



Let  $X_i \in [0, 36]$  be the current state, or position of the traveler. The traveler always starts at position  $X_0 = 0$ . The final state must be  $X_N \in [19, 36]$ .

Now that we've defined some notation, we can write the transition matrix  $P$ . Because a  $37 \times 37$  matrix is cumbersome, we combine the states  $[19, 36]$  into a

$$P = \begin{pmatrix} p_{0,0} = 0 & p_{0,1} = \frac{1}{6} & p_{0,2} = \frac{1}{6} & p_{0,3} = \frac{1}{6} & p_{0,4} = \frac{1}{6} & p_{0,5} = \frac{1}{6} & p_{0,6} = \frac{1}{6} & p_{0,7} = 0 & p_{0,8} = 0 & p_{0,9} = 0 & p_{0,10} = 0 & p_{0,11} = 0 & p_{0,12} = 0 & p_{0,13} = 0 & p_{0,14} = 0 & p_{0,15} = 0 & p_{0,16} = 0 & p_{0,17} = 0 & p_{0,18} = 0 & p_{0,19} = 0 \\ p_{1,0} = \frac{1}{6} & p_{1,1} = 0 & p_{1,2} = \frac{1}{6} & p_{1,3} = 0 & p_{1,4} = 0 & p_{1,5} = 0 & p_{1,6} = \frac{1}{6} & p_{1,7} = \frac{1}{6} & p_{1,8} = \frac{1}{6} & p_{1,9} = \frac{1}{6} & p_{1,10} = 0 & p_{1,11} = 0 & p_{1,12} = 0 & p_{1,13} = 0 & p_{1,14} = 0 & p_{1,15} = 0 & p_{1,16} = 0 & p_{1,17} = 0 & p_{1,18} = 0 & p_{1,19} = 0 \\ p_{2,0} = 0 & p_{2,1} = \frac{1}{6} & p_{2,2} = 0 & p_{2,3} = \frac{1}{6} & p_{2,4} = 0 & p_{2,5} = 0 & p_{2,6} = 0 & p_{2,7} = 0 & p_{2,8} = 0 & p_{2,9} = \frac{1}{6} & p_{2,10} = \frac{1}{6} & p_{2,11} = \frac{1}{6} & p_{2,12} = 0 & p_{2,13} = 0 & p_{2,14} = 0 & p_{2,15} = 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$$Q = \begin{pmatrix} P_{0,0} = 0 & P_{0,1} = \frac{1}{6} & P_{0,2} = \frac{1}{6} & P_{0,3} = \frac{1}{6} & P_{0,4} = \frac{1}{6} & P_{0,5} = \frac{1}{6} & P_{0,6} = \frac{1}{6} & P_{0,7} = 0 & P_{0,8} = 0 & P_{0,9} = 0 & P_{0,10} = 0 & P_{0,11} = 0 & P_{0,12} = 0 & P_{0,13} = 0 & P_{0,14} = 0 & P_{0,15} = 0 & P_{0,16} = 0 & P_{0,17} = 0 & P_{0,18} = 0 \\ P_{1,0} = \frac{1}{6} & P_{1,1} = 0 & P_{1,2} = 0 & P_{1,3} = 0 & P_{1,4} = 0 & P_{1,5} = 0 & P_{1,6} = 0 & P_{1,7} = \frac{1}{6} & P_{1,8} = \frac{1}{6} & P_{1,9} = \frac{1}{6} & P_{1,10} = 0 & P_{1,11} = 0 & P_{1,12} = 0 & P_{1,13} = 0 & P_{1,14} = 0 & P_{1,15} = 0 & P_{1,16} = 0 & P_{1,17} = 0 & P_{1,18} = 0 \\ P_{2,0} = \frac{1}{6} & P_{2,1} = \frac{1}{6} & P_{2,2} = 0 & P_{2,3} = \frac{1}{6} & P_{2,4} = 0 & P_{2,5} = 0 & P_{2,6} = 0 & P_{2,7} = 0 & P_{2,8} = 0 & P_{2,9} = \frac{1}{6} & P_{2,10} = \frac{1}{6} & P_{2,11} = \frac{1}{6} & P_{2,12} = 0 & P_{2,13} = 0 & P_{2,14} = 0 & P_{2,15} = 0 & P_{2,16} = 0 & P_{2,17} = 0 & 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\frac{1}{6} & P_{15,5} = \frac{1}{6} & P_{15,6} = 0 & P_{15,7} = 0 & P_{15,8} = 0 & P_{15,$$

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$N =$	$P_{0,0} = \frac{45}{16}$		$P_{0,1} = \frac{16}{16}$		$P_{0,2} = \frac{16}{16}$		$P_{0,3} = \frac{16}{16}$		$P_{0,4} = \frac{16}{16}$		$P_{0,5} = \frac{16}{16}$		$P_{0,6} = \frac{16}{16}$		$P_{0,7} = \frac{16}{16}$		$P_{0,8} = \frac{16}{16}$		$P_{0,9} = \frac{16}{16}$		$P_{0,10} = \frac{16}{16}$		$P_{0,11} = \frac{16}{16}$		$P_{0,12} = \frac{16}{16}$		$P_{0,13} = \frac{16}{16}$		$P_{0,14} = \frac{16}{16}$		$P_{0,15} = \frac{16}{16}$		$P_{0,16} = \frac{16}{16}$		$P_{0,17} = \frac{16}{16}$		$P_{0,18} = \frac{16}{16}$		$P_{0,19} = \frac{16}{16}$		$P_{0,20} = \frac{16}{16}$		$P_{0,21} = \frac{16}{16}$		$P_{0,22} = \frac{16}{16}$		$P_{0,23} = \frac{16}{16}$		$P_{0,24} = \frac{16}{16}$		$P_{0,25} = \frac{16}{16}$		$P_{0,26} = \frac{16}{16}$		$P_{0,27} = \frac{16}{16}$		$P_{0,28} = \frac{16}{16}$		$P_{0,29} = \frac{16}{16}$		$P_{0,30} = \frac{16}{16}$		$P_{0,31} = \frac{16}{16}$		$P_{0,32} = \frac{16}{16}$		$P_{0,33} = \frac{16}{16}$		$P_{0,34} = \frac{16}{16}$		$P_{0,35} = \frac{16}{16}$		$P_{0,36} = \frac{16}{16}$		$P_{0,37} = \frac{16}{16}$		$P_{0,38} = \frac{16}{16}$		$P_{0,39} = \frac{16}{16}$		$P_{0,40} = \frac{16}{16}$		$P_{0,41} = \frac{16}{16}$		$P_{0,42} = \frac{16}{16}$		$P_{0,43} = \frac{16}{16}$		$P_{0,44} = \frac{16}{16}$		$P_{0,45} = \frac{16}{16}$		$P_{0,46} = \frac{16}{16}$		$P_{0,47} = \frac{16}{16}$		$P_{0,48} = \frac{16}{16}$		$P_{0,49} = \frac{16}{16}$		$P_{0,50} = \frac{16}{16}$		$P_{0,51} = \frac{16}{16}$		$P_{0,52} = \frac{16}{16}$		$P_{0,53} = \frac{16}{16}$		$P_{0,54} = \frac{16}{16}$		$P_{0,55} = \frac{16}{16}$		$P_{0,56} = \frac{16}{16}$		$P_{0,57} = \frac{16}{16}$		$P_{0,58} = \frac{16}{16}$		$P_{0,59} = \frac{16}{16}$		$P_{0,60} = \frac{16}{16}$		$P_{0,61} = \frac{16}{16}$		$P_{0,62} = \frac{16}{16}$		$P_{0,63} = \frac{16}{16}$		$P_{0,64} = \frac{16}{16}$		$P_{0,65} = \frac{16}{16}$		$P_{0,66} = \frac{16}{16}$		$P_{0,67} = \frac{16}{16}$		$P_{0,68} = \frac{16}{16}$		$P_{0,69} = \frac{16}{16}$		$P_{0,70} = \frac{16}{16}$		$P_{0,71} = \frac{16}{16}$		$P_{0,72} = \frac{16}{16}$		$P_{0,73} = \frac{16}{16}$		$P_{0,74} = \frac{16}{16}$		$P_{0,75} = \frac{16}{16}$		$P_{0,76} = \frac{16}{16}$		$P_{0,77} = \frac{16}{16}$		$P_{0,78} = \frac{16}{16}$		$P_{0,79} = \frac{16}{16}$		$P_{0,80} = \frac{16}{16}$		$P_{0,81} = \frac{16}{16}$		$P_{0,82} = \frac{16}{16}$		$P_{0,83} = \frac{16}{16}$		$P_{0,84} = \frac{16}{16}$		$P_{0,85} = \frac{16}{16}$		$P_{0,86} = \frac{16}{16}$		$P_{0,87} = \frac{16}{16}$		$P_{0,88} = \frac{16}{16}$		$P_{0,89} = \frac{16}{16}$		$P_{0,90} = \frac{16}{16}$		$P_{0,91} = \frac{16}{16}$		$P_{0,92} = \frac{16}{16}$		$P_{0,93} = \frac{16}{16}$		$P_{0,94} = \frac{16}{16}$		$P_{0,95} = \frac{16}{16}$		$P_{0,96}$
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$$t = N\mathbf{1}$$
[illegible]

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