PHYS 1443 – Section 002
Lecture #3

Wednesday, September 3, 2008
Dr. Jaehoon Yu

- Dimensions and Dimensional Analysis
- Fundamentals of kinematics
- One Dimensional Motion
- Displacement
- Speed and Velocity
- Acceleration
- Motion under constant acceleration

Today's homework is homework #2, due 9pm, Monday, Sept. 8!!

Announcements

- Homework
  - 58 out of 68 registered so far.
  - Still have trouble w/ UT e-ID?
    - Check out https://hw.utexas.edu/bur/commonProblems.html
  - 25% of the total. So it is very important for you to set this up ASAP!!!
- 49 out of 68 subscribed to the class e-mail list
  - 3 point extra credit if done by midnight today, Wednesday, Sept. 3
  - Will send out a test message tomorrow, Thursday, for confirmation
  - Please reply only to me NOT to all!!
- Physics Department colloquium schedule at
  - http://www.uta.edu/physics/main/phys_news/colloquia/2008/Fall2008.html
  - Today's topic is Nanostructure Fabrication
- The first term exam is to be on Wednesday, Sept. 17
  - Will cover CH1 – what we finish on Monday, Sept. 15 + Appendices A and B
  - Mixture of multiple choices and essay problems
  - Jason will conduct a review in the class Monday, Sept. 15

Physics Department
The University of Texas at Arlington
COLLOQUIUM

Nanostructures Fabricated by Glancing Angle Deposition and Their Novel Applications

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Wednesday, September 3, 2008 at 4:00 pm in Room 101 SH

Abstract

Glancing Angle Deposition (GLAD) is a simple nanofabrication technique that combines oblique angle deposition (OAD) with substrate manipulations and source controls in a physical vapor deposition system. The geometry shadowing effect is the dominant growth mechanism resulting in the formation of various nanostructure arrays by programming the substrate rotation in polar and/or azimuthal direction. With recent advance in a multilayer deposition procedure, one can design complex and multifunctional heterogeneous nanostructures. In addition, with a co-deposition system of two or more sources, novel nanocomposites or doped nanostructure arrays can be produced, which results in nanostructures with different morphology. In this talk, I will highlight our recent progress in multi-component nanorod array fabrication. We find that the multicomponent nanorods can be used as a high sensitive virus and bacteria sensor base on florescence enhancement. Using a unique multilayer deposition configuration, catalytically driven nanomotors have also been fabricated and demonstrated, which can directly convert chemical energy into mechanical energy. This device holds a great promising to mimic biological motors.

Refreshments will be served in the Physics Lounge at 3:30 pm

Dimension and Dimensional Analysis

- An extremely useful concept in solving physical problems
- Good to write physical laws in mathematical expressions
- No matter what units are used the base quantities are the same
  - *Length* (distance) is length whether meter or inch is used to express the size: Usually denoted as *[L]*
  - The same is true for *Mass ([M])* and *Time ([T])*
  - One can say "Dimension of Length, Mass or Time"
  - Dimensions are treated as algebraic quantities: Can perform two algebraic operations; multiplication or division

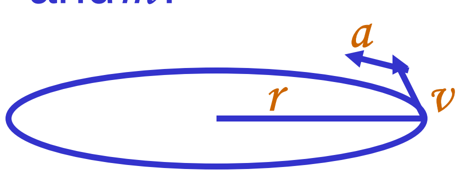
Dimension and Dimensional Analysis

- One can use dimensions only to check the validity of one's expression: Dimensional analysis
  - Eg: Speed $[v] = [L]/[T]=[L][T^{-1}]$
    - *Distance (L) traveled by a car running at the speed V in time T*
      - $L = V*T = [L/T]*[T]=[L]$
- More general expression of dimensional analysis is using exponents: eg. $[v]=[L^n T^m] =[L][T^{-1}]$ *where n = 1 and m = -1*

Examples

- Show that the expression *[v] = [at]* is dimensionally correct
  - Speed: *[v]* =[L]/[T]
  - Acceleration: *[a]* =[L]/[T]^2
  - Thus, *[at]* = (L/T^2)xT=LT$^{(-2+1)}$ =LT^{-1} =[L]/[T]= *[v]*

•Suppose the acceleration a of a circularly moving particle with speed v and radius r is proportional to r^n and v^m. What are n and m?



$$a = kr^n v^m$$

Dimensionless constant

Length

Speed

$$L^1T^{-2} = (L)^n\left(\frac{L}{T}\right)^m = L^{n+m}T^{-m}$$

$$-m = -2 \Rightarrow m = 2$$

$$n + m = n + 2 \equiv 1 \Rightarrow n = -1$$

$$a = kr^{-1}v^2 = \frac{v^2}{r}$$

Some Fundamentals

- Kinematics: Description of Motion without understanding the cause of the motion
- Dynamics: Description of motion accompanied with understanding the cause of the motion
- Vector and Scalar quantities:
  - Scalar: Physical quantities that require magnitude but no direction
    - Speed, length, mass, height, volume, area, magnitude of a vector quantity, etc
  - Vector: Physical quantities that require both magnitude and direction
    - Velocity, Acceleration, Force, Momentum
    - It does not make sense to say "I ran with velocity of 10miles/hour."
- Objects can be treated as point-like if their sizes are smaller than the scale in the problem
  - Earth can be treated as a point like object (or a particle)in celestial problems
    - Simplification of the problem (The first step in setting up to solve a problem…)
  - Any other examples?

Some More Fundamentals

- Motions:Can be described as long as the position is known at any given time (or position is expressed as a function of time)
  - Translation: Linear motion along a line
  - Rotation: Circular or elliptical motion
  - Vibration: Oscillation
- Dimensions
  - 0 dimension: A point
  - 1 dimension: Linear drag of a point, resulting in a line ➔ Motion in one-dimension is a motion on a line
  - 2 dimension: Linear drag of a line resulting in a surface
  - 3 dimension: Perpendicular Linear drag of a surface, resulting in a stereo object

Displacement, Velocity and Speed

One dimensional displacement is defined as:

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

Displacement is the difference between initial and final positions of motion and is a vector quantity. How is this different than distance?

Average velocity is defined as:

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

Displacement per unit time in the period throughout the motion

Average speed is defined as:

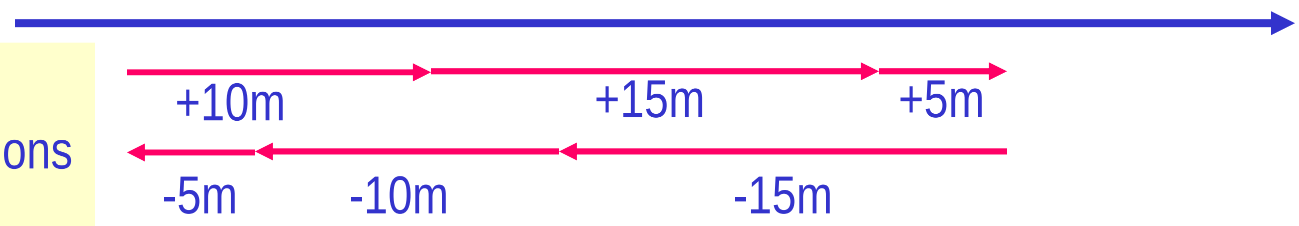
$$v \equiv \frac{\text{Total Distance Traveled}}{\text{Total Time Spent}}$$

Can someone tell me what the difference between speed and velocity is?

Difference between Speed and Velocity

- Let's take a simple one dimensional translation that has many steps:

Let's call this line as X-axis



Let's have a couple of motions in a total time interval of 20 sec.

Total Displacement: $\Delta x \equiv x_f - x_i = x_i - x_i = 0(m)$

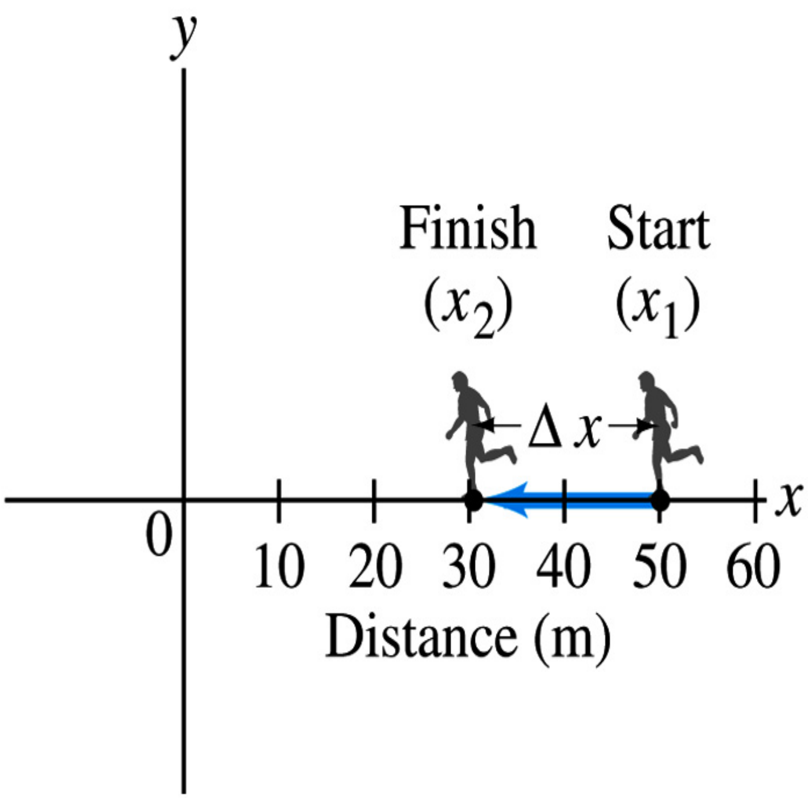
Average Velocity: $v_x \equiv \frac{x_f - x_i}{t_f - t_i} = \frac{\Delta x}{\Delta t} = \frac{0}{20} = 0(m/s)$

Total Distance Traveled: $D = 10 + 15 + 5 + 15 + 10 + 5 = 60(m)$

Average Speed: $v \equiv \frac{\text{Total Distance Traveled}}{\text{Total Time Interval}} = \frac{60}{20} = 3(m/s)$

Example 2.1

The position of a runner as a function of time is plotted as moving along the x axis of a coordinate system. During a 3.00-s time interval, the runner's position changes from x_1=50.0m to x_2=30.5 m, as shown in the figure. What was the runner's average velocity? What was the average speed?



- Displacement:

$$\Delta x \equiv x_f - x_i = x_2 - x_1 = 30.5 - 50.0 = -19.5(m)$$

- Average Velocity:

$$v_x \equiv \frac{x_f - x_i}{t_f - t_i} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{\Delta x}{\Delta t} = \frac{-19.5}{3.00} = -6.50(m/s)$$

- Average Speed:

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

$$= \frac{50.0 - 30.5}{3.00} = \frac{+19.5}{3.00} = +6.50(m/s)$$