities in the grammar.

NP → N J