Physics Lab - Crossing Paths 9/19/17 **Name**_____

Using Position vs. Time Graphs to Calculate Intersection **Date**_____ **Hour** ___

Purpose: Create position versus time graphs for two separate objects rolled down the hallway in two separate trials, and use the graphs to predict, both graphically and algebraically, the time and place at which the objects will cross if they are both rolled in one trial.

Procedure: (Make diagrams and take notes in your notebook so you can write directions that other classes could follow to do this lab.) Write out a clear procedure, with numbered steps, using as few pronouns as possible. Do not write sentences such as, "We measured the ball." Write, "**4. Record the time at which the ball passes each blue tape mark. Include the position of the tape mark on the data table."**

Data: The timers in the hallway will give their position and time data, clearly and precisely, to a few data recorders, who will give that data to the teacher, who will type it all into one Excel file to share.

Results:

1) Make one Position vs. Time graph which has the proper range to cover all the positions and times we measured during the lab. (e.g., at least 0-15 seconds and 0-20 meters). Use the graph paper in landscape orientation.

Hey! "e.g." stands for "exempli gratia", which is Latin for "for example". Now you know!

2) Using pencil, plot all of the points for Ball A. Note that it may be easier to go up to the position, which will be an exact number like 12.00 m, and then over to the proper time, such as 6.31 seconds.
3) Using a ruler, preferably see-through, plot the best fit straight line which comes closest to the most points. Extend the line to the borders of the graph, so you can see the x-intercept.
4) Select two points far apart on the best fit line which are not data points. Try to find points on graph lines, since this will make your measurements a little more precise.
5) Calculate the slope between those two points. Show calculations, including all units, and round to the proper number of significant digits.
6) Using the x-intercept as the point, (the ball started at position = zero), write the point-slope equation for the line. $y - y_1 = m(x - x_1)$
7) In the equation, replace the x and y with the variables we actually used, and make sure you include the units for the numbers that have units. (x_1, y_1, and m). Use a logical number of decimal places.
8) Repeat steps 2-7 for Ball B, but instead of using the x-intercept (at position = zero), use the point where the line intersects the starting position for Ball B, which for most of our labs is around 20 m.
9) You should now have an equation for the Position of Ball A, and an equation for the Position of Ball B. Plug in the original unrounded slopes, set the two equations equal to each other, and solve for the time at which the two positions are equal.
10) Use the calculated time of crossing to calculate the Position at which the Balls will pass each other.
11) Examining the two straight lines on your graph, record the coordinates (time, position) at which they cross. Be sure (as always) to include units.

Conclusion: We will release the balls at the top of their respective ramps at the same time, and watch as they roll in opposite directions. We will record as precisely as possible when and where they cross. Calculate the percent error between your predicted crossing time and the actual crossing time.

Summary: Explain the significance of the various numbers which were measured from the graph or calculated using algebra. Focus on units, signs, and the physical meaning of the numbers such as intercepts and slopes. Write as if you were explaining this to your parent, or to a new student who missed this lab.

Crossing Paths Lab Report Checklist:

Did I do all these things that were directly stated as instructions in the lab, or does my teacher need to go buy more red pens?

- Put a proper heading (Name, Date, Period, Title)
- Make a position vs. time graph
  - Landscape orientation
- Best Fit Lines
  - Use a ruler
  - Extend lines to edge of graph
- Calculate the slope
  - Choose points far apart, which are not data points
  - Show calculations
  - Include units (meters/sec)
  - Correct significant digits (probably 3 sig dig, with 2 decimal places)
- Write the first point-slope equation (for the positive-velocity ball)
  - Use the x-intercept as the point
  - Replace "y" and "x" with position and time
  - Include units
- Write the second point-slope equation
  - Use the starting point of the ball as the point (Intersection of line and the horizontal line position = 22m)
- Set the two equations for Position equal to each other
  - Do the algebra, and solve for t, the time at which they cross
  - Substitute the value for t back into the equations to solve for position
- Examine the graph and record the intersection of the two lines
  - Give the coordinates (time, position) of the intersection
  - Check to see if that point matches the values you got from the previous step, since those values were based on your graph lines.
- Calculate the percent error between time predicted from graph or algebra and the time when the balls actually crossed in the hall.

Summary: Did I show that I have been studying physics, and mention terms like slope and velocity?

- "Explain the significance of the numbers"
  - slopes of lines (which equal_____)
  - signs of slopes (which tell _____of each ball)
  - units of the slopes
  - magnitudes of the slopes (which tell which ball was moving faster)
  - x-intercepts (which tell _____ at which ball reached bottom of ramp, and crossed starting line)