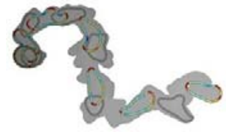
Physics 131- Fundamentals of Physics for Biologists I



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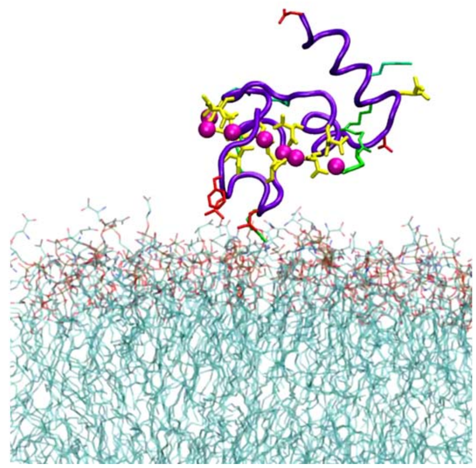

Video: Simulation of Blood Clotting Protein binding to a membrane

Outline

- Quiz 5 review
- Random Motion
- Diffusion
- Fick's Law

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Quiz review

1a	1b	2a	2b	2c	2d
D	B	D	B	C	C
D	B	E	A	C	C
D	B	E	A	E	A
D	A	F	D	F	D
A	B	C	G	C	G
D	C	H	F	C	C
B	BE	E	A	D	F
D	B	E	A	C	C
D	B	E	A	E	A
CORRECT					
D	BE	E	A	E	A

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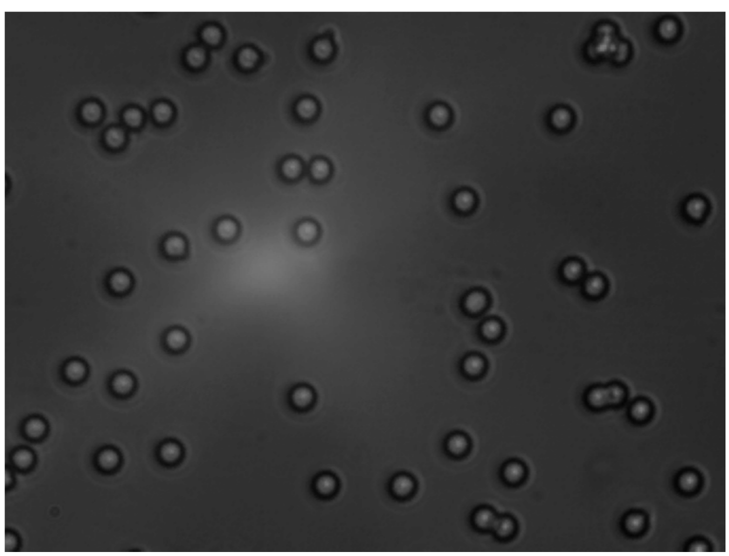
Random Motion



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- Can I think about this process in terms of Newton's laws?
- If the trajectories are unpredictable after a few collisions, what can I say about the motion?
- Is this jiggling really similar to collisions of billard balls? Does it carry momentum? Do collisions exert a force?

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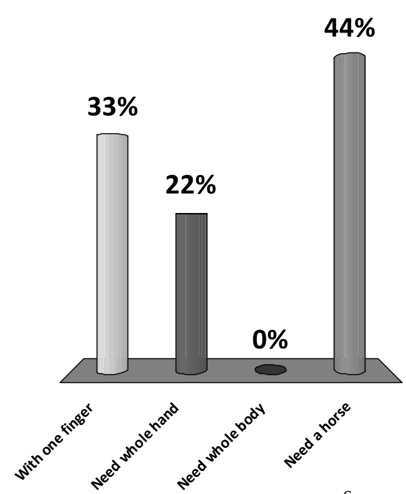
How easy is it to move a sheet of paper, against the pushing from air molecules bouncing against the sheet?

1. With one finger
2. Need whole hand
3. Need whole body
4. Need a horse



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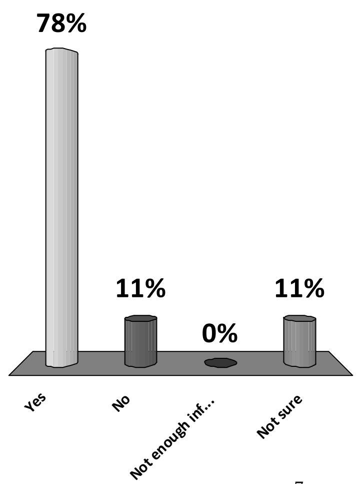
Can I think about this process in terms of Newton's laws?

1. Yes
2. No
3. Not enough information
4. Not sure



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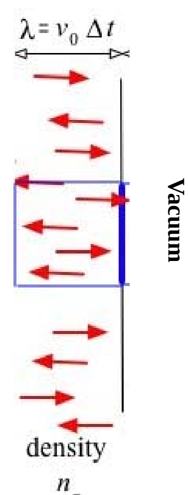
- An extreme example: Vacuum on the right side!
- More atoms want to move to the right than to the left!



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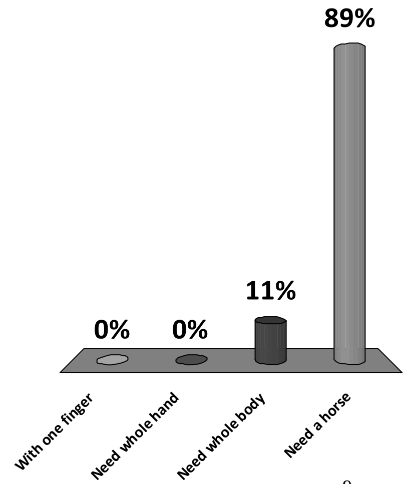
How easy is it to move a sheet of paper now?

1. With one finger
2. Need whole hand
3. Need whole body
4. Need a horse



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- Why is the paper not torn to shreds by such forces from BOTH sides?

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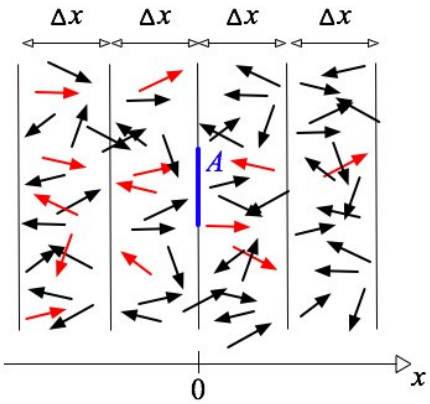
Diffusion: Fick's law (1D analysis)

- Uniform fluid containing (red) molecules with a varying concentration.
- Fluid molecules jiggle the (red) molecules around.



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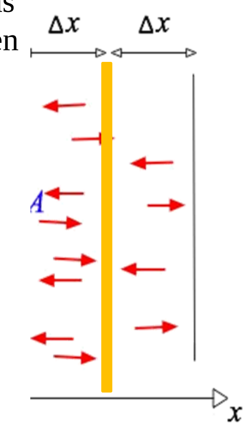
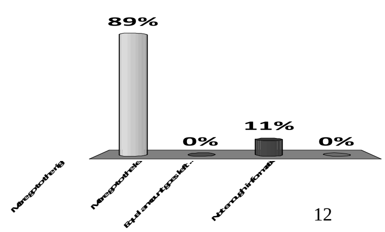
Atoms move randomly in two containers. More atoms are on the left than on the right of a yellow gate. When the gate is suddenly lifted, some of the randomly moving atoms travel across the gate.



1. More go to the right
2. More go to the left
3. Equal amount goes left and right in random motion
4. Not enough information



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How many cross *A* in a time Δ*t*?

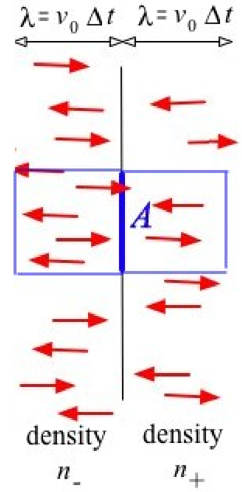
- Number hitting A from left

  $\frac{1}{2}n_-\left(Av_0\Delta t\right)$
- Number hitting A from right

  $\frac{1}{2}n_+\left(Av_0\Delta t\right)$
- Net flow across A

  $\frac{1}{2}\left(n_- - n_+\right)\left(Av_0\Delta t\right)$
- Define flux (per unit area per unit time) as J therefore:

$$JA\Delta t = \tfrac{1}{2}\left(n_- - n_+\right)\left(Av_0\Delta t\right)$$
$$J = \tfrac{1}{2}\Delta n\left(v_0\right)$$



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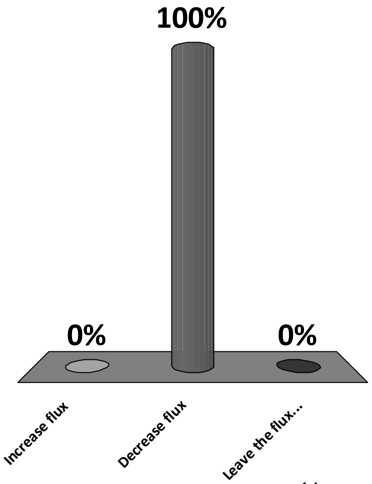
Lower density of the gas will

1. Increase flux
2. Decrease flux
3. Leave the flux unchanged



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Fick's law

- 1D result

$$J = -D\frac{dn}{dx} \quad D = \tfrac{1}{2}\lambda v_0$$

- For all directions (not just 1D) Fick's law becomes

$$\vec{J} = -D\vec{\nabla}n$$

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