Diffusion times:

$\langle x^2(t)\rangle = 2Dt.$

(a). $\sqrt{\langle x^2(t)\rangle} = \sqrt{2Dt}.$

$\langle x^2(t)\rangle = \ell^2$

$\Rightarrow t = \dfrac{\ell^2}{2D} = \dfrac{(1\times10^{-3})^2}{2\times10^{-10}} = \frac{1}{2}\cdot10^4 = 5.000\,s$

$= 83.33$ min.

(b). $t = \dfrac{1^2\,cm^2}{2\times 0.2\,cm^2\,s^{-1}} = \dfrac{100}{0.4}\,s = 250\,s = 4.17$ min < 83.33 min

for 10 cm; for 1 mm

= 100 mm

∴ 100 × more distance in less time.

(c). Diffusion is, indeed, a slow process.

- If: s = 330 m/s: ℓ = 10 cm ⇒ $\dfrac{0.10}{330} = 3.03\times10^{-4}\,s$

= 0.303 ms ≪ 4.17 mins.

Also, t = 200 µs: ℓ ≈ 2 cm ... ≪ than the times that of (b).

we've computed in both (a) and (b), which, once again,

illustrates that diffusion is indeed: too slow :(in general

- Faster processes: EM radiation propagation (c), e.g.

- Slower processes: - sedimentation; - osmosis; - electrophoresis. - etc. (maybe slower than diffusion.)

- Advection.
- convection.
- Chemical reactions.
- etc.