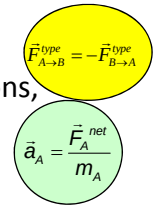
January 28, 2013 Physics 132 Prof. W. Losert

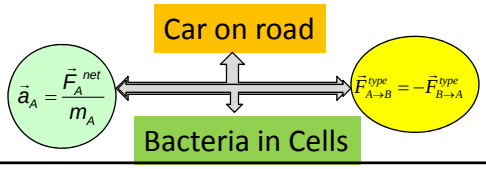
Review of Friday Class

AIM of Class: Building a reliable web of physics knowledge to solve physics, physical chemistry, and physical biology problems

- **Knowledge of Foothold ideas:** Through homework, in class activities, labs, and recitations, build experience with physics concepts we can count on in a wide variety of circumstances



- **Experience how to connect physics and physical biology problems to foothold ideas in a coherent way:** Discussions in class and during HW sessions



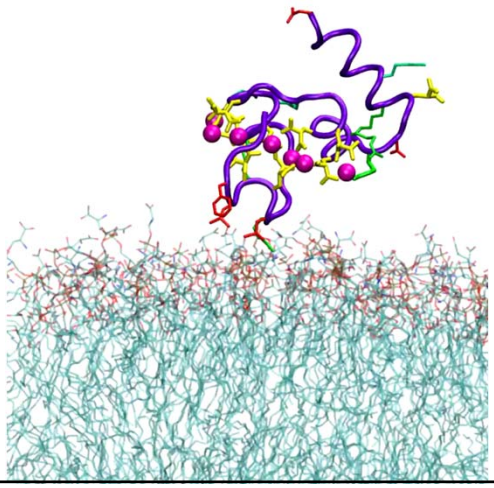
1/28/13 **1**

Outline

- **Random Motion (review from 131)**
- Energy and Enthalpy

1/23/13 Physics 132 **2**

➢Random Motion (Review from Phys131)



Blood Clotting Protein

Membrane

1/25/13

3

Example: Random walk in 1D

- Assume we have 1001 proteins starting at x=0 μm (or repeat the experiment with one protein 1001 times).
- As a result of random motion, each protein will move in a time Δt by an unpredictable amount.
- Nevertheless, the distribution of distances moved is predicable. This phenomenon is called *diffusion*

Number of proteins: 1001

Δt=15 sec

Distance Travelled

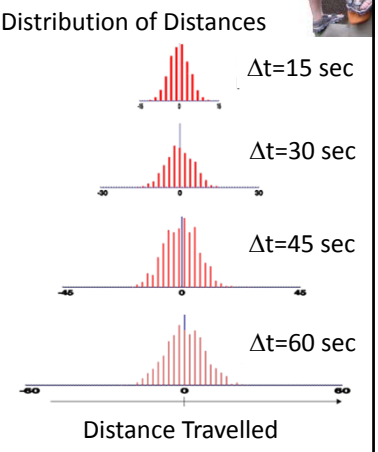
4

Foothold ideas: Random walk in 1D

- In random motion, the distribution of distances moved in a time Δt is predicable. This phenomenon is called *diffusion*
- The square of the average distance traveled during random motion will grow with time:

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

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



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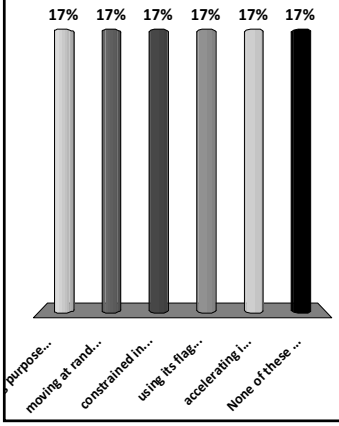
http://www.gifsoup.com/view/3511095/kinesin-walking.html

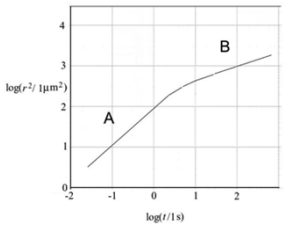
- If the protein was a motor protein and moved at a constant velocity v, how does Δx change with time?

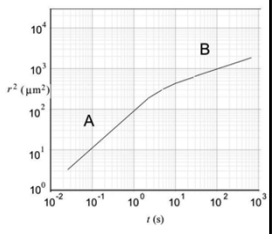
$$\left\langle (\Delta x)^2 \right\rangle = ??$$

A student in lab observes the motion of a bacterium with a video camera. His log-log plot of the square deviation is shown. The bacterium seems to have two distinct behaviors: for times shorter than 1 second (A) and for times longer than 10 seconds (B). What might be an appropriate hypothesis for what might be causing the two different behaviors?

In Region A the bacterium is







1. moving purposefully in response to a chemical gradient.
2. moving at random in response to the thermal motion of its environment.
3. constrained in some way.
4. using its flagella (which work like propellers) to move at a constant velocity
5. accelerating in response to a force in a fixed direction.
6. None of these behaviors are consistent with that part of the graph.

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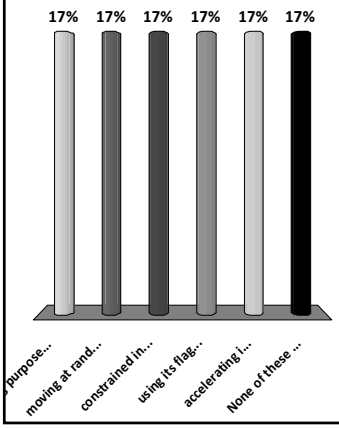
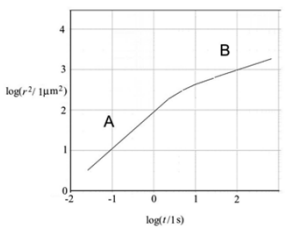
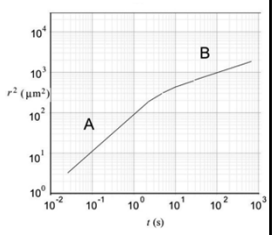
In Region B the bacterium is







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Energy and Enthalpy

Examples:

Table 1: Egg placed in water in a rolling boil

Table 2: Man stands still holding a weight at arm's length.

The SYSTEM of interest is colored RED
Discuss and describe what energies of the system may change in this process on your whiteboard

Foothold ideas: Energy

- Kinds of energy
  - Kinetic
  - Potential
  - Thermal
  - Chemical
- First law of thermodynamics
  - Conservation of total energy

Energy of System

Thermal energy Entering system

Work done on system

$$\Delta E = Q + W$$