Donald Doyle
UIN: 128005953

HW 6 301

1) $\nu\Sigma_f = 0.175\ cm^{-1}$

$\Sigma_a^{fuel} = 0.1\ cm^{-1}$

$\Sigma_a^{non\text{-}fuel} = 0.04\ cm^{-1}$

$\Sigma_{transport} = \frac{1}{27}\ cm^{-1}$

a) $K_\infty = \frac{\nu\Sigma_f}{\Sigma_a} = \frac{0.175}{0.14} = 1.25$

b) $\eta = \frac{\nu\Sigma_f}{\Sigma_a^{fuel}} = \frac{0.175}{0.1} = 1.75$

c) $u = \frac{\Sigma_a^{fuel}}{\Sigma_a^{non\text{-}fuel}} = \frac{0.1}{0.04} = 2.5$

d) $D = \frac{1}{3\Sigma_{transport}} = 9$

e) $L = \sqrt{\frac{D}{\Sigma_a}} = \sqrt{\frac{9}{0.14}} = 8.02$

f) i) $K = 1 = \frac{\nu\Sigma_f}{\Sigma_a + DB_g^2} \Rightarrow B_g^2 = \frac{\nu\Sigma_f - \Sigma_a}{D}$

$B_g^2 = \frac{0.175 - 0.14}{9} = 0.004$

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f) ii) $K = K_\infty P_{NL}$

$1 = 1.25\, P_{NL} \Rightarrow P_{NL} \frac{1}{1.25} = 0.8$

f) iii) $B_g^2 = 3\left(\frac{\pi}{\hat{a}}\right)^2 \Rightarrow \frac{\pi}{\hat{a}} = \sqrt{\frac{B_g^2}{3}}$

$\hat{a} = \pi / \sqrt{\frac{B_g^2}{3}} = \pi / \sqrt{0.004/3} = 86.04$ cm

f) iv) $\hat{a} = a + 4D$

$a = \hat{a} - 4D = 86.04 - 4(9) = 50.04$ cm

$V = a^3 = 50.4^3 = 125221$ cm^3

g) i) $B_g^2 = \left(\frac{\pi}{a+4D}\right)^2 + \left(\frac{\pi}{2a+4D}\right)^2 + \left(\frac{\pi}{\frac{a}{2}+4D}\right)^2$

$B_g^2 = \left(\frac{\pi}{50.04+4(9)}\right)^2 \left(\frac{\pi}{2(50.04)+4(9)}\right)^2 + \left(\frac{\pi}{\frac{50.04}{2}+4(9)}\right)^2$

$B_g^2 = 0.00452$

$K = \frac{\nu \Sigma_f}{\Sigma_a + D B_g^2} = \frac{0.175}{0.14 + 9(0.00452)} = 0.969$

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g) ii) $1 = \frac{\nu\Sigma_f}{\Sigma_a + DB_g^2}$

$\nu\Sigma_f = \Sigma_a + DB_g^2$

$B_g^2 = \frac{\nu\Sigma_f - \Sigma_a}{D} = \frac{0.175 - 0.14}{9} = 0.00389$

$0.00389 = \left(\frac{\pi}{a' + 4D}\right)^2 + \left(\frac{\pi}{\frac{a'}{2} + 4D}\right)^2 + \left(\frac{\pi}{2a' + 4D}\right)^2$

$a' = 57.86 \text{ cm}$

g) iii) $V_a = 125271 \text{ cm}^3$

$V_{a'} = (57.82)\left(\frac{57.87}{2}\right)(2(57.82)) = 193301 \text{ cm}^3$

The right parallelepiped takes more moved

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2)a)

$$\Sigma_t = \left(\frac{19\ g}{1\ cm^3}\right)\left(\frac{1\ mol}{239\ g}\right)\left(\frac{6.022\times10^{23}\ \text{atoms}}{mol}\right)\left(\frac{5.87\ b}{\text{atom}}\right)\left(\frac{10^{-24}\ cm^2}{b}\right)$$

$$\Sigma_t = 0.281\ cm^{-1}$$

$$\Sigma_a = \frac{19}{239}(6.022\times10^{23})\cdot(1.81)(10^{-24}) = 0.0867\ cm^{-1}$$

$$\nu\Sigma_f = \frac{19}{239}(6.022\times10^{23})(5.52)(10^{-24}) = 0.264\ cm^{-1}$$

b) $$K_\infty = \frac{\nu\Sigma_f}{\Sigma_a} = \frac{0.264}{0.0867} = 3.045$$

c) $$D = \frac{1}{3\Sigma_t} = \frac{1}{3(0.284)} = 1.17$$

$$L = \sqrt{\frac{D}{\Sigma_a}} = \sqrt{\frac{1.17}{0.0867}} = 3.67$$

d) $$B_m^2 = \frac{\nu\Sigma_f - \Sigma_a}{D} = \frac{0.264 - 0.0867}{1.17} = 0.152$$

e) $$K = 1 = \frac{\nu\Sigma_f}{\Sigma_a + D\left(\frac{\pi}{R}\right)^2}$$

$$\left(\frac{\pi}{R}\right)^2 = \frac{\nu\Sigma_f - \Sigma_a}{D}$$

$$\frac{\pi}{R} = \sqrt{\frac{\nu\Sigma_f - \Sigma_a}{D}}$$

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$$\beta = \frac{\pi}{\sqrt{\frac{2mE - E_V}{D}}}$$

$$r + 2D = \frac{\pi}{\sqrt{\frac{2mE - E_V}{D}}}$$

$$r = \frac{\pi}{\sqrt{\frac{0.264 - 0.0267}{1.17}}} - 2(3.67)$$

$$r = 0.73 \text{ cm}$$

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3) $K_\infty = 1.4$

$$K = \frac{K_\infty}{1+\left(\frac{\pi}{R_c}\right)^2} = 1$$

$$1.4 = 1 + \left(\frac{\pi}{R_c}\right)^2 K_\infty$$

$$0.4 = \left(\frac{\pi}{R_c}\right)^2$$

$$0.632 = \frac{\pi}{R_c}$$

$$R_c = \frac{\pi}{0.632} = 4.97$$

$$\frac{R_c}{2} = \frac{4.97}{2} = 2.485$$

$$K = \frac{1.4}{1+\left(\frac{\pi}{2.485}\right)^2} = 0.539$$