Inquiry Master 10.1
Performance Assessment Directions

Directions The purpose of this part of the assessment is to see how well you can use your scientific knowledge and equipment, follow directions, interpret data, and draw conclusions. Read the Procedure and complete the activities as indicated. You and your lab partner should work together, but you should write your own responses to the questions on Student Sheet 10.1.

MATERIALS

1 pegboard assembly
7 washers (large), 30 g
1 electric motor with wire leads and alligator clips
1 motor pulley with nail
1 motor clamp
3 machine screws with wing nuts
1 miniature lightbulb
1 miniature lightbulb holder
1 insulated connector wire with alligator clips, black
1 insulated connector wire with alligator clips, red
1 paper clip (large)
1 piece of string, 1.5 m
1 meterstick
1 spring scale, 0 to 2.5 N

PROCEDURE

1. Use the pegboard and motor setup from Lesson 9. Note that there is no battery connected to the motor. Connect the lightbulb to the motor in the same way you would connect the motor to a battery.

2. Check to see that the paper clip attached to the string reaches the floor when the string is completely unwound.

3. Wind the string around the nail until the paper clip touches the nail.

4. Hold the paper clip firmly and put five washers on the paper clip.

5. Release the washers and watch the lightbulb as the washers fall.

6. What, if anything, happened to the lightbulb? Record your observation in the second row of the table on Student Sheet 10.1. Save the first row for later.

7. Answer the questions on Student Sheet 10.1.

Inquiry Master 10.2
Performance Assessment Rubric for Individual or Group Performance Skills

Table 1 Rubric for Individual or Group Performance Skills

Task/Activity	**Correctly Done** (All directions followed)	**Mostly Correct** (Most directions followed)	**Partially Correct** (Many directions not followed)	**Incorrectly Done** (Directions not followed)
Lightbulb is connected to motor.				
String is wound around nail.				
Washers are released at shaft and allowed to fall to floor.				
Number of washers is changed as instructed.				
Spring scale is correctly used to measure weight.				

Comments: _____

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Inquiry Master 10.3
Performance Assessment Rubric: Student Sheet 10.1

1. What happened to the lightbulbs when the washers fell? *(As the washers fall, the bulb lights.)*

2. What do you think would happen if you put different numbers of washers on the paper clip and let them fall? *(Make sure a prediction is made. Give credit for any prediction that addresses how the bulb would light.)*

3. Now put different numbers of washers, as indicated in Table 1, on the paper clip and let them fall. Record your observations in the table. *(Students' descriptions of the bulb's brightness will be qualitative. They cannot measure the brightness, but they can see and describe varying levels of brightness. This requires careful attention and observation. They should see the bulb's brightness increase as the number of washers increases. In some cases, the bulb may not light with four washers.)*

Table 1 Rubric for Table 1: Trials With Washers on Student Sheet 10.1

Number of Washers	What I Observed
4	*The bulb is dimmer or does not light.*
5	*The bulb lights as the washers fall.*
6	*The bulb is brighter.*
7	*The bulb is brighter still.*

4. What can you conclude from your observations? *(As more washers are attached and fall, the bulb glows brighter.)*

5. Where does the energy to light the bulb come from? *(The washers fall and release energy.)*

6. How much work does the force of gravity do on the washers as they fall? To answer this question, complete Table 2.

(continued)

Inquiry Master 10.3 (continued)

Table 2 Sample Data for Table 2 (Calculations: Work Done by Gravity) on Student Sheet 10.1

Number of Washers	Weight of Washers	Distance Washers Fall	Work Done by Gravity
4	*1.2 N*	*1.10 m*	*1.3 N-m*
5	*1.5 N*	*1.10 m*	*1.7 N-m*
6	*1.8 N*	*1.10 m*	*2.0 N-m*
7	*2.1 N*	*1.10 m*	*2.3 N-m*

7. Examine your observations and the work data. Explain your observations using your work data. *(As more work is done, the bulb glows more brightly because more work converts more energy to light and heat in the bulb.)* What determines how much energy the lightbulb receives? *(The number of washers and the distance of fall determines the work done during the fall, and this determines the energy available to light the bulb.)*

8. List other things you could change in this experiment that would affect the brightening of the bulb. *(Student answers will vary. Give credit for any reasonable answer. For example, some students may want to change the distance the mass falls; others may want to tie the string around the pulley instead of around the nail.)*

9. Design a procedure to obtain data to calculate the average power generated each time the washers fall. Write your procedure here. *(To calculate the power for each trial, measure the weight of the mass, the distance it falls, and the time it takes to reach the floor. To calculate average power, divide the amount of work by the time to fall.)*

10. Think about the battery you made in Lesson 3. Could you use the motor and falling washers to charge your battery? Give evidence to justify your answer. *(The battery can be charged using this setup. It would take a long time to put the energy in the battery, but the energy of the falling mass would become stored energy in the battery if the battery replaced the lightbulb. As the mass falls and turns the shaft of the motor, an electric current flows through the battery. This charges the battery in the same manner as the battery charger did in Lessons 3 and 4.)*

Inquiry Master 10.4
Data Analysis Rubric for Student Sheet 10.2

NOTE The purpose of this part of the assessment is to evaluate how well students manipulate and interpret data. This rubric can be used to assess students' mastery of these skills.

Table 1 Rubric for Data Analysis Table and Graph on Student Sheet 10.2

Skill	Complete	Partially Complete	Not Done
Average distances correct			
Points plotted correctly			
Axes labeled with units			
Line drawn through data points			

Students' average distance lifted values should be the same as those shown in Table 2.

(continued)

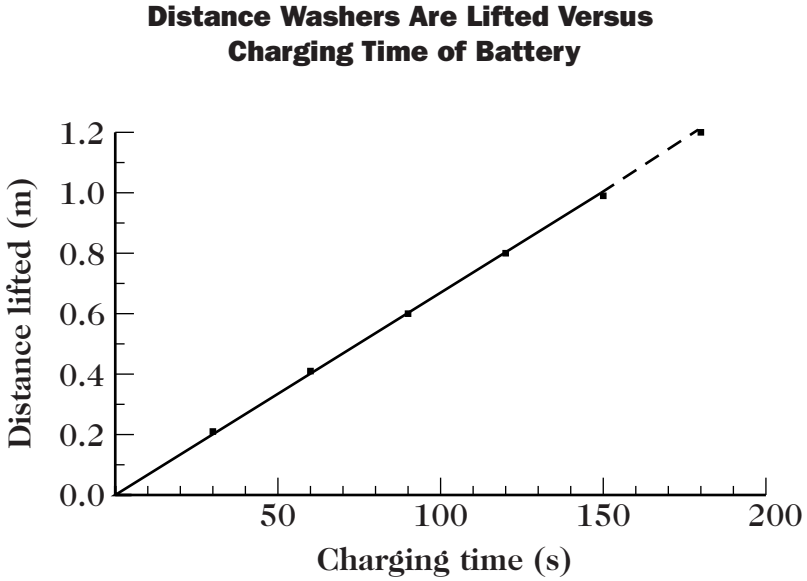
Inquiry Master 10.4 (continued)

Table 2 Sample Data for Analysis Table on Student Sheet 10.2

Battery-Charging Time (s)	**Distance Lifted** Trial 1 (m)	**Distance Lifted** Trial 2 (m)	**Distance Lifted** Trial 3 (m)	**Average Distance Lifted** (m)
30	0.20	0.22	0.21	0.21
60	0.41	0.42	0.41	0.41
90	0.62	0.60	0.59	0.60
120	0.81	0.81	0.79	0.80
150	1.01	0.98	0.99	0.99

Sample student graph

Students' graphs should look like the following:



1. What can you conclude about the relationship between battery-charging time and distance lifted? *(The distance lifted is proportional to the charging time of the battery. The longer the charging time, the greater the distance the load of washers is lifted.)*

2. If you charged the battery for 180 seconds, how high would the motor lift the washers? *(Students must extrapolate from the graph or table to determine this. The lift distance for 180 s should be about 1.20 m.)*

Inquiry Master 10.5
Multiple-Choice Questions

Directions On Student Sheet 10.3, circle the response that best answers each question or completes each statement. *Make no marks on this sheet.*

1. A student charges a battery and then connects a lightbulb to the battery. Which statement best describes what happens while the bulb is connected to the battery?
   A. The battery stores the energy as chemical energy for later use.
   B. Energy in the battery becomes light energy and heat energy in the bulb.
   C. The lightbulb adds energy to the battery.
   D. The battery uses up the energy of the lightbulb.

2. Which of the following is *not* an example of work being done on an object?
   A. Pushing a cart across the floor.
   B. Pitching a baseball.
   C. Kicking a soccer ball.
   D. Holding a bag of groceries.

3. A crane lifts a steel beam to the top of a building. Which pair of measurements would you use to calculate the power of the crane?
   A. The force on the beam and the time needed to lift it.
   B. The work done lifting the beam and the time needed to lift it.
   C. The distance the beam moves and the time needed to lift it.
   D. The work done on the beam and the distance it rises.

4. A rubber band is stretched 4.0 cm with a spring scale and the spring scale registers 2.0 N. If you stretched the rubber band to twice as far (to 8.0 cm), what would you expect the spring scale to register?
   A. 2.0 N
   B. 4.0 N
   C. 8.0 N
   D. 12.0 N

(continued)

Inquiry Master 10.5 (continued)

5. Which of the following factors determines the force of friction on a block pulled across a surface?
   A. How fast the block is pulled.
   B. How far the block is pulled.
   C. The kind of surface in contact with the block.
   D. The size of the area of the block in contact with the surface.

6. The weight of an object is dependent on its—
   A. Mass
   B. Length
   C. Surface area
   D. Volume

7. You pull a wooden block at a steady speed across a tabletop with a spring scale. The scale registers 1.50 N. If you place another block (just like the first one) on top of the block and pull the two blocks with the spring scale at a steady speed, what will the scale register?
   A. 0.00 N
   B. 0.75 N
   C. 1.50 N
   D. 3.00 N

Inquiry Master 10.6
Multiple-Choice and Short-Answer Responses Rubric for Student Sheet 10.3

Multiple-Choice Answers

1. b
2. d
3. b
4. b
5. c
6. a
7. d

Short-Answer Responses

1. Use evidence from what you have learned in this module to justify this statement: Energy can be converted into different forms. *(Energy in a closed system is not lost; rather, it is transformed—it changes from one form to another. All the energy in a closed system can be accounted for if one considers all the possible forms that energy can take.)*

2. Describe something you could do to prove an object has energy. *(Energy is the ability to do work. If an object stores energy, that energy can be transformed to some other form. For example, a battery can be put in a circuit, where its chemical energy is converted to heat and light. A falling mass can release energy and light a bulb. A moving car has energy of motion [kinetic energy] and the brakes of the car turn the kinetic energy of the car into heat when the car stops.)*

3. Give an example of a word whose scientific meaning is different from its everyday meaning. Explain the difference in meanings. *(Scientific words are more exact in their meaning than ordinary words are. Scientific words describe relationships among things in a precise way. The word "work" is a good example of this distinction; students may suggest other words.)*

Name:_____

Class:_____ Date:_____

Student Sheet 10.1
Performance Assessment

Directions Answer the questions as you and your partner have performed the inquiry described in Inquiry Master 10.1.

1. What happened to the lightbulbs when the washers fell?

2. What do you think would happen if you put different numbers of washers on the paper clip and let them fall?

3. Now put different numbers of washers, as indicated in Table 1, on the paper clip and let them fall. Record your observations in the table.

Table 1 Observations From Four Trials With Different Numbers of Washers

Number of Washers	What I Observed
4	
5	
6	
7	

4. What can you conclude from your observations?

(continued)

Student Sheet 10.1 (continued)

5. Where does the energy to light the bulb come from?

6. How much work does the force of gravity do on the washers as they fall? To answer this question, complete Table 2.

Table 2 Calculation Table: Work Done by Gravity

Number of Washers	Weight of Washers	Distance Washers Fall	Work Done by Gravity
4			
5			
6			
7			

7. Examine your observations and the work data. Explain your observations using your work data. What determines how much energy the lightbulb receives?

8. List other things you could change in this experiment that would affect the brightening of the bulb.

9. Design a procedure to obtain data to calculate the average power generated each time the washers fall. Write your procedure here.

10. Think about the battery you made in Lesson 3. Could you use the motor and falling washers to charge your battery? Give evidence to justify your answer.

Name:_____

Class:_____ Date:_____

Student Sheet 10.2
Data Analysis

Directions For this part of the assessment, you will work individually. Complete the data table as directed, graph the data, then answer the questions.

1. A student performed an experiment using a rechargeable battery and a motor. The student connected the battery to a battery charger like the one used in Lessons 3 and 4 and charged the battery for 30 seconds. The student attached the battery to a motor on the pegboard and measured the distance the battery lifted a mass of 10 washers. The student repeated the trial two more times, then repeated the experiment three more times, increasing the charging time 30 seconds each time. The data are shown in Table 1.

Table 1 Data Analysis Table

Battery-Charging Time (s)	**Distance Lifted** Trial 1 (m)	**Distance Lifted** Trial 2 (m)	**Distance Lifted** Trial 3 (m)	**Average Distance Lifted** (m)
30	0.20	0.22	0.21	
60	0.41	0.42	0.41	
90	0.62	0.60	0.59	
120	0.81	0.81	0.79	
150	1.01	0.98	0.99	

1. Calculate the average distance for each charge time.

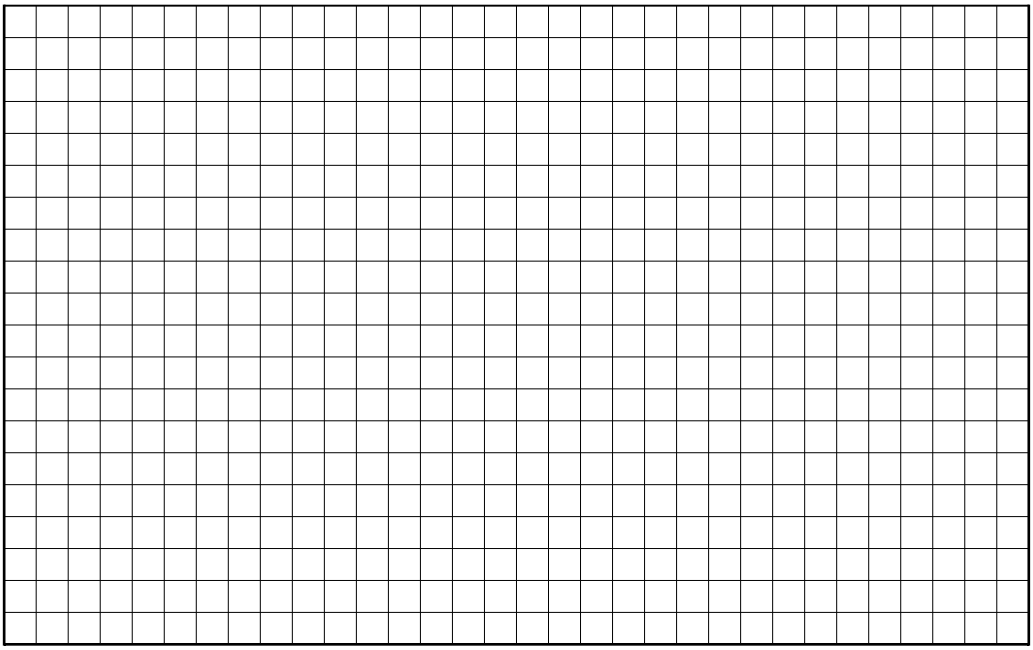
(continued)

Student Sheet 10.2 (continued)

2. Make a graph of "Distance lifted" and "Battery charging time." Plot your graph on the grid below. When you finish plotting your graph, answer the following questions.

Graph of distance lifted and battery charging time

Title:_____



1. What can you conclude about the relationship between battery-charging time and distance lifted?

2. If you charged the battery for 180 seconds, how high would the motor lift the washers?

Name:_____

Class:_____ Date:_____

Student Sheet 10.3
Multiple-Choice and Short-Answer Response Sheet

Directions Circle the letter of your selection for each multiple-choice question. Then answer Questions 1 through 3. Use complete sentences.

1. a b c d

2. a b c d

3. a b c d

4. a b c d

5. a b c d

6. a b c d

7. a b c d

1. Use evidence from what you have learned in this module to justify this statement: Energy can be converted into different forms.

2. Describe something you could do to prove that an object has energy.

3. Give an example of a word whose scientific meaning is different from its everyday meaning. Explain the difference in meanings.