

NOTE: All materials are those of the project team and do not represent KDE endorsement.

Classroom Embedded Assessment [CEA] Title: Pendulum Swing

a. Targeted Performance Expectation(s)

3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. {Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.} {Assessment Boundary: Assessment does not include technical terms such as period and frequency.}
Practices in the foreground – Planning and Carrying Out Investigations, Analyzing Data
Cross Cutting Concept in the foreground - Patterns

b. Learning Goal(s)

1. Learners will make observations of a pendulum and record their results on a chart.
2. Learners will identify patterns within their results.
3. Learners will make a logical (evidence based) prediction of how many times the pendulum will swing with the string cut to a new length on the pendulum.
4. Learners will give evidence from their chart to help support their prediction.

c. Instructional Context

This CEA will be administered in the middle of the forces and interactions unit and before introducing magnets or the forces observed from static electricity. Before this CEA, students have explored balanced and unbalanced forces and the results of gravity and friction. Students have interacted with these topics through experimentation, recording observations in their journals, as well as completing noticing routines to help generate testable questions.

Prior to this experience, students have completed a probe predicting what affects the number of swings of a pendulum within a given time period and informally collected data on how the weight of the pendulum, the release height of the pendulum, and the length of the string to see which variables affect the number of times it swings. After discussion and analysis of data collected, they have concluded that the length of the string is the only one of those three factors that changes the number of times a pendulum swings within a given time period.

Now, we are going to evaluate how the length of the string affects the number of swings in 30 seconds look to see if a pattern emerges in the data, and if we can predict the approximate number of swings with a new length of string, based on any observed patterns. As a class, the teacher and students will collaboratively develop a procedure for testing, controlling variables to make it a fair test, and participating in multiple trials at each string length.

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d. Student Task/Prompt – *see end of document for exact copy of handouts distributed to students*

Directions: We are going to collect data about the number of times a pendulum swings in a 30 second period. We will try each length of string three times and count how many swings occur. Complete the chart below with your observations, then answer the questions using your data as evidence. (As class, students investigate four different lengths of pendulums, recording the number of times the pendulum swings for three trials. They may make other notes as they work in the right-hand column.)

Length of string	Number of swings in 30 sec.			Other observations to note
	1 st trial	2 nd trial	3 rd trial	
8 inches				
12 inches				
16 inches				
20 inches				
You may choose a length ____ inches				

Using your data from your chart, answer the following questions.

- From your observations and the data you collected, what are two patterns you noticed?
 The first pattern I noticed was _____.
 The second pattern I noticed was _____.
- Using the patterns you observed, make a prediction. If the string was 18 inches long, about how many times do you think it would swing? _____

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3. Why do you think that would be true? Use evidence from your chart to support your answer.

Or an alternative format could be more scaffolded – I think an 18 inch string would swing _____ times because _____.

4. What prediction would you make about a pendulum that has a string length of 4 inches?

5. What evidence from your chart supports your answer?

e. Success Criteria

A strong student response might look like this:

Directions: We are going to collect data about the number of times a pendulum swings in a 30 second period. We will try each length of string three times and count how many swings occur. Complete the chart below with your observations, then answer the questions using your data as evidence. (As class, students investigate four different lengths of pendulums, recording the number of times the pendulum swings for three trials. They may make other notes as they work in the right-hand column.)

Length of string	Number of swings in 30 sec.			Other observations to note
	1 st trial	2 nd trial	3 rd trial	
8 inches	37 swings	36 swings	36 swings	Moves fast, all three times the result was close to the same, 36 or 37
12 inches	29 swings	29 swings	29 swings	Swings a few less times, all had 29 swings
16 inches	24 swings	24 swings	23 swings	All results were close to the same, 23 or 24. It is swinging fewer times than with either 8 or 12 inch strings.

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20 inches	22 swings	22 swings	22 swings	All results the same. It is swinging fewer times than with the 16 inch string.
You may choose a length ___24_ inches	19 swings	19 swings	18 swings	This is the lowest number of swings yet. I chose 24 to see if the pattern would continue.

Using your data from your chart, answer the following questions.

- From your observations and the data you collected, what are two patterns you noticed?
 The first pattern I noticed was every time in the chart, the string got longer. We measured at 8, 12, 16, 20, 24 inches. Each time the string was four inches longer.
 The second pattern I noticed was the number of swings was less as the string got longer. At 8 inches we got 37 swings. At 12 inches we got 29 swings. (29 is less than 37.) At 16 inches we got 24 swings. (24 is less than 29.) At 20 inches we got 22 swings. (22 is less than 24.)
 Note: Other patterns may be found in the data that could logically be used here.
- Using the patterns you observed, make a prediction. If the string was 18 inches long, about how many times do you think it would swing? If the string was 18 inches long I think it would swing 23 times.
- Why do you think that would be true? Use evidence from your chart to support your answer.
I think it would swing 23 times because 18 inches is in between 16 and 20, so I think the number of times it would swing would be in between 22 and 24. 23 is in between 22 and 24.
 Or an alternative format could be more scaffolded – I think an 18 inch string would swing ___23___ times because 23 is in between 22 and 24, and the 18 inch string is in between 16 and 20.
- What prediction would you make about a pendulum that has a string length of 4 inches?
I think it would be swinging a lot of times in 30 seconds, maybe like 50 swings.
- What evidence from your chart supports your answer?
 In my chart you can see that at 8 inches, it swung 36 or 37 times. A 4 inch string is really short, so I think it will swing a lot more than 37 times, maybe about 50 times. As the string is shorter, the number of swings gets higher.

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Success Criteria for Learning Goal 1 –

- Learners will make observations of a pendulum and record their results on a chart.

Successful	On the way	Doesn't meet the learning goal
Student made observations and recorded them in the chart appropriately.	Student made some observations or measurements but their record isn't complete.	Student does not attempt to record observations in the chart.

Success Criteria for Learning Goal 2 –

- Learners will identify patterns within their results.

Successful	On the way	Doesn't meet the learning goal
Student can identify two patterns in the data chart.	Student can identify one pattern in the data chart.	Student cannot identify patterns in the data chart.

Success Criteria for Learning Goal 3 –

- Learners will make a logical (evidence based) prediction of how many times the pendulum will swing with the string cut to a new length on the pendulum.

Successful	On the way	Doesn't meet the learning goal
Student makes prediction that shows they understand the pattern that is observed.	Student makes a prediction that shows incomplete understanding of the pattern that is observed.	Student doesn't make a prediction or makes a prediction that does not reflect understanding of the pattern.

Success Criteria for Learning Goal 4 –

- Learners will give evidence from their chart to help support their prediction.

Successful	On the way	Doesn't meet the learning goal
Student cites evidence from data collected that shows their prediction is based on a pattern observed.	Student cites evidence but connection to the prediction isn't clear or accurate.	Student doesn't cite evidence to support their prediction.

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f. Next Instructional Steps

For students who need additional help with Learning Goal 1 –

If the student has trouble with filling in the data chart, provide construction paper strips to cover unused portions of the chart and help them stay on the right line, or provide a partner to assist with data collection. You might also allow alternative formats to be used to collect data or record results, with increased scaffolding.

For students who need additional help with Learning Goal 2–

If the student has trouble identifying patterns, you might provide multiple opportunities to look for patterns in data (increasing numbers, decreasing number, numbers that are similar) including nonexamples (no pattern evident or random data). These opportunities could include other force and interaction experiences with data, weather and climate data, etc. Data may be either qualitative or quantitative. You could use color coding of certain results to help patterns become more apparent. For example color green the fast swings where there is a higher number of swings, yellow medium speed where the number of swings is lower, orange the slower swings, red for the very slow swings.

For students who need additional help with Learning Goal 3–

If the student has difficulty with a written prediction, you might scaffold the sentence for them, such as “I think at 18 inches, it will swing ___ times. I think this because _____.” Highlighting data from the chart that they want to include in their response may be helpful. If they need practice extending patterns, real examples to do this can be highlighted. For example, students could collect data about the types of clothing they see on the playground at different temperatures, and then extend that pattern. If we see all kids wear jackets in cold weather (below 40 degrees) and many kids wear jackets in cool weather (less than 60 degrees), and only a few kids wear jackets in warm weather (less than 80 degrees), then what will happen in hot weather? I think this because _____.

For students who need additional help with Learning Goal 4–

If the students are having trouble giving evidence to support their prediction, data can be graphed to help give a better visual to see the pattern. The I Squared Method (BSCS) can help students connect what is observed with what that means. They could cite evidence to back predictions with data in other scenarios.

Ideas for Extensions:

- Students can create pendulums with varying objects and see if the number of swings changes with different objects weighting the end of the pendulum. Is the behavior of the pendulum predictable from the pattern observed?
- Graph results of the number of swings in a bar graph or pictograph. Invite students to think of different ways to represent the data.
- Look for objects that are pendulums around us in everyday usage (swings, metronome, etc.) What would happen to the speed of the swing if the chains were shortened?

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g. Student Work Samples

The task has been altered now from the original form, and so student work samples were based on a previous version of this task.

h. Reflection and Revision

Students needed more opportunities to analyze the data we collect to see more examples of the patterns within data. Next time I'll build in additional experiences prior to administering this classroom embedded formative assessment.

NOTE: Student handout pages begin on next page

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Name: _____ Date: _____

Pendulum Swing

3-PS2-2: *Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.*

I can make observations of an object’s motion to help me predict its future motion.

Directions: We are going to collect data about the number of times a pendulum swings in a 30 second period. We will try each length of string three times and count how many swings occur. Complete the chart below with your observations, then answer the questions using your data as evidence.

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Using your data from your chart, answer the following questions.

1. From your observations and the data you collected, what are two patterns you noticed?

The first pattern I noticed was _____
_____.

The second pattern I noticed was _____
_____.

2. Using the patterns you observed, make a prediction. If the string was **18 inches** long, how many times do you think it would swing?

3. Why do you think that would be true? Use evidence from your chart to support your answer.

4. What prediction would you make about a pendulum that has a string length of **4 inches**?

5. What evidence from your chart supports your answer?
