## Physics 131- Fundamentals of Physics for Biologists I <br> 

Professor: Wolfgang Losert wlosert@umd.edu

Technotronic - Pump Up The Jam


## Outline

- QUIZ
- Kinematics: Modeling Motion
- Position vs time
- Velocity
- Average Velocity


## Quiz

Answers
Average: 5.5
Quiz 1

## Q1 <br> Q2 <br> Q3

D, $\mathrm{H} \quad \mathrm{B}$

## D or E



## Q1

(3 pts) You know that 1 cubic centimeter of biomaterial has a mass of 1 gram. What's the mass of 1 cubic meter of biomaterial?
A. 10 g
B. $10^{2} \mathrm{~g}$ ??
C. $10^{4} \mathrm{~g}$
D. $10^{6} \mathrm{~g}$
E. 1 kg
F. 10 kg
G. 100 kg
H. 1000 kg

## Q2

(3 pts) Which equation could represent the surface area of a cylinder

A $2 \pi R+2 \pi R h$
B $\quad 2 \pi R^{2}+2 \pi R h$
с $2 \pi R^{2}+2 \pi h \backsim ? ?$
D $\pi R^{2} h$

## Q3

(2 pts) Estimate the thickness of a page in a typical textbook. (2 pts) Explain your reasoning
A. $10^{-1} \mathrm{~m}$
B. $10^{-2} \mathrm{~m}$
C. $10^{-3} \mathrm{~m}$
D. $10^{-4} \mathrm{~m}$
E. $10^{-5} \mathrm{~m}$
F. $10^{-6} \mathrm{~m}$
G. $10^{-7} \mathrm{~m}$
H. $10^{-8} \mathrm{~m}$

## Outline

## - QUIZ

- Kinematics: Modeling Motion
- Position vs time
- Velocity
- Average Velocity


## Be more specific in your question: <br> Can we go over the uniform motion equations?

Will we be required at some point to know the different forms of the equations in uniform motion section?

## The sonic ranger (motion detector)

- The sonic ranger measures distance to the nearest object by echolocation.
- A speaker clicks 30 times a second. A microphone detects the sound bouncing back from the nearest object in front of it.
- The computer calculates the time delay between and using the speed of sound (about $343 \mathrm{~m} / \mathrm{s}$ at room temperature) it can calculate the distance to the object.


## Using Position Graphs to Describe Motion

- If I place the sonic ranger at the left side of the room and you walk slowly towards it at almost a constant velocity what will the position graph look like?

Generate the graph on your whiteboard.

## Which is the correct graph?



## Describe in your own words the motion captured in this position vs time graph



## Velocity: Change in position

- Average velocity
= (how far did you go?)/ (how long did it take you?)

$$
\langle\nu\rangle=\frac{\Delta x}{\Delta t}
$$

- Instantaneous velocity = same (but for short $\Delta t$ )

$$
v=\frac{d x}{d t}
$$

## Position to velocity



$$
v(t)=\frac{d x}{d t}
$$

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


## Using Velocity graphs to describe motion

- If I place the sonic ranger at the left side of the room and you walk slowly towards it at almost a constant velocity what will the velocity graph look like?

Generate the graph on your whiteboard.

## Velocity graph

(1)

(2)

(3)

(4)

(5)



File Controls Help View


How many times does the man's speed go to zero?

1. Never
2. Once
3. Twice
4. Three times
5. Four times

## Predicting Position from Velocity




$$
d x=v(t) d t \Leftarrow \quad \begin{aligned}
& \text { change in posi } \\
& \text { takes place in }
\end{aligned}
$$

## Predicting the Future with differential equations

Suppose we know the value of something as a function of time at a given time, $f(t)$, and we know its derivative, $d f / d t$ at that time. We can use that to predict the future!

$$
\begin{aligned}
& \frac{d f}{d t}=\frac{\Delta f}{\Delta t}=\frac{f_{\text {end }}-f_{\text {beginning }}}{\Delta t} \\
& f_{\text {end }}-f_{\text {beginning }}=\left(\frac{d f(t)}{d t}\right) \Delta t \\
& f(t+\Delta t)-f(t)=\left(\frac{d f(t)}{d t}\right) \Delta t \\
& f(t+\Delta t)=f(t)+\left(\frac{d f(t)}{d t}\right) \Delta t
\end{aligned}
$$

## Example of a Diff Eq.

- Epidemiology: Number of people infected by a disease is proportional by the number of people in the population
- A simple model for the spread of infection

$$
\begin{aligned}
& \frac{d I(t)}{d t}=A I(t)-B I(t) \\
& A=\text { rate at which population gets infected } \\
& B=\text { rate at which infected people are cured (or die) } \\
& \frac{d I}{d t}=(A-B) I
\end{aligned}
$$

## Example

- How do you have to walk to make the sonic ranger produce the following velocity graph?

- Draw the position graph.

