

--- Day 11: Dumbo Octopus ---

You enter a large cavern full of rare bioluminescent **dumbo octopuses**! They seem to not like the Christmas lights on your submarine, so you turn them off for now.

There are 100 octopuses arranged neatly in a 10 by 10 grid. Each octopus slowly gains energy over time and flashes brightly for a moment when its energy is full. Although your lights are off, maybe you could navigate through the cave without disturbing the octopuses if you could predict when the flashes of light will happen.

Each octopus has an energy level - your submarine can remotely measure the energy level of each octopus (your puzzle input). For example:

```
5483143223
2745854711
5264556173
6141336146
6357385478
4167524645
2176841721
6882881134
4846848554
5283751526
```

The energy level of each octopus is a value between `0` and `9`. Here, the top-left octopus has an energy level of `5`, the bottom-right one has an energy level of `6`, and so on.

You can model the energy levels and flashes of light in steps. During a single step, the following occurs:

- First, the energy level of each octopus increases by `1`.
- Then, any octopus with an energy level greater than `9` flashes. This increases the energy level of all adjacent octopuses by `1`, including octopuses that are diagonally adjacent. If this causes an octopus to have an energy level greater than `9`, it also flashes. This process continues as long as new octopuses keep having their energy level increased beyond `9`. (An octopus can only flash at most once per step.)
- Finally, any octopus that flashed during this step has its energy level set to `0`, as it used all of its energy to flash.

Adjacent flashes can cause an octopus to flash on a step even if it begins that step with very little energy. Consider the middle octopus with `1` energy in this situation:

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Before any steps:  
11111  
19991  
19191  
19991  
11111

After step 1:  
34543  
40004  
50005  
40004  
34543

After step 2:  
45654  
51115  
61116  
51115  
45654

An octopus is highlighted when it flashed during the given step.

Here is how the larger example above progresses:

Before any steps:  
5483143223  
2745854711  
5264556173  
6141336146  
6357385478  
4167524645  
2176841721  
6882881134  
4846848554  
5283751526

After step 1:  
6594254334  
3856965822  
6375667284  
7252447257  
7468496589  
5278635756  
3287952832  
7993992245  
5957959665  
6394862637

After step 2:  
8807476555  
5089087054  
8597889608  
8485769600  
8700908800  
6600088989  
6800005943  
0000007456  
9000000876  
8700006848

After step 3:  
0050900866  
8500800575

99000000039  
97000000041  
99350800063  
77123000000  
79112500009  
22111300000  
04211250000  
00211190000

After step 4:

2263031977  
0923031697  
0032221150  
0041111163  
0076191174  
0053411122  
0042361120  
5532241122  
1532247211  
1132230211

After step 5:

4484144000  
2044144000  
2253333493  
1152333274  
1187303285  
1164633233  
1153472231  
6643352233  
2643358322  
2243341322

After step 6:

5595255111  
3155255222  
3364444605  
2263444496  
2298414396  
2275744344  
2264583342  
7754463344  
3754469433  
3354452433

After step 7:

6707366222  
4377366333  
4475555827  
3496655709  
3500625609  
3509955566  
3486694453  
8865585555  
4865580644  
4465574644

After step 8:

7818477333  
5488477444  
5697666949  
4608766830  
4734946730  
4740007688

400097688  
6900007564  
0000009666  
8000004755  
6800007755

After step 9:

9060000644  
7800000976  
6900000080  
5840000082  
5858000093  
6962400000  
8021250009  
2221130009  
9111128097  
7911119976

After step 10:

0481112976  
0031112009  
0041112504  
0081111406  
0099111306  
0093511233  
0442361130  
5532252350  
0532250600  
0032240000

After step 10, there have been a total of 204 flashes. Fast forwarding,  
here is the same configuration every 10 steps:

After step 20:

3936556452  
5686556806  
4496555690  
4448655580  
4456865570  
5680086577  
7000009896  
0000000344  
6000000364  
4600009543

After step 30:

0643334118  
4253334611  
3374333458  
2225333337  
2229333338  
2276733333  
2754574565  
5544458511  
9444447111  
7944446119

After step 40:

6211111981  
0421111119  
0042111115  
0003111115  
0003111116  
0065611111

332351111  
3322234597  
2222222976  
2222222762  
  
After step 50:  
9655556447  
4865556805  
4486555690  
4458655580  
4574865570  
5700086566  
6000009887  
8000000533  
6800000633  
5680000538  
  
After step 60:  
2533334200  
2743334640  
2264333458  
2225333337  
2225333338  
2287833333  
3854573455  
1854458611  
1175447111  
1115446111  
  
After step 70:  
8211111164  
0421111166  
0042111114  
0004211115  
0000211116  
0065611111  
0532351111  
7322235117  
5722223475  
4572222754  
  
After step 80:  
1755555697  
5965555609  
4486555680  
4458655580  
4570865570  
5700086566  
7000008666  
0000000990  
0000000800  
0000000000  
  
After step 90:  
7433333522  
2643333522  
2264333458  
2226433337  
2222433338  
2287833333  
2854573333  
4854458333  
3387779333  
3333333333

000000000

After step 100:

0397666866  
0749766918  
0053976933  
0004297822  
0004229892  
0053222877  
0532222966  
9322228966  
7922286866  
6789998766

After 100 steps, there have been a total of 1656 flashes.

Given the starting energy levels of the dumbo octopuses in your cavern, simulate 100 steps. How many total flashes are there after 100 steps?

Your puzzle answer was 1723.

--- Part Two ---

It seems like the individual flashes aren't bright enough to navigate. However, you might have a better option: the flashes seem to be synchronizing!

In the example above, the first time all octopuses flash simultaneously is step 195:

```
After step 193:
5877777777
8877777777
7777777777
7777777777
7777777777
7777777777
7777777777
7777777777
7777777777
7777777777

After step 194:
6988888888
9988888888
8888888888
8888888888
8888888888
8888888888
8888888888
8888888888
8888888888
8888888888
8888888888
8888888888

After step 195:
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
```

If you can calculate the exact moments when the octopuses will all flash simultaneously, you should be able to navigate through the cavern. What is the first step during which all octopuses flash?

Your puzzle answer was .

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

At this point, all that is left is for you to [admire your Advent calendar](#).

If you still want to see it, you can [get your puzzle input](#).

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