Investigation: Acceleration of Gravity (Ball Toss) **Name** _____

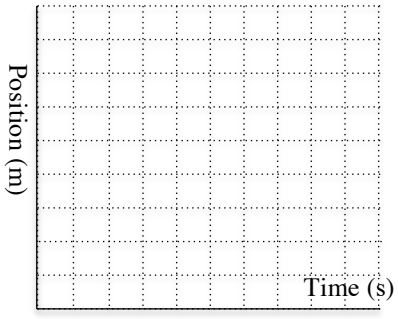
I. The Exploration

We will analyze the motion of an object thrown straight upward and allow to return to its original starting point. We will consider the ground to be the origin and upward as positive. When we conjecture on the behavior of the d vs. t, v vs. t and a vs. t graphs, we will not include the wait time, push time or catch time in our graphs.

Indicate which object you used in the experiment.

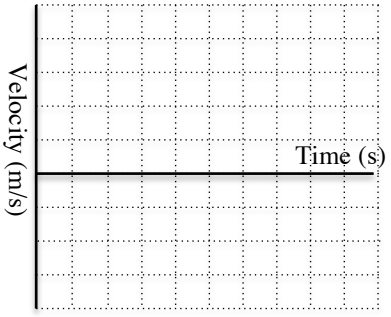
II. Predictions

Using a green pencil, sketch the position vs. time, velocity vs. time and acceleration vs. time graphs for the motion of the object going up & then down (the origin is to be taken at the floor & upward is positive). Do NOT include the wait time, push time or catch time.



III. Small Group Discussion

Share your thinking with your partners. Advocate for your ideas using logic, experience, intuition and imagination, but also listen to your partners' ideas with respect and an open mind. This method of collegial discourse sits at the heart of scientific discovery.

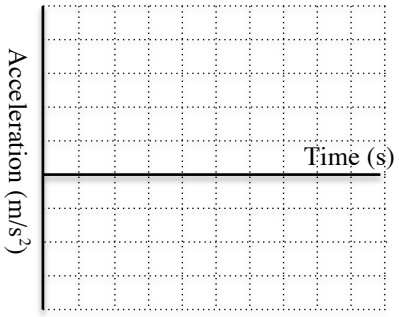


IV. Class or Multiple Laboratory Group Discussion

Sharing with the larger community.

V. Modify Individual Predictions

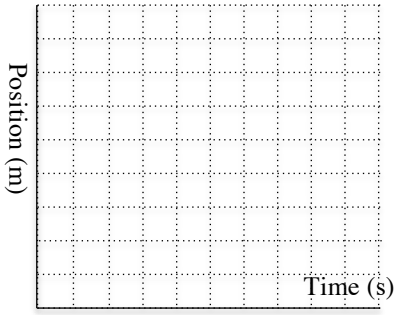
Guided by the previous discourse and reflective thinking edit your graphs to reflect any new beliefs. Use a different color pencil to distinguish your original graphs from the revised ones. If you make no revisions, in large print write **NC** (no change) in the upper right hand of each graph.



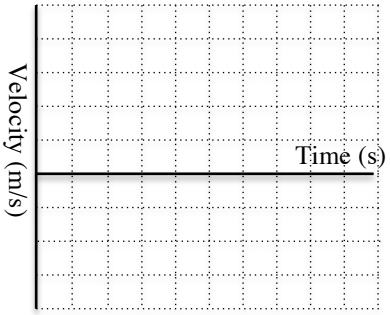
VI. Nature Speaks - Do the Experiment and Collect Data.

VII. Record Results and Class Discussion.

a. ***Acceleration by slope of velocity graph method***: Click and drag over the velocity graph where the graph is a straight diagonal. Then select "Fit" from the tool bar and choose *linear*. This exploration, unlike the acceleration of the cart on the ramp, gives us a direct experimental result for the value of free fall acceleration near the surface of the Earth. Record in box a your slope (acceleration) value with units.



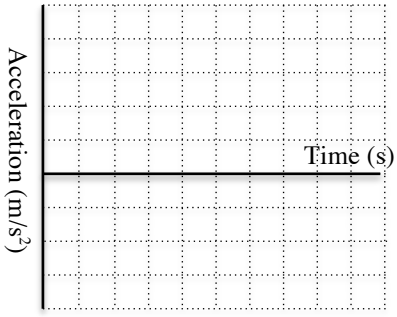
b. ***Acceleration from acceleration graph method***: Click and drag over the acceleration graph that corresponds to the same time interval that you chose in part (a) above. Then select "statistic" (sigma) from the tool bar. Record the average value of the acceleration of the object in box b during the time interval where the velocity looks like a straight line.



a. Acc. from slope v-t Graph

b. Acc. from a-t Graph Mean

c. We often want to know how an experimental value compare to an accepted value for a quantity we find. The general formula for calculating the percent difference between an accepted value and an experimentally determined value is: % difference = 100 x |(experimental value – accepted value)| ÷ (accepted value). Start off with re-writing the formula for % difference, then substitute into the formula your experimental value and the accepted value for g of 9.81m/s^2 and finally determine your % error. Use the average of (a) & (b) for your experimental value.



VII. Extended Discussion - Reflections

a. Comment on how the acceleration of an object thrown straight upward behaves on the way up, at the highest point of the motion and on the way down. Your comments should reference magnitude and direction for the acceleration during/at each of these regions/locations.

b. Comment on how the velocity of an object thrown straight upward behaves on the way up, at the highest point of the motion and on the way down. Your comments should reference magnitude and direction for the velocity during/at these regions/locations.

c. Comment on how the acceleration of an object thrown straight upward depends on the mass of the object and the initial speed the object is thrown with (compare your experimental value with those from other groups that used an object of different mass and/or threw the object at a different initial speed than you).

VIII. Extending Our Thinking

a. An anvil having a mass of 12kg falls from an overhang directly above Wile E. Coyote and takes 6.0s to reach the hapless critter below. (a) What height above the coyote's head was the anvil dropped from and (b) What is the speed of the anvil as it strikes Mr. Wile E. Coyote?

b. You are stranded on an unknown planet in a newly discovered stellar system. The acceleration of gravity on the surface of a planet depends on the planet's mass and radius. If you can determine the acceleration due to gravity on your planet and get that information to the scientists back home, they can narrow down the search effort. You can climb up a small ridge and you have a meter stick, stopwatch and a rock. Design an experiment to determine the acceleration due to gravity.

Method:

Perform the Experiment & Record Results in a Data Table (several trials)**:**

Calculation (show formula used, then substitution of values with units and finally an answer with units)**:**

% Difference with Accepted Earth Value: