

--- Day 21: Dirac Dice ---

There's not much to do as you slowly descend to the bottom of the ocean. The submarine computer challenges you to a nice game of **Dirac Dice**.

This game consists of a single **die**, two **pawns**, and a game board with a circular track containing ten spaces marked **1** through **10** clockwise. Each player's **starting space** is chosen randomly (your puzzle input). Player 1 goes first.

Players take turns moving. On each player's turn, the player rolls the die **three times** and adds up the results. Then, the player moves their pawn that many times **forward** around the track (that is, moving clockwise on spaces in order of increasing value, wrapping back around to **1** after **10**). So, if a player is on space **7** and they roll **2**, **2**, and **1**, they would move forward 5 times, to spaces **8**, **9**, **10**, **1**, and finally stopping on **2**.

After each player moves, they increase their **score** by the value of the space their pawn stopped on. Players' scores start at **0**. So, if the first player starts on space **7** and rolls a total of **5**, they would stop on space **2** and add **2** to their score (for a total score of **2**). The game immediately ends as a win for any player whose score reaches **at least 1000**.

Since the first game is a practice game, the submarine opens a compartment labeled **deterministic dice** and a 100-sided die falls out. This die always rolls **1** first, then **2**, then **3**, and so on up to **100**, after which it starts over at **1** again. Play using this die.

For example, given these starting positions:

```
Player 1 starting position: 4
Player 2 starting position: 8
```

This is how the game would go:

- Player 1 rolls **1+2+3** and moves to space **10** for a total score of **10**.
- Player 2 rolls **4+5+6** and moves to space **3** for a total score of **3**.
- Player 1 rolls **7+8+9** and moves to space **4** for a total score of **14**.
- Player 2 rolls **10+11+12** and moves to space **6** for a total score of **9**.
- Player 1 rolls **13+14+15** and moves to space **6** for a total score of **20**.
- Player 2 rolls **16+17+18** and moves to space **7** for a total score of **16**.
- Player 1 rolls **19+20+21** and moves to space **6** for a total score of **26**.
- Player 2 rolls **22+23+24** and moves to space **6** for a total score of **22**.

...after many turns...

- Player 2 rolls **82+83+84** and moves to space **6** for a total score of **742**.
- Player 1 rolls **85+86+87** and moves to space **4** for a total score of **990**.
- Player 2 rolls **88+89+90** and moves to space **3** for a total score of **745**.
- Player 1 rolls **91+92+93** and moves to space **10** for a final score, **1000**.

Since player 1 has at least **1000** points, player 1 wins and the game ends. At this point, the losing player had **745** points and the die had been rolled a total of **993** times; **745 * 993 = 739785**.

Play a practice game using the deterministic 100-sided die. The moment either player wins, **what do you get if you multiply the score of the losing player by the number of times the die was rolled during the game?**

Your puzzle answer was **679329**.

The first half of this puzzle is complete! It provides one gold star: ★

--- Part Two ---

Now that you're warmed up, it's time to play the real game.

A second compartment opens, this time labeled **Dirac dice**. Out of it falls a single three-sided die.

As you experiment with the die, you feel a little strange. An informational brochure in the compartment explains that this is a **quantum die**: when you roll it, the universe **splits into multiple copies**, one copy for each possible outcome of the die. In this case, rolling the die always splits the universe into **three copies**: one where the outcome of the roll was **1**, one where it was **2**, and one where it was **3**.

The game is played the same as before, although to prevent things from getting too far out of hand, the game now ends when either player's score reaches at least **21**.

Using the same starting positions as in the example above, player 1 wins in **444356092776315** universes, while player 2 merely wins in **341960390180808** universes.

Using your given starting positions, determine every possible outcome. **Find the player that wins in more universes; in how many universes does that player win?**

Answer: [\[Submit\]](#)

Although it hasn't changed, you can still [get your puzzle input](#).

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