Bouncing Ball Lab

Due: Monday, September 21, 2009

Names: _____

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Read this lab before coming to class on Friday, September 11th. Look up any terms you do not know before coming to class. Each person will be provided with a condensed lab handout, and should take notes on a separate sheet of paper. (Each group member should keep their own records of the data just in case, as well as any other notes they may need.)

Bell: _____

Date: _____

Final lab reports can be neatly written, but typing is preferred. If handwritten, be sure to include every section mentioned below. Each group will submit only one report. The template can be accessed online from the course website (at home or at school), just be sure to save your file before beginning any work, and remember to save often. If typing on the template, much of the required information is already included. To prevent waste (and printing fees for being wasteful at school), be sure to proofread your work, and [Print Preview] to make sure everything is correct before printing. If desired, use the copier in the library to make copies for each member of the group.

This lab report will be the first quarter project grade, which will be worth 10% of your quarter grade. Lab reports should be turned in as soon as complete, and must be turned in no later than 2:45pm Monday September 21st for full credit. A 10% deduction will be taken for each day late (20% for the weekend), through Monday, September 28th.

I. Title: Bouncing Ball Lab

II. Purpose:

III. Supplies/Materials:

A. One each:
- **1.** Tennis ball
- **2.** Racquet ball
- **3.** Golf ball
- **4.** Golf practice ball / whiffle ball

B. Meter stick or yard stick.
C. Flat Wall to measure against.
D. Hard surface to bouncing balls against.
E. Data table, pencils, etc.
F. Math book, science book, dictionary, library, internet, and other research resources may be necessary.
G. **Draw** a picture of the experimental setup in the space below. Call the drop height D and the bounce height B. Label both D and B in the drawing.

IV. Procedure:

A. Divide the activities so that one student drops the ball, one student watches the bounce and estimates the height to which it bounces, and one student records the data.
B. Obtain a set of balls to bounce from the class set provided and record the ID letters of the balls. You may need to use one or two, return them to the set and get the others, or trade with another group.
C. Drop each ball from various heights. The height to which the ball bounces is to be estimated as carefully as possible. Both the height of drop and the height of bounce should be recorded in data tables 1-4.
D. Drop the ball three times from each height with the average of the bounce heights used as the final measurement.
E. Drop the ball from at least four different heights between 9" and 42". Increase the height of drop by *at least* six inches (6") at a time until four or more drop heights have been completed.

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F. Care must be taken in doing the estimations. Use the same point on the ball (top) or (bottom) when judging both the height of the drop and the height of the bounce.

G. Graph.

1. Plot the data from all four tables on one sheet of graph paper. Choose your scale carefully. Be sure to leave room for extrapolation, and label your graph with a title, and *x*- and *y*-axis labels & scale.

2. Draw a trend line for the data points. Calculate the prediction equation for each ball, and include the equations on the graph.

3. Use the graph (or prediction equation) to predict the height of the bounce for a tennis ball dropped half way between two drop heights. This is called ***interpolation***. Record your prediction in data table 5.

4. Use your graph (or prediction equation) to predict the height of the bounce for a tennis ball dropped from 5-10 feet. This is called ***extrapolation***. Record your prediction in data table 5.

5. Test the predictions by dropping the ball from the chosen heights and measuring the bounce. Compare your predictions with the results from testing. Check with other groups and see if their results are similar to yours.

V. Observations:

VI. Data / Results:

A. Table 1: Type of Ball: Tennis Ball ID #

D, Drop Height _____ *units*	**B**, Bounce Height _____ *units*				
	Trial 1	Trial 2	Trial 3	**Average**	Ratio $\frac{B}{D}$

B. Table 2: Type of Ball: ID #

D, Drop Height _____ *units*	**B**, Bounce Height _____ *units*			
	Trial 1	Trial 2	Trial 3	**Average**

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C. Table 3: Type of Ball: ID #

D, Drop Height _____ *units*	**B**, Bounce Height _____ *units*			
	Trial 1	Trial 2	Trial 3	**Average**

D. Table 4: Type of Ball: ID #

D, Drop Height _____ *units*	**B**, Bounce Height _____ *units*			
	Trial 1	Trial 2	Trial 3	**Average**

E. Table 5: Interpolation and Extrapolation Predictions (Tennis Ball)

	Prediction	Test Results	Difference	% Error
Value between data points				
Value beyond data points				

VII. Calculations:

A. Provide calculations for finding the prediction equation for one of your curves. You may write this by hand, or use the equation editor in Word (Click Insert/Object/Microsoft Equation 3.0.)

VIII. Questions:

A. What is the ***independent variable*** in this experiment? What is the ***dependent variable***? How do you know which is which?

B. What variables should be held constant during each trial? Explain.

C. Why is it a good idea to carry out two to three trials for each value of D? Explain.

D. Were the measurements that you took during the lab ***precise***? Were they ***accurate***? What's the difference? Describe how your measurements were or were not ***precise*** or ***accurate***.

E. Identify possible sources of error for the Bouncing Ball Lab. Then explain how each of the sources of error in the lab could be minimized.

F. Attach your graph as the last page of the report.

1. On which axis (horizontal or vertical, and *x*- or *y*-) did you plot the ***independent variable***?

2. On which axis (horizontal or vertical, and *x*- or *y*-) did you plot the ***dependent variable***?

3. Should (0, 0) be included as a data point? Why or why not?

4. Should the line pass through (0, 0)? Why or why not?

5. Is D (drop height) a ***quantitative*** or a ***qualitative*** variable? Explain.

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6. Is the type of ball a ***quantitative*** or a ***qualitative*** variable? Explain.

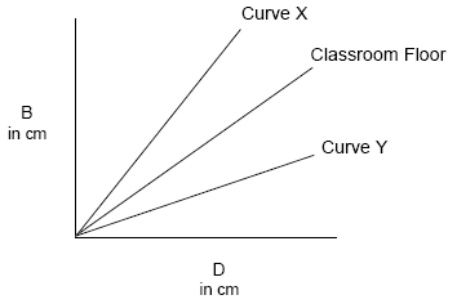
7. After you graphed your data you were asked to ***interpolate*** and ***extrapolate*** information from your graph. What do you conclude about the ***accuracy*** of information found from a graph by ***interpolating*** between data points and ***extrapolating*** beyond them? Explain your answer.

8. What happens to the bounce height as the drop height increases? What relationship does this suggest?

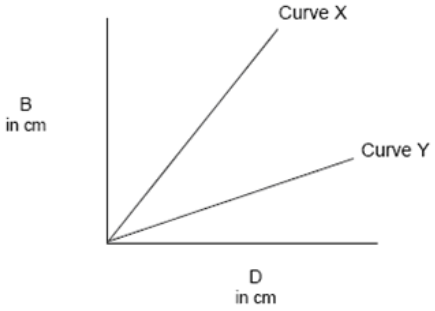
9. From the graph of the tennis ball, find the ratio $\frac{B}{D}$ for each of the tennis ball trials. Record the ratios in Table 1. Are the ratios close to each other?

- **a.** Based on your ratios and prediction equation, if you dropped your tennis ball from 25 ft, about how high would it bounce? Explain.
- **b.** Based on your ratios and prediction equation, if the ball bounced only 3 inches, about how high was it when dropped? Explain.
- **c.** What does the ratio $\frac{B}{D}$ represent?

10. If you did your experiment with the tennis ball on a carpeted classroom floor instead of the science lab, would the curve you obtained in the science lab be more like Curve X or Curve Y? Explain.



11. Balls are supposed to bounce higher on clay tennis courts than grass courts. Does Curve X or Curve Y in the graph below show data taken on a clay court? Explain.



IX. Conclusions:

X. Bonus A: If you complete all required data collection in class and have time for more, repeat the tennis ball experiment for several heights between 5-10ft. Do not include this data on the graph with all four bouncing balls. Create a new graph showing the complete tennis ball data. Is the relationship still linear? If so, does the slope of the best fit line change? If not, what type of relationship does it appear to be now? Discuss your findings.

XI. Bonus B: Use Excel to create a table of values for the four bouncing balls, and graph the resulting scatter plot. (Do not include the additional data from Bonus A.) Add trendlines to the graph for each ball, and display the equations on the graph. Compare your Excel graph with your hand-drawn graph, and the trendline equations with the prediction equations you calculated. Discuss your findings.