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Date _____

Purpose: Determine what variables affect the period of a pendulum.

Period (T): The amount of time for one complete oscillation or wave. A “complete” oscillation is a full “back and forth”.

Formula: Period = Time/cycle = (Total time) ÷ (# of cycles)

Example: A pendulum takes 50 seconds to swing back and forth 20 times. Period = _____ =

Hypothesis:

Materials: Thin String (at least 10 meters) Paper Clips Tape Timer
10 Round Masses between 10 and 200 grams Meter sticks or Measuring Tape

Procedure:

Part I: Manipulated Variable: Length

Responding Variable: Period

1. Hang up pendulums of various lengths, ranging from 0.10 m (10 cm) up to the maximum which will fit in your classroom. There should be at least 8 different lengths.
2. Go to one pendulum, as assigned by your teacher. Measure the length of the pendulum, from the attachment point at the top, down to the center of the bob. The bob is the object on the string.
3. Measure the amount of time it takes to make 15 complete (back and forth) swings.) **Important:** The pendulum should swing in the shortest possible arc. Pull the pendulum to the side only 5-10 cm (2-4 inches). Start the timer as you release the pendulum and say “GO”. Count a swing every time the pendulum returns to the spot you released it.
4. Stop the timer exactly as the pendulum reaches 15 complete cycles. Record the exact time on the timer, which measures to the hundredth of a second. Example: $t = 23.58 \text{ s}$
5. Record the number of swings, and the total time, in the data table.
6. Go to a pendulum you have not measured, and repeat steps 3 to 5. After you are done, repeat steps 3 to 5 for all the other pendulums.

Data and Results Table 1

[illegible]

Part II: Manipulated Variable: Mass of Bob

Responding Variable: Period

1. Measure the mass of 4 or 5 objects which can serve as pendulum bobs. Select 4 which have different masses. For example, you could use a small lead ball, a large lead ball, a golf ball, and a baseball.
2. Using these bobs, hang up at least 4 pendulums, all of which have the same length as measured to the center of the bob. Any length of 1 to 2 meters should work well, but you must make sure that the lengths are the same to the center of the bob.
3. Measure the period of the four pendulums using the same steps as in Part I of the procedure.

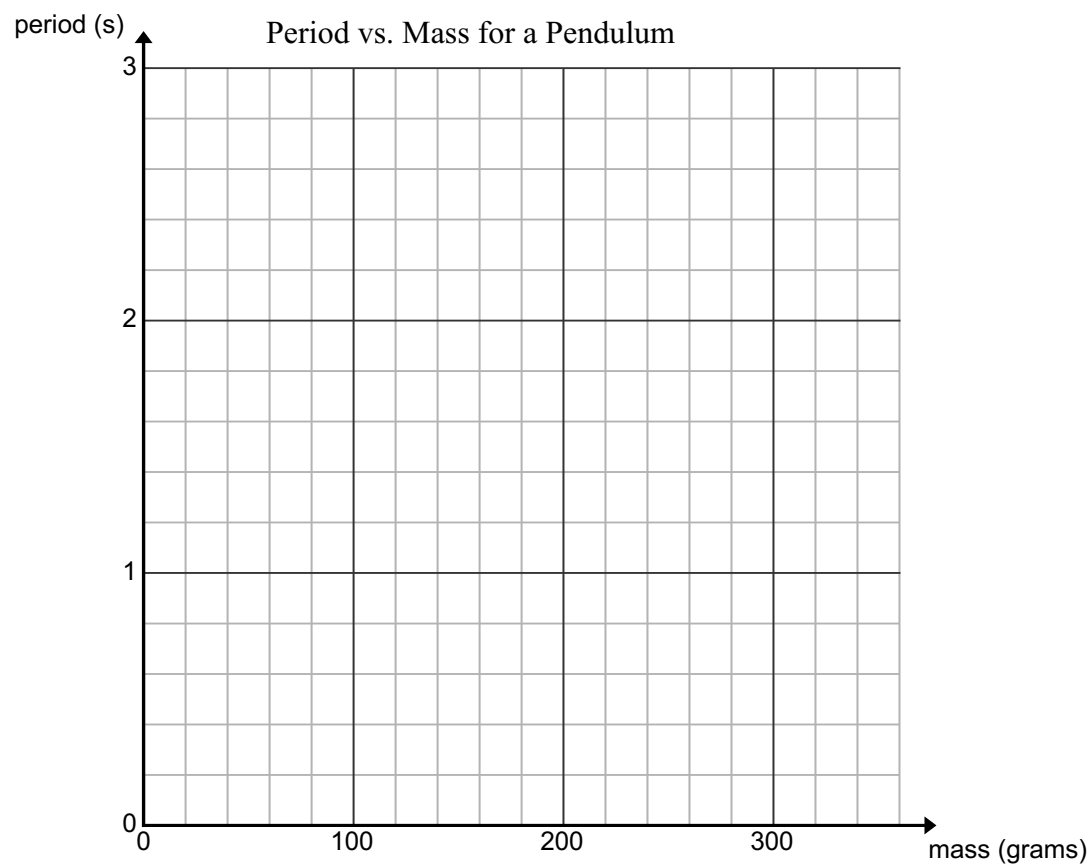
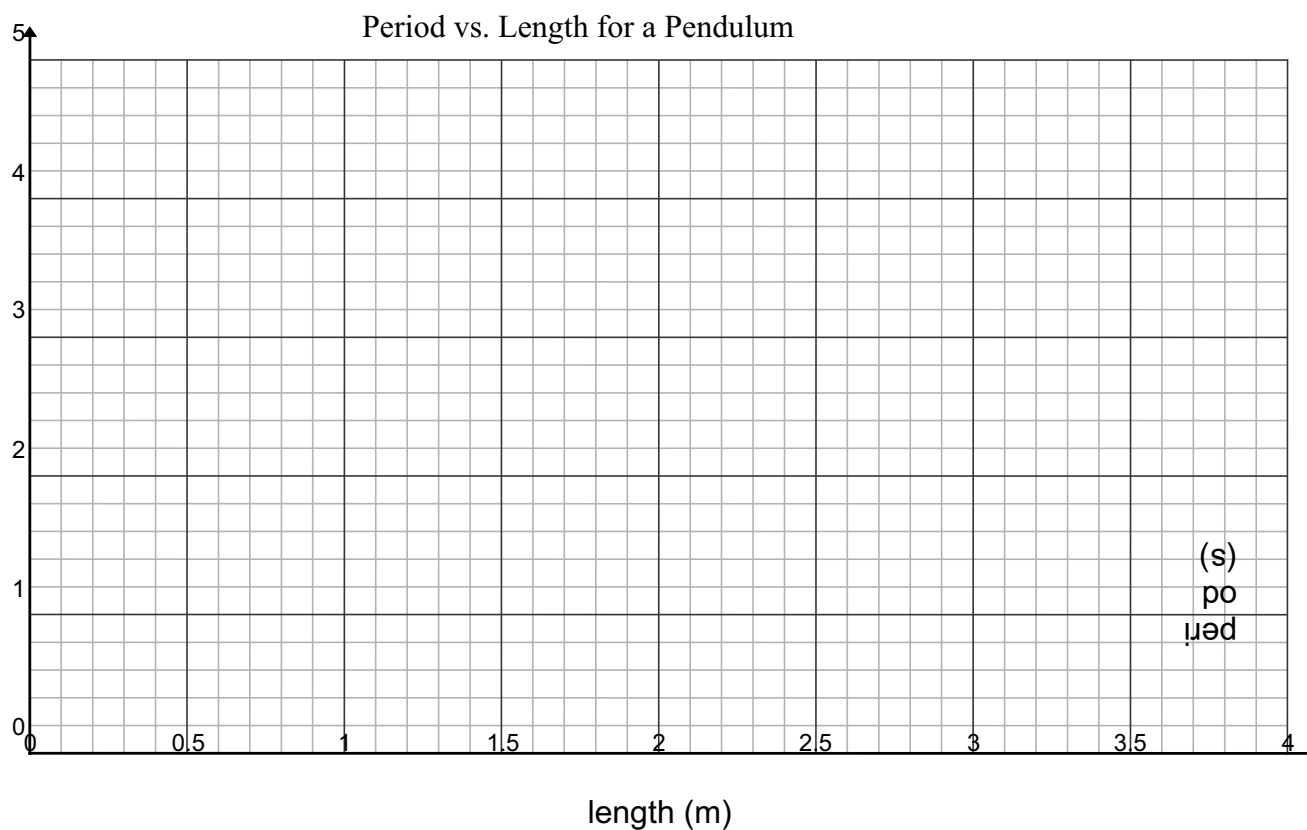
Data and Results Table 2

Pendulum	W	X	Y	Z
Length (m)				
Total Time				
# of cycles				
Period				

Calculations and Results

1. For each pendulum in Part I, calculate the period. (Remember, Period = total time / #cycles !)
2. From the data in Part I, make a graph of period versus length. This means that period is on the vertical y-axis, while length is on the x-axis, which is horizontal. Each pendulum should have one point on the graph. **DO NOT CONNECT THE DOTS.**
3. With a pencil, lightly sketch a best-fit curve through the points. The curve should be smooth, not jagged, and be near as many data points as possible, but it doesn't necessarily have to hit any data points exactly. There should be about as many data points above the curve as below the curve.
4. For each pendulum in Part II, calculate the period.
5. From the data in Part II, make a graph of period vs. mass.
6. With a pencil and a straightedge, sketch a best-fit line which comes close to all of the data points. Using a clear ruler will help a lot.

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Summary and Conclusion:

Answer these questions using complete sentences. If you are not sure what that means, ask your teacher.

1. Describe the relationship between the length and period of the pendulum.

As the length of the pendulum increased,

2. On your graph of period vs. length, were there any outliers, or points that were very far away from the best-fit curve? If so, what do you think caused the points to be so different from the others?

3. Describe the relationship between the mass and period of the pendulum.

4. What had a bigger effect on the pendulum's period, changing the mass or changing the length?

5. From your first graph, what would be the period of a pendulum which had a length of exactly 2.0 meters?

6. From your first graph, what length would a pendulum have to be to have a period of exactly 2.4 seconds?

Bonus Challenges: (in increasing order of difficulty)

- a) *In Data Table 1, calculate and fill in the square of the period in the blank spaces.*
- b) *On a separate sheet of graph paper, graph the square of the period vs. the length.*
- c) *Draw a best-fit straight line, and calculate the slope of this line. From this, you can calculate the exact formula for the period of any length pendulum.*