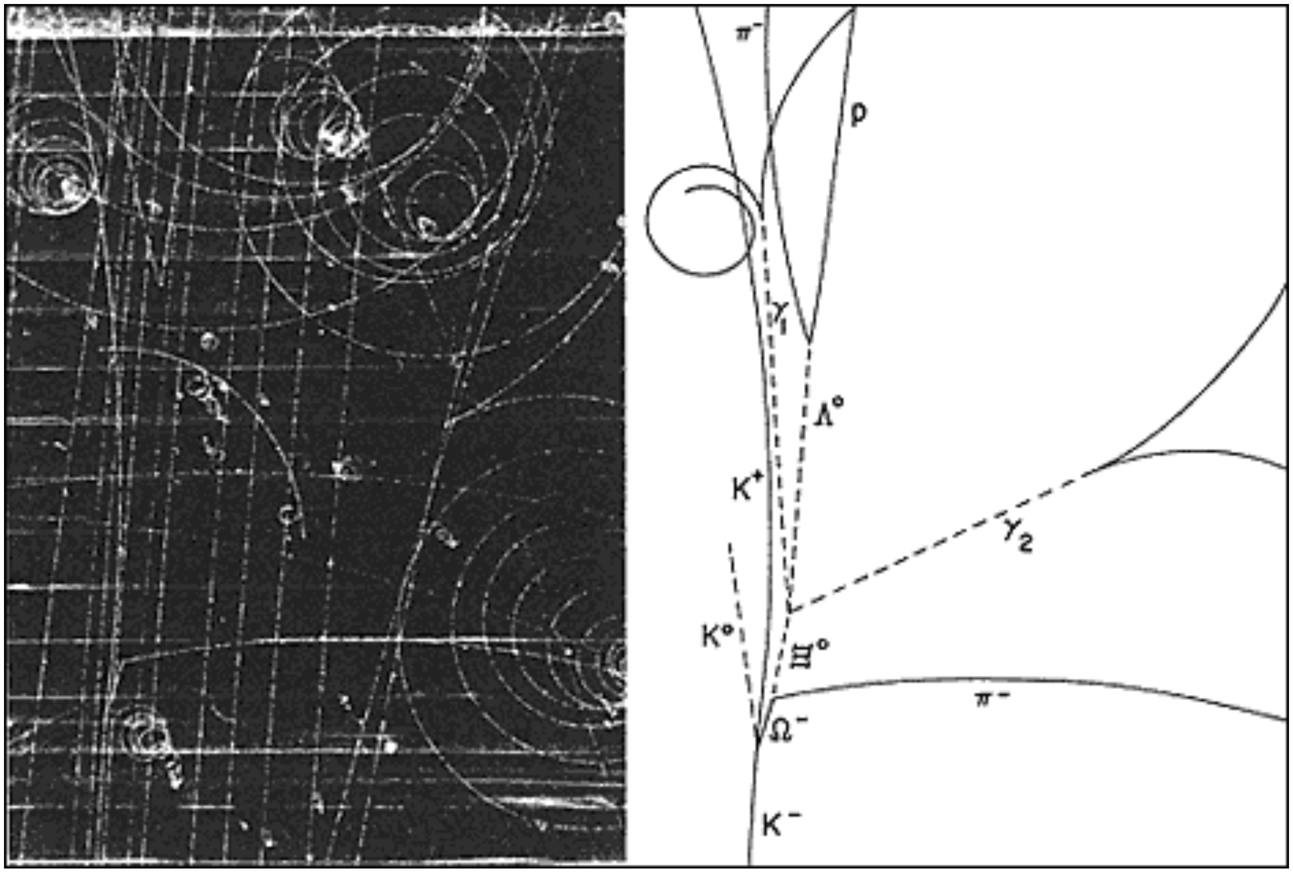
Physics 121.
Tuesday January 22, 2008.



Credit: Brookhaven National Laboratory, NY, USA
http://www.bnl.gov/bnlweb/history/Omega-minus.asp

The bubble chamber picture of the first omega-minus. An incoming K^- meson interacts with a proton in the liquid hydrogen of the bubble chamber and produces an omega-minus, a K_0 and a K^+ meson which all decay into other particles. Neutral particles which produce no tracks in the chamber are shown by dashed lines. The presence and properties of the neutral particles are established by analysis of the tracks of their charged decay products and application of the laws of conservation of mass and energy.

Physics 121.
Tuesday January 22, 2008.

- Today's topics:
  - Physics 121 website, and homework
  - Introduction to PRS
  - Chapter 2: Describing One Dimensional Motion:
    - Position
    - Velocity
    - Acceleration

Physics 121.
Course Information.

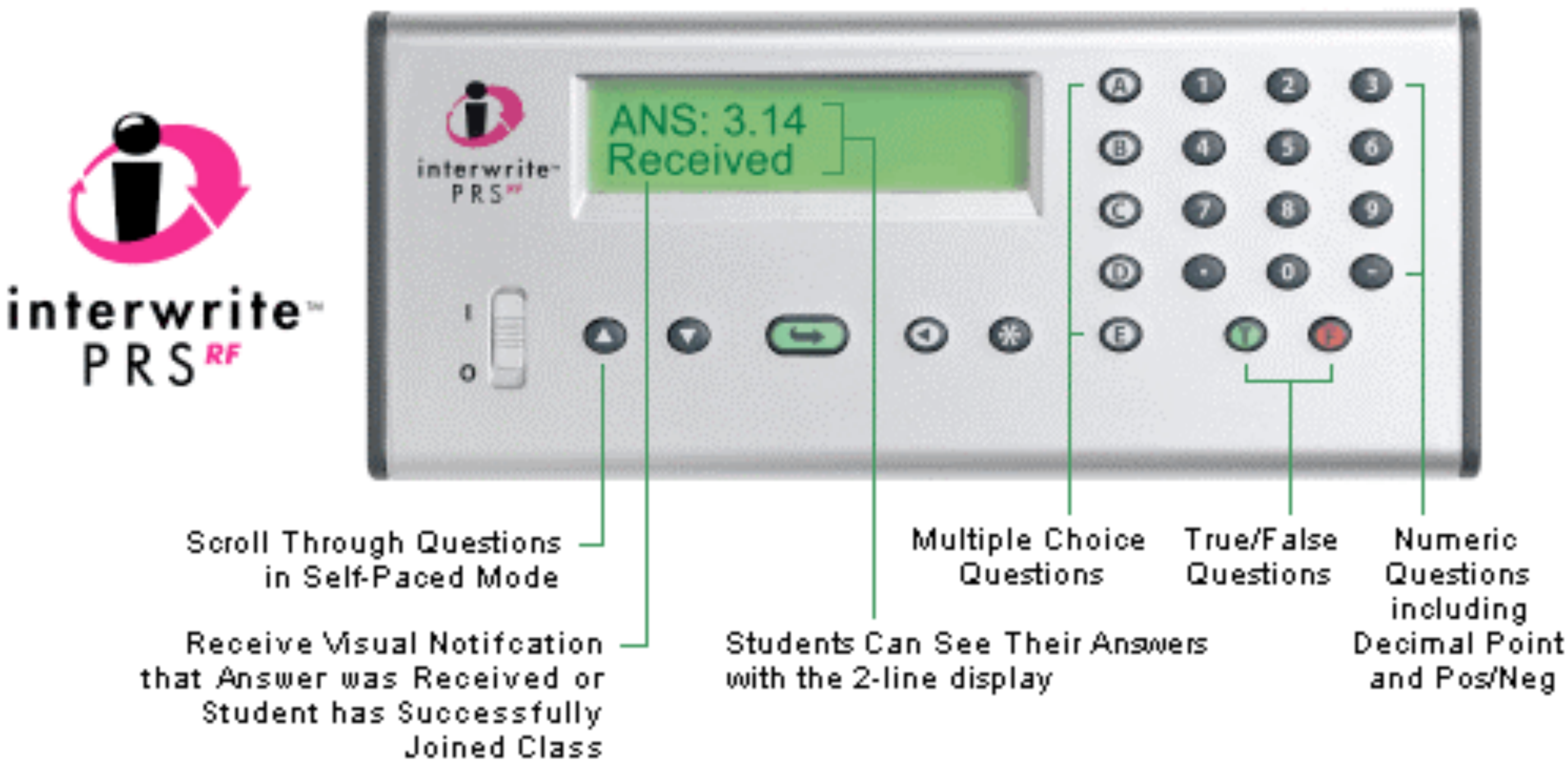
- Our web site provides up-to-date course information:
  - All course handouts are posted in pdf format on our web site.
  - The web site contains links to workshop and laboratory information.
  - The web site contains a link to our homework system and homework solutions (the solutions are password protected).
  - The web site contains links to practice exams and their solutions.
  - All lecture presentations, including audio recordings, will be available on the web site shortly before or after class.

http://teacher.pas.rochester.edu/phy121/Phy121HomePage.html

Physics 121.
Course Information.

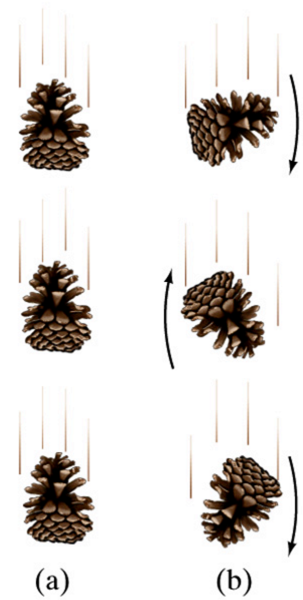
- Additional comments:
  - Homework set # 0 is now available; it is due on Saturday 1/26 at 8.30 am. This set is to make you familiar with WeBWorK and does not count toward your final grade. Make sure you verify that you can log in to WeBWorK.
  - Homework set # 1 will be available later this week and is due on Saturday 2/2 at 8.30 am. This set will be the first set that counts towards your final grade.

Introduction to the Personal Response System (PRS).



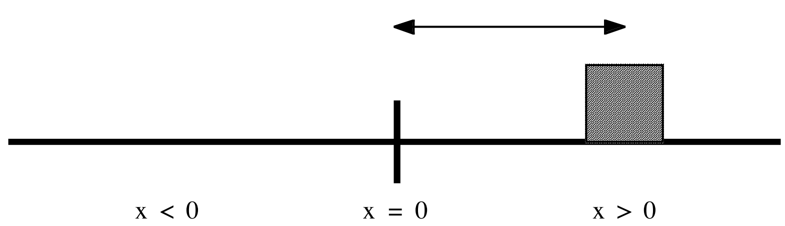
Describing motion in one dimension.

- There are different ways in which we can describe the motion of an object.
- In Chapter 2 we will focus on describing motion along a straight line, or one-dimensional motion.
- The direction of motion is not limited to the horizontal direction, but for example can also be in the vertical direction (e.g. free fall).
- One dimensional motion can be simply translational but may also include rotational motion.



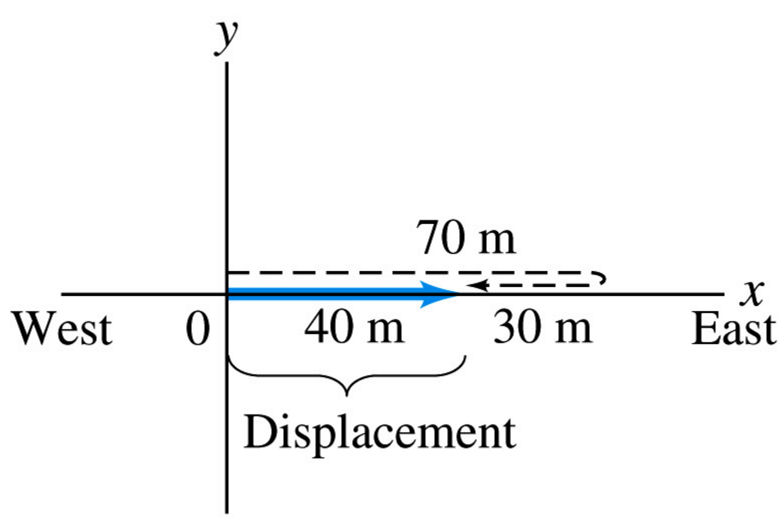
Describing motion in one dimension.

- When we limit ourselves to pure translational motion, we in general can describe the motion in terms of three parameters:
  - The position $x(t)$: units m.
  - The velocity $v(t)$: units m/s.
  - The acceleration $a(t)$: units m/s^2.
- To specify the position x of an object we need to define the origin (the point where $x = 0$ m) of our coordinate system.



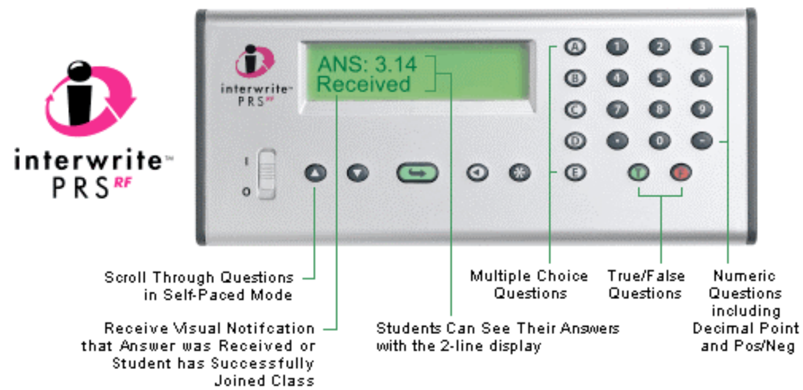
Position.

- Two terms often confused in in describing the motion of an object are:
  - **Distance traveled**: the total distance the object moved during the motion from its starting point to its end point. Note: depends on the exact path followed and is always positive.
  - **Displacement**: the change in the position of an object. Note: depends only on its starting point and its end point.



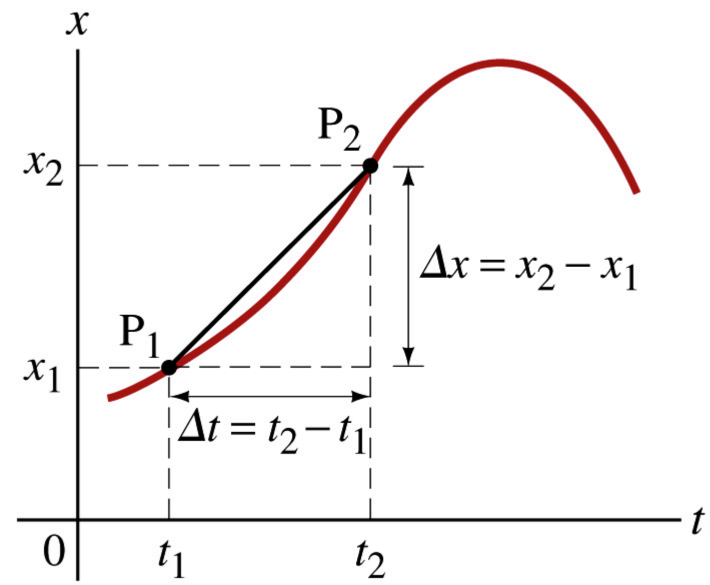
Position.

- Do we understand position versus time graphs and do we really understand the difference between distance traveled and displacement?
- Let's see: Concept Tests 2.1 and 2.2.



Velocity.

- All information about the motion of an object is in principle contained in the time dependence of its position $x(t)$.
- Often it is useful to talk about the velocity v of the object, which is defined as the ratio of the change in position, Δx, and the change in time Δt.
- The velocity calculated in this manner is the average velocity over the time interval Δt.

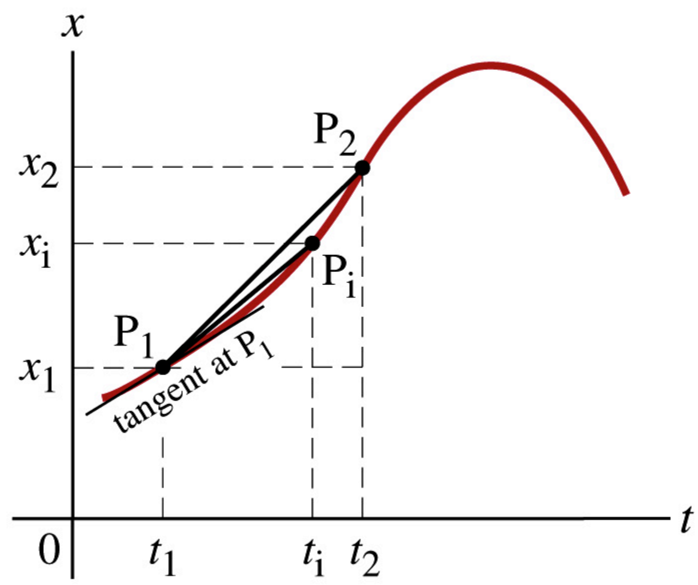


Velocity.

- Some remarks about velocity:
  - Velocity can be positive and negative. In our choice of coordinate system, a positive velocity corresponds to motion towards the right, and negative velocity corresponds to motion towards the left.
  - The sign of the velocity is does not depend on the sign of the position.
  - The speed and velocity of an object are often confused. The speed of an objective is the magnitude of the velocity of the object. It is thus always positive!

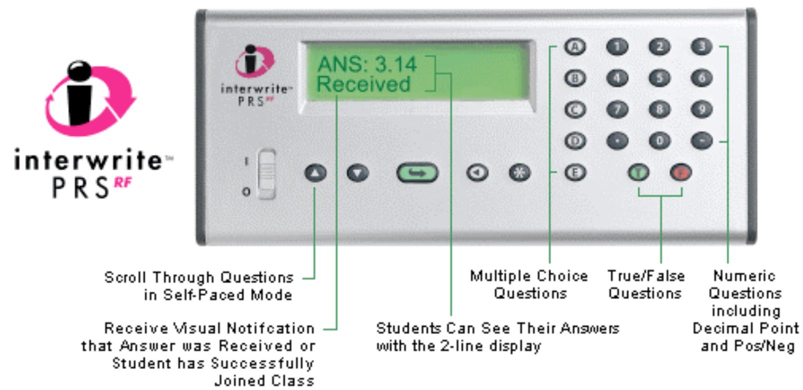
Velocity.

- When the time interval Δt decreases, the average velocity approaches the instantaneous velocity.
- The velocity of the object is related to the slope of the position versus time graph:
  - A positive slope correspond to a positive velocity; a negative slope corresponds to a negative velocity.
  - When the slope increases, the velocity increases..



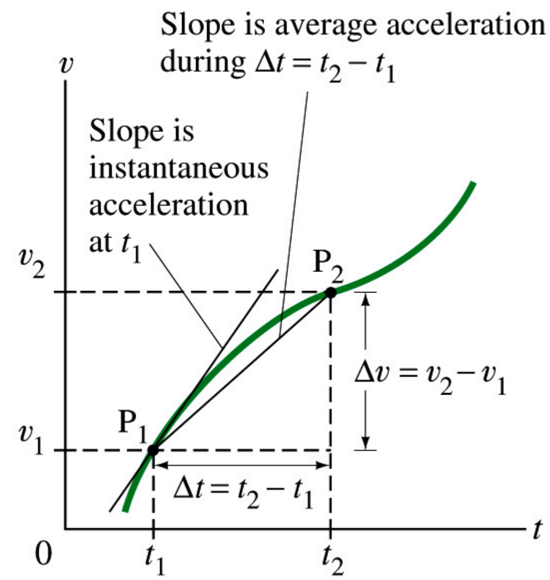
Velocity.

- Understanding velocity. Do you get it?
  - Concept Tests 2.3, 2.6, and 2.7



Acceleration.

- The acceleration of an object is defined at the ratio of the change of the velocity of an object, Δv, and the change in time Δt.
- The acceleration calculated in this manner is the average acceleration over the time interval Δt.
- The acceleration can be positive or negative depending on whether $\Delta v > 0$ m/s or $\Delta v < 0$ m/s.



Acceleration.

- Some remarks about acceleration:
  - Acceleration can be positive and negative.
  - In our every day life, we often use the term **acceleration** when we speed up and **deceleration** when we slow down. This leads to the assumption that a positive acceleration implies an increase in speed while a negative acceleration corresponds to a decrease in speed. **THIS IS ABSOLUTELY WRONG!!!!!!!!!**
  - Negative acceleration implies that $\Delta v < 0$ m/s. This can be achieved in a number of different ways:
    - If $v_1 = 30$ m/s and $v_2 = 10$ m/s: a reduction in speed!
    - If $v_1 = -10$ m/s and $v_2 = -30$ m/s: an increase in speed!

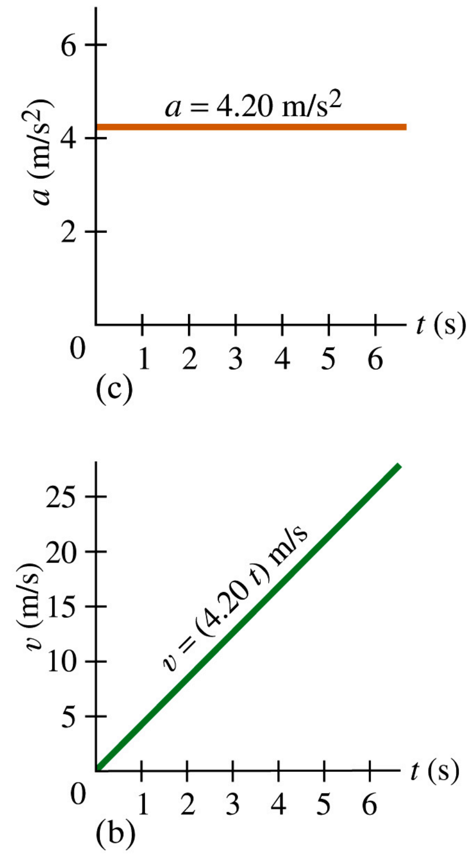
Constant acceleration.

- Many important physics effects involve motion with constant acceleration.
- Constant acceleration implies that

$$a = \frac{dv}{dt} = \text{constant}$$

- In this case, the velocity will have a linear dependence on time:

$$v(t) = v_0 + a\,t$$



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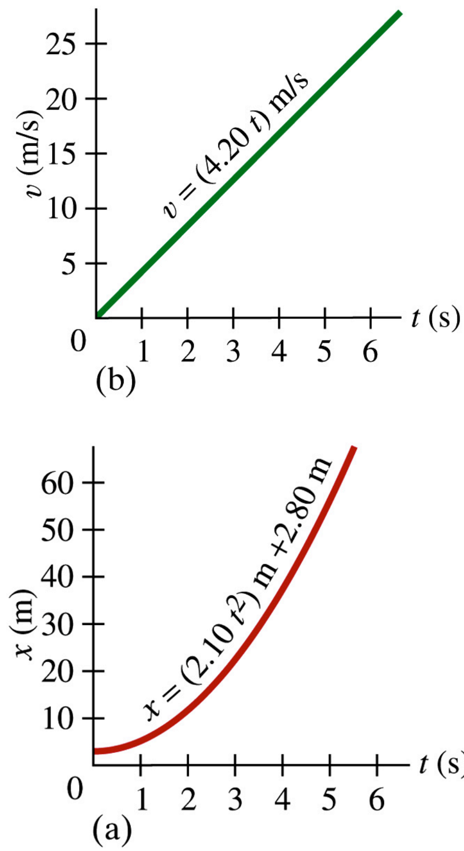
Constant acceleration.

- When the velocity of an object has a linear dependence on *t*, the position of the object will have a quadratic dependence on *t*:

$$x(t) = x_0 + v_0 t + \frac{1}{2} a t^2$$

- An important case of constant acceleration, is the vertical motion of objects under the influence of the gravitational force.



Constant acceleration.

- In order to fully define the motion of an object if we know the acceleration, we need to have more information:
  - We need to know v_0, which is the velocity of the object at time $t = 0$ s.
  - We need to know x_0, which is the position of the object at time $t = 0$ s.
- Make sure the signs are consistent!

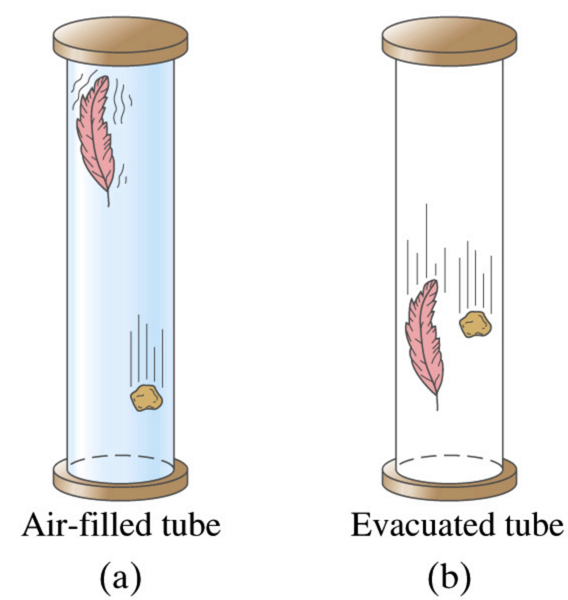
$$a = \frac{dv}{dt} = \text{constant}$$

$$v(t) = v_0 + a\,t$$

$$x(t) = x_0 + v_0\,t + \frac{1}{2}\,a\,t^2$$

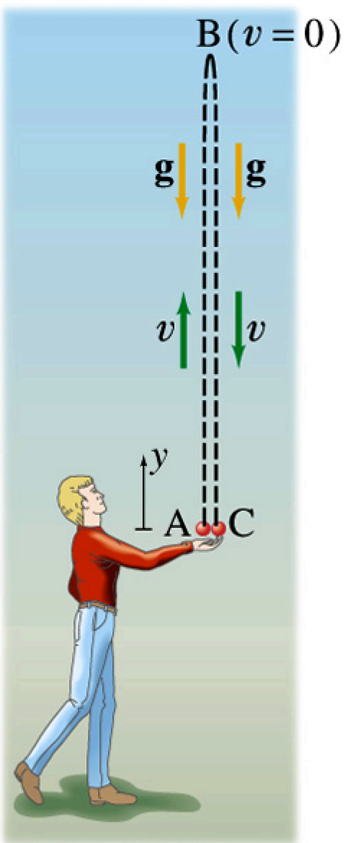
Constant gravitational acceleration.

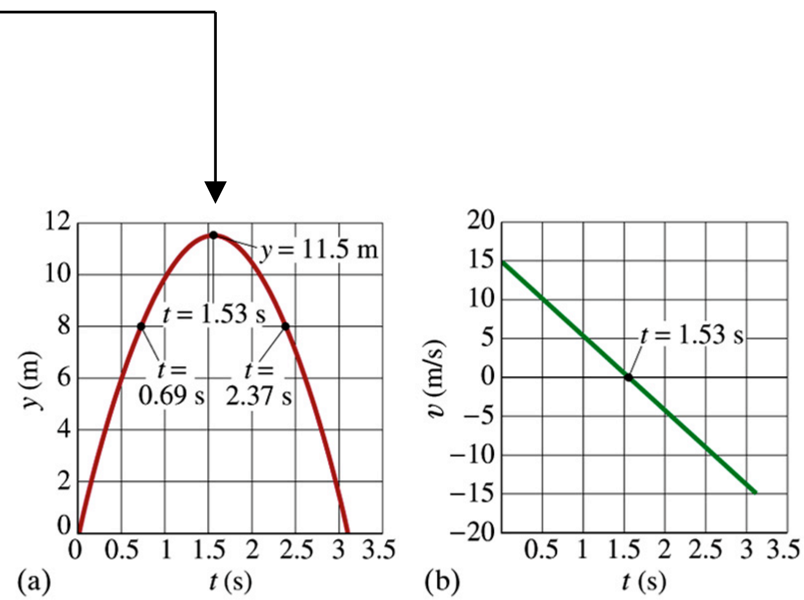
- Objects moving in the vertical direction close to the surface of the earth experience a constant gravitational acceleration due to the gravitational force between the earth and the object.
- In the absence of other forces, such as the drag force due to the air, all objects will experience the same acceleration, independent of their mass or shape.
- The gravitational acceleration is $g = -9.8$ m/s^2. The minus sign indicated that the acceleration is directed downwards.



Note: many people set $g = 9.8$ m/s^2 and then use -g to represent the gravitational acceleration.

Constant gravitational acceleration.





Note: velocity and acceleration do not have to be directed in the same direction!

Measuring the gravitational acceleration.

- There are many different ways in which we can measure the gravitational acceleration. In order to describe vertical motion we usually use *y* coordinates.
- Let's consider an object falling from rest, from the origin of our coordinate system.
- The initial conditions are such that $v_0 = 0$ m/s and $y_0 = 0$ m.
- We conclude that y/t^2 equals $g/2$ and measuring the time required to fall a distance *y* allows us to calculate *g*. Let's do it!

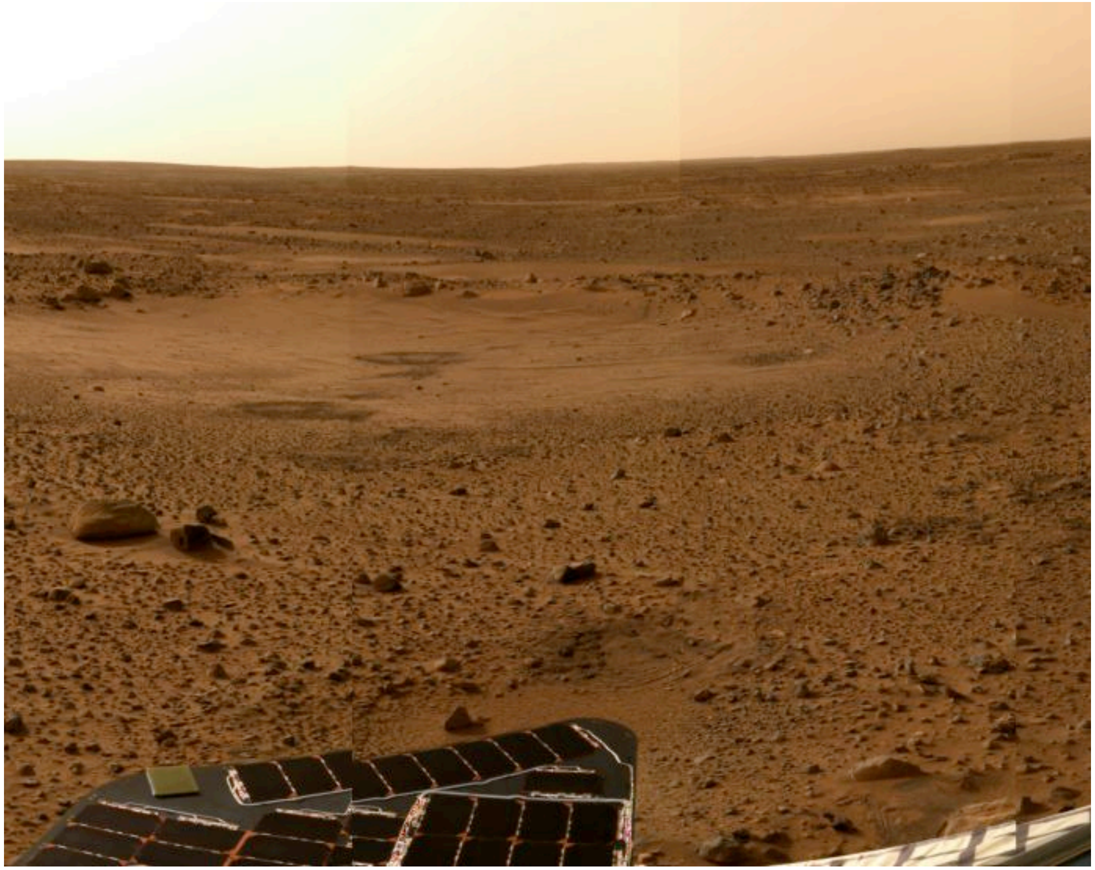
$$a = \frac{dv}{dt} = -g$$

$$v(t) = v_0 - g\,t$$

$$y(t) = y_0 + v_0\,t - \frac{1}{2}g\,t^2$$

Note: in this format, *g* is assumed to be the magnitude of the gravitational acceleration.

We are done for today!
Please review Chapter 3 before the next class.



Sol 5 Postcard from Mars
Credit: Mars Exploration Rover Mission, JPL, NASA