Diffusion

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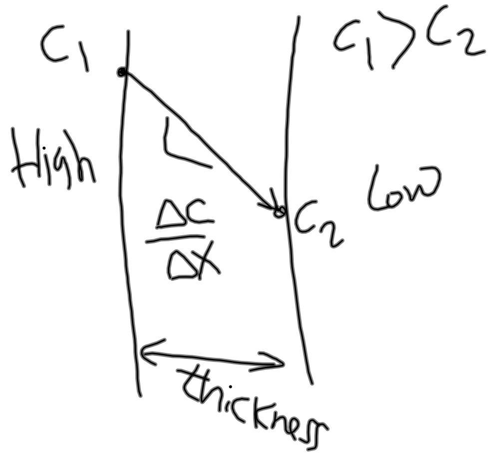
Steady-State



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Q1

C_1, J
C_2, X

$$J = -D \frac{\Delta C}{\Delta X}$$

$\Delta C \rightarrow C_2 - C_1$

ΔX = thickness (m)

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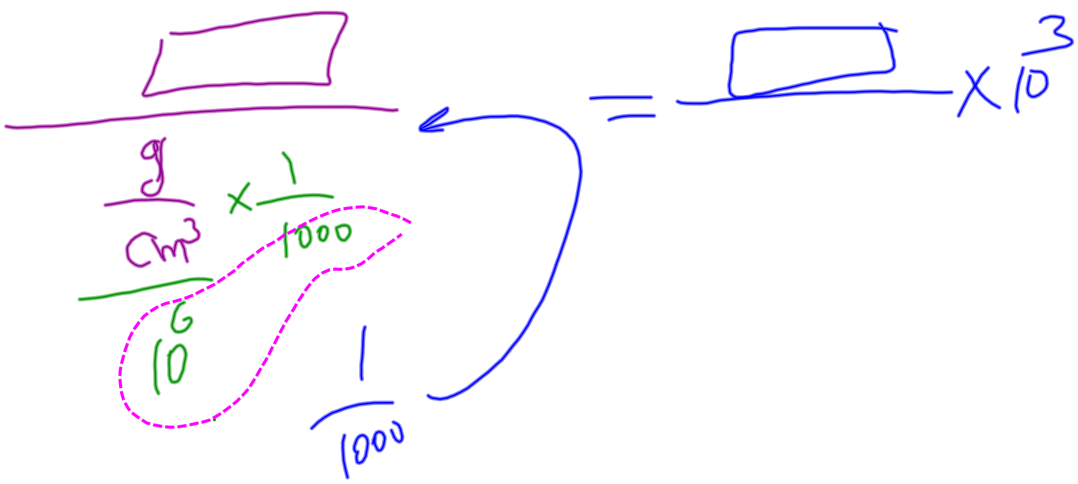

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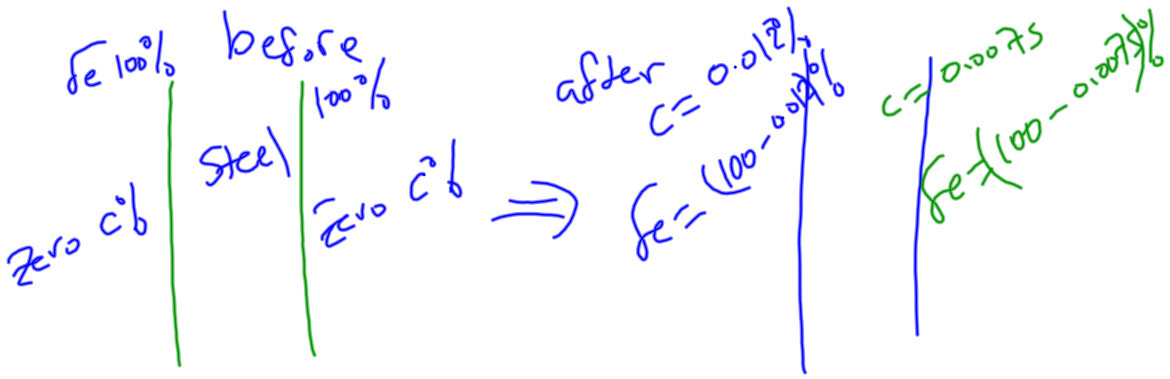
Composition conversions (chapter 4)



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Q2

J_1 ✓

$T_1 = 1200$

$\left.\frac{\Delta C}{\Delta X}\right)_1 = -500$

$J_1 = -D_1 \left.\frac{\Delta C}{\Delta X}\right)_1$

$D_0 \exp\left(-\frac{Q_d}{RT_1}\right)$

$J_2 = ?$

$T_2 = 1000\ C^\circ$

$\left.\frac{\Delta C}{\Delta X}\right)_2 = \left.\frac{\Delta C}{\Delta X}\right)_1 = -500$

$J_2 = -D_2 \left.\frac{\Delta C}{\Delta X}\right)_2$

$D_0 \exp\left(-\frac{Q_d}{RT_2}\right)$

$T_{in}\ C^\circ + 273$

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Non-Steady State

Steady $C = f(X) \Rightarrow$ Linear

Non-Stead $C = f(x, t)$

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Assumptions

1- $t = 0$, $C = C_0$ (initial)

2- $t > 0$, $C = C_s$ (surface)

3- C_x at any x at any time

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$$D = D_0 \exp\left(-\frac{Q_d}{R \cdot T}\right)$$

D_0: const.
Q_d: activation energy
R: Gas const
T: temp. (K)

D is used for steady and the non-steady cases

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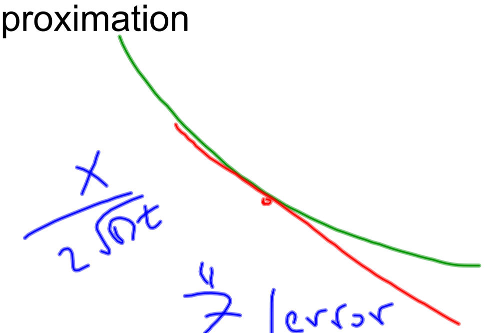
Approximation



z	error
y	7

$$\frac{C_x - C_0}{C_s - C_0} = 1 - \text{error}$$

$C_x = 3$, C_0 = const, C_s: const

$$\text{error} = f\left(\frac{x}{2\sqrt{D \cdot t}}\right)$$ (function)

$$\text{error} = f(z)$$

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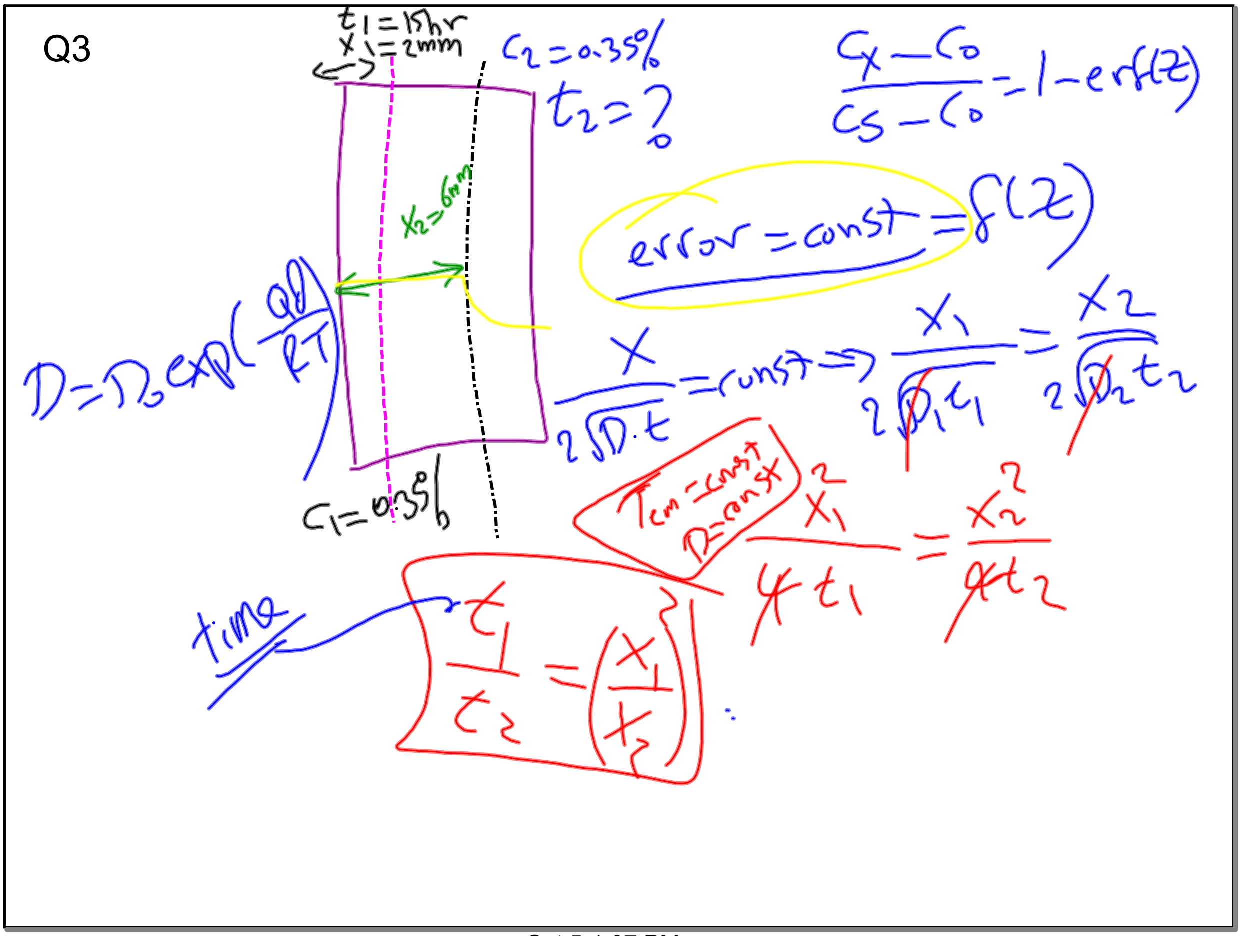

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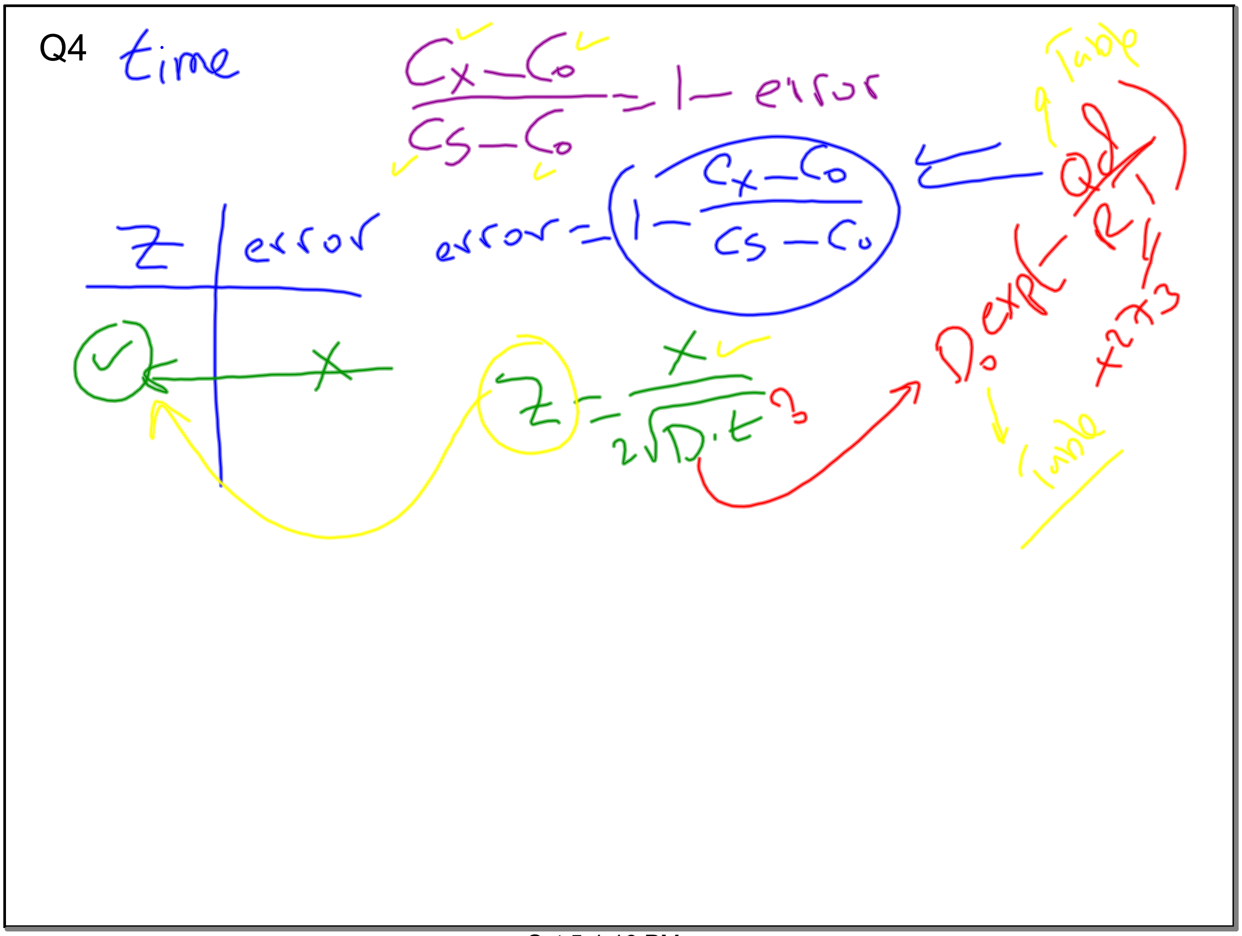

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Q5

$$\frac{C_x - C_0}{C_s - C_0} = 1 - \text{erro}$$

error =

z	error
?	x

$$z = \frac{x}{2\sqrt{D\,\text{time}}}$$

= sec

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