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~~Settlers of Catan~~ A board game is played on a hexagonal grid of 19 tiles. A 'traveler' token starts on the center tile. Each turn a die is rolled to determine what neighboring tile the traveler moves to (all six directions equally likely). The turn that the traveler leaves the board, the game ends. What is the expected number of turns of the game?

A hexagonal grid of 36 cells, numbered 0 to 35. The grid is arranged in a larger hexagonal shape. Each cell contains a red dot and a number. The numbers are: 0 (center), 1-6 (inner ring), 7-12 (second ring), 13-18 (third ring), 19-24 (fourth ring), 25-30 (fifth ring), 31-36 (outer ring). The numbers are arranged in a specific pattern, with 0 at the center and 36 at the top right.

The dice is truly random, so there is no upper bound on  $N$ . We note that this game is really akin to a Markov chain, in that it doesn't matter what the past states are.



$N =$	$P_{0,0} = \frac{45}{16}$	$P_{1,0} = \frac{15}{16}$	$P_{2,0} = \frac{15}{16}$	$P_{3,0} = \frac{15}{16}$	$P_{4,0} = \frac{15}{16}$	$P_{5,0} = \frac{15}{16}$	$P_{6,0} = \frac{15}{16}$	$P_{7,0} = \frac{7}{2}$	$P_{8,0} = \frac{5}{4}$	$P_{9,0} = \frac{7}{2}$	$P_{10,0} = \frac{15}{16}$	$P_{11,0} = \frac{7}{2}$	$P_{12,0} = \frac{5}{4}$	$P_{13,0} = \frac{7}{2}$	$P_{14,0} = \frac{5}{4}$	$P_{15,0} = \frac{7}{2}$	$P_{16,0} = \frac{5}{4}$	$P_{17,0} = \frac{7}{2}$	$P_{18,0} = \frac{5}{4}$
	$P_{1,1} = \frac{10571}{16384}$	$P_{2,1} = \frac{6595}{16384}$	$P_{3,1} = \frac{6595}{16384}$	$P_{4,1} = \frac{10571}{16384}$	$P_{5,1} = \frac{10571}{16384}$	$P_{6,1} = \frac{10571}{16384}$	$P_{7,1} = \frac{10571}{16384}$	$P_{8,1} = \frac{21905}{262144}$	$P_{9,1} = \frac{21905}{262144}$	$P_{10,1} = \frac{10571}{16384}$	$P_{11,1} = \frac{21905}{262144}$	$P_{12,1} = \frac{21905}{262144}$	$P_{13,1} = \frac{10571}{16384}$	$P_{14,1} = \frac{21905}{262144}$	$P_{15,1} = \frac{21905}{262144}$	$P_{16,1} = \frac{21905}{262144}$	$P_{17,1} = \frac{10571}{16384}$	$P_{18,1} = \frac{21905}{262144}$	$P_{19,1} = \frac{10571}{16384}$
	$P_{2,2} = \frac{10571}{16384}$	$P_{3,2} = \frac{6595}{16384}$	$P_{4,2} = \frac{6595}{16384}$	$P_{5,2} = \frac{10571}{16384}$	$P_{6,2} = \frac{10571}{16384}$	$P_{7,2} = \frac{10571}{16384}$	$P_{8,2} = \frac{21905}{262144}$	$P_{9,2} = \frac{21905}{262144}$	$P_{10,2} = \frac{10571}{16384}$	$P_{11,2} = \frac{21905}{262144}$	$P_{12,2} = \frac{21905}{262144}$	$P_{13,2} = \frac{10571}{16384}$	$P_{14,2} = \frac{21905}{262144}$	$P_{15,2} = \frac{21905}{262144}$	$P_{16,2} = \frac{21905}{262144}$	$P_{17,2} = \frac{10571}{16384}$	$P_{18,2} = \frac{21905}{262144}$	$P_{19,2} = \frac{10571}{16384}$	$P_{20,2} = \frac{10571}{16384}$
	$P_{3,3} = \frac{10571}{16384}$	$P_{4,3} = \frac{6595}{16384}$	$P_{5,3} = \frac{6595}{16384}$	$P_{6,3} = \frac{10571}{16384}$	$P_{7,3} = \frac{10571}{16384}$	$P_{8,3} = \frac{10571}{16384}$	$P_{9,3} = \frac{21905}{262144}$	$P_{10,3} = \frac{21905}{262144}$	$P_{11,3} = \frac{10571}{16384}$	$P_{12,3} = \frac{21905}{262144}$	$P_{13,3} = \frac{21905}{262144}$	$P_{14,3} = \frac{10571}{16384}$	$P_{15,3} = \frac{21905}{262144}$	$P_{16,3} = \frac{21905}{262144}$	$P_{17,3} = \frac{10571}{16384}$	$P_{18,3} = \frac{21905}{262144}$	$P_{19,3} = \frac{10571}{16384}$	$P_{20,3} = \frac{21905}{262144}$	$P_{21,3} = \frac{10571}{16384}$
	$P_{4,4} = \frac{10571}{16384}$	$P_{5,4} = \frac{6595}{16384}$	$P_{6,4} = \frac{6595}{16384}$	$P_{7,4} = \frac{10571}{16384}$	$P_{8,4} = \frac{10571}{16384}$	$P_{9,4} = \frac{10571}{16384}$	$P_{10,4} = \frac{21905}{262144}$	$P_{11,4} = \frac{21905}{262144}$	$P_{12,4} = \frac{10571}{16384}$	$P_{13,4} = \frac{21905}{262144}$	$P_{14,4} = \frac{21905}{262144}$	$P_{15,4} = \frac{10571}{16384}$	$P_{16,4} = \frac{21905}{262144}$	$P_{17,4} = \frac{21905}{262144}$	$P_{18,4} = \frac{10571}{16384}$	$P_{19,4} = \frac{21905}{262144}$	$P_{20,4} = \frac{10571}{16384}$	$P_{21,4} = \frac{21905}{262144}$	$P_{22,4} = \frac{10571}{16384}$
	$P_{5,5} = \frac{10571}{16384}$	$P_{6,5} = \frac{6595}{16384}$	$P_{7,5} = \frac{6595}{16384}$	$P_{8,5} = \frac{10571}{16384}$	$P_{9,5} = \frac{10571}{16384}$	$P_{10,5} = \frac{10571}{16384}$	$P_{11,5} = \frac{21905}{262144}$	$P_{12,5} = \frac{21905}{262144}$	$P_{13,5} = \frac{10571}{16384}$	$P_{14,5} = \frac{21905}{262144}$	$P_{15,5} = \frac{21905}{262144}$	$P_{16,5} = \frac{10571}{16384}$	$P_{17,5} = \frac{21905}{262144}$	$P_{18,5} = \frac{21905}{262144}$	$P_{19,5} = \frac{10571}{16384}$	$P_{20,5} = \frac{21905}{262144}$	$P_{21,5} = \frac{10571}{16384}$	$P_{22,5} = \frac{21905}{262144}$	$P_{23,5} = \frac{10571}{16384}$
	$P_{6,6} = \frac{10571}{16384}$	$P_{7,6} = \frac{6595}{16384}$	$P_{8,6} = \frac{6595}{16384}$	$P_{9,6} = \frac{10571}{16384}$	$P_{10,6} = \frac{10571}{16384}$	$P_{11,6} = \frac{10571}{16384}$	$P_{12,6} = \frac{21905}{262144}$	$P_{13,6} = \frac{21905}{262144}$	$P_{14,6} = \frac{10571}{16384}$	$P_{15,6} = \frac{21905}{262144}$	$P_{16,6} = \frac{21905}{262144}$	$P_{17,6} = \frac{10571}{16384}$	$P_{18,6} = \frac{21905}{262144}$	$P_{19,6} = \frac{21905}{262144}$	$P_{20,6} = \frac{10571}{16384}$	$P_{21,6} = \frac{21905}{262144}$	$P_{22,6} = \frac{10571}{16384}$	$P_{23,6} = \frac{21905}{262144}$	$P_{24,6} = \frac{10571}{16384}$
	$P_{7,7} = \frac{10571}{16384}$	$P_{8,7} = \frac{6595}{16384}$	$P_{9,7} = \frac{6595}{16384}$	$P_{10,7} = \frac{1057$															

$$t = N\mathbf{1}$$
[illegible]

Finally, we see that  $t_0 = \boxed{\frac{213}{29} \approx 7.345}$