

PHYS 1441 – Section 002

Lecture #5

Wednesday, Sept. 9, 2009

Dr. Jaehoon Yu

- Acceleration
- Motion under constant acceleration
- One Dimensional Motion
- Kinematic Equations of Motion on a Straight Line
- Free Fall

Today's homework is homework #3, due 9pm, Tuesday, Sept. 15!!



Announcements

- E-mail distribution list: 68 of you have subscribed to the list so far
 - Test message was sent out yesterday!!
 - Thank you for responding ONLY to me.
 - If you haven't received my message or haven't subscribed to the list yet, please try subscribing to the list as soon as possible.
- Homework
 - 81 of you registered.
 - That still leaves 5 of you to register
 - If in doubt, come and check with me after the class
 - Common mistake in HW registration was registering to “Spring09”
- First non-comprehensive term exam on Wednesday, Sept. 23!!
 - In the class, 1 – 2:20pm
 - Covers Appendices A1 – A8 and CH1 – what we finish Wednesday, Sept. 16
 - There will be a review session Monday, Sept. 21 in the class
- Focus on faculty – Dr. De of physics department
 - Noon – 1pm, next Wednesday, Sept. 16
 - Double extra credit → Get his signature on the flier
- Physics Department colloquium today and tomorrow
 - Faculty research expo. → Extra credit points!! Be sure to sign in!!



Department of Physics

University of Texas - Arlington

Faculty Research Expo-I

Wednesday (9th Sept 2009)

Venue:

Time	Speaker	Title
4.00-4.10	Alexander Weiss	Development of Advance Methods of Surface Analysis Utilizing Positron Beams
4.10-4.20	Jaehoon Yu	Search for the Higgs Particle at LHC and Advanced Detector Development
4.20-4.30	Andy White	The International Linear Collider - beyond the LHC
4.30-4.40	Ramon E. Lopez	Solar Wind-Magnetosphere Coupling and Energy Transfer
4.40-4.50	Samar Mohanty	NanoBiophotonics
4.50-5.00	Manfred Cuntz	Research in Astrophysics & Astrobiology

Department of Physics
University of Texas - Arlington
Faculty Research Expo-II

Wednesday (10th Sept 2009)

Venue:

Time	Speaker	Title
3.30-3.40	<u>Nilakshi Veerabathina</u>	Serve-Teach-Learn: More than an Experiential Learning
3.40-3.50	<u>Qiming Zhang</u>	Searching for Affordable Solar-cell Materials: A Computational Study
3.50-4.00	<u>Wei Chen</u>	<u>Nanoparticle Based Photodynamic and Photothermal Therapies For Cancer</u>
4.00-4.10	<u>Yue Deng</u>	Energy input from magnetosphere to ionosphere/thermosphere
4.10-4.20	<u>Muhammad Huda</u>	<u>Materials Physics for Renewable Energy</u>
4.20-4.30	<u>Nail Fazleev</u>	Superconducting Ferromagnetic Hybrid structures
4.30-4.40	<u>Andrew Brandt</u>	A <u>Picosecond</u> Timing Window to the <u>the Higgs Boson</u>

Reminder: Special Problems for Extra Credit

- Derive the quadratic equation for $yx^2 - zx + v = 0$
→ 5 points
- Derive the kinematic equation $v^2 = v_0^2 + 2a(x - x_0)$
from first principles and the known kinematic
equations → 10 points
- You must **show your OWN work in detail** to obtain
the full credit
 - Must be in much more detail than on page 13 of this lecture note!!!
- Due Monday, Sept. 14



Which Planetarium Show for Extra Credit?

- Allowed shows:
 - Black Holes
 - Stars of the Pharaohs
 - Bad Astronomy
 - Unseen Universe: The Vision of SOFIA
 - IBEX: Search for the Edge of the Solar System
 - Two Small Pieces of Glass
- Must obtain signature and the date on the back of your ticket stubs from the presenter
- Collect the stubs and staple them on a sheet of paper
- Submit the sheet at the end of the semester



Displacement, Velocity and Speed

Displacement

$$\Delta x \equiv x_f - x_i$$

Average velocity

$$v_x \equiv \frac{x_f - x_i}{t_f - t_i} = \frac{\Delta x}{\Delta t}$$

Average speed

$$v \equiv \frac{\text{Total Distance Traveled}}{\text{Total Time Spent}}$$

Instantaneous velocity

$$v_x = \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t}$$

Instantaneous speed

$$|v_x| = \left| \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t} \right|$$



Acceleration

Change of velocity in time (what kind of quantity is this?)

• Average acceleration:

Vector!

$$a_x \equiv \frac{v_{xf} - v_{xi}}{t_f - t_i} = \frac{\Delta v_x}{\Delta t} \quad \text{analogous to} \quad v_x \equiv \frac{x_f - x_i}{t_f - t_i} = \frac{\Delta x}{\Delta t}$$

Dimension?

[LT⁻²]

Unit?

m/s²

• Instantaneous acceleration: Average acceleration over a very short amount of time.

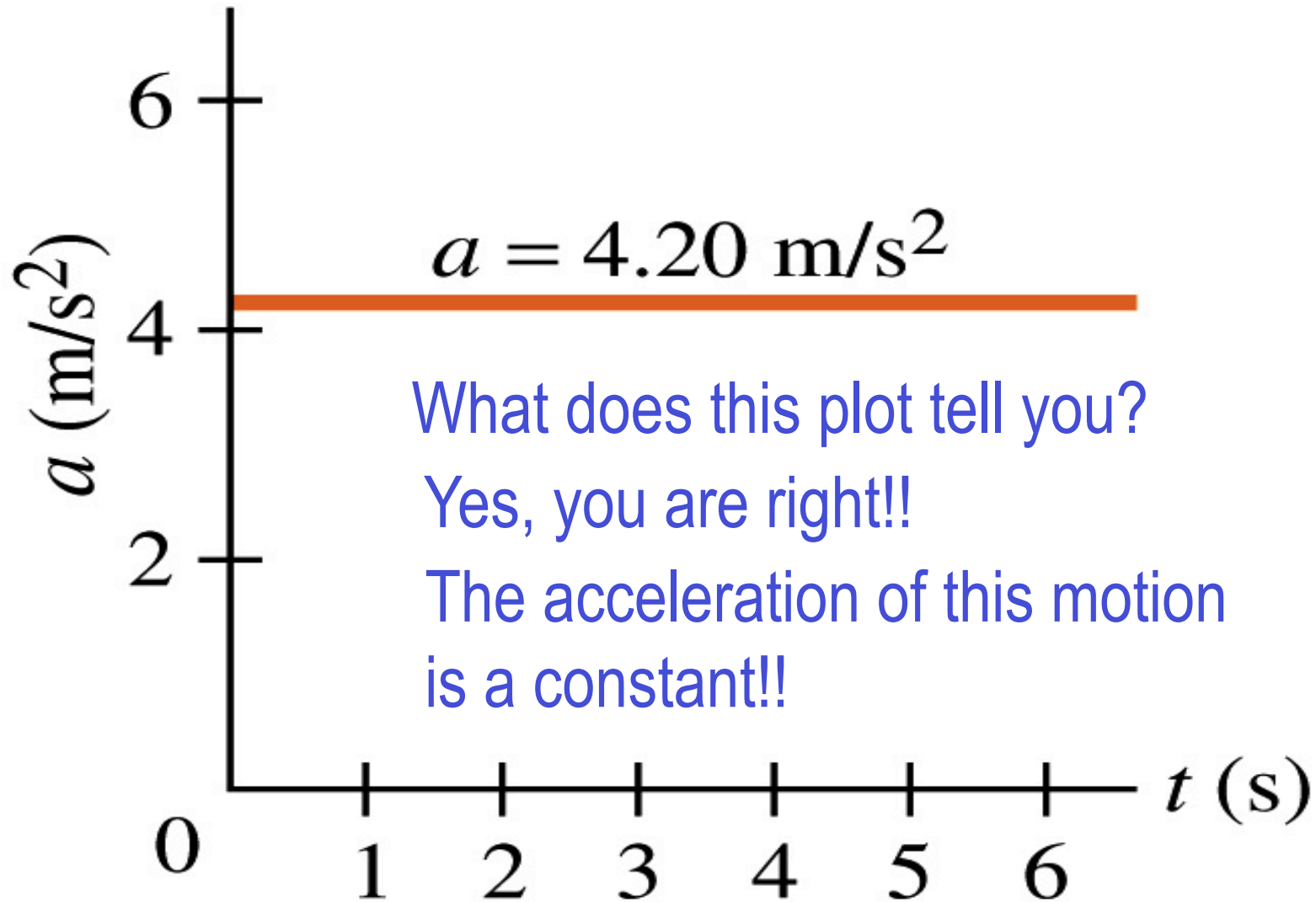
$$a_x \equiv \lim_{\Delta t \rightarrow 0} \frac{\Delta v_x}{\Delta t}$$

analogous to

$$v_x \equiv \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t}$$

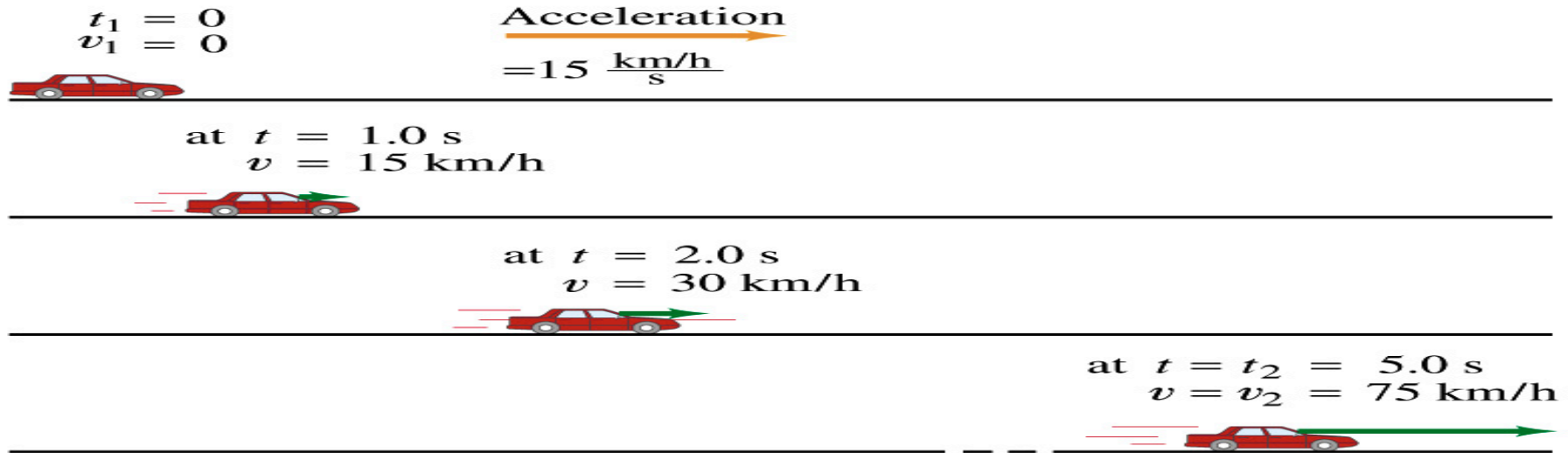


Acceleration vs Time Plot



Example 2.3

A car accelerates along a straight road from rest to 75km/h in 5.0s.



What is the magnitude of its average acceleration?

$$v_{xi} = 0 \text{ m/s}$$

$$v_{xf} = \frac{75000 \text{ m}}{3600 \text{ s}} = 21 \text{ m/s}$$

$$a_x = \frac{v_{xf} - v_{xi}}{t_f - t_i} = \frac{\Delta v_x}{\Delta t} = \frac{21 - 0}{5.0} = \frac{21}{5.0} = 4.2 (\text{m/s}^2)$$

$$= \frac{4.2 \times (3600)^2}{1000} = 5.4 \times 10^4 (\text{km/h}^2)$$

Few Confusing Things on Acceleration

- When an object is moving in a constant velocity ($v=v_0$), there is no acceleration ($a=0$)
 - Is there any acceleration when an object is not moving?
- When an object is moving faster as time goes on, ($v=v(t)$), acceleration is positive ($a>0$).
 - Incorrect, since the object might be moving in negative direction initially
- When an object is moving slower as time goes on, ($v=v(t)$), acceleration is negative ($a<0$)
 - Incorrect, since the object might be moving in negative direction initially
- In all cases, velocity is positive, unless the direction of the movement changes.
 - Incorrect, since the object might be moving in negative direction initially
- Is there acceleration if an object moves in a constant speed but changes direction?

The answer is YES!!



One Dimensional Motion

- Let's focus on the simplest case: acceleration is a constant ($a=a_0$)
- Using the definitions of average acceleration and velocity, we can derive equations of motion (description of motion, velocity and position as a function of time)

$$\bar{a}_x = a_x = \frac{v_{xf} - v_{xi}}{t_f - t_i} \quad (\text{If } t_f=t \text{ and } t_i=0) \quad a_x = \frac{v_{xf} - v_{xi}}{t} \quad \Rightarrow \quad v_{xf} = v_{xi} + a_x t$$

For constant acceleration, average velocity is a simple numeric average

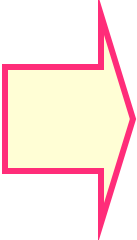
$$\bar{v}_x = \frac{v_{xi} + v_{xf}}{2} = \frac{2v_{xi} + a_x t}{2} = v_{xi} + \frac{1}{2} a_x t$$


$$\bar{v}_x = \frac{x_f - x_i}{t_f - t_i} \quad (\text{If } t_f=t \text{ and } t_i=0) \quad \bar{v}_x = \frac{x_f - x_i}{t} \quad \Rightarrow \quad x_f = x_i + \bar{v}_x t$$

Resulting Equation of Motion becomes

$$x_f = x_i + \bar{v}_x t = x_i + v_{xi} t + \frac{1}{2} a_x t^2$$

One Dimensional Motion cont'd

Average velocity $\bar{v}_x = \frac{v_{xi} + v_{xf}}{2}$  $x_f = x_i + \bar{v}_x t = x_i + \left(\frac{v_{xi} + v_{xf}}{2} \right) t$

Since $a_x = \frac{v_{xf} - v_{xi}}{t}$  $t = \frac{v_{xf} - v_{xi}}{a_x}$

Substituting t in the above equation,

$$x_f = x_i + \left(\frac{v_{xf} + v_{xi}}{2} \right) \left(\frac{v_{xf} - v_{xi}}{a_x} \right) = x_i + \frac{v_{xf}^2 - v_{xi}^2}{2a_x}$$

Resulting in $v_{xf}^2 = v_{xi}^2 + 2a_x (x_f - x_i)$

Kinematic Equations of Motion on a Straight Line Under Constant Acceleration

$$v_{xf}(t) = v_{xi} + a_x t$$

Velocity as a function of time

$$x_f - x_i = \frac{1}{2} \bar{v}_x t = \frac{1}{2} (v_{xf} + v_{xi}) t$$

Displacement as a function of velocities and time

$$x_f = x_i + v_{xi} t + \frac{1}{2} a_x t^2$$

Displacement as a function of time, velocity, and acceleration

$$v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i)$$

Velocity as a function of Displacement and acceleration

You may use different forms of Kinetic equations, depending on the information given to you for specific physical problems!!

