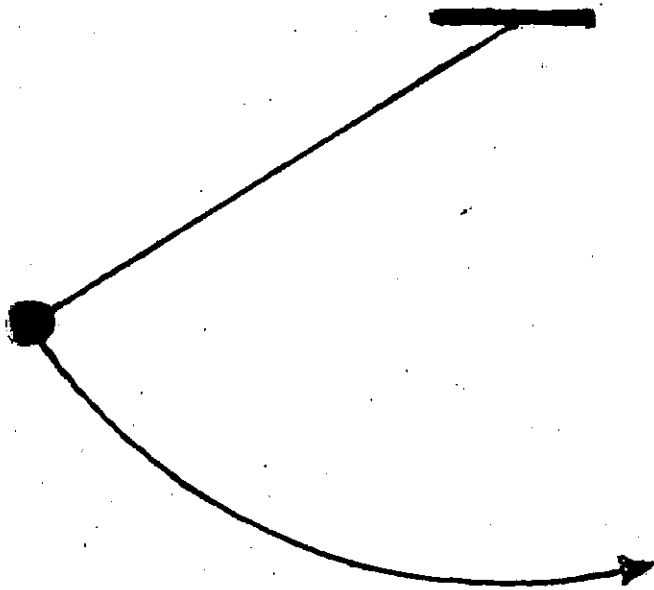


# **Inquiry Science**



**Confratute 2017  
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NAME: \_\_\_\_\_

You have just graduated from college and are applying for a position at a well-known engineering company that is opening an office in your area. The company is looking for four important skills in its new employees.

1. **Formulating Questions and Hypothesizing:** The company is looking for people who can give sound reasons for the predictions they make. The prediction does not have to be correct, but it must be supported by logical explanations, backed by scientific reasoning.
2. **Planning And Critiquing Investigations:** The company is looking people who can accurately describe how they collect their data and clearly explain what is being changed and what is being controlled in the experiments.
3. **Conducting Investigations:** The company is looking for people who can work cooperatively with others to accurately collect data, present it in both data charts and graphs, and give a clear summary of the data.
4. **Developing and Evaluating Explanations:** The company is looking for people who can use data to support conclusions, explain whether or not a prediction is supported by data, and come up with new and/or better ways to test a hypothesis.

The company has asked selected candidates, including you, to complete an activity they have designed to test for these qualities. When you arrive at the company you are broken up into small groups and given the following problem to solve.

**SCENARIO:** An amusement park owner has come to the company for help with an idea for a new ride. It involves attaching one to three people to a steel wire, lifting them, and letting them swing like a large pendulum. He has come to your engineering firm to have you determine whether the weight of the riders or the length of the pendulum will make a difference in the time it takes the pendulum to complete a swing.

Your assignment is to submit your individual packages - with all parts complete - as well as a final group report. Your group report must contain all of the following parts:

1. A cover page that includes a title, date, names of group members and at least one illustration.
2. Initial hypotheses on the effect of length and weight on a pendulum's swing.
3. A clear description of how you constructed your model and collected your data, preferably with a numbered, step-by-step procedure for your experiment.
4. Data charts containing the data collected and line graphs made using your data. Each graph must have a title and each axis must be labeled and numbered.
5. Conclusions based on and supported by the data collected.
6. Any additional observations or illustrations that will help the amusement park owner understand your report.

NAME: \_\_\_\_\_

**Part One: FORMULATING QUESTIONS AND HYPOTHESIZING**

**1. HOW DOES WEIGHT AFFECT THE SPEED OF A PENDULUM'S SWING?**

Will a heavier pendulum make it swing faster, slower, or about the same as a pendulum that is not as heavy?

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Why do you think your prediction is true?

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**2. HOW DOES THE LENGTH AFFECT THE SPEED OF A PENDULUM?**

Will a longer pendulum swing faster, slower, or about the same as a shorter pendulum?

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Why do you think your prediction is true?

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NAME: \_\_\_\_\_

**Part Two: PLANNING AND CRITIQUING INVESTIGATIONS:**

One of your team members thinks that you can use a piece of string and 20 metal washers to model the ride and collect data. She says that you must keep the length constant while you are changing the number of washers, and you must keep the number of washers constant while you are changing the length.

**3. How could you make a model of this ride using a piece of string and 20 washers?**

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**4. Why is it important to keep the length of the pendulum constant while you are changing the number of washers? What might have happened if you changed the length AND the number of washers?**

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**Part Three: CONDUCTING INVESTIGATIONS:**

You decide to measure each pendulum by counting the number of swings the pendulum makes in 30 seconds. You want to test at least three different weights and at least three different lengths.

**5. Explain how you will collect data. Be sure to describe your model, and tell what lengths and weights you will use. Someone reading this part of your report should be able to repeat your experiment exactly.**

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NAME: \_\_\_\_\_

6. Record the data for changing weight, then graph your data :

**DATA CHART: CHANGING WEIGHT** (length = \_\_\_\_\_ cm)

# OF WASHERS	TRIAL #1 (swings)	TRIAL #2 (swings)	TRIAL #3 (swings)	AVERAGE (swings)

**TITLE** \_\_\_\_\_

**# OF SWINGS IN 30 SECONDS**


**# OF WASHERS**

NAME: \_\_\_\_\_

7. Record the data for changing length, then graph your data:

**DATA CHART: CHANGING LENGTH** (# of washers = )

LENGTH (centimeters)	TRIAL #1 (swings)	TRIAL #2 (swings)	TRIAL #3 (swings)	AVERAGE (swings)

**TITLE**

**# OF SWINGS IN 30 SECONDS**


**LENGTH (centimeters)**

NAME: \_\_\_\_\_

GROUP \_\_\_\_\_

**Part Four: DEVELOPING AND EVALUATING EXPLANATIONS**

**8. What did you discover about the relationship between the weight and the speed of a pendulum? Be sure to use your data to support your answer.**

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**9. What did you discover about the relationship between the length and the speed of a pendulum? Be sure to use your data to support your answer.**

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**10. Look back at your original prediction about the effect of weight on the speed of a pendulum. Look at your data. Did your data support your prediction? Use your data to explain your thinking.**

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**11. Look back at your original prediction about the effect of length on the speed of a pendulum. Look at your data. Did your data support your prediction? Use your data to explain your thinking.**

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**12. Predict how long a pendulum would have to be to complete ten full swings in 30 seconds and explain your thinking.**

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**13. Write a different experimental question (cause and effect) about pendulums that you might investigate. Be sure to use the verb AFFECT in your question.**

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**14. How would you collect information to help you answer your new question?**

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## INQUIRY SCIENCE TASK.....THE PENDULUM:

The following scoring guide is similar to the one used in the released NECAP materials.

### Items #1,2 Point Range: 0-2

- 2** - Response includes a prediction that is reasonable in terms of available evidence **AND** response includes an explanation that supports the prediction.
- 1** - Response includes a prediction that is reasonable in terms of available evidence but lacks a supporting explanation **OR** response has an explanation but does not include a prediction.
- 0** - Response includes a prediction that is not reasonable in terms of available evidence **AND** response lacks any supporting explanation **AND** response is not relevant to the question being asked.

### Item #4 Point Range: 0-2

- 2** - Response indicates the importance of changing only one variable at a time **AND** response explains that results would not be reliable if more than one variable was changed.
- 1** - Response indicates the importance of changing one variable at a time.
- 0** - Response does not correctly indicate the importance of changing only one variable at a time **OR** response is not relevant to question being asked.

### Items #6, 7 Point Range: 0-3 (Use same scoring for each of the two graphs.)

- 3** - Response is a line graph that accurately represents the data (the numbers of swings, lengths and numbers of washers plotted on the graph correspond to the recorded data) **AND** response (graph) includes a scale appropriate to the range of the data collected **AND** response (graph) includes a relevant title.
- 2** - Response is a line graph that accurately represents the data. (The numbers of swings, lengths and numbers of washers plotted on the graph correspond to the recorded data) **AND** response (graph) includes a scale appropriate to the range of the data collected **OR** response (graph) includes a relevant title.
- 1** - Response is a line graph or another representation that displays data but omits required components **OR** response (graph) includes a scale appropriate to the range of the data collected **OR** response (graph) includes a relevant title **OR** response indicates a limited understanding of representing data in a graph.
- 0** - Response does not accurately represent data, uses an incorrect scale, and lacks a relevant title.

**Items #8, 9 Point Range: 0–3**

- 3** - Response provides a reasonable explanation that accurately reflects the correct relationship between the length (or weight) of a pendulum and the speed of its swing **AND** response includes data to support the explanation.
- 2** - Response provides a reasonable explanation that accurately reflects the correct relationship between the length (or weight) of a pendulum and the speed of its swing **AND** response does not include data to support the explanation.
- 1** - Response includes a more general explanation of the relationship between the length (or weight) of a pendulum and the speed of its swing **AND** response does not include data to support the explanation.
- 0** - Response includes an incorrect explanation of the relationship between the length (or weight) of a pendulum and the speed of its swing **AND** response does not include data to support the explanation.

**Items #10, 11 Point Range: 0–2**

- 2** - Response correctly indicates whether the data supports the prediction **AND** response includes data to correctly explain the relationship between the prediction and the findings.
- 1** - Response correctly indicates whether the data supports the prediction **OR** response explains the relationship between the prediction and the findings but omits supporting data.
- 0** - Response incorrectly indicates whether the data supports the prediction **AND** response does not include an explanation or includes an explanation that is incorrect or irrelevant **AND** response omits supporting data.

**Item #12 Point Range: 0–2**

- 2** - Response includes a prediction that is reasonable in terms of available evidence **AND** response includes an explanation that supports the prediction.
- 1** - Response includes a prediction that is reasonable in terms of available evidence, but lacks a supporting explanation **OR** response includes an explanation but does not include a prediction.
- 0** - Response includes a prediction that is not reasonable in terms of available evidence **AND** response lacks a supporting explanation **OR** response is not relevant to the question being asked.

**Item #13 Point Range: 0–2**

- 2** - Response is a question that includes a cause-and-effect relationship.
- 1** - Response is a question that does not include a cause-and-effect relationship.
- 0** - Response is not a question.

**Item #14 Point Range: 0–2**

- 2** - Response clearly identifies key pieces of evidence that would need to be collected to answer the question.
- 1** - Response identifies general evidence that would need to be collected to answer the question.
- 0** - Response does not include evidence related to the question **OR** response describes evidence that would answer a different question.

## INQUIRY SCIENCE TASK.....THE PENDULUM:

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### Item #4 Point Range: 0-2

- 2** - Response indicates the importance of changing only one variable at a time **AND** response explains that results would not be reliable if more than one variable was changed.
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- 2** - Response provides a reasonable explanation that accurately reflects the correct relationship between the length (or weight) of a pendulum and the speed of its swing **AND** response does not include data to support the explanation.
- 1** - Response includes a more general explanation of the relationship between the length (or weight) of a pendulum and the speed of its swing **AND** response does not include data to support the explanation.
- 0** - Response includes an incorrect explanation of the relationship between the length (or weight) of a pendulum and the speed of its swing **AND** response does not include data to support the explanation.

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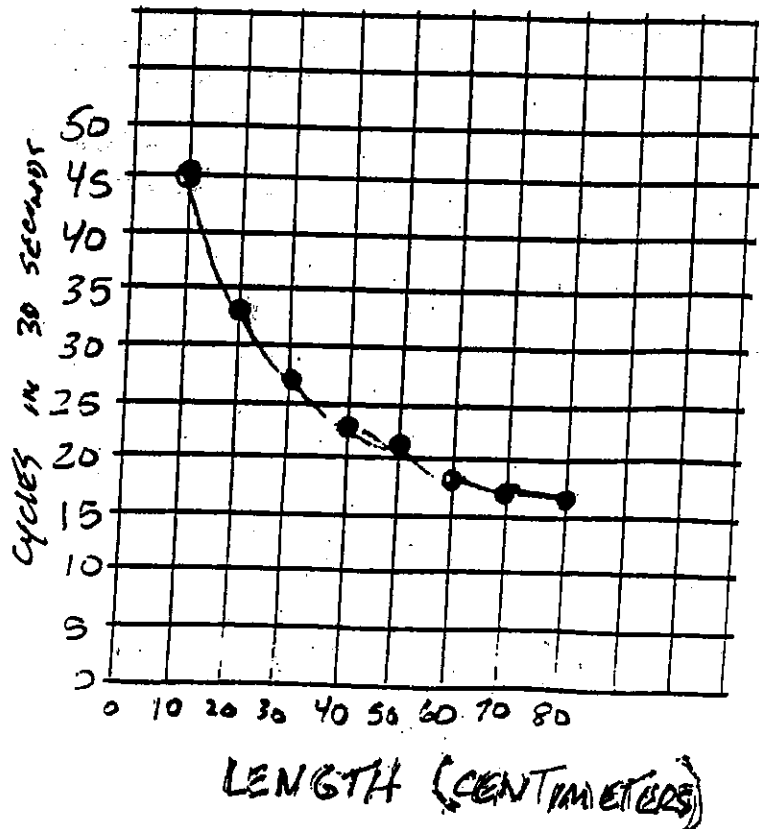
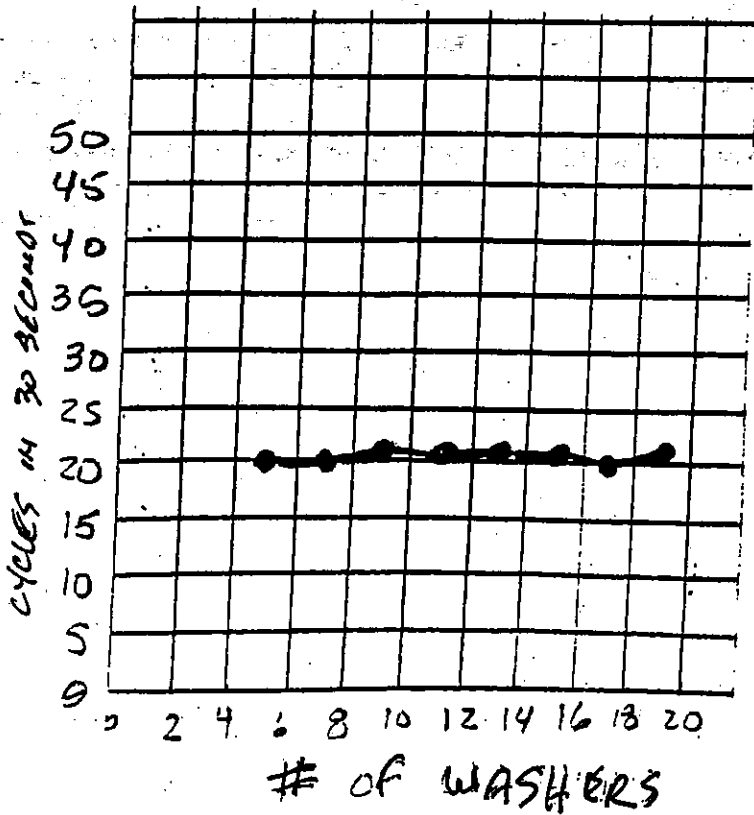
# SAMPLE PENDULUM DATA

Pendulum 50 centimeters long

washers	cycles in 30 seconds
5	20
7	20
9	21
11	20.5
13	21
15	20.5
17	20
19	21

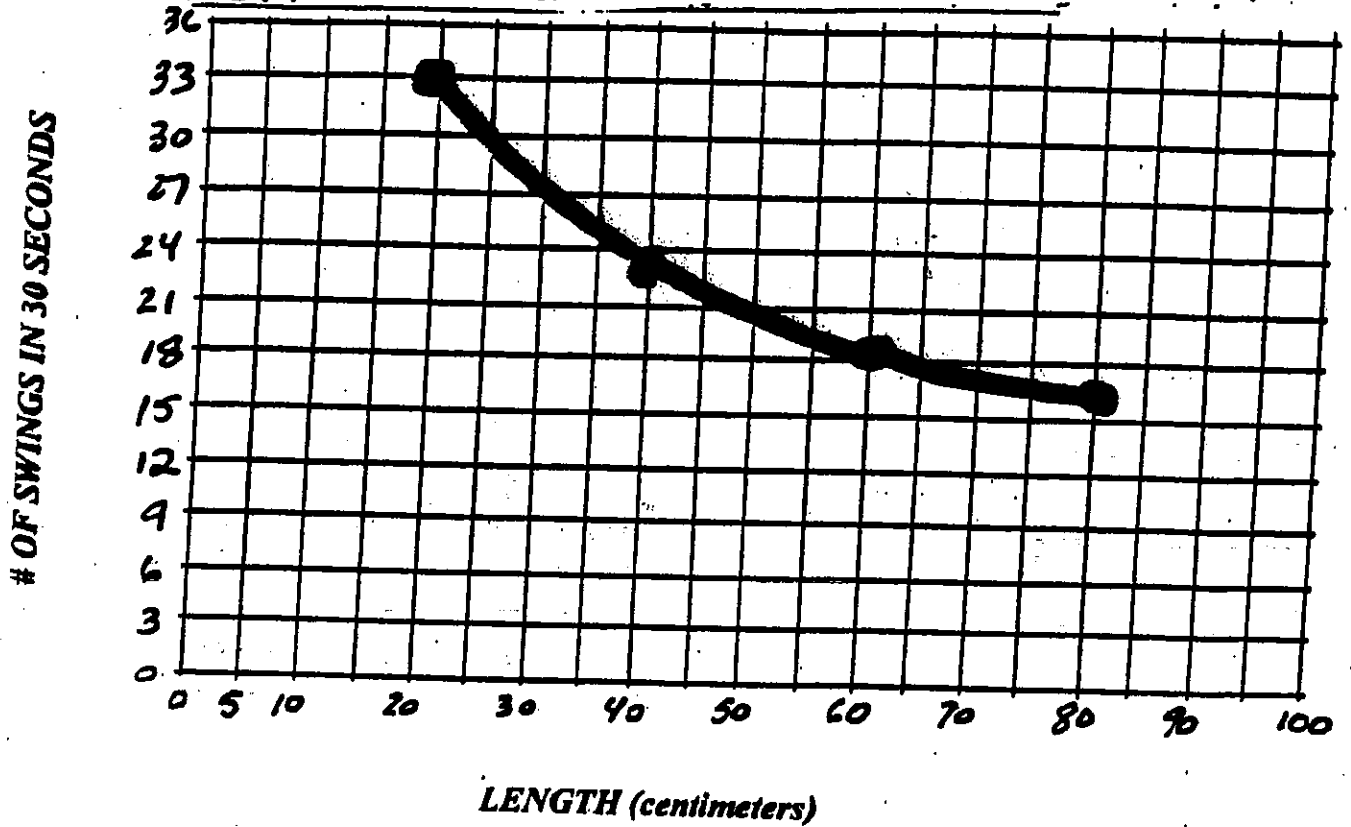
Pendulum with 10 washers

length (centimeters)	cycles in 30 seconds
10	45
20	33
30	27
40	23
50	20.5
60	18.5
70	17
80	16.5



# SAMPLE DATA

TITLE EFFECT OF LENGTH ON A PENDULUM'S SPEED

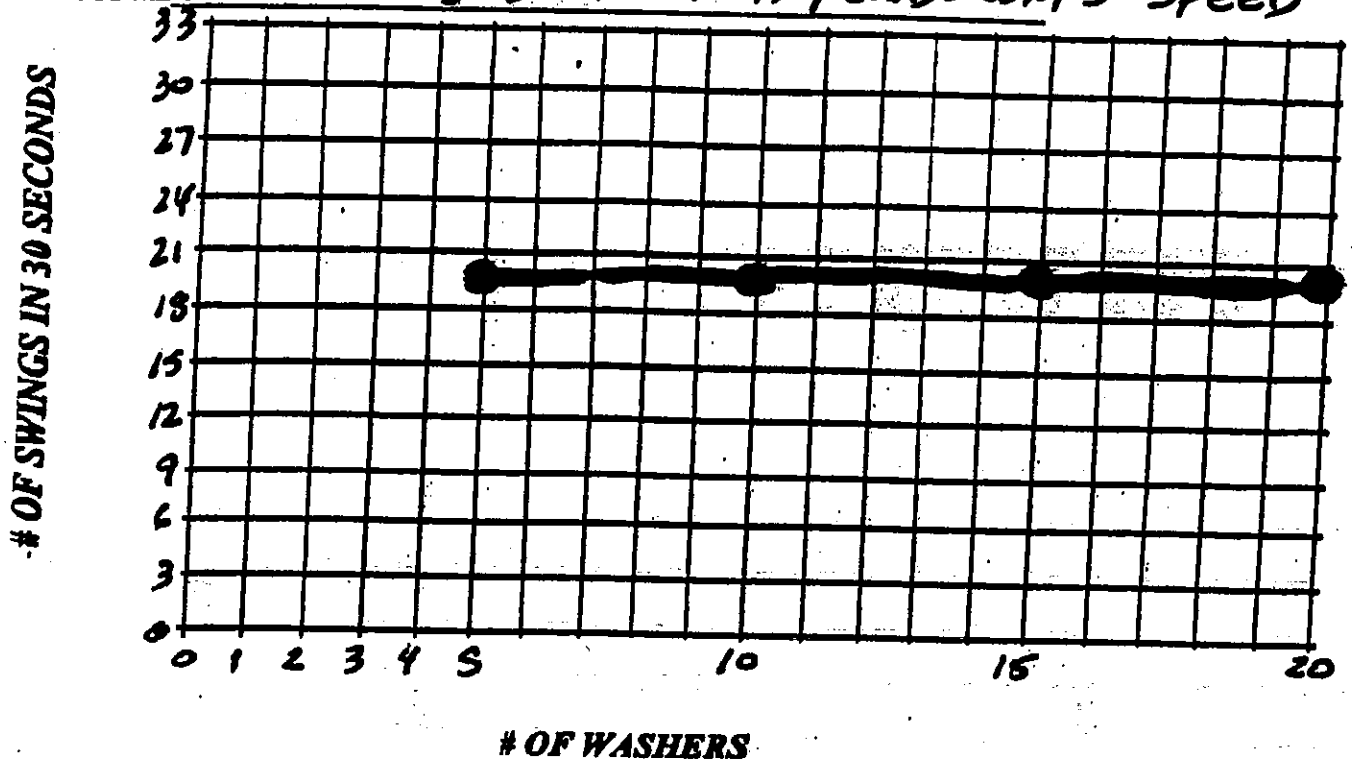


CHANGING LENGTH (weight = 20 washers)

LENGTH (centimeters)	TRIAL #1 (swings)	TRIAL #2 (swings)	TRIAL #3 (swings)	AVERAGE (swings)
20	33	32	34	33.0
40	22	24	23	23.0
60	18	19	18	18.3
80	17	17	16	16.7

## SAMPLE DATA

TITLE: EFFECT OF WEIGHT ON A PENDULUM'S SPEED

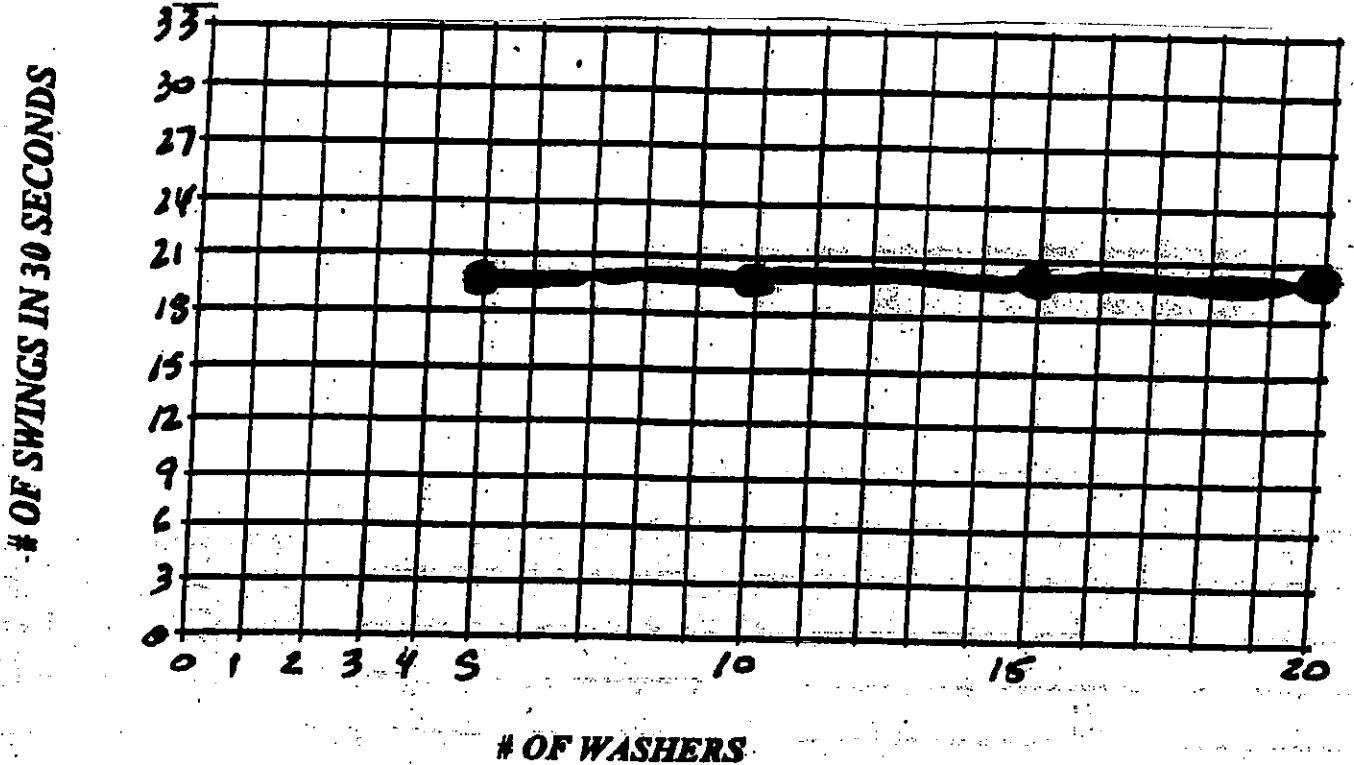


CHANGING WEIGHT (length = 50 cm)

# OF WASHERS	TRIAL #1 (swings)	TRIAL #2 (swings)	TRIAL #3 (swings)	AVERAGE (swings)
5	20	19	21	20.0
10	21	20	20	20.3
15	20	20	20	20.0
20	20	21	20	20.3

## SAMPLE DATA

**TITLE:** Effect of ANGLE OF RELEASE on a pendulum's frequency



**CHANGING ANGLE OF RELEASE**  
(length=50 cm, weight=20 washers)

ANGLE of RELEASE	TRIAL #1 (swings)	TRIAL #2 (swings)	TRIAL #3 (swings)	AVERAGE (swings)
30°	20	19	21	20.0
45°	21	20	20	20.3
60°	20	20	20	20.0
90°	20	21	20	20.3



NAME: \_\_\_\_\_

Congratulations on being a finalist for the new positions at TNPLB Engineering. Please read the scenario below and submit a report containing the information requested in each of the four sections that follow.

### **SCENARIO**

A client has come to TNPLB Engineering for help in designing a new amusement park ride. It involves attaching one to three people to a steel wire, lifting them off the ground, and letting them swing like a pendulum. He wondered whether the weight of the people or the length of the wire would affect how fast a pendulum swings.

### **HYPOTHESES**

**Changing weight:** Explain whether you think a heavier pendulum will swing faster than, slower than, or about the same as, a pendulum that has less weight. Defend your explanation using logical reasoning, scientific knowledge, observations, and/or data.

**Changing length:** Explain whether you think a longer pendulum will swing faster than, slower than, or about the same as, a pendulum that is shorter. Defend your explanation using logical reasoning, scientific knowledge, observations, and/or data.

### **PLANNING INVESTIGATIONS**

You will model the ride using string and metal washers. Design an experiment that will help you to test your hypotheses about weight and length. Explain why your experiments will give you useful data. Describe what is being controlled and what is varying in all experiments. Be sure to use an organized and logical approach to gathering data.

### **CONDUCTING INVESTIGATIONS**

In small groups, and using the materials provided, conduct your experiments and gather data. Be sure to measure accurately, and use both data charts and graphs when you organize and represent your data. Collect enough data to justify your conclusions. Summarize results based on data.

### **DEVELOPING AND EVALUATING EXPLANATIONS**

Analyze your data and give your conclusions about the effect of weight and length on the speed of a pendulum. Be sure to look back at your original hypotheses and tell whether the data supported or refuted your hypotheses. Propose further investigations that would gather useful data. Be sure to use scientific knowledge to explain results.

## **BROAD AREAS OF INQUIRY**

### **Broad Area 1: Formulating Questions and Hypothesizing**

1. Analyze information from observations, research, or experimental data for the purpose of formulating a question, hypothesis, or prediction: (DOK 3)
  - 1a. Appropriate for answering with scientific investigation
  - 1b. For answering using scientific knowledge
2. Construct coherent argument in support of a question, hypothesis, prediction (DOK 2 or 3 depending on complexity of argument)
3. Make and describe observations in order to ask questions, hypothesize, make predictions related to topic (DOK 2)

### **Broad Area 2: Planning and Critiquing of Investigations**

4. Identify information/evidence that needs to be collected in order to answer the question, hypothesis, prediction (DOK 2 – routine; DOK 3 non-routine/ more than one dependant variable)
5. Develop an organized and logical approach to investigating the question, including controlling variables (DOK 2 – routine; DOK 3 non-routine)
6. Provide reasoning for appropriateness of materials, tools, procedures, and scale used in the investigation (DOK 2)

### **Broad Area 3: Conducting Investigations**

7. Follow procedures for collecting and recording qualitative or quantitative data, using equipment or measurement devices accurately (DOK 1 – use tools; routine procedure; DOK 2 – follow multi-step procedures; make observations)
8. Use accepted methods for organizing, representing, and manipulating data (DOK 2 – compare data; display data)
9. Collect sufficient data to study question, hypothesis, or relationships (DOK 2 – part of following procedures)
10. Summarize results based on data (DOK 2)

### **Broad Area 4: Developing and Evaluating Explanations**

11. Analyze data, including determining if data are relevant, artifact, irrelevant, or anomalous (DOK 2 – specify relationships between facts; ordering, classifying data)
12. Use evidence to support and justify interpretations and conclusions or explain how the evidence refutes the hypothesis (DOK 3)
13. Communicate how scientific knowledge applies to explain results, propose further investigations, or construct and analyze alternative explanations(DOK 3)