Quiz 16.3 – Diffusion and Time

Name: Key

Fick's Second Law $C(x,t) = \frac{n_0}{A\sqrt{\pi Dt}} e^{\frac{-x^2}{4Dt}}$ $x_{rms} = \sqrt{2Dt}$

A solute has a diffusion coefficient of $6.5 \times 10^{-9} \frac{m^2}{s}$ in water. $0.25 mol$ of the solute are dissolved at one end of a water-filled tube. The tube has $A = 1.5 cm^2$ and is long enough to allow continual diffusion over the time frames considered. Diffusion along the pipe is observed as time passes.

For each of the following times, find the concentration at $1 cm$, the concentration at $10 cm$, and the rms displacement (Using a spreadsheet can make these calculations considerably easier)

- 1 hour
  - $C_{(1cm)} = 66,800 \frac{mol}{m^3} = 66\ M$
  - $C_{(10cm)} = 7.76 \cdot 10^{-42} \frac{mol}{m^3} = 7.76 \cdot 10^{-45}\ M$
  - $x_{rms} = 0.00684\ m = 0.684\ cm$
- 1 day
  - ~~10s~~
  - $C_{(1cm)} = 38,000 \frac{mol}{m^3} = 38\ M$
  - $C_{(10cm)} = 463 \frac{mol}{m^3} = 0.463\ M$
  - $x_{rms} = 0.0335\ m = 3.35\ cm$
- 1 month
  - ~~100s~~
  - $C_{(1cm)} = 7230 \frac{mol}{m^3} = 7.23\ M$
  - $C_{(10cm)} = 6245 \frac{mol}{m^3} = 6.245\ M$
  - $x_{rms} = 0.184\ m = 18.4\ cm$
- 1 year
  - ~~1000s~~
  - $C_{(1cm)} = 2080 \frac{mol}{m^3} = 2.08\ M$
  - $C_{(10cm)} = 2050 \frac{mol}{m^3} = 2.05\ M$
  - $x_{rms} = 0.641\ m = 64.1\ cm$