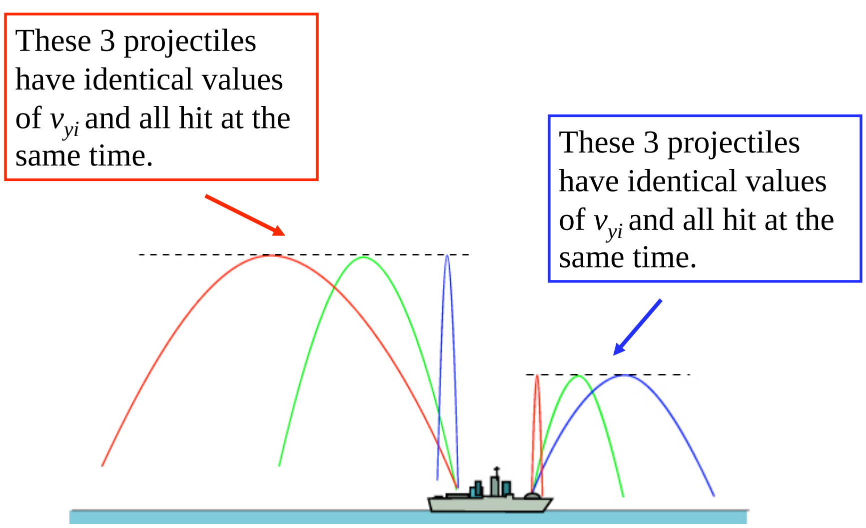
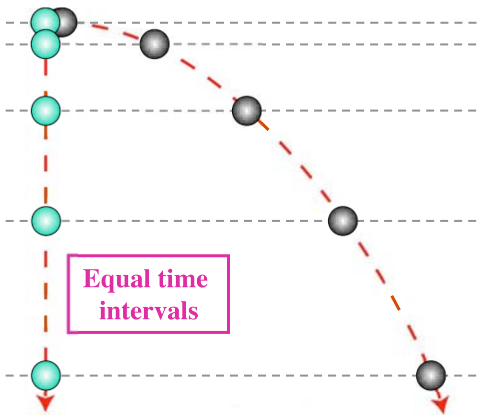
Announcements 27 Feb 09

- **Homework #4**
  - Written homework due now
  - Online homework due on Tue Mar 3 by 8 am
- **Exam 1**
  - *Answer keys and scores will be posted by end of the week*
- **Supplemental Instruction sessions next week**
  - *Wednesday 8:45 – 10:00 pm DuBois 10th floor*
  - *Thursday 4:15 – 5:30 pm (usual day and time)*



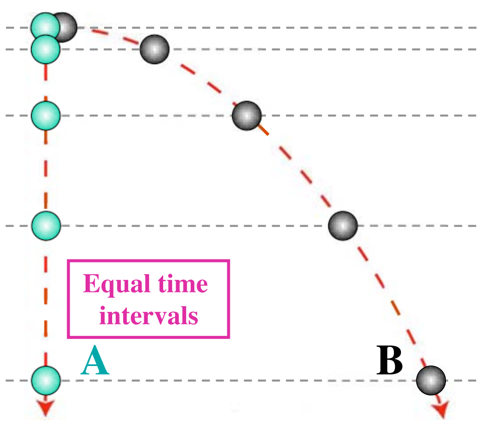


Balls from the same height hit the ground at the **same time.**

Why?

- Same initial v_y (both = 0)
- same acceleration a_y (both = $-g$)

Different v_x is irrelevant!



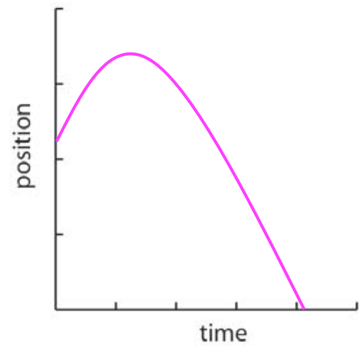
What was v_y for ball B just before it hit?

$$\begin{aligned} v_{yf} &= v_{yi} - g\Delta t \\ &= -9.8\ \text{m/s}^2 \times 0.64\ \text{s} \\ &= -6.3\ \text{m/s} \end{aligned}$$

What was v_x for ball B just before it hit?

Same as it always has been: 2.5 m/s

Toss a coin straight up and let it fall.



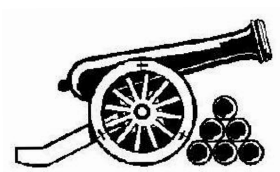
At the top of the trajectory, is the acceleration positive or negative?

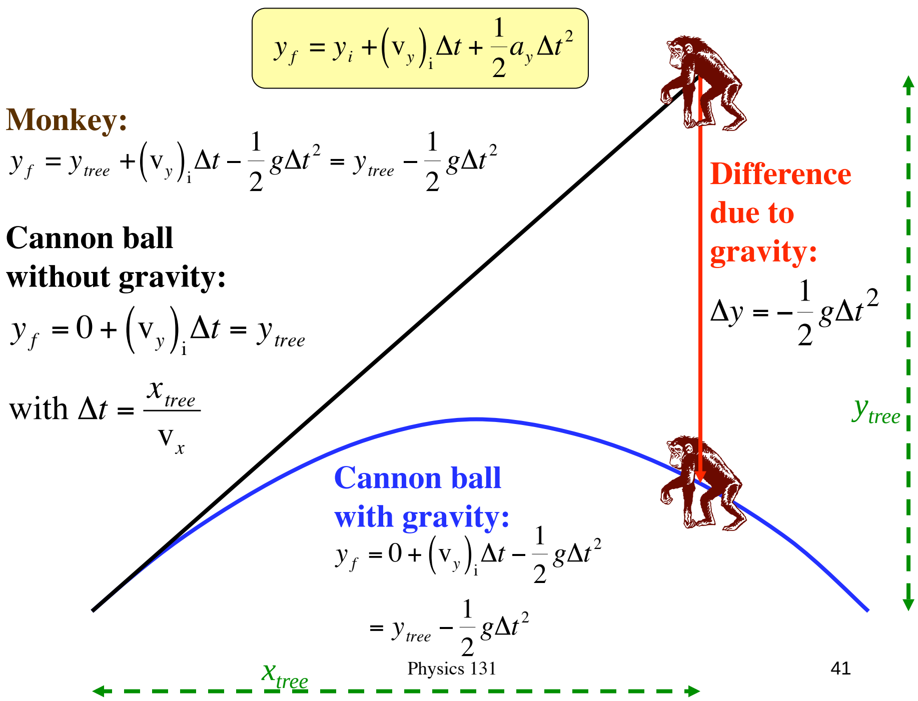
At the top of the trajectory, is the velocity positive or negative?

PRS

A hunter aims his cannon directly at a monkey in a tree. When the cannon goes off, the startled monkey drops from the tree to the ground. Where does the cannon ball go?

A. The ball passes above the monkey
B. The ball passes below the monkey
C. The ball hits the monkey
D. Not enough information
E. I have no idea





Projectile Motion example

In the movie *Road Trip*, some students are seeking to jump a car across a gap in a bridge. One student, who professes to know what he is talking about ("Of course I'm sure—with physics, I'm always sure."), says that they can easily make the jump. He gives the following data: The car weighs 2100 pounds, with passengers and luggage. Right before the gap, there's a ramp that will launch the car at an angle of 30°.The gap is 10 feet wide. He then suggests that they should drive the car at a speed of 50 mph in order to make the jump.

a. If the car actually went airborne at a speed of 50 mph at an angle of 30° with respect to the horizontal, how far would it travel before landing?
b. Does the mass of the car make any difference in your calculation?

Projectile Motion

MP PROBLEM-SOLVING STRATEGY 3.1 Projectile motion problems

PREPARE There are a number of steps that you should go through in setting up the solution to a projectile motion problem:

- Make simplifying assumptions. Whether the projectile is a car or a basketball, the motion will be the same.
- Draw a visual overview including a pictorial representation showing the beginning and end points of the motion.
- Establish a coordinate system with the x-axis horizontal and the y-axis vertical. In this case, you know that the horizontal acceleration will be zero and the vertical acceleration will be free-fall: $a_x = 0$ and $a_y = -g$.
- Define symbols and write down a list of known values. Identify what the problem is trying to find.

SOLVE There are two sets of kinematic equations for projectile motion, one for the horizontal component and one for the vertical:

Horizontal	Vertical
$x_f = x_i + (v_x)_i \Delta t$	$y_f = y_i + (v_y)_i \Delta t - \frac{1}{2}g(\Delta t)^2$
$(v_x)_f = (v_x)_i =$ constant	$(v_y)_f = (v_y)_i - g\,\Delta t$

Δt is the same for the horizontal and vertical components of the motion. Find Δt by solving for the vertical or the horizontal component of the motion, then use that value to complete the solution for the other component.

ASSESS Check that your result has the correct units, is reasonable, and answers the question.

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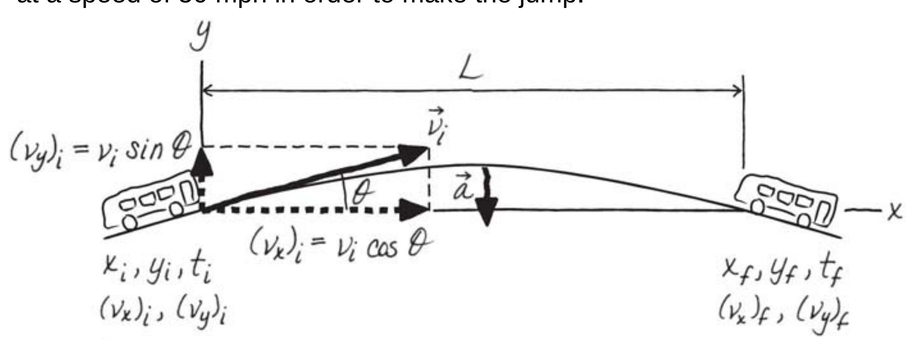


Known

$x_i = y_i = 0$ m, $t_i = 0$ s

$v_i = 50$ mph $= 22.2$ m/s, $\theta = 30^o$

$y_f = 0$ m, $L = 3.0$ m

$(v_x)_i = v_i \cos\theta = (22.2 \text{ m/s})\cos(30^o) = 19.2$ m/s

$(v_y)_i = v_i \sin\theta = (22.2 \text{ m/s})\sin(30^o) = 11.1$ m/s

Find

x_f

We need to find Δt to compute Δx via $\Delta x = (v_x)_i\,\Delta t$

$\Rightarrow$ solve vertical motion to get Δt

Vertical motion

$$y_f = y_i + (v_y)_i \Delta t - \frac{1}{2} g (\Delta t)^2$$

$$0 = 0 + (v_y)_i \Delta t - \frac{1}{2} g (\Delta t)^2$$

$$0 = \left[(v_y)_i - \frac{1}{2} g \Delta t \right] \Delta t$$

$$\Rightarrow (v_y)_i = \frac{1}{2} g \Delta t$$

$$\Rightarrow \Delta t = \frac{2(v_y)_i}{g} = \frac{2(11.1 \text{ m/s})}{9.8 \text{ m/s}^2} = 2.27 \text{ s}$$

Horizontal motion

$$x_f = x_i + (v_x)_i \Delta t$$

$$x_f = 0 + (19.2 \text{ m/s})(2.27 \text{ s}) = 43.6 \text{ m}$$

$$\Rightarrow \Delta x = 43.6 \text{ m is much greater than L} = 10 \text{ ft} = 3.0 \text{ m}$$

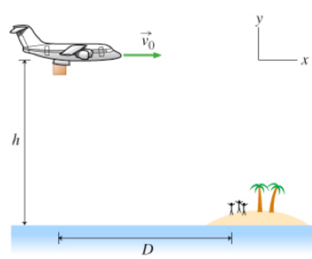
Projectile Motion: Delivering a Package by Air (Hmwk #4)

A relief airplane is delivering a food package to a group of people stranded on a very small island. The island is too small for the plane to land on, and the only way to deliver the package is by dropping it. The airplane flies horizontally with constant speed of 250 mph at an altitude of 800 m. The positive x and y directions are defined in the figure. For all parts, assume that the "island" refers to the point at a distance D from the point at which the package is released, as shown in the figure. Ignore the height of this point above sea level. Assume that the acceleration due to gravity is g = 9.80 m/s^2.

A. Time for package to reach sea level?

B. At what distance D should package be released for it to land on the island?

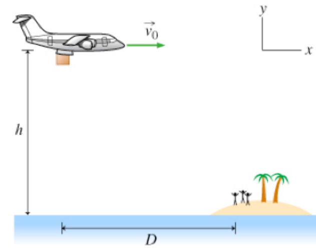
C. Speed v_f of the package when it hits the ground?



Projectile Motion: Delivering a Package by Air

Know: v_0 = 250 mph and h = 800 m

Find: time Δt, distance D, speed v_f



1. Prepare the problem:
   Draw picture (initial + final snapshots)
   Organize known quantities
2. Solve using kinematics equations
   treat motion along x- and y-axes separately

First solve vertical motion to get Δt
Then find horizontal displacement during that Δt

Find $(v_y)_f$ to compute final speed $v_f = \sqrt{(v_x)_f^2 + (v_y)_f^2}$

Projectile Motion: Speed of a Softball (Hmwk #4)

A softball is hit over a third baseman's head with some speed v_0 at an angle theta above the horizontal. Immediately after the ball is hit, the third baseman turns around and begins to run at a constant velocity v = 7.00 m/s. He catches the ball t = 2.00 s later at the same height at which it left the bat. The third baseman was originally standing L = 18.0 m from the location at which the ball was hit.

A. Find v_0 (use g = 9.81 m/s^2).

B. Find the angle θ in degrees.

Use Δt = 2.0 s to find $(v_y)_i$

Compute horizontal displacement to find $(v_x)_i$