10/12/23

10/17/23
10/24/23 } → No in-person class

Pre-recorded lecture → [redacted] 10/17/23 part 4

? Review session → 10/20/23
Friday 5-7 PM
↓
For Midterm

Midterm → 10/26/23
5-7 PM

$$q = -\frac{kA}{\mu}\frac{dP}{dx}$$

Boyle's Law:

$$qP = q_{sc}P_{sc}$$

↳ Ref.

Ideal Gas

$$\rightsquigarrow \quad \frac{q_{sc}P_{sc}}{P} = -\frac{kA}{\mu}\frac{dP}{dx}$$

$$\rightsquigarrow \quad q_{sc} = \frac{-kA}{\mu P_{sc}}\left(P\frac{dP}{dx}\right)$$

$$P\frac{dP}{dx} = \frac{1}{2}\frac{dP^2}{dx}$$

$$\rightsquigarrow \quad q_{sc} = \frac{-k_g A}{2\mu P_{sc}}\left(\frac{P_2^2 - P_1^2}{L}\right)$$

$$\rightsquigarrow \quad k_g = \frac{2 q_{sc} \mu L P_{sc}}{A(P_1^2 - P_2^2)}$$

Klinkenberg Effect

Mean free path for gas molecules:

$$\lambda = \frac{k_B T}{\sqrt{2}\pi d^2 P}$$

Helium

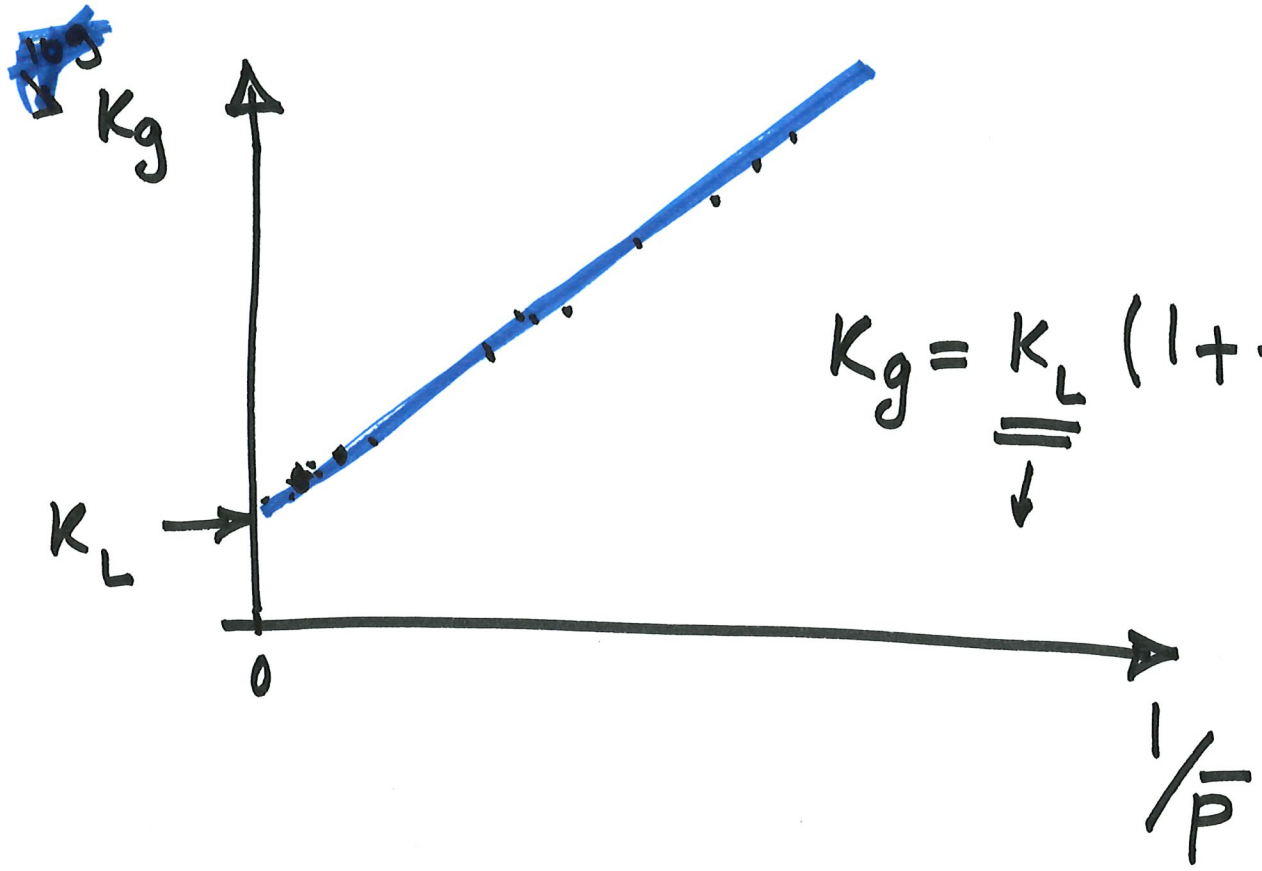
$d = 6.2 \times 10^{-12}$ m

$k_B = 1.38 \times 10^{-23}$ J/K

$T = 293$ K

$P = 200$ Psi $= 1.379$ MPa

$\Rightarrow \lambda = ?$ $\underline{\underline{17\ \mu m}}$

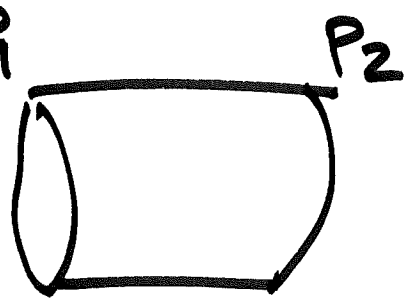


$$K_g = K_L \left(1 + \frac{b}{\bar{P}}\right)$$

$$\bar{P} = \frac{P_1 + P_2}{2}$$

P_1	P_2	q_{sc} → @②	K_g	$\bar{P}$
⋮	⋮	⋮	→ ⋮	⋮

Example:



$D_{core} = 2.54$ cm

$L_{core} = 2.54$ cm

$\mu_g = 0.018$ cp

$P_{sc} = 1$ atm

P_1 (atm)	P_2 (atm)	q_{sc} (cm^3/min)
1.133	1	6.4
1.667	1	35.6
3.000	1	132.8

P_1	P_2	q_{sc}	k_g	$\bar{P}$
•	•	•	✓	✓
•	•	•	✓	✓
•	•	•	✓	✓

$$k_g = \frac{2 q_{sc} \mu L P_{sc}}{A (P_1^2 - P_2^2)}$$

$$\bar{P} = \frac{P_1 + P_2}{2}$$