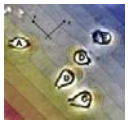
Physics 131- Fundamentals of Physics for Biologists I



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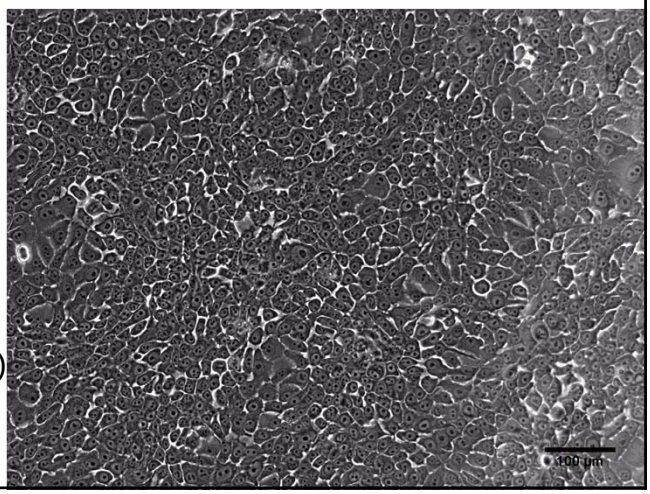
9/12/2012
Main Topic:
Motion

-How can we describe motion (Kinematics)

- What is responsible for motion (Dynamics)

Movie of the Day
Motion inside Cell Sheet



Outline

- Go over Quiz 1
- MCAT
- Kinematics recap
- Using the kinematics equations

Quiz 1

- Problem 1
- Problem 2

1.1	1.2	1.3
e	mR/(1/T^2)	f
dg	mRv^2	b
d	mRv^2	b
e	[m][R]/v	f
d	mR/(1/T^2)	b
be	mR/T	b
be	mRv	b
dh	mRv^2	b

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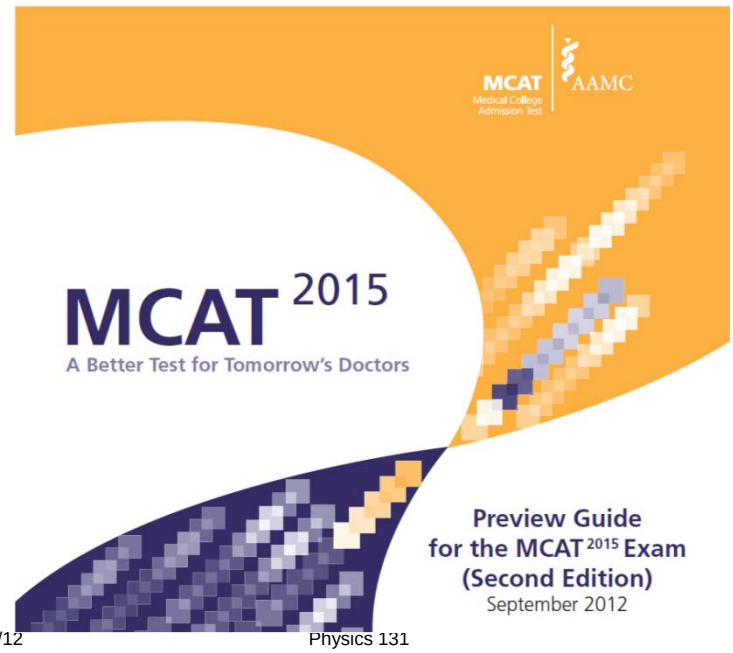

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MCAT and multiple representations

- **From the recent guide on the revisions of the MCAT that will start in 2015 Skills to be tested are**
- **Skill 1: *Knowledge of Scientific Concepts and Principles***
  - Identifying the relationships between different representations of concepts (verbal, symbolic, graphic)
  - Using mathematical equations to solve problems
- **Skill 2: *Scientific Reasoning and Problem-solving***
  - Determining and using scientific formulas to solve problems
- **Skill 4: *Data-based and Statistical Reasoning***
  - Using, analyzing, and interpreting data in figures, graphs, and tables
  - Evaluating whether representations make sense for particular scientific observations and data
  - Reasoning about random and systematic error
  - Using data to explain relationships between variables or make predictions
  - Using data to answer research questions and draw conclusions

Chemical and Physical Foundations of Biological Systems

Foundational Concept 4[14]

Complex living organisms transport materials, sense their environment, process signals, and respond to changes using processes that can be understood in terms of physical principles.

Content Category 4A: ***Translational motion, forces, work, energy, and equilibrium in living systems***

The motion of any object can be described in terms of displacement, velocity, and acceleration. Objects accelerate when subjected to external forces and are at equilibrium when the net force and the net torque acting upon them are zero. Many aspects of motion can be calculated with the knowledge that energy is conserved, even though it may be converted into different forms. In a living system, the energy for motion comes from the metabolism of fuel molecules, but the energetic requirements remain subject to the same physical principles.

The content in this category covers several physics topics relevant to living systems including translational motion, forces, work, energy, and equilibrium. The topics and subtopics in this category are:

Translational Motion (PHY)

- Units and dimensions
- Vectors, components
- Vector addition
- Speed, velocity (average and instantaneous)
- Acceleration

Equilibrium (PHY)

- Concept of force, units
- Analysis of forces acting on an object
- Newton's First Law of Motion, inertia

. . .

Please Note

Topics that appear on multiple content lists will be treated differently. Questions will focus on the topics as they are described in the narrative for the content category.

Velocity: Predicting the future position

- Average velocity is defined by

$$\langle \vec{v} \rangle = \frac{\Delta \vec{r}}{\Delta t} = \frac{\text{vector displacement}}{\text{time it took to do it}}$$

Note: an average velocity goes with a time interval.

- Instantaneous velocity is what we get when we consider a very small time interval (compared to times we care about)

$$\vec{v} = \frac{d\vec{r}}{dt}$$

Note: an instantaneous velocity goes with a specific time.

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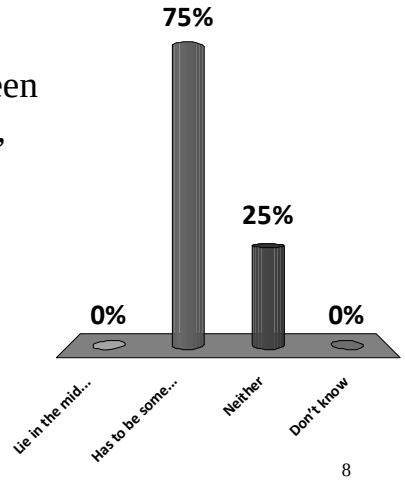
Does the value of the Average velocity

1. Lie in the middle between the initial and final velocity
2. Has to be somewhere between the initial and final velocity, depends on how velocity changes with time
3. Neither
4. Don't know



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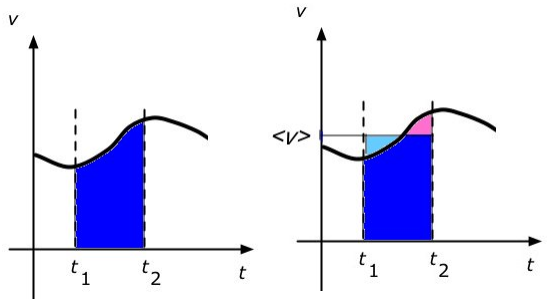
Average velocity - graphical



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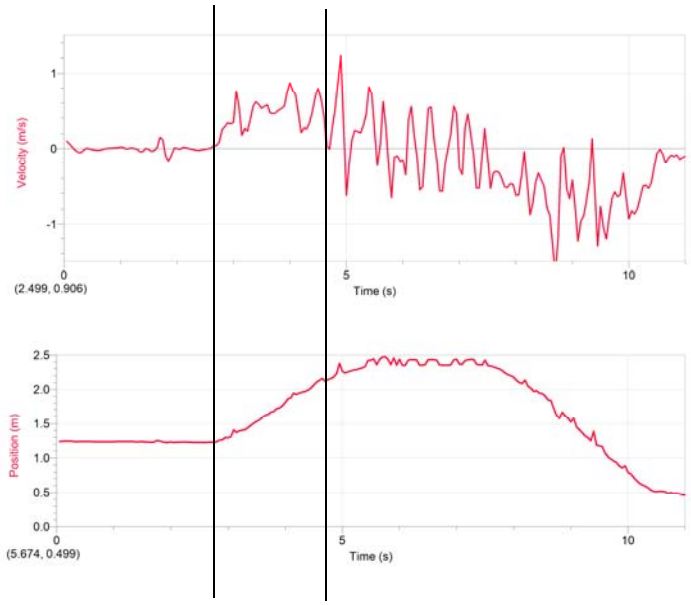

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Foothold ideas: Acceleration

- Average acceleration is defined by

$$\langle \vec{a} \rangle = \frac{\Delta \vec{v}}{\Delta t} = \frac{\text{change in velocity}}{\text{time it took to do it}}$$

Note: an average acceleration goes with a time interval.

- Instantaneous acceleration is what we get when we consider a very small time interval (compared to times we care about)

$$\vec{a} = \frac{d\vec{v}}{dt}$$

Note: an instantaneous acceleration goes with a specific time.

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Technical term alert!

- Note that in physics we use the term "**acceleration**" in a technically defined way:
  - "acceleration" = changing velocity
- The object may be speeding up or slowing down or keeping the same speed and changing direction. We still say "it has acceleration"
- In common speech "*ACCELERATION*" = speeding up, "*DECELERATION*" = slowing down, and "*TURNING*"=changing direction.
- How many (physics) accelerators are there on your car?

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Uniformly changing motion

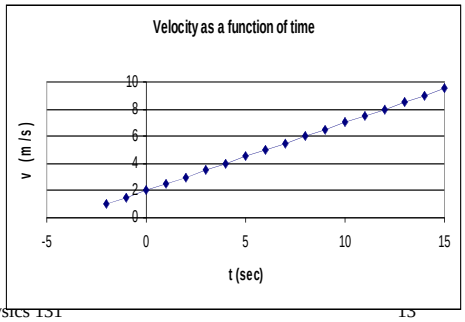
- If an object moves so that it changes its velocity by the same amount in each unit of time, we say it is in uniformly accelerated motion.
- This means the average acceleration will be the same no matter what interval of time we choose.

$$< \vec{a} > = \frac{\Delta \vec{v}}{\Delta t} = \vec{a}_0$$

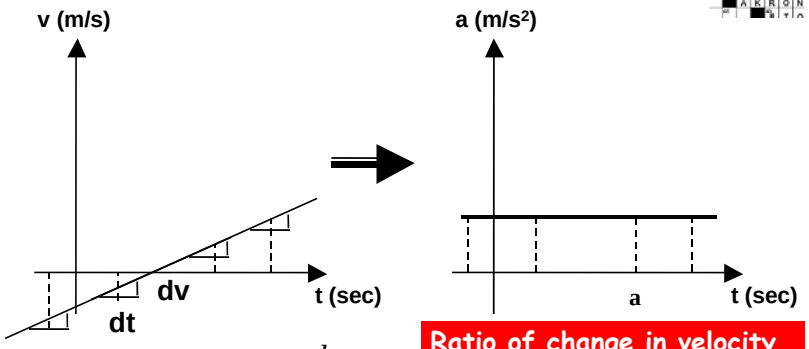
$$\Delta \vec{v} = \vec{a}_0 \ \Delta t$$

$$\vec{v}(t_2) - \vec{v}(t_1) = \vec{a}_0 \ \Delta t$$

$$\vec{v}_{final} = \vec{v}_{initial} + \vec{a}_0 \ \Delta t$$



Velocity to acceleration



$$a(t) = \frac{dv}{dt}$$

Ratio of change in velocity that takes place to the (small) time interval

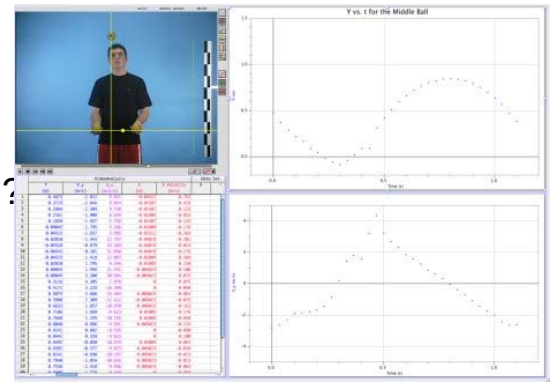
Difference of two velocities at two (close) times

$$a(t) = \frac{v(t + \Delta t/2) - v(t - \Delta t/2)}{\Delta t}$$

Figuring out acceleration

- Looked at the y-t, and v_y-t plots for a ball going up and down.
- Acceleration is the derivative of the velocity. How is the velocity changing? Why?

$$\vec{a} = \frac{d\vec{v}}{dt}$$



At what time does the juggler release the ball

1. 0.2 sec
2. 0.3 sec
3. 0.4 sec
4. 0.5 sec
5. 0.6 sec
6. 0.7 sec
7. 0.8 sec
8. Another time