Spring 2014

PHYS-2010

Lecture 3

Clicker Question

Room Frequency BA

Am I moving?

A) Yes, definitely

B) Maybe

C) It depends what you mean by “moving”

D) No, definitely not

Announcements

- **CAPA** Homework #1 due next Tuesday at 11 pm.
- Textbook Reading – **Chapter 2** in Giancoli (1D Kinematics).
- Print **Recitation Assignment # 2** for your Section next week:

http://www.colorado.edu/physics/phys2010/phys2010_sp14/LabIndex.html

- **No Lecture** next Monday – MLK Day.
- I will be away next week.
- Lectures on Wed. (Jan. 22) and Fri. (Jan. 24) will be given by **Prof. Pollock**.
- I will not have **office hours** next Tuesday.

Remember the Metric Prefixes

giga	G	10^9
mega	M	10^6
kilo	k	10^3
hecto	h	10^2
deka	da	10^1
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro†	μ	10^{-6}
nano	n	10^{-9}

1,000,000,000 = Giga

1,000,000 = Mega

1000 = kilo

0.01 = 1/100 = centi

0.001 = 1/1000 = milli

0.000000001 = 1/1,000,000,000 = nano

Not really nano, but just smaller

Remember the Algebra of Exponents

$$a^m \times a^n = a^{m+n}$$

$$100{,}000 = 10^5 = 10^{3+2} = 10^2 10^3$$

$$\frac{1}{a^m} = a^{-m}$$

$$\frac{1}{1000} = \frac{1}{10^3} = 10^{-3} = 0.001$$

$$\frac{a^m}{a^n} = a^{m-n}$$

$$\frac{100}{1000} = \frac{10^2}{10^3} = 10^{2-3} = 10^{-1} = 0.1$$

$$\left(a^m\right)^n = a^{m\times n}$$

$$\left(10^3\right)^2 = 10^{2\times 3} = 10^6 = 1{,}000{,}000$$

Clicker Question

Room Frequency BA

1 meter = 100 centimeters (1 m=100 cm).
How many cm^2 in 1 m^2 ?

A) 10

B) 1000

C) 2000

D) 10^5

E) None of the above

1 m = 100 cm

$1\ m^2 = (1\ m)^2$

We must square both sides

$(1\ m)^2 = (100\ cm)^2 = 100^2\ cm^2$

$1\ m^2 = 10^4\ cm^2$

KINEMATICS

(Ch. 2 in Giancoli)

Teach you I will !

Objects in Motion

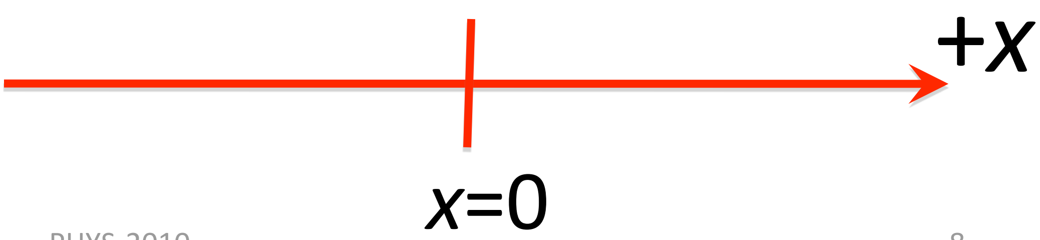
Kinematics – study of motion irrespective of considering what caused the motion

Dynamics – study of what causes the motion (i.e. forces)

Any description of motion (position, distance, or speed) requires specifying a "**Reference Frame**".

Start with one-dimensional motion...
Need to specify:

- origin (x=0)
- positive direction



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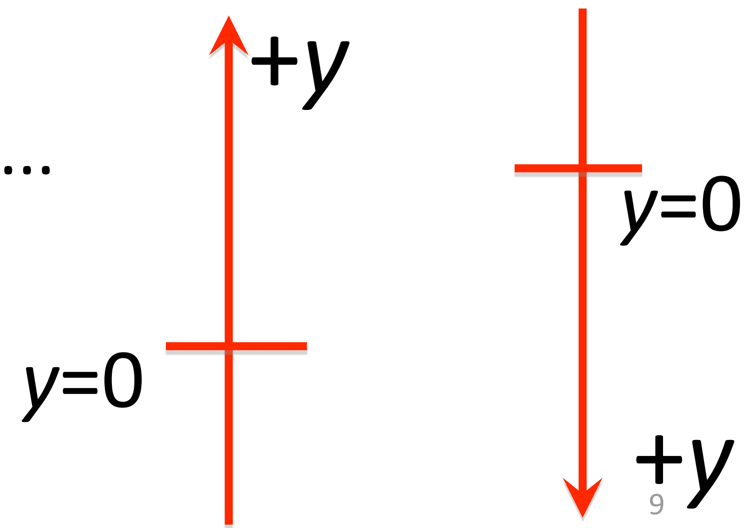
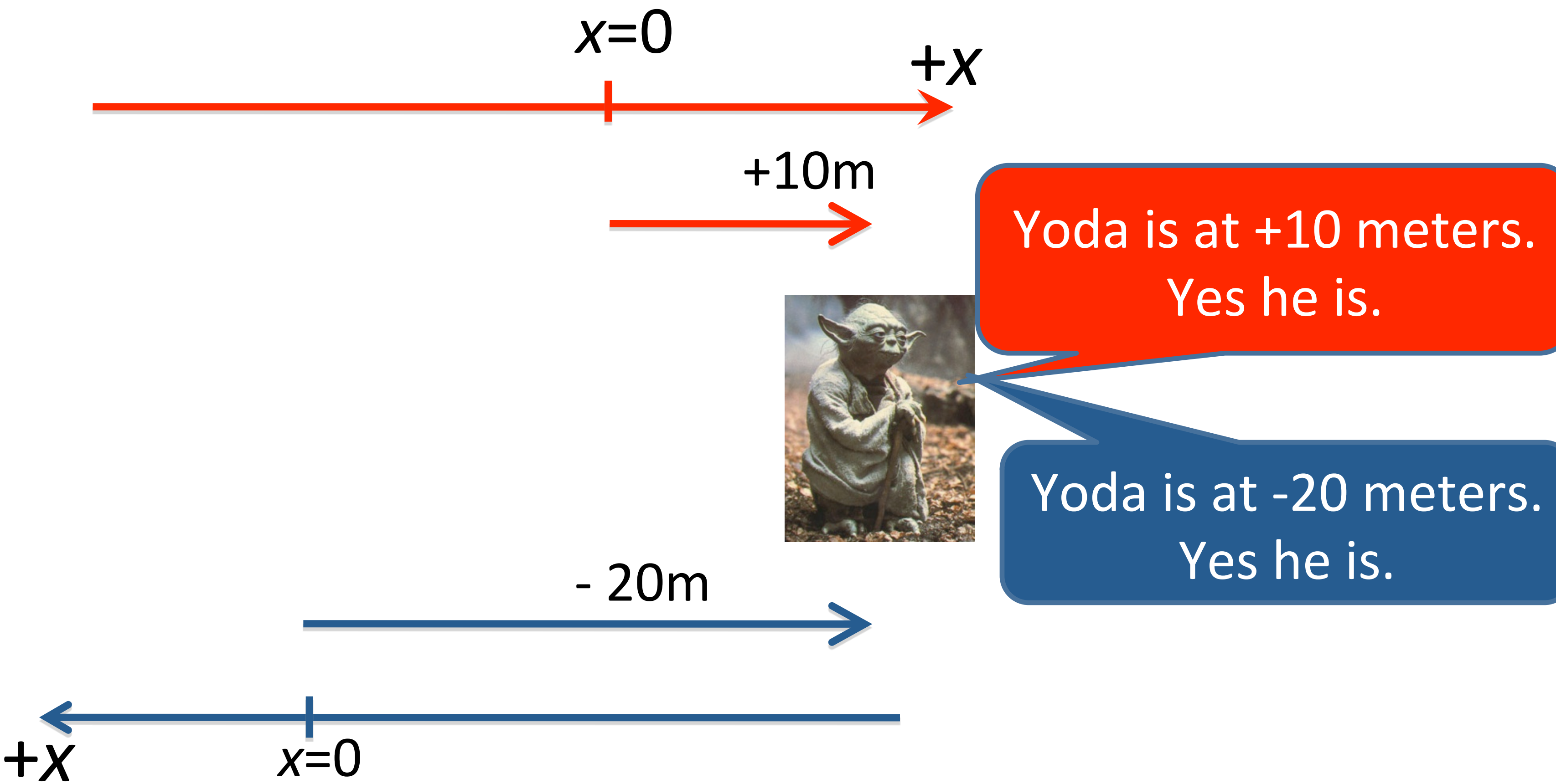
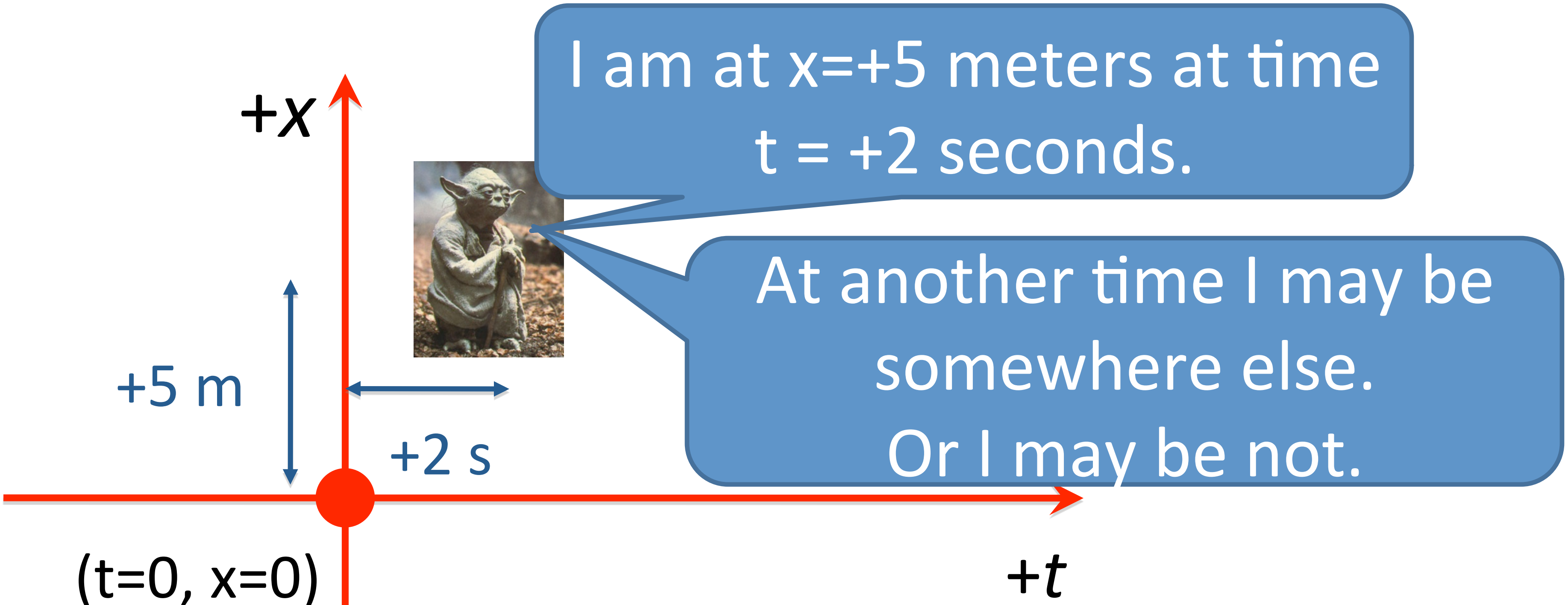


Position depends on the **Reference Frame**:



Different answers in different Reference Frames.
Giving position without specifying the Reference Frame is meaningless.

Even in one spatial dimension (e.g. *x* coordinate), we also need to specify the **Reference Frame** for the **time** dimension.

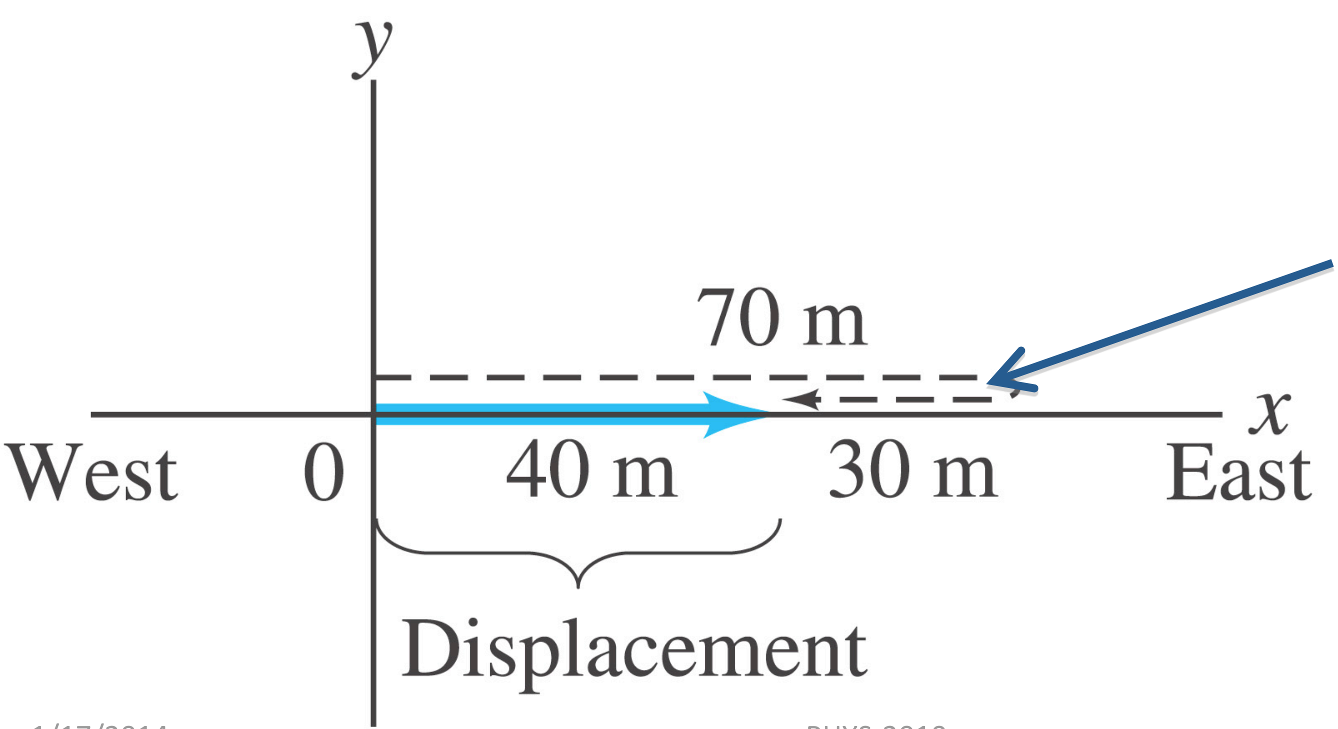


Only meaningful with definition for time $t = 0$.

Displacement and Distance Travelled

Displacement is the difference in positions between the ending point and the starting point (can be positive or negative): $\Delta x = x_2 - x_1$

Distance Traveled – distance measured along the actual path taken (always positive).



distance travelled = 100 m

Clicker Question

Room Frequency BA

What is the **displacement** of the walking Yoda?

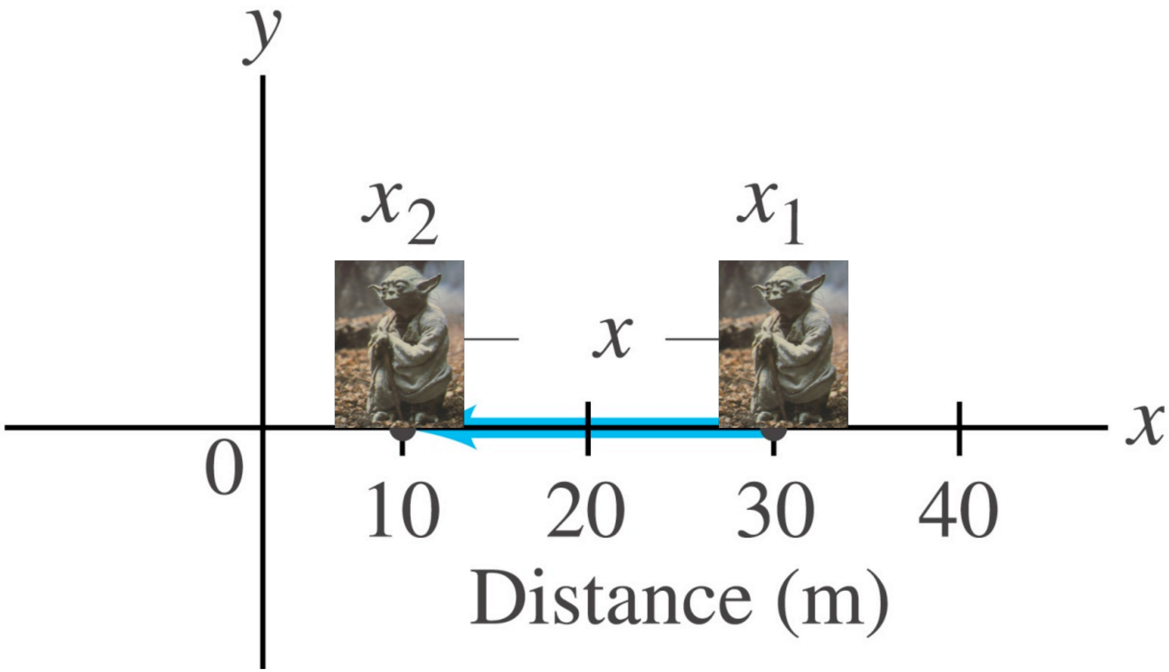
A) +10 m

B) +30 m

C) +20 m

D) -20 m

E) -10 m



$$\Delta x = x_2 - x_1 = 10\text{ m} - 30\text{ m} = -20\text{ m}$$

Note: **displacement** can be positive or negative, but **distance traveled** is always positive.

Speed and Velocity

Speed = how far an object travels divided by the elapsed time of travel.

$$\bar{s} \quad \text{average speed} = \frac{\text{distance traveled}}{\text{time elapsed}} \qquad \frac{+}{+} \geq 0$$

Velocity includes directional information:

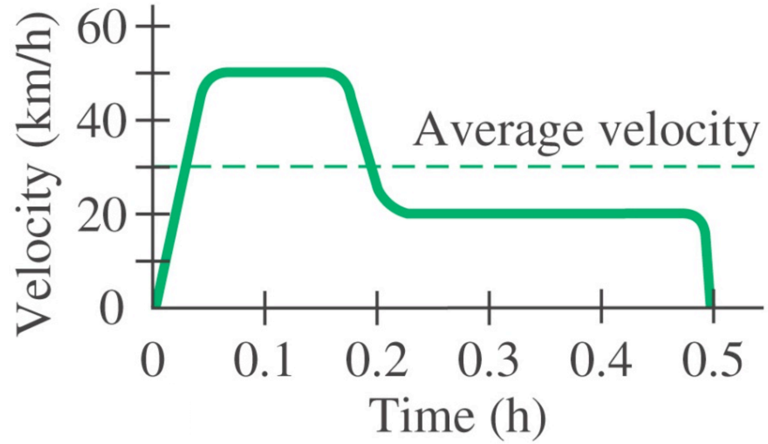
$$\bar{v} \quad \text{average velocity} = \frac{\text{displacement}}{\text{time elapsed}} \qquad \frac{\Delta x}{\Delta t} \begin{matrix} > \\ = \\ < \end{matrix} 0$$

Velocity includes speed and direction

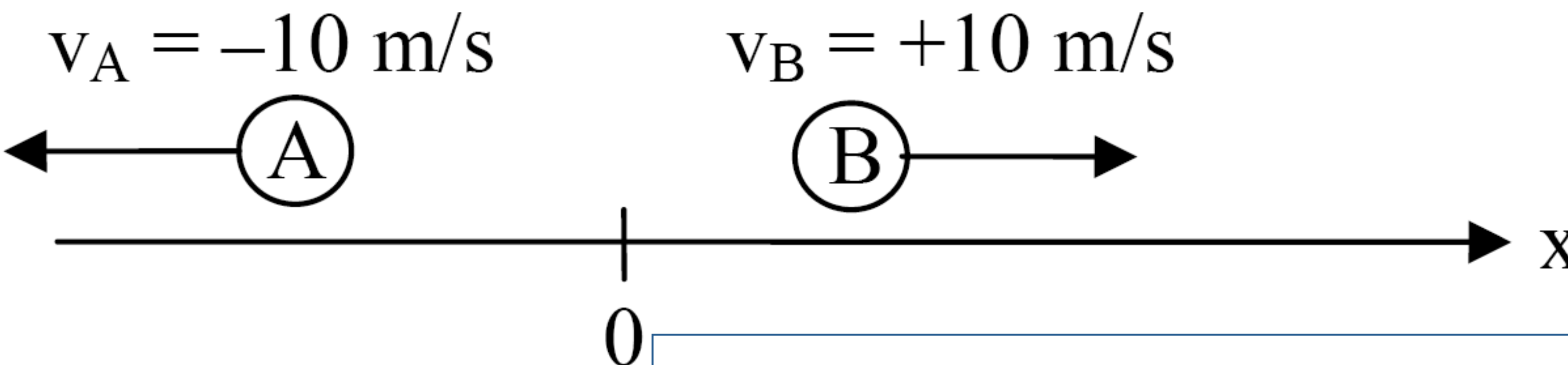
Instantaneous and Average Velocity

The **instantaneous velocity** is the average velocity, in the limit as the time interval becomes infinitesimally short.

$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$$



Objects can have a positive or negative average or instantaneous velocity:

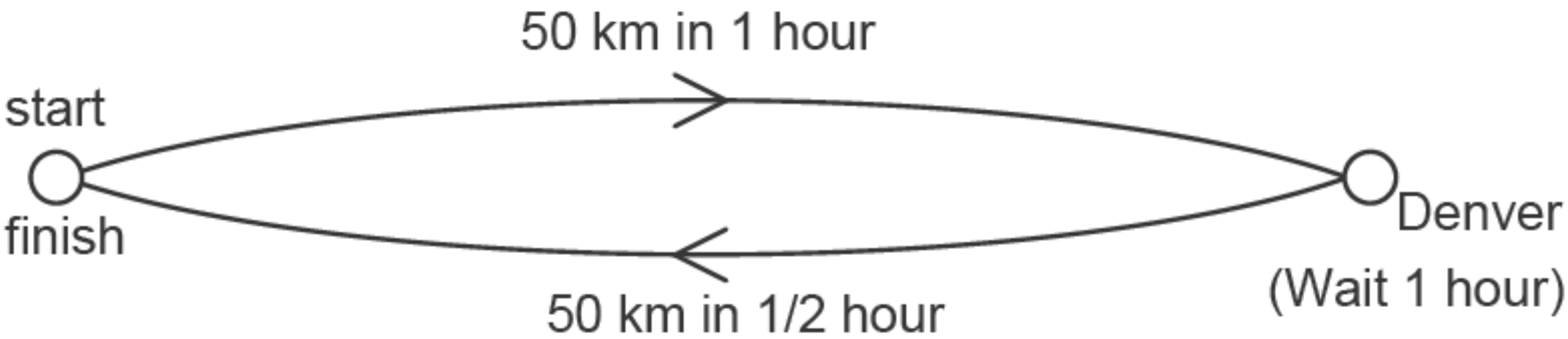


But, speed s = |v| $s_A = s_B$

Clicker Question

Room Frequency BA

A student starts in Boulder, drives to Denver 50 km away in 1 hr, stays in Denver for 1 hr, then speeds back to Boulder in 30 minutes.



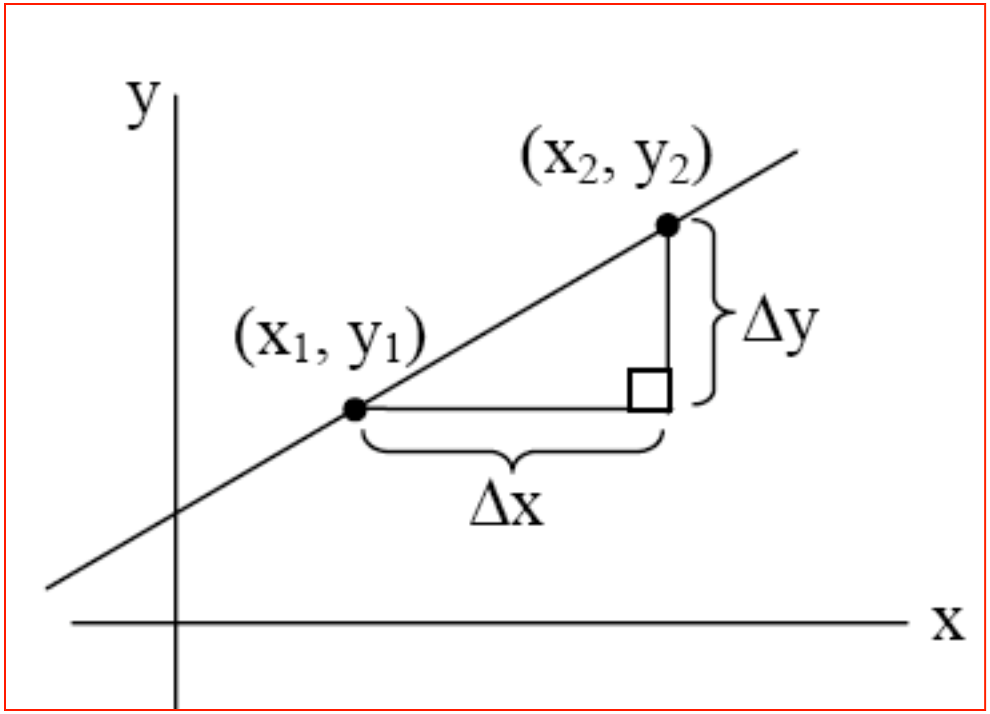
What is the average **speed** of this round trip?

A) Zero
B) -67 km/hr
C) +40 km/hr
D) 67 km/hr
E) None of these.

Average speed = distance traveled / elapsed time
= 100 km / 2.5 hr
= 40 km / hr

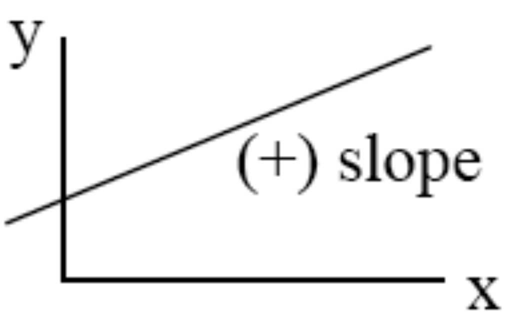
What about average velocity?

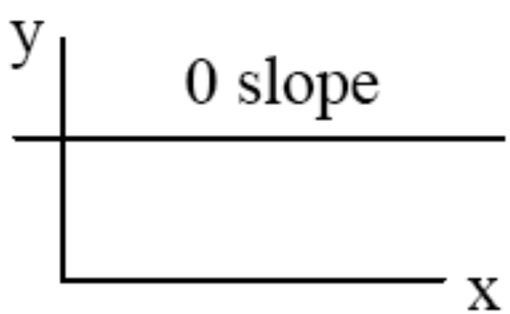
Quick Graph Review

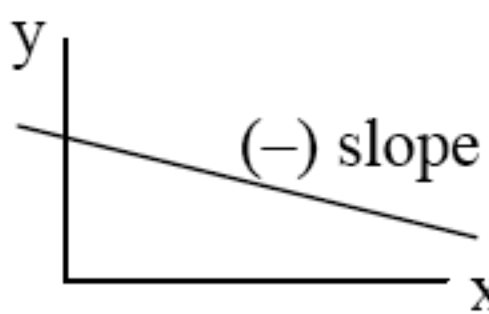


$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{\Delta y}{\Delta x}$$

$$= \frac{y_2 - y_1}{x_2 - x_1}$$

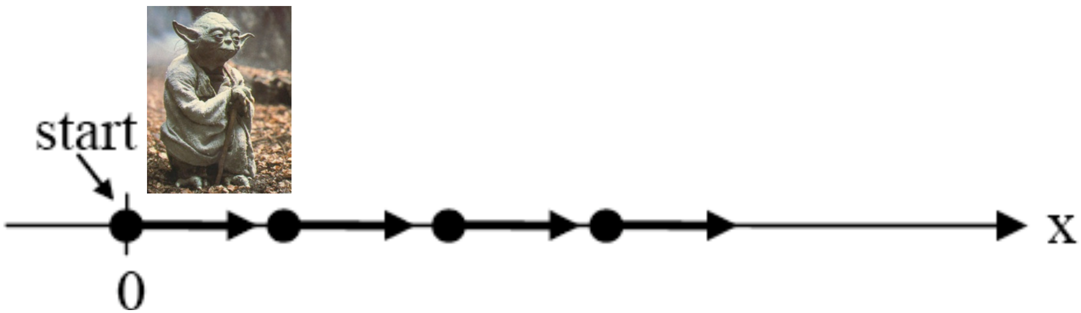


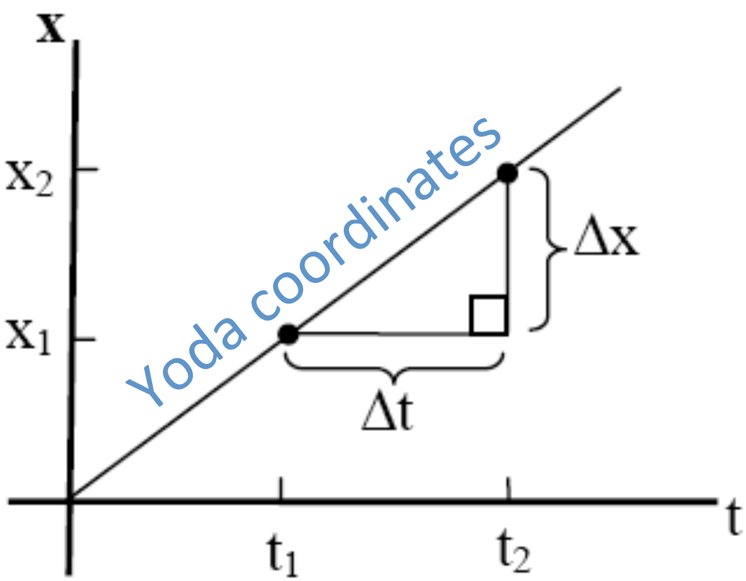




Graph of Position (x) versus Time (t)

Travel in the +x direction at a constant velocity v:





$$\text{slope} = \frac{\text{rise}}{\text{run}} = \cancel{\frac{\Delta y}{\Delta x}} = \frac{\Delta x}{\Delta t} = v$$

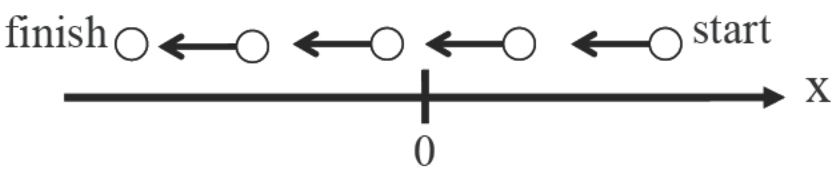
y-axis is x, x-axis is t .

If constant velocity → straight line on graph (constant slope)

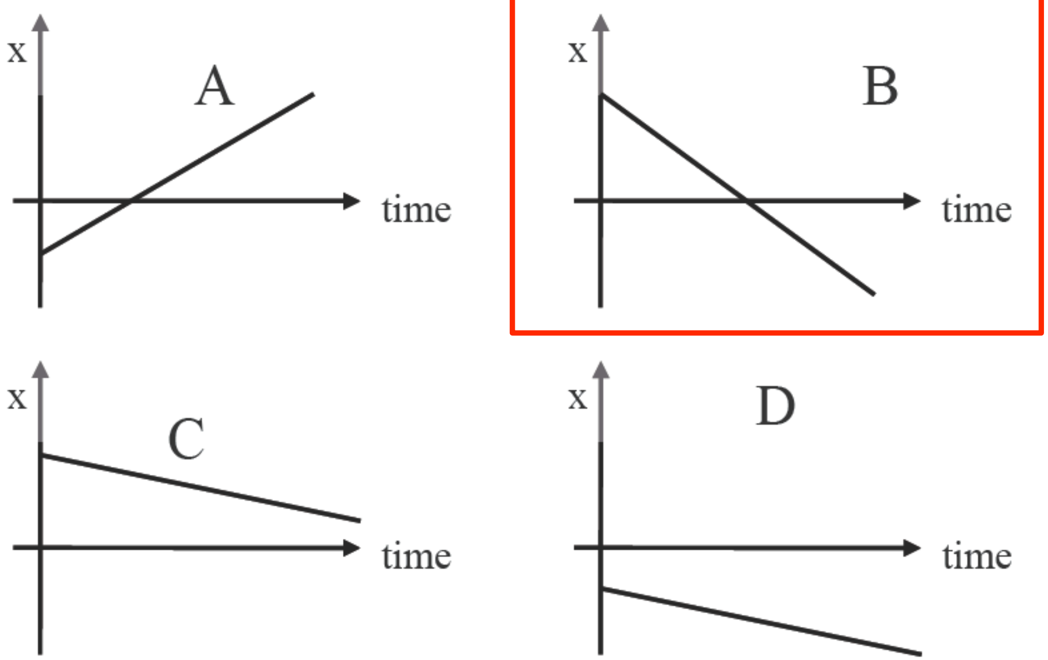
Clicker Question

Room Frequency BA

An object starts at x = +5 and moves left along the x-axis at a constant speed:



Which graph best represents this motion?



E: None of these!

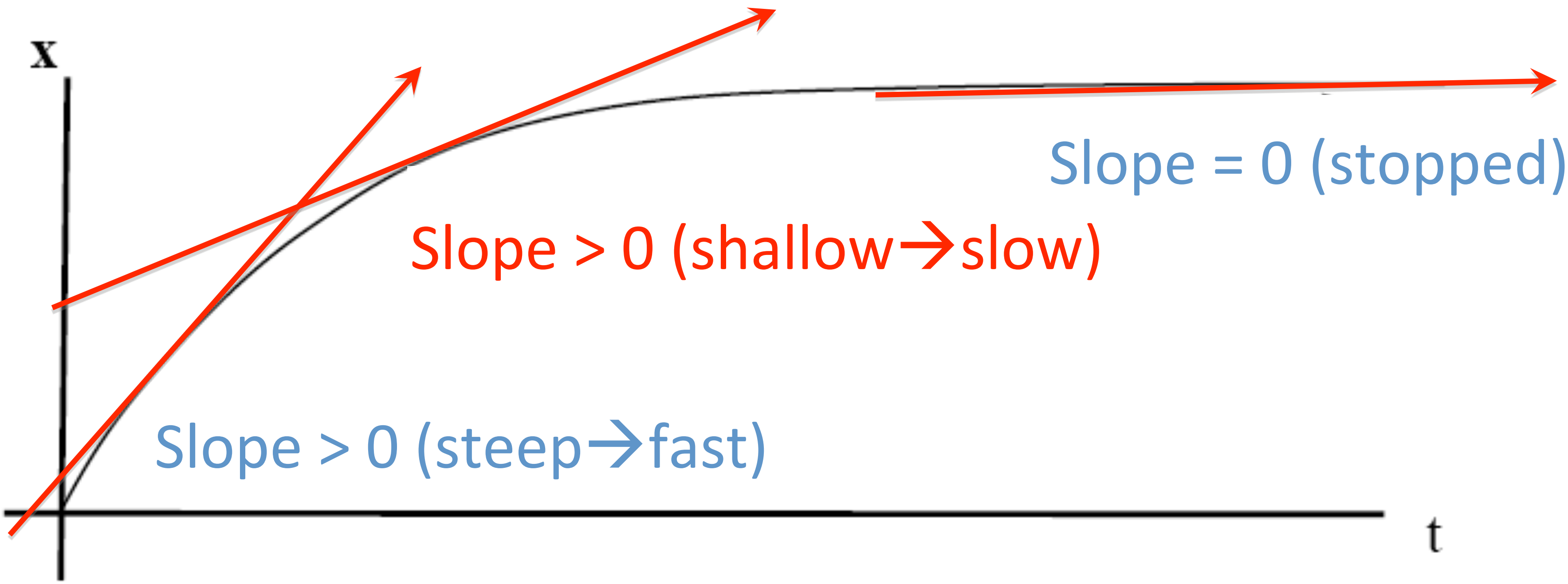
At time t = 0, the position x > 0.

Negative velocity gives negative slope.

At some time, position x < 0.

Graph of Position versus Time

Is Yoda moving at constant velocity?

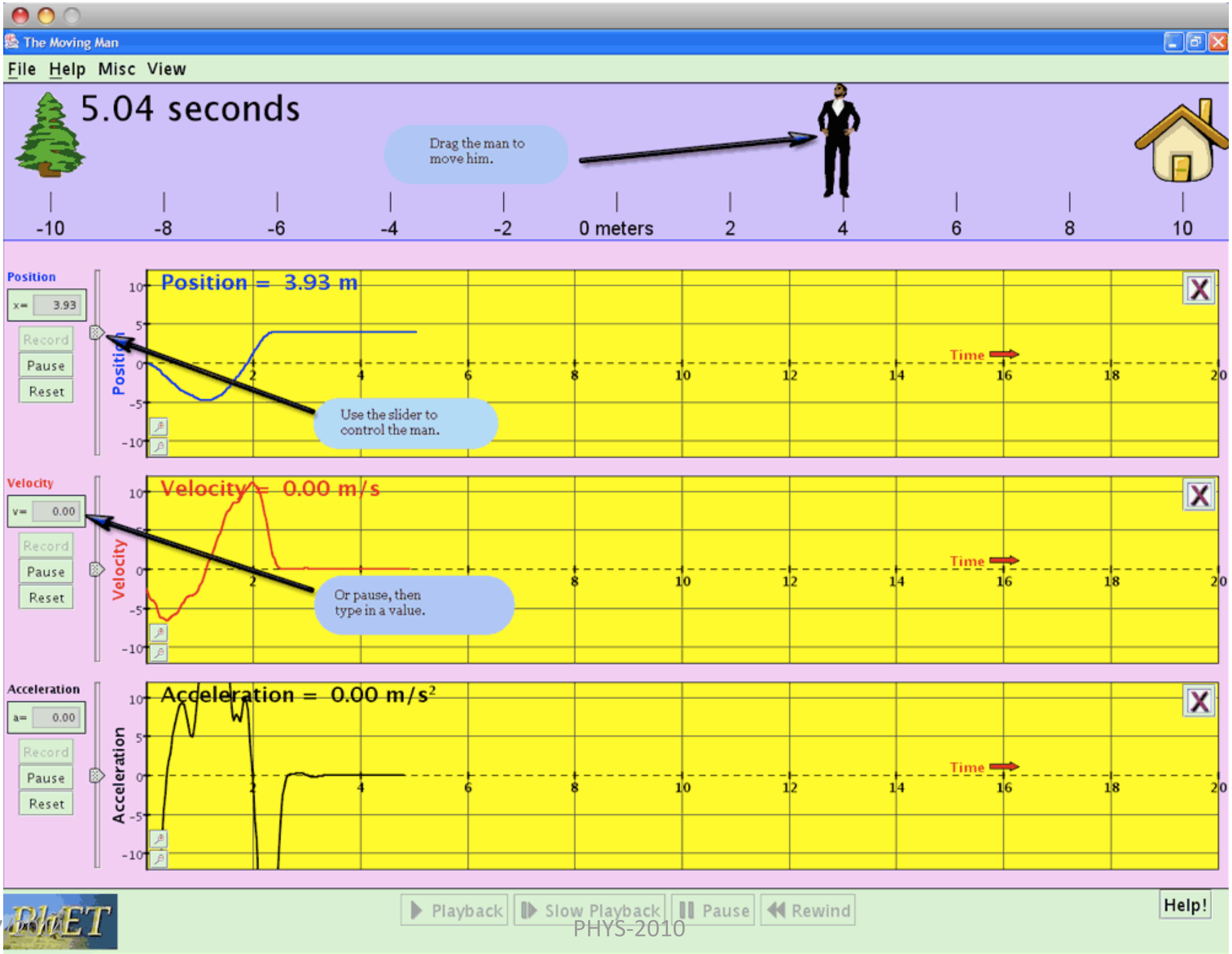


The instantaneous velocity is the slope of the line tangent to the *x* vs *t* curve at the point.

$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$$

“Moving Man” PhET Applet:

http://phet.colorado.edu/simulations/sims.php?sim=The_Moving_Man



REMINDERS:

- Complete your 1st CAPA assignment and upload the solutions on-line by 11 pm next Tuesday.
- Finish reading Chs. 1 & 2 by next class (Wed).
- To prepare for next week's Recitation, print out Recitation Assignment # 2 and bring it to your Recitation section.
- No lecture next Monday
- Next week's Wed, Fri lectures by Prof. Pollock