Swing Time Lab

Follow a pendulum procedure and use the data to explain a pattern.

CCSS.ELA-Literacy.RST.11-12.3 "Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Number the procedure actions in order, underline every measurement or condition that must be controlled, and circle the results and explanations that show what the data mean.

Testing Pendulum Periods

1. To investigate how pendulum length affects period, gather a ring stand, clamp, string, metal washer, meterstick, stopwatch, and a data table. Tie the washer to one end of the string. Secure the other end in the clamp so the washer can swing freely without striking the stand. Measure from the clamp point to the center of the washer, then adjust the string to 25.0 centimeters. Record this length before releasing the pendulum. Keep the same washer for every trial, because changing its mass would add an unnecessary variable.

2. Pull the washer sideways until the string forms an angle smaller than 10 degrees from vertical. Do not push it. Start the stopwatch as the washer passes the center position, count the initial pass as zero, then stop on the tenth return to that point in the same direction. Divide the recorded time by ten to find one period. Repeat this timing procedure twice more at 25.0 centimeters, then average the three periods. Next, change only the measured length to 50.0 centimeters and 75.0 centimeters, completing three trials and an average at each length.

3. The averages were 1.01 seconds at 25.0 centimeters, 1.42 seconds at 50.0 centimeters, and 1.74 seconds at 75.0 centimeters. Thus, longer pendulums took more time for each swing, but doubling the length did not double the period. This pattern fits the relationship for a small-angle pendulum, in which period increases with the square root of length. If a trial produced a much shorter period at 75.0 centimeters, check whether the length was measured to the washer's center or whether the pendulum was pushed during release. Either error could change the result.

2 ANSWER WITH EVIDENCE

Use the passage

1. Describe the exact timing sequence, from starting the stopwatch through finding one period.

2. What two release conditions must stay the same before each timing trial, and why do they matter when comparing lengths?

3. Use the averages at 25.0 and 50.0 centimeters to explain why doubling the length did not double the period.

4. A 75.0-centimeter trial has a much shorter period than expected. What two possible errors should you check?

3 YOUR TURN

Your own words

With teacher supervision, carry out the procedure at 25.0, 50.0 and 75.0 cm using a securely clamped light washer and clear swing area. Do not swing it near anyone. At each length, record three actual ten-swing times in seconds, divide each by ten, and calculate the average period. Use a separate labeled data sheet. Analyze your actual pattern using paragraph 3; describe one control and any unusual result or trial problem. Then retain the extension: write four steps for 100.0 cm and predict its period. Do not substitute the passage's example data for measurements.

ANSWER KEY

Swing Time Lab

PART 1 · READ AND MARK

Number the procedure actions in order, underline every measurement or condition that must be controlled, and circle the results and explanations that show what the data mean. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Describe the exact timing sequence, from starting the stopwatch through finding one period.	**Start at a center pass counted as zero; count ten full cycles and stop at the tenth center return in the same direction. Divide the total time by ten.**
2	What two release conditions must stay the same before each timing trial, and why do they matter when comparing lengths?	**Keep the release angle smaller than 10 degrees and do not push the washer. Keeping these conditions consistent makes length the intended changing variable.**
3	Use the averages at 25.0 and 50.0 centimeters to explain why doubling the length did not double the period.	**The length doubles from 25.0 to 50.0 centimeters, but the period rises from 1.01 to 1.42 seconds, not to 2.02 seconds. This supports the square-root relationship.**
4	A 75.0-centimeter trial has a much shorter period than expected. What two possible errors should you check?	**Check whether the length was measured to the washer's center and whether the pendulum was pushed during release.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Illustrative record only, not measured student data: at 25.0 cm, ten-swing times 10.0, 10.2, 10.1 s give periods 1.00, 1.02, 1.01 s and mean 1.01 s. At 50.0 cm, 14.1, 14.2, 14.3 s give mean 1.42 s; at 75.0 cm, 17.3, 17.4, 17.5 s give mean 1.74 s. Longer lengths have longer periods; doubling 25.0 cm gives about 1.41 times its period, not twice. Check actual deviations and release/length controls.
Extension: 1. Set 100.0 cm pivot-to-center length with the same washer. 2. Release below 10 degrees without pushing. 3. Time ten complete cycles from a center pass to the tenth return in the SAME direction and divide by ten. 4. Repeat twice and average. Predicted period is about 2.0 s, twice the 25.0 cm example.

Teacher sets up and supervises safe secured apparatus, supports timing roles and checks actual procedure-following. Require labeled actual times, periods, means and analysis using the text; allow measurement variation and discuss controls rather than force matching example results. Check units and calculations. Retain the four-step extension and approximately 2.0 s square-root prediction. The model values are illustrative only; a plan or copied example does not complete execution.