

--- Day 14: Extended Polymerization ---

The incredible pressures at this depth are starting to put a strain on your submarine. The submarine has **polymerization** equipment that would produce suitable materials to reinforce the submarine, and the nearby volcanically-active caves should even have the necessary input elements in sufficient quantities.

The submarine manual contains instructions for finding the optimal polymer formula; specifically, it offers a **polymer template** and a list of **pair insertion** rules (your puzzle input). You just need to work out what polymer would result after repeating the pair insertion process a few times.

For example:

```
NNCB
CH -> B
HH -> N
CB -> H
NH -> C
HB -> C
HC -> B
HN -> C
NN -> C
BH -> H
NC -> B
NB -> B
BN -> B
BB -> N
BC -> B
CC -> N
CN -> C
```

The first line is the **polymer template** - this is the starting point of the process.

The following section defines the **pair insertion** rules. A rule like **AB -> C** means that when elements **A** and **B** are immediately adjacent, element **C** should be inserted between them. These insertions all happen simultaneously.

So, starting with the polymer template **NNCB**, the first step simultaneously considers all three pairs:

- The first pair (**NN**) matches the rule **NN -> C**, so element **C** is inserted between the first **N** and the second **N**.
- The second pair (**NC**) matches the rule **NC -> B**, so element **B** is inserted between the **N** and the **C**.
- The third pair (**CB**) matches the rule **CB -> H**, so element **H** is inserted between the **C** and the **B**.

Note that these pairs overlap: the second element of one pair is the first element of the next pair. Also, because all pairs are considered simultaneously, inserted elements are not considered to be part of a pair until the next step.

After the first step of this process, the polymer becomes **NCNBCHB**.

Here are the results of a few steps using the above rules:

```
Template:      NNCB
After step 1:  NCNBCHB
After step 2:  NBCCNBBBCBHCB
After step 3:  NBBBCNCCNBBNBNBBCHBHHBCHB
After step 4:  NBBNBNBBCCNBCNCCNBBNBBNBBNBBNBBBCBHCBHHNHCBBBCBHCB
```

This polymer grows quickly. After step 5, it has length 97; After step 10, it has length 3073. After step 10, **B** occurs 1749 times, **C** occurs 298 times, **H** occurs 161 times, and **N** occurs 865 times; taking the quantity of the most common element (**B**, 1749) and subtracting the quantity of the least common element (**H**, 161) produces **1749 - 161 = 1588**.

Apply 10 steps of pair insertion to the polymer template and find the most and least common elements in the result. **What do you get if you take the quantity of the most common element and subtract the quantity of the least common element?**

Your puzzle answer was **3048**.

--- Part Two ---

The resulting polymer isn't nearly strong enough to reinforce the submarine. You'll need to run more steps of the pair insertion process; a total of **40 steps** should do it.

In the above example, the most common element is **B** (occurring **2192039569602** times) and the least common element is **H** (occurring **3849876073** times); subtracting these produces **2188189693529**.

Apply **40** steps of pair insertion to the polymer template and find the most and least common elements in the result. **What do you get if you take the quantity of the most common element and subtract the quantity of the least common element?**

Your puzzle answer was **3288891573057**.

**Both parts of this puzzle are complete! They provide two gold stars: \*\***

At this point, you should **return to your Advent calendar** and try another puzzle.

If you still want to see it, you can **get your puzzle input**.

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