B1.

1) (a) Fick

(b) $J_A = C_A(v_A - u^*)$

$\quad = C_A(v_A - x_A v_A - x_B v_B)$

$\quad = N_A - C_A(x_A v_A + x_B v_B)$

$\quad = N_A - C x_A(x_A v_A + x_B v_B)$

$\quad = N_A - x_A(C_A v_A + C_B x_B) = N_A - x_A(N_A + N_B)$

2) (c) $N_{Bz} = 0$ より $J_{Az} = N_{Az}(1 - x_A) = -CD\dfrac{dx_A}{dz}$

より $\dfrac{dx_A}{dz} = -(1 - x_A)\dfrac{N_{Az}}{CD}$

(d) $\displaystyle\int_{x_{A0}}^{x_A} \dfrac{dx_A}{1 - x_A} = \int_{z_0}^{z_0 + z} -\dfrac{N_{Az}}{CD}\, dz$

$-\Big[\ln(1 - x_A)\Big]_{x_{A0}}^{x_A} = -\dfrac{N_{Az}}{CD}\cdot z$

$\ln\left(\dfrac{1 - x_A}{1 - x_{A0}}\right) = \dfrac{N_{Az}}{CD}\cdot z$

(e) より $z = z_0 + H$ までの範囲では

$\ln\left(\dfrac{1 - x_{AH}}{1 - x_{A0}}\right) = \dfrac{N_{Az}}{CD} H$

$N_{Az} = \dfrac{CD}{H}\cdot \ln\left(\dfrac{1 - x_{AH}}{1 - x_{A0}}\right) = \dfrac{CD}{H}\cdot(x_{A0} - x_{AH})\cdot\dfrac{\ln\left(\dfrac{1 - x_{AH}}{1 - x_{A0}}\right)}{(x_{A0} - x_{AH})}$

ここで $x_{A0} = 1 - x_{B0}$, $x_{AH} = 1 - x_{BH}$ より

$x_{A0} - x_{AH} = x_{BH} - x_{B0}$, $\ln\left(\dfrac{1 - x_{AH}}{1 - x_{A0}}\right) = \ln\left(\dfrac{x_{BH}}{x_{B0}}\right)$

より $N_{Az} = \dfrac{CD}{H}\cdot(x_{A0} - x_{AH})\cdot\dfrac{\ln\left(\dfrac{x_{BH}}{x_{B0}}\right)}{(x_{BH} - x_{B0})}$

より $x_{BLM} = \dfrac{x_{BH} - x_{B0}}{\ln\left(\dfrac{x_{BH}}{x_{B0}}\right)}$