① CW.

1.

By the symmetry of the system we can see that

$$A + B = N \Rightarrow B = N - A$$

2.

$$\frac{\partial p_n}{\partial t} = \underbrace{P_{n-1}\left(\overbrace{k_1 \underbrace{(N-n+1)}_{B=N-(n-1)}}^{\text{Reac. a)}} + \overbrace{\frac{k_2}{v}\underbrace{(n-1)}_{A}\underbrace{(N-n+1)}_{B}}^{\text{Reac. c)}} + \overbrace{\frac{k_3}{v^2}\underbrace{(n-1)}_{A}\underbrace{(n-2)}_{(A-1)}\underbrace{(N-n+1)}_{B}}^{\text{Reac. e)}}\right)}_{\text{term 1.}}$$

$$\underbrace{+ P_{n+1}\left(\overbrace{k_1 \underbrace{(n+1)}_{A}}^{\text{Reac. b)}} + \overbrace{\frac{k_2}{v}\underbrace{(n+1)}_{A}\underbrace{(N-n-1)}_{B=N-(n+1)}}^{\text{Reac. d)}} + \overbrace{\frac{k_3}{v^2}\underbrace{(n+1)}_{A}\underbrace{(N-n-1)}_{B}\underbrace{(N-n-2)}_{B-1}}^{\text{Reac. f)}}\right)}_{\text{term 2}}$$

$$\underbrace{- P_n\left(k_1 N + 2\frac{k_2}{v} n (N-n) + \frac{k_3}{v^2} n \cancel{A} (N-n)(N-2)\right)}_{\text{term 3}}$$

Rename reactions as follow.

a) $B \xrightarrow{k_1} A$ , c) $A+B \xrightarrow{k_2} 2A$ , e) $2A + B \xrightarrow{k_3} 3A$

b) $A \xrightarrow{k_1} B$ , d) $A+B \xrightarrow{k_2} 2B$ , f) $A + 2B \xrightarrow{k_3} 3B$

$$P_n(t+dt) = \overset{*_1}{P_n(t)}(1 - \text{prob. Something Happens}) + \overset{*_2}{P_{n+1}}(t)(\text{propensity func.}) + \overset{*_3}{P_{n-1}}(t)(\text{propens. func}).$$

$*_1$ we are in the correct state ~~and~~ so nothing happens.

$*_2$ we have n+1 molecules of A, so we loose one. (Reac. b), d), f))

$*_3$ we have n-1 molecules of A, so we get one. (Reac. a), c), e))