Solution to Problem 2.1

Given that

$$l_i = (N-i)\,l \qquad i = 0,1,2,\ldots\ldots.,N$$
$$m_i = m \qquad i = 1,2,\ldots\ldots\ldots.,N$$

the flow balance equations may then be written as

$$Nl p_0 = mp_1 \qquad p_1 = Nrp_0 \qquad r = \frac{l}{m}$$
$$(N-k)\,l p_k = mp_{k+1} \qquad p_{k+1} = (N-k)\,rp_k$$
$$lp_{N-1} = mp_N \qquad p_N = rp_{N-1}$$

or $\quad p_k = \dfrac{N!}{(N-k)!}\, r^k p_0 \qquad$ for $k=0,1,2\ldots\ldots\ldots.N$

The probability p_0 may be found by applying the normalisation condition that $\sum_{k=0}^{\infty} p_k = 1$

$$p_0 \sum_{k=0}^{\infty} \frac{N!}{(N-k)!}\, r^k = 1 \quad \text{giving} \quad p_0 = \frac{1}{\sum_{k=0}^{\infty} \frac{N!}{(N-k)!}\, r^k}$$