FREE FALL LAB: ACCELERATION DUE TO GRAVITY

Purpose: *To determine the acceleration due to gravity and to determine if our results support that fact that the mass of an object has no effect on its free-fall acceleration.*

Materials:

- CPO Photogate timer
- Gravity Drop apparatus
- Physics Stand
- 1 steel marble
- 1 plastic marble
- balance
- Vernier Caliper
- 1 meter sticker

Procedure:

1. Set up the Gravity Drop apparatus in the following way:
    a. Attach the catch basket into the lowest hole on the physics stand by putting the screw through the hole and tightening the attachment knob.
    b. Attach the release clamp into the highest hole on the physics stand so that opens directly above the catch basket. Put the screw through the hole on the stand and tighten the attachment knob.
2. Set up the photogate timers in the following way:
    a. Clamp one photogate directly onto the stand, approximately 2-3 cm below the release clamp (the gate should be approximately even with the first hole visible below the releaser). Make sure the gate is clamped tight to the stand so that there is no space between it and the stand at all; the gate should be clamped in such a way that the opening is on the side of the stand that the basket and releaser are on.
    b. Clamp the second photogate approximately 5-8 cm below the first, following the same attachment guidelines as stated for the first gate.
    c. Attach the gates to the timer box using the phone cables. The top gate should be "Gate A", and the bottom gate should be "Gate B"
    d. Set the timer to "Interval" mode
3. Using the Vernier caliper, carefully measure the diameter of both the steel marble and the plastic marble. Record these measurements. (Note: You will have to repeat this step on day 2 if you do not complete data collection on the first day)
4. Measure and record the positions of gate A and gate B relative to the top of the stand.
5. Insert either the steel or the plastic marble into the release clamp; hold the base of the physics stand so that it does not wobble and release the marble.
    a. If the marble falls directly into the catch basket, it is a good drop, so move on to step 5 to record data.
    b. If the marble does not fall directly into the catch basket, it is not a good drop, so the data should not be recorded. Try again until you get a good trial and can move on to the next step.
6. When you have a good trial (the marble fell directly into the catch basket), record the following pieces of data from the timer box:
    a. The time it took the marble to travel through gate A
    b. The time it took the marble to travel through gate B
    c. The total time it took the marble to pass from gate A to gate B.

7. Remove the marble from the catch basket; repeat steps 5-7 for at least 2 more good trials at that position of gate B.
8. Repeat steps 6-8 for the other marble.
9. Loosen gate B and lower it approximately 5-8 cm; tighten it on the stand, again making sure that there is no space between the gate and the stand. (Note: gate A will remain in the same position throughout the lab)
10. Measure the position of gate B relative to the top of the stand.
11. Repeat steps 5-10 for a total of at least 10 positions of gate B.

Data Collection:

- Create 2 data tables—one for the steel marble and one for the plastic marble—***raw data only, no calculated values***!
- Record the following information for at least 3 GOOD trials of EACH marble (i.e. the marble falls into the catch basket) at each of at least 10 positions:
    - Position of gate B
    - Time through gate A
    - Time through gate B
    - Total time of falling (time between gates A and B)
- Record the position of gate A
- Record the mass and the diameter of both marbles

Data Analysis - Calculations: *(2 data tables)*

- For each marble, create a data table for the following calculated data—don't forget to show one example for the average calculation, and one example of a velocity calculation:
    - Average time through gate B
    - Average total time (time between gates A and B)
    - Instantaneous Velocity at gate B

Data Analysis - Graphs: *(2 graphs)*

- Create a graph to show the relationship between the instantaneous velocity of the marble and the total time it took for the marble to reach that velocity.
- You should have 2 graphs—one showing velocity vs. time for the plastic marble, and one showing velocity vs. time for the steel marble. OR 1 graph with two lines and a legend (key)

Conclusion:

1. According to your results, what is the acceleration due to gravity for each of the marbles?
2. The accepted average acceleration due to gravity is 9.81 m/s^2. Determine the percent difference for each marble. How accurate are each of your marbles' results?
3. Compare your marbles' results. Your values would be "significantly different", therefore disproving the assumption that all masses accelerate at the same rate, if your values are more than 8% different from one another. Do you think your results allow you to assume that mass is irrelevant, or do you think your results show that mass does indeed affect an object's acceleration due to gravity?
4. Discuss any errors that may have affected your results and, therefore, your answer to #3.