## --- Day 11: Dumbo Octopus ---

You enter a large cavern full of rare bioluminescent [dumbo octopuses](https://www.youtube.com/watch?v=eih-VSaS2g0)! 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:

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

9900000039

9700000041

9935080063

7712300000

7911250009

2211130000

0421125000

0021119000

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

4740097688

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

0532351111

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

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 1562.

## --- 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

After step 195:

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 268.

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

At this point, you should [return to your Advent calendar](https://adventofcode.com/2021) and try another puzzle.

If you still want to see it, you can [get your puzzle input](https://adventofcode.com/2021/day/11/input).

You can also [Share] this puzzle.