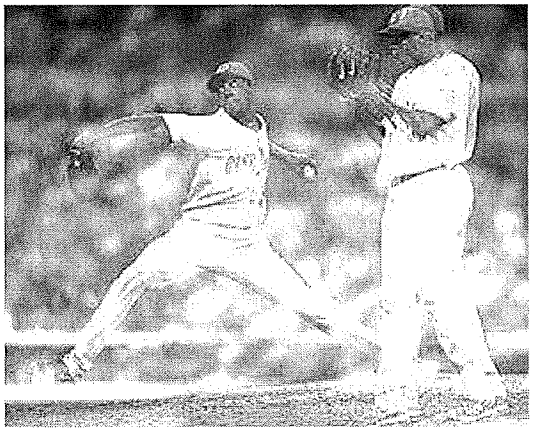
PROJECTILE LAB: (SOFTBALL)	Name: _____ Partner's Names: _____ Date: _____
Physics 12 ☼ LAB	

PURPOSE: To **calculate** the speed of a softball projectile and its launch angle by **measuring** only the time and distance it is in the air and compare your fastest speed to the fastest speed ever recorded for throwing a baseball.

MATERIALS: softball, stopwatch, measuring tape, calculator, writing utensil, data table.

Chapman throws fastest pitch ever recorded



(Christopher Hanewinckel/US Presswire)

SAN DIEGO – Ardolis Chapman_was summoned from the bullpen one batter too late to make a difference in the game. No matter. The 22-year-old Cincinnati Reds left-hander made do by making history Friday night, throwing the fastest pitch recorded in a major league game, a 105-mph fastball.

Ardolis Chapman's 25 pitches on Friday night (each registering 100 mph or faster, including his record-breaking 105 mph heater) must have been a blur to Padres batters.

PRELIMINARY QUESTION:

1. How fast was Chapman's 105 mile per hour pitch in m/s? **HINT:** 1600 m = 1 mile, 1 hr = 3600 sec _____
2. How many classrooms would Chapman's ball pass through in one second? Room 215 is 9 meters long. _____
3. How much vertical distance (in m) would Chapman's ball have fallen if the pitcher's mound is 18.4 m away from home plate? _____.

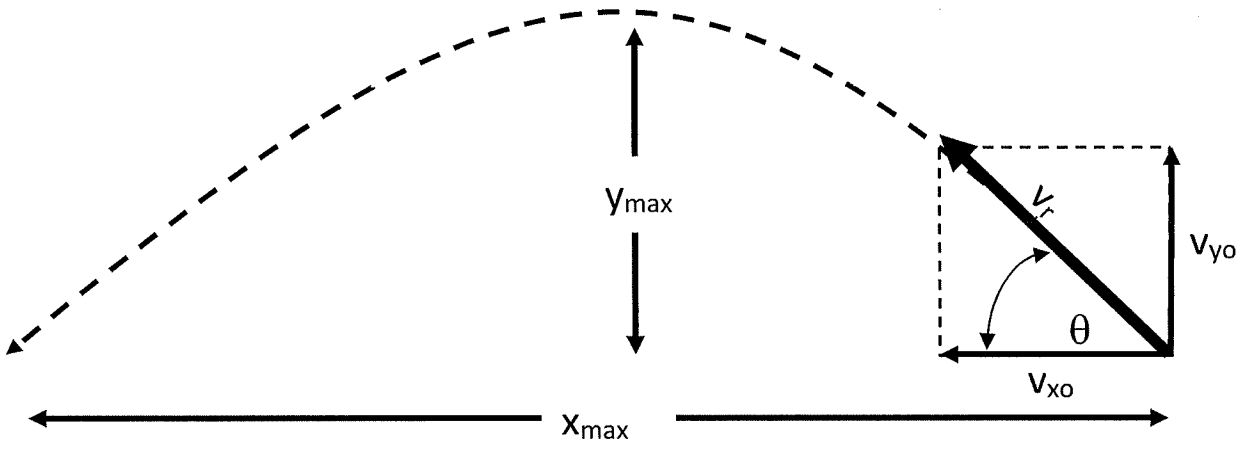
LAB DIRECTIONS: Do the following lab in groups of three. You will need a distance measurer, a timer, and a thrower. You will take turns playing these roles so everybody gets a shot.

STEP 1: Take a softball, stopwatch, meter stick (or measuring tape), writing utensil, and this lab sheet and go with your partners out to the throwing range (where we go for the fire drill).

STEP 2: While laying on the ground, so we can assume starts + lands at same height, Take turns throwing the ball from the starting line *as far as you can* (be careful not to hit anybody). To get the maximum range, **You should *not* throw horizontally**. While the thrower throws, the timer should be measuring the time the softball is in the air and the distance measurer should be keeping an eye on the ball to see where it lands. The timer and distance measurer should record the *time elapsed* (in sec) and total *horizontal distance* thrown (in m) in the table below.

NAME	FARTHEST DISTANCE THROWN, x_{max}, (in m)	LONGEST TIME IN THE AIR, t, (in sec)

STEP 3: You will now dissect your own throw in terms of ***horizontal*** (v_{xo}) and ***vertical*** (v_{yo}) **components** (in m/s) of your **initial velocity**, the **resultant (v_r) initial velocity** (in m/s), the ***launch angle*** (θ), and the **maximum height**, y_{max} (in m) attained (see figure below). Once you find all this information by following the steps on the following pages, you put these values in the table on Page 6 of this document.



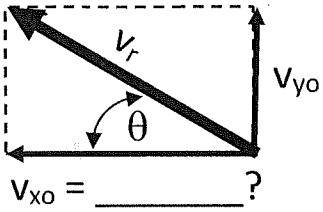
Answer the following questions:

TO FIND INITIAL HORIZONTAL VELOCITY (V_{xo}) IN m/s:

1. *How much horizontal distance* (in m) did the ball travel? _____

2. *How much time* (in sec) did the ball travel? _____

3. *How fast* (in m/s) did the ball travel (**HINT:** Do In your head or use the equation $x = v_{xo} \cdot t$ and solve for v_{xo})? In other words, what is your ball's *initial horizontal velocity* (v_{xo})? Label you answer in the blank below and also in the table on the last page (p. 6).



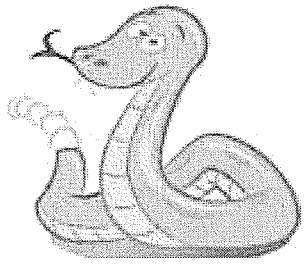
4. Does gravity, *g*, affect horizontal motion? ☐ YES ☐ NO

5. Neglecting air resistance, are there any other factors that, in ideal conditions, would slow down the softball horizontally? ☐ YES ☐ NO

6. If the ball is *not* accelerating positively or negatively in the horizontal direction, this means our ball has c_____ (*synonym for non-accelerating*) velocity. If so, *how far* (in m) horizontally would the ball travel in...
   1 sec: _____? 2 sec: _____? 3 sec: _____?

7. *How many times greater* is Chapman's horizontal velocity than yours?
   _____

8. *How far (in m)* would Chapman throw in the same time you threw in ⌗ **2**? _____



TO FIND INITIAL VERTICAL VELOCITY (V_{yo}) IN m/s:

1. *How much time* (in sec) was your ball in the air? _____

2. *How much time* (in sec) *did your ball rise?* _____

3. *How much time* (in sec) did your ball fall (assume it is thrown and lands at the same height)? _____

4. _____ **MULTIPLE CHOICE:** What is the formula for finding vertical velocity in your particular situation? (where v_y = final vertical velocity (in m/s), v_{yo} = initial vertical velocity (in m/s), a = gravity (in m/s^2), t = time (in sec))

   a. **v_y = constant**

   b. $V_y^2 = V_{yo}^2 + 2ad$

   c. $d = V_{yo}t + \frac{1}{2}at^2$

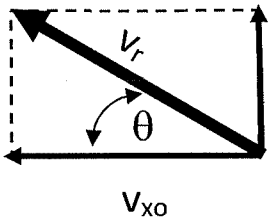
   d. $V_y = V_{yo} + at$

5. a. What is the *vertical velocity, v_y,* (in m/s) of your ball at the top of its flight? _____

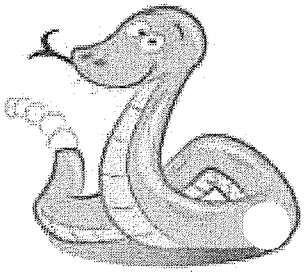
   b. What is the value of gravity, *g* (in m/s^2)? _____

   c. *How much time, t* (in sec) passes for the ball to reach the top of its flight? _____ (Same as **Probl. 2**)

6. Plug v_y, *g*, and *t* into your vertical velocity formula from **Probl. 4** and find v_{yo}, your ball's *initial vertical velocity* (in m/s). Label your answer in the blank below.
   Also write your initial vertical velocity in the table on the last page (p. 6).

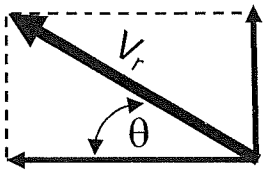


V_{yo} = _____?



TO FIND THE RESULTANT VELOCITY (V_r) IN m/s AND THE LAUNCH ANGLE (θ):

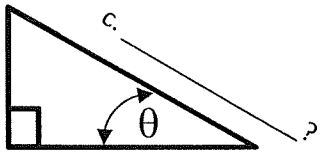
7. Plug in v_{xo} and v_{yo} that you found in the previous two pages and write them in the vector diagram below.



V_{yo} = _____?

V_{xo} = _____?

8. Match the sides of your right triangle, v_{xo}, v_{yo}, v_r , with the labels "hypotenuse", "adjacent", and "opposite" on the right triangle below. Write them in:



a. _____?

b. _____?

b. redraw the triangle with the V_{yo} and V_{xo}:

9. _____ **MULTIPLE CHOICE.** To find the *resultant velocity*, v_r, you would use:

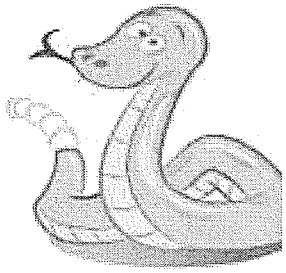
a. Pythagorean Theorem: $a^2 + b^2 = c^2$ **b.** S.O.H.C.A.H.T.O.A. **c.** $x = v_{xo} \cdot t + \frac{1}{2} \cdot a \cdot t^2$

10. _____ Find your *resultant velocity*, v_r (in m/s). Put your answer in the table on the last page (p. 6) as well.

11. _____ **MULTIPLE CHOICE.** To find the *launch angle* of your ball, θ, which is the angle to the horizontal you would use:

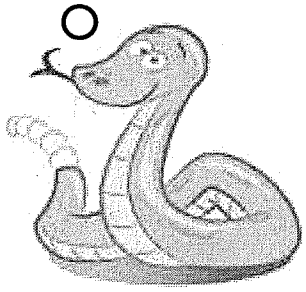
a. Pythagorean Theorem: $a^2 + b^2 = c^2$ **b.** S.O.H.C.A.H.T.O.A. **c.** $x = v_{xo}t + \frac{1}{2}at^2$

12. _____ Find your launch angle θ and record it. Also put it in the table on the last page (p. 6).



TO FIND THE MAXIMUM HEIGHT (y_{max})
AND FORMULAS TO DESCRIBE YOUR FLIGHT PATH, y(t):

13. _____ Find your maximum height.



Fill out the table below with your own data:

NAME	FARTHEST DISTANCE THROWN (in m)	LONGEST TIME IN THE AIR (in sec)	HORIZONTAL VELOCITY, V_{xo}, (in m/s)	INITIAL VERTICAL VELOCITY, v_{yo}, (in m/s)	RESULTANT VELOCITY, v, (in m/s)	LAUNCH ANGLE (θ) (in degrees)	MAXIMUM HEIGHT, y_{max} (in m)

If we did a slightly different lab, this time from a standing position, where the ball is launched from 2.0m up at 24m/s at an angle of 38°, fill in the table below... (Show your organized work!)

NAME	FARTHEST DISTANCE THROWN (in m)	LONGEST TIME IN THE AIR (in sec)	HORIZONTAL VELOCITY, V_{xo}, (in m/s)	INITIAL VERTICAL VELOCITY, v_{yo}, (in m/s)	RESULTANT VELOCITY, v, (in m/s)	LAUNCH ANGLE (θ) (in degrees)	MAXIMUM HEIGHT, y_{max} (in m)
					24 m/s	38°	