Announcements – 10 Sep 2009

1. **Exam 1 starts today!**
   a. You have 6 days to take it, today through next Wed, close of Testing Center.
      i. Testing center closed on Saturday!
      ii. Testing center open 1 – 7 pm on Friday (last test handed out at 6 pm)
   b. Late fee on Wed after 1 pm

2. **More exam details later in the lecture**
   a. We'll start by finishing the vector stuff we didn't get to last time, and doing some 2D kinematics problems

3. TA-led **exam review session tonight**, 7:00 - 8:30 pm, in C-215 ESC

4. **HW 3 due tonight**
   a. I'll post HW 3 solutions in display case tomorrow

5. **No HW due next Tuesday**

Which part of today's assignment was particularly hard or confusing?

Do we need to know ALL of the 2D motion equations in the book?

How would you go about studying for this first test?

i always hate the word problems. i never really understand quite what they're saying. i noticed that a lot of the things are conversions. yet we haven't spoken anything about them. not only that but do the kinesmatic equations work for basically everything?

General comments:

What is the average score for the first exam?

I noticed there were a few people in class that just gave up on their questions because they were not seen in time. Looking up more often might help resolve issues common to the class.

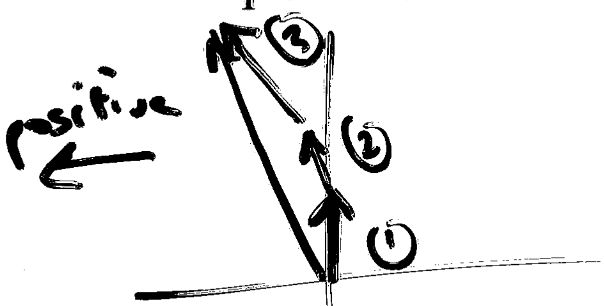
you're moving through this stuff awfully fast. Will it be like this the rest of the quarter?

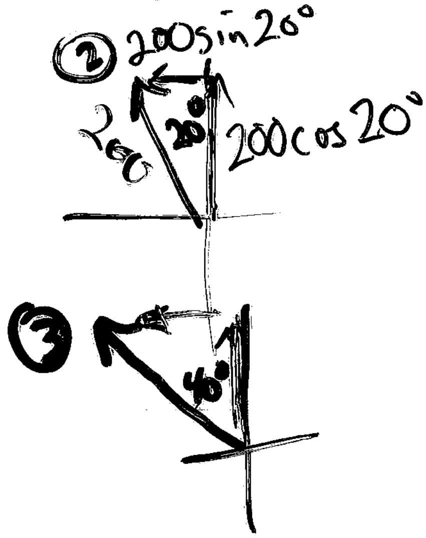
When I check my grades, there is a comment along the lines of " * indicates grades made perfect". What does this mean?

Continued from last time…

When adding vectors, never forget this:
You can add components but you can't add magnitudes

Worked Problem: A boy scout carefully walks north for 300 m, then 20° west of north for 200 m, then 40° west of north for 400 m. How far from his starting point is he? What the angle of his displacement?

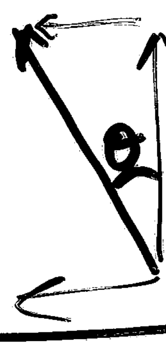




$\cos 20° = \frac{adj}{hyp}$

$adj = hyp \cdot \cos 20°$

	X	Y
①	0	300
②	200sin20°	200cos20°
③	400sin40°	400cos40°
Total	325.5m	794.4m



$\tan\theta = \frac{325}{794}$

$\theta = 22.3°$ W of N

$\sqrt{325^2 + 794^2} = 858.47\text{m}$

Answers: x = 325.52 m, y = 794.36 m, total = 858.47 m at 22.28° W of N (67.72° N of W)

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**

only the x-velocity

Projectiles

x-direction

$$v_x = v_{0x} + a_x t$$

$$x = x_0 + v_{0x} t + \tfrac{1}{2} a_x t^2$$

$$v_{fx}^2 = v_{0x}^2 + 2a_x \Delta x$$

$$V_x = V_{0x}$$

$$x = x_0 + V_{0x} t$$

y-direction

$$v_y = v_{0y} + a_y t$$

$$y = y_0 + v_{0y} t + \tfrac{1}{2} a_y t^2$$

$$v_{fy}^2 = v_{0y}^2 + 2a_y \Delta y$$

$$v_y = v_{0y} - gt$$

$$y = y_0 + v_{0y} t - \tfrac{1}{2} g t^2$$

$$v_{fy}^2 = v_{0y}^2 - 2g\Delta y$$

2-D Projectile motion:

$a_x = 0$ $a_y = -g$

projectile: an object in free fall

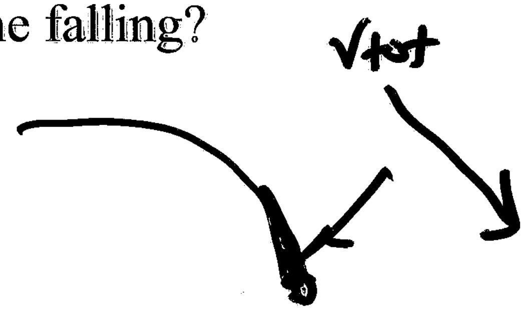
$(= -9.8\ m/s^2)$

Dr. Stokes' flash animation: baseball velocity components

http://stokes.byu.edu/baseball_flash.html

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

Clicker quiz: Which spends the longest time falling?



a. Sally's
b. Bob's
c. same

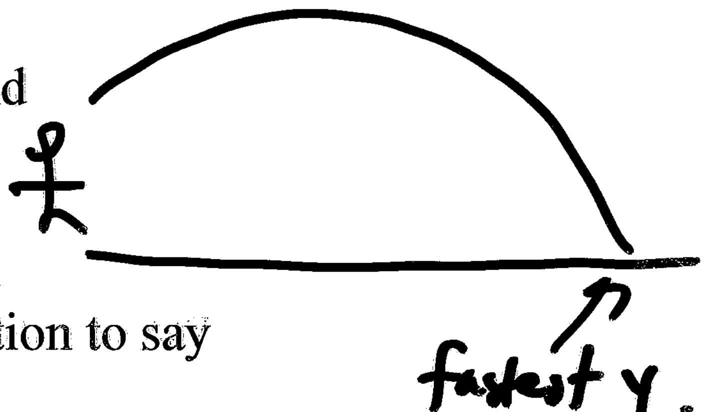
Clicker quiz: Which rock is going fastest (vector magnitude) just before it hits the ground?

a. Sally's
b. Bob's
c. same

y-dir: same velocity
x-dir: Sally's is faster

From warmup: 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



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?

Sally's

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?

Answer from the class:

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From the time the ball leaves your hand, gravity is slowing it down. It cannot have upward acceleration if it is slowing down as it goes up.

Warmup question: In 2D projectile problems, usually you use equations from one of the directions to figure out the time the projectile is in the air. (Look over the book examples, see if they do this.)

a. True

b. False

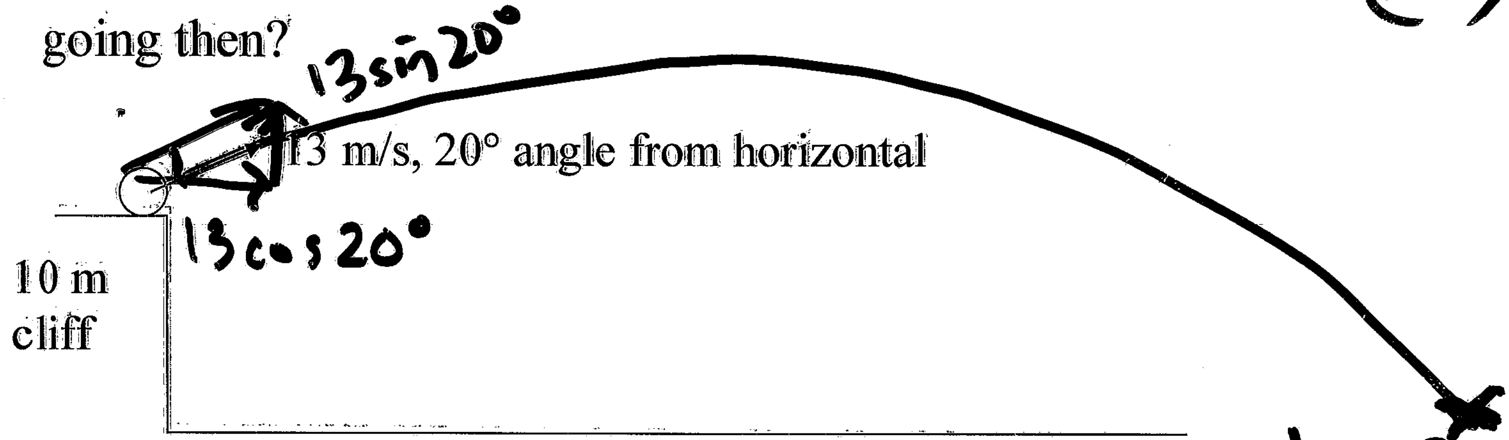
Range problems

Usually use the **y-equations** to figure out the **time** it takes
→ Then use the **x-equations** to figure out **how far** it has traveled in that time

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

$\sin = \frac{opp}{hyp} \rightarrow opp = (hyp) \times (\sin\theta)$

Worked Problem: Where does the ball hit? How fast is it going then?



$x = x_0 + v_{0x}t$

$v_x = v_{0x}$

$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$

$v_y = v_{0y} - gt$

$v_{fy}^2 = v_{0y}^2 - 2g\Delta y$

$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$

$-10 = 0 + 13\sin 20° t - \frac{1}{2}(9.8)t^2$

$4.9t^2 - 13\sin 20° t - 10 = 0$

$$t = \frac{-(-13\sin 20°) \pm \sqrt{(-13\sin 20°)^2 - 4(4.9)(-10)}}{2(4.9)}$$

$$t = 1.95\text{ s}$$

$$x = x_0 + v_{0x}t$$

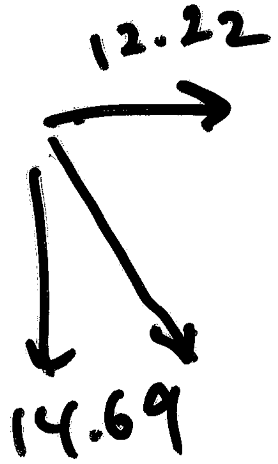
$$x = 0 + (13\cos 20)(1.95) = 23.85\text{ m}$$

$$v_x = v_{0x} = 13\cos 20° = 12.22\text{ m/s}$$

$$v_y = v_{0y} - gt$$

$$= +13\sin 20° - (9.8)(1.95)$$

$$= -14.69\text{ m/s}$$

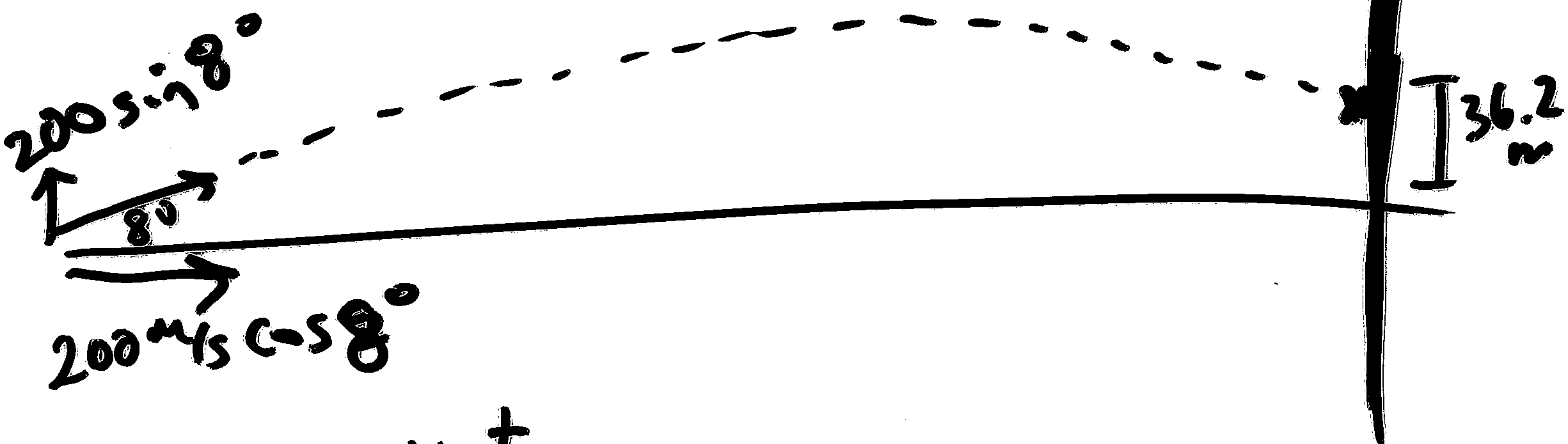


$$v_{tot} = \sqrt{12.22^2 + 14.69^2}$$

$$= 19.10\text{ m/s}$$

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 8° above the horizontal. The initial velocity of the bullet is 200 m/s. How far above/below the center does the bullet hit?



$$x = x_0 + v_{0x} t$$

$$400 = 0 + (200 \cos 8°) t$$

$$t = 2.02\,s$$

$$y = y_0 + v_{0y} t - \frac{1}{2} g t^2$$

$$= 0 + (200 \sin 8°)(2.02) - \frac{1}{2}(9.8)(2.02)^2$$

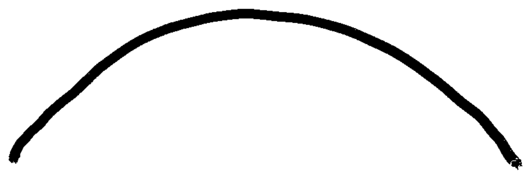
$$= 36.2\,m$$

Answers: t = 2.02 s, y = 36.23 m

Maximum range

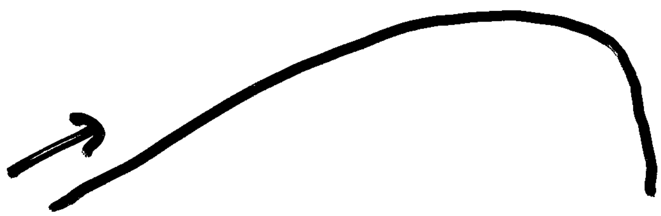
Warmup question: Neglecting air resistance, at what angle should you throw a ball on a flat field in order to get the maximum range?

a. 30°
b. 45°
c. 60°
d. It depends on the initial speed



→ The height of the person will also have an effect.

What if you do worry about **air resistance**?



Simulation:
http://phet.colorado.edu/new/simulations/sims.php?sim=Projectile_Motion

On your own: "Scorched Earth" computer game (free!)
http://whicken.com/scorch/index.html

Exam Information

Scratch paper: You shouldn't need (I give you space), but if you're worried, you can bring a couple of pages on your own.

1. Covers through today's lecture
   a. Chapters 1-3
   b. HW 1-3
1. No time limit
   a. I'm guessing the median time will be 1 hour 15 mins
      ...but you should allow for more to be safe
2. Closed notes, closed book
   a. Some equations given, but not all. For example:
      $v_{ave} = \Delta x/\Delta t$ is not given but $v_f^2 = v_0^2 + 2a\Delta x$ is.
      → **See website for the list of given equations!**
3. Calculators:
   a. Should not be needed.
   b. Personal calculators are not allowed.
   c. Testing center calculators can be used if needed.
4. Most (80-90%) of the problems come from the following sources. Problems won't be <u>identical</u>, just <u>very similar</u>.
   a. HW
   b. Worked problems from class
   c. Clicker quizzes/other conceptual problems from class
   d. Warmup questions
   e. Demos
   f. Old midterms/final exams, posted to website
      → Key difference: **this exam will only count 60 pts**
      → **Format of this exam is most like 2008 final exam**

Side note: exam pts ≠ warmup pts ≠ clicker pts ≠ HW pts

Review

1. Units
   a. In general, use standard metric "SI" or "mks" units
   b. How to convert units
      i. If non-metric, I'll give you conversion factors
      ii. You should know things like 100 cm = 1 m
      (I won't think twice about assuming you know that)

2. Math
   a. Need to know how sin, cos, and tan work

$$\sin\theta = \frac{opposite}{hypotenuse}$$

$$\cos\theta = \frac{adjacent}{hypotenuse}$$

$$\tan\theta = \frac{opposite}{adjacent}$$

   b. Quadratic formula? Given on exam

$$\text{If } ax^2 + bx + c = 0, \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

3. Motion:
   a. Position vs. Displacement
   b. Velocity vs. Speed
      i. Definition: $v_{ave} = \langle v \rangle = \dfrac{\Delta x}{\Delta t}$

Not given

1. slope between two points on x vs t graph

ii. Instantaneous v

1. slope at single point of x vs t graph (use tangent line)

c. Acceleration

i. Definition: $a_{ave} =< a >= \frac{\Delta v}{\Delta t}$

1. slope between two points on v vs. t graph

ii. Instantaneous a

1. slope at single point of v vs. t graph (use tangent line)

iii. Positive vs. negative—increases or decreases $\boldsymbol{v}$

1. but not necessarily *magnitude* of $\boldsymbol{v}$

d. How to interpret $x(t)$, $v(t)$ and $a(t)$ graphs: "Describe the motion with words"

4. Kinematic problems

a. Be careful:

i. Draw pictures, be clear about which direction is +

1. Write given info on picture, properly labeled (example: $v_f = 10$ m/s)
2. Write missing info on picture, also labeled (example: $\Delta x = ?$)

ii. Think about which equations describe the motion

iii. Write down the most relevant equations with just symbols, before plugging in any numbers

iv. Do algebra, carefully

v. Plug numbers into calculator—twice!

b. Problems can be done more than one way—if you have time, check with other equations

c. The kinematics formulas: (given on exam)

$$x = x_o + v_o t + \frac{1}{2} a t^2$$

$$v = v_o + at$$

$$v_f^{\,2} = v_o^{\,2} + 2a\Delta x$$

5. Adding Vectors
   a. Graphically—always do this first!
   b. With components
      i. Use cos, sin to get *x*-and *y*- "shadows"
      ii. Add *x*- and *y*-components separately to get components of final vector
      iii. Magnitude of final vector: Pythagorean theorem
      iv. Angle of final vector: inverse tangent

6. Free-fall/projectiles
   a. Two sets of kinematic equations (*x* and *y*)
      i. $a_x = 0$
      ii. If up = positive, then $a_y = -g = -9.8$ m/s^2
   b. If initial velocity at an angle: divide v_0 into *x*- and *y*-components
   c. If 2D "range"-type problem: think about which coordinate sets the time.
      i. Solve for time

ii. Plug into other coordinate's equation(s)

7. Relative motion:
   a. One-dimension: usually easy to figure out, just add or subtract speeds
   b. 2-dimensions: draw **vectors**, and write the vector equation: $\mathbf{v}_{a\text{-}c} = \mathbf{v}_{a\text{-}b} + \mathbf{v}_{b\text{-}c}$ with "a", "b", and "c" being objects from the problem. Then be sure your work (components) agrees with it.

"So, Dr. Colton, what's *really* going to be on the exam?"