**Name:**

**Lab Partners:**

**Course: AP Physics**

**Period:**

**Date:**

**AP Lab #3- Projectile Motion**

**Purpose/Problem:** To analyze the motion of a projectile under the influence of only gravity and therefore determine its acceleration due to gravity.

**Hypothesis:** You know what to do here. (Refer to Lab #2)

**Materials:** marble launcher, photogate timers, plastic marble, meter stick or tape measure, (RESTRICTION: no stopwatches! – don’t include this restriction in your materials list when you publish)

**Experimental Design & Procedure:**

1. (Set up the photogate timer and marble launcher as demonstrated by Mr Fallon. Your write-up needs to explain more of the details of your set-up and will not include this parenthetical).

Launch the ball horizontally only. Adjust the initial velocity to obtain changing range values along the floor. (You may want to average many values to get an idea of where it is landing.) Use these two measurements along with the drop height to determine the acceleration of gravity. Hint: you will have to linearize this again, but it will be helpful to determine the theoretical relation between the two variables beforehand this time to guide what you should place on each axis in order to do so.

**Observations & Data:**

|  |  |  |  |
| --- | --- | --- | --- |
| Launch height: | | | |
| Trial | Horizontal Distance Covered  (m) | Time from Photogate Timer  (s) | Initial Velocity of Launch (m/s) |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |

|  |  |  |
| --- | --- | --- |
| Trial | y-axis values necessary for linearization (appropriate units) | x-axis values necessary for linearization (appropriate units) |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
|  |  |  |

**Analysis:**

1. Calculate the initial velocities for each launch and fill them into the table *above*. Show a sample calculation here. Remember to include initial equation using familiar variables, plug-in values, and units.
2. Graph the horizontal distance covered against the horizontal velocity values. Remember that by convention the IV goes along the x-axis and the DV goes on the y-axis.
3. Show all your work to determine the algebraic relationship between your measured values and the acceleration due to gravity. This needs to start from somewhere we all recognize, i.e. familiar kinematic equations – they’re well-established! (I'll give you a hint: the time from the photogate timer is **not** the time of flight and therefore can’t be plugged into a kinematic equation that uses the time of flight as “the time”). When you’re finished, aside from any constants, you should be left with only initial velocity, vertical displacement, horizontal displacement, and the acceleration due to gravity.
4. What, when plotted on x and y axes, will linearize the function? (In other words: A graph of \_\_\_\_\_\_\_ (y-axis) versus \_\_\_\_\_\_(x-axis) will produce a linear function.)
5. Perform the calculations necessary to linearize the function you determined in step 2 (you do not need to show your calculations for these values unless they require more than one mathematical operation). Use these values to fill in the table *above (in the data section)*. (Label the columns specifically: not just “y-values…”, but say what they actually are.)
6. Plot your linearized graph from step 5. As usual, you will use this to find the best-fit line and determine the slope of the line (which, in physics, always includes units unless the units cancel) with which you will determine the equation of the best-fit line. Show all your calculations and final equations in the analysis section here.
7. “Unpack” the acceleration from your slope. Show your work here to really make a clear statement of the acceleration determined from your data set.
8. Compare the acceleration you found to the theoretical value of the acceleration due to gravity. In our labs, the word “compare” means to calculate a "percent difference." Again, this is calculated in the following way (note the absolute value symbols—in physics, percent difference is typically reported as a positive value):

% Difference = ׀ Most Trusted Value – Least Trusted Value׀ 100% X

Most Trusted Value

**Conclusion:**

1. Relate the conclusion to the problem and hypothesis.
2. Do NOT repeat procedure, observations, or data unless you’re going somewhere with it

**Error Analysis:**

1. Make sure this is *at least* a four to five sentence paragraph.
2. Error Analysis Tips:
   1. work backwards (How did you get the final value? What did you need to plug in to get there? How did you get those original values to plug in? [usually measurements] What did you use to measure them? Could they be uniformly too big? Too small?)
   2. *quantify*: estimate amounts! (how closely did you round your measurements? How much will the sources of “error” [which in science means “uncertainties caused by things having to do with the measurement procedures” – not “mistakes”] effect the final calculation?)
   3. use the equation you used to calculate the experimental value to determine how much effect your sources of “error” have on the final result (For Example: if you’re calculating with a *time2* in the denominator of your calculation and your time measurements are all about twice as large as the actual values are, you’ll be getting *four* times the denominator you need, so the overall calculation will be *one fourth* as big – at least that’s the contribution from this measurement. Provide an analysis like this)

***Lab Report* Rubric**

**AP Physics 1 Lab #3: Projectile Motion**

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Period\_\_\_\_\_\_\_\_\_

**15 pts**

Penalty Box (check means that there are problems in that area)

|  |  |
| --- | --- |
| □ lab notes not attached to lab report  □ doesn’t use third-person voice  □ lab framework is not followed (calculations not in analysis section, data tables not together in proper section, etc) | □ more than a few obvious spelling/grammatical errors  □ math is not easy to follow (original algebra not shown, plug-in not shown, unclear progression) |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Missing** | **Inadequate** | **Needs** **Improvement** | **Adequate** | **Points** |
| **Title, Heading, Purpose, Hypothesis, Materials** (1 pt) | | | | |  |
| **Graphs**  (2 pt) | Concern with 3 or all:  \* correct labels & units \* axes are scaled correctly \* best-fit line \* detailed title | Concern with two:  \* correct labels & units \* axes are scaled correctly \* best-fit line \* detailed title | Concern with one:  \* correct labels & units \* axes are scaled correctly \* best-fit line (points drawn from table rather than line)  \* detailed title | \* correct labels & units  \* axes are scaled correctly  \* best-fit line(s)  \* detailed title(s) |  |
| **Diagrams & Data Tables**  (2 pt) | \* diagram is missing  \* data tables are missing or extremely vague (i.e. numerical values only) | \* diagram is unclear or unrelated  or has major omissions  \* data tables have major omissions  (i.e. table missing for a graphed set of data) | \* diagram is vague or has minor omissions  \* data tables have minor omissions  (i.e. units incorrect or missing) | \* diagram present & clear  \*diagram labeled and captioned as necessary  \* data tables clear and complete  \* tables include labels and proper units |  |
| **Procedure & Conclusion**  (3 pt) | \* procedure or conclusion extremely vague or missing altogether  \*unintelligible  \*missing: no attempt made to explain | \*major problems with procedure and conclusion  \*unclear with important details missing  \*lengthy/unrelated digressions  \*vague or ambiguous statements | \* minor problems with procedure and conclusion: unclear  \*vague details or omissions  \* effort required to comprehend the progression  \*unrelated digressions  \*All logical steps present, but in non-sequential order | \* procedure clear & complete, matching what was actually done  \* conclusion is drawn that is related to the purpose/problem  \* makes sense on 1st read-through  \* organized, sequential, argues from evidence |  |
| **Error Analysis**  (2 pt) | \*error analysis missing  \*emotional response  \*”miscalculation” or ”mistake”  \*”faulty equipment”  \*”human error” | \*estimated values not related to calculated results  \*no attempt/failed attempt to quantify  \*ambiguous, unclear language  \*missing necessary diagrams  \*incorrect statements | \*sources of error identified, but focus on non-major sources  \*estimated values unfounded or unreasonable--related loosely/not related to calculations  \*ambiguous, unclear language  \*incorrect statements | \*major sources identified & explored  \* quantified (amounts estimated)  \*shows effect on calculation  \*diagrams included |  |
| **Analysis Questions**  (5 pt) | These are graded question by question.  -please include questions along with the answers in the lab report- | | | |  |
| **Total :** | | | | |  |