Dec 7th, 2015 LB 273, Physics I

Prof. Vashti Sawtelle
Prof. Leanne Doughty

Today:

- Diffusion

Irish Phrasebook

Conas ata tu? *– How are you? (Singular)*

(It's 'Conas ata sibh?' if there is more than one person)

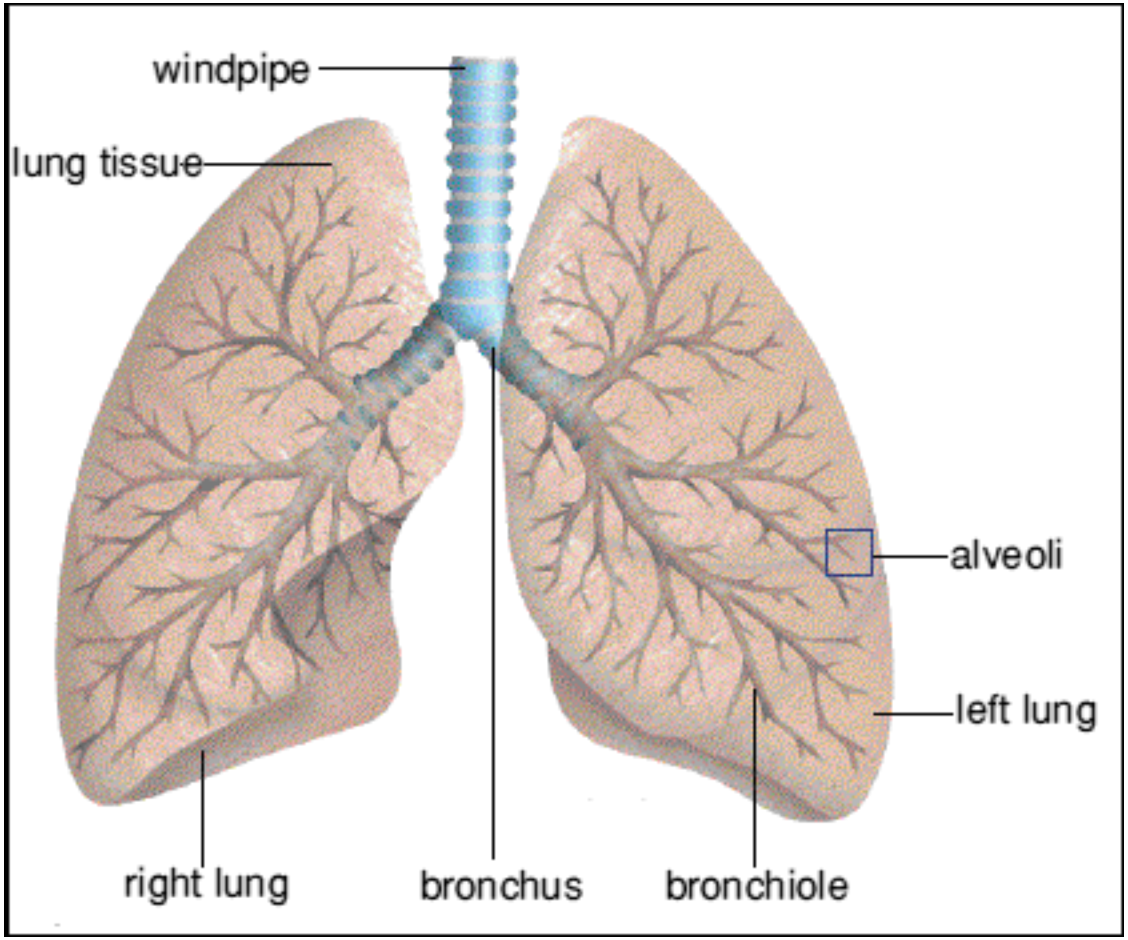
Announcements

- Please bring a WiFi enabled device to class on Wednesday
- LON-CAPA Homework for Ch13 and Ch14 due Wednesday 9th
- Review session:
  - Thursday 10th, 7pm, C106
- Extra Office Hours:
  - Thursday and Friday, 9-11am

Extra Credit Survey Details

- You will receive an email from Sonia Underwood at under108@msu.edu
- By end of the day tomorrow (Tuesday)
- The email will contain the directions on how to complete the activity, the website to go to, information about logging into the system, and downloading silverlight when prompted.
- The activity will be due Friday December 11th at 5pm.

Ch 14 - Diffusion



Penny Demo

- 12 volunteers
- Flip a penny and move Right if Heads, Left if Tails
- See what happens after a few flips

How to describe this motion?

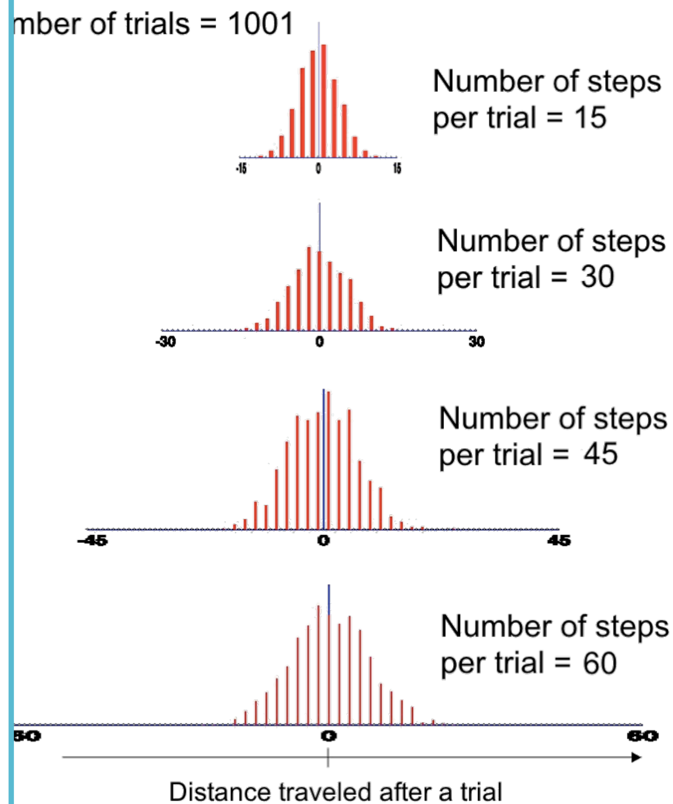
- Root mean square
- Mean free path

Foothold ideas: Random walk in 1D

- As a result of random motion, an initially localized distribution will spread out, getting wider and wider. This phenomenon is called *diffusion*
- The width of the distribution will grow like

$$\left\langle (\Delta x)^2 \right\rangle = 2Dt$$

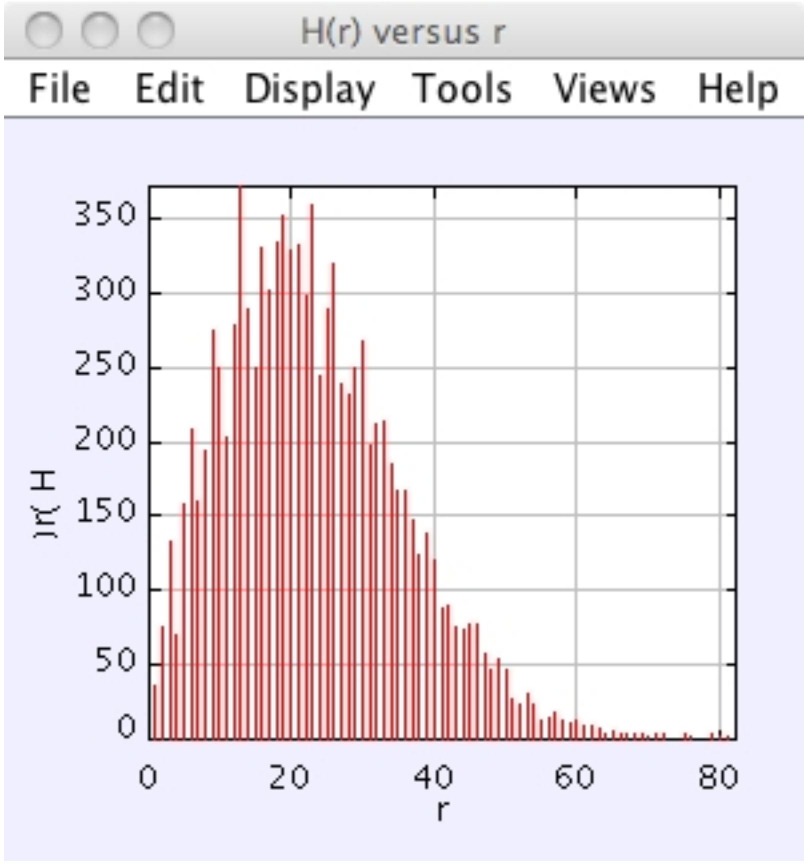
- *D* is called *the diffusion constant* and has dimensionality [*D*] = L^2/T



Foothold ideas: Random walk in 2D

- The density of walkers decreases uniformly as you get farther from the source.
- The total number within a given radius peaks
- The width of the peak grows with the square root of time.
- In 2D:

$$\left\langle (\Delta r)^2 \right\rangle = \left\langle (\Delta x)^2 \right\rangle + \left\langle (\Delta y)^2 \right\rangle = 4Dt$$



In the 1-D equation for diffusion ($\langle x^2 \rangle = 2Dt$) where is the thickness of material being diffused across?

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B. In the D
C. In the t
D. Something else

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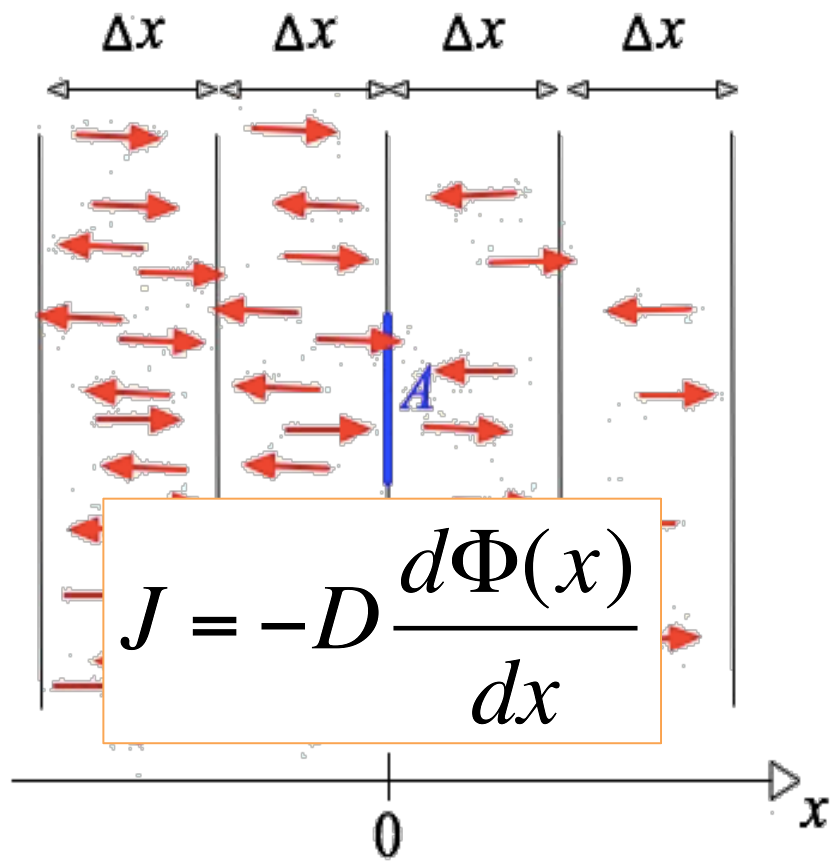
The $\langle x^2 \rangle$ is talking about the average distance a molecule travels in a diffusive process. So the thickness of the material traveling across is in the $\langle x^2 \rangle$.

Fick's law: a simplified model of diffusion

- The red molecules do a random walk (as a result of collisions with fluid molecules)
- Assume
  - Uniform density in each bin
  - Ignore up/down motions
  - Move with uniform (average) velocity
  - Choose bin width to be average distance red molecule travels before colliding.
  - Ask net amount going through a surface of area A in a time



$$J = -D\frac{d\Phi(x)}{dx}$$

In Fick's Law what does the dΦ /dx tell us?

A. The flow of particles depends on the concentration
B. The flow of particles depends on the differences in concentration in time
C. The flow of particles depends on the differences in concentration in space
D. Something else

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The d-phi/dx is showing that what matters is the change in concentration as we move along the tube in space. So if you imagine walking along the tube when you encounter more stuff in one place and less stuff in another place.

We introduce ammonia (NH_3) and Hydrogen chloride (HCl) into a tube. We introduce one at each end, and they diffuse toward each other. NH_3 has a molar mass of 17 grams, while HCl has a molar mass of 36.5 grams.

Where does the gas meet?

A. Closer to the NH_3 end
B. Closer to the HCl end
C. Right in the middle of the tube
D. Not enough information to determine

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Since the ammonia weighs less than the HCl, the speed of the individual ammonia molecules will have to be higher. As a result, the diffusion constant will be higher for HCl and thus the ammonia will diffuse faster than the HCL