Announcements – 11 Sep 2014

1. **A Cappella Auditions!** – Many of the groups in the BYU a cappella club are having a joint audition Tuesday at 7 pm, Varsity Theater. All parts needed, male and female. Prepare 60 seconds of music to sing. They will also do range checks and tonal memory checks.

   → Facebook page: [www.facebook.com/acappellaclub](http://www.facebook.com/acappellaclub)
“Which of the problems from last night's HW assignment would you most like me to discuss in class today?”
Adding vectors by components – review

Web demo:
http://phet.colorado.edu/sims/vector-addition/vector-addition_en.html
Relative velocities

From warmup (last time): A man on a treadmill is walking at 1.5 m/s to the left. The treadmill is going at 2 m/s to the right. If you are standing still, it looks like the man is moving:

a. 0.5 m/s left
b. 3.5 m/s left
c. stationary
d. 0.5 m/s right
e. 3.5 m/s right
Dr. Colton’s “one size fits all” relative velocity equation

\[ \vec{v}_{13} = \vec{v}_{12} + \vec{v}_{23} \]

- Read \( v_{13} \) as “velocity of object 1 relative to object 3”
- These are vectors!

In this case

\[ \vec{v}_{\text{man-ground}} = \vec{v}_{\text{man-treadmill}} + \vec{v}_{\text{treadmill-ground}} \]
A jet pointed N at 100 mph airspeed (v of plane w.r.t. air) flies in a 200 mph wind (air w.r.t. ground) going NE.

Clicker quiz: What is the jet’s true bearing (velocity with respect to the ground)?

a.  

b.  

c.  

d.  

Colton - Lecture 4 - pg 6
Question: How would you figure out the jet’s total velocity (magnitude)?
Clicker quiz
A captain wants her boat to sail exactly **E** on a map, with a speed relative to the **earth** of 10 mph. What direction should she point her boat if there is a 5 mph current to the **N**?

a. a little bit north of east   b. a little bit east of north

   c. a little bit south of east   d. a little bit east of south

**Hint**: Start with an approximate picture

\[
v_{\text{boat-earth}} = v_{\text{boat-water}} + v_{\text{water-earth}}\]
Worked Problem

How fast will the boat have to go, and what’s the exact heading?

Answer: 11.18 m/s, 26.6° south of east
**Demo:** Cart & ball

**Clicker quiz:** What will happen?
- A. Ball will land in front of cart
- B. Ball will land in back of cart
- C. Ball will land in cart
**Demo:** “Shooter & dropper” (2 balls: one shot & one dropped)

**Clicker quiz:** What will happen?
- A. Dropped ball will land first
- B. Shot ball will first
- C. Two balls will land at same time
2D Motion: Basic Concept
Motions in perpendicular directions are independent
From warmup
Which geometrical shape does a 2D projectile follow?
   a. line
   b. circle
   c. ellipse
   d. parabola
   e. hyperbola
Why is that?

http://en.wikipedia.org/wiki/Parabola

http://www.aapt.org/Programs/contests/pc08.cfm
Dr. Stokes’ flash animation: baseball velocity components
http://stokes.byu.edu/teaching_resources/baseball_flash.html
Equations

x-direction

\[ v_x = v_{0x} + a_x t \]
\[ x = x_0 + v_{0x} t + \frac{1}{2} a_x t^2 \]
\[ v_{fx}^2 = v_{0x}^2 + 2a_x \Delta x \]

y-direction

\[ v_y = v_{0y} + a_y t \]
\[ y = y_0 + v_{0y} t + \frac{1}{2} a_y t^2 \]
\[ v_{fy}^2 = v_{0y}^2 + 2a_y \Delta y \]

2-D Projectile motion:  \[ a_x = 0 \]  \[ a_y = -g \]

projectile: an object in free fall  \[ (= -9.8 \text{ m/s}^2) \]
Warmup Questions

I throw a ball at an upward angle across a flat field. Neglecting air resistance, at what part of its path does the ball have its *minimum* speed?

- a. right before it hits the ground
- b. halfway to the top
- c. at the top of its path
- d. right after it leaves my hand
- e. There's not enough information to say

I throw a ball at an upward angle across a flat field. Neglecting air resistance, at what part of its path does the ball have its *maximum* speed?

- a. right before it hits the ground
- b. halfway to the top
- c. at the top of its path
- d. right after it leaves my hand
- e. There's not enough information to say
Clicker Quizzes

Sally and Bob each throw a rock horizontally from a cliff. Sally throws her rock hard. Bob throws his more easily.

Q1: Which spends the longest time falling?
   a. Sally’s
   b. Bob’s
   c. same

Q2: Which rock is going fastest (vector magnitude) just before it hits the ground?
   a. Sally’s
   b. Bob’s
   c. same
Question
Sally throws a rock horizontally from a cliff. Bob throws his at an angle above horizontal. They throw at the same speed. Whose hits first?
Demo: Monkey gun

**Clicker quiz:** What will happen?
A. Bullet will pass over monkey
B. Bullet will pass under monkey
C. Bullet will hit monkey
Warmup question
A ball is thrown upwards at an angle. Ralph thought that since the ball is still moving upwards for a while after it is thrown, it must have some upwards acceleration in the air after it leaves my hand that continues to propel the ball. I told him "No, that's not quite what is happening." Can you help Ralph understand what is happening?

“Think-pair-share”
- Think about it for a bit
- Talk to your neighbor, find out if he/she thinks the same as you
- Be prepared to share your answer with the class if called on

Clicker: I am now ready to share my answer if randomly selected.
   a. Yes

Note: you are allowed to "pass" if you would really not answer.
Range problems
Usually use the \textit{y-equations} to figure out the \textit{time} it takes
→ Then use the \textit{x-equations} to figure out \textit{how far} it has traveled in that time

\textit{Exception}: Sometimes the nature of the problem means the \textit{x-equations} determine the time it takes—for example, if the projectile runs into a wall

\textbf{Worked Problem}: Where does the ball hit? How fast is it going then?

\begin{itemize}
  \item 13 m/s, 20° angle from horizontal
  \item 10 m cliff
\end{itemize}

Step 1: find the time

Answer: \( t = 1.9526 \text{ s} \)
Worked Problem, cont.: Where does the ball hit? How fast is it going then?

13 m/s, 20° angle from horizontal

10 m cliff

Step 2: use the time

Answers: $t = 1.9526$ s, $x = 23.85$ m, $v_{fx} = 12.22$ m/s, $v_{fy} = 14.69$ m/s, $v_{f,tot} = 19.10$ m/s
Worked Problem
A rifle at the same height as a very large target tries to hit the center, 400 m away. The rifle is shot at 8º above the horizontal. The initial velocity of the bullet is 200 m/s. How far above/below the center does the bullet hit?

Answers: t = 2.02 s, y = 36.23 m
Maximum range

Warmup question: Neglecting air resistance, at what angle should you throw a ball on a flat field in order to get the maximum range? (also neglecting height of person)
   a. 30°
   b. 45°
   c. 60°
   d. It depends on the initial speed

Caveats…