Testing the Effects of Forces
Teacher Facilitation Notes

In General . . .

- Project the slide deck in edit mode–do not show it as a slideshow.
- Hide the speaker notes before projecting. (View/Show Speaker Notes)
- Hide the filmstrip to the left. (View/Hide Filmstrip.)
- Hide the toolbar. (Click on the up arrow at the right end of the tool bar.)
- Call on students to read the various content shown on slides.

Materials Needed Per Group:

<u>Explore: Ramp and Roll</u>

Metric ruler with groove down the middle
Large marble
Scissors
Meter stick or metric tape measure
Styrofoam cup
Textbooks, 2

<u>Elaborate: 3 . . . 2 . . . 1 . . . Blast Off!</u>

Straws, 1 or 2
Balloons, 2
Tape measure
Clothespin
String, 6 meters
Masking tape
Meter stick

Other Materials

Student Recording Sheets
Student Summative Evaluation
Pencils
Science notebooks

Engage: Using the Scientific Method

- Introduce the Scientific Method using the video. Discuss.
- Read and discuss the remainder of the Engage slides.
- If students have never completed a C - E - R graphic organizer, this can be done as a class activity rather than an individual student assignment. The scientific reasoning section is often the most difficult for the students to complete. In this example, the car on the higher ramp has more potential energy than the car on the lower ramp. By increasing the height of the ramp, the amount of gravitational potential energy that can turn into kinetic energy is increased. However, since potential/kinetic energy have not been taught, this can be tricky to answer. Additionally, speed is not measured in this activity, but it can be assumed that the car on the higher ramp travels faster than the car on the lower ramp (more potential gravitational energy). Just discuss this on a level your students can understand.
- On the final slide, have the class work together to complete a summary of the car/ramp investigation and their conclusions.

Testing the Effects of Forces
Teacher Facilitation Notes, p. 2

Explore: Ramp and Roll

- Read and discuss the introductory slide about designing an experimental investigation.
- Call on volunteers to read the task and the question for this investigation. Have students formulate and record a hypothesis for this investigation.**
- Read and discuss the definitions of the different types of variables in an investigation. Direct students to record the different variables on their recording sheets.
- Call students' attention to the illustration of the marble rolling down a ruler. Tell them that they will be making a system such as this to test their hypothesis.
- Read and discuss the type of data students can collect in an investigation. Be sure they understand that they will be recording both observations and measurements.
- Depending on the ability level of the students, choose one of the following options for writing the procedures for this investigation:
    - Option 1: Have students work in independent groups to create a set of procedures for investigating the question. Then they will carry out their investigations independently.
    - Option 2: Have students work in independent groups to create a set of procedures for investigating the question. Bring the groups together as a class and discuss their procedures. Come to a consensus on a class set of procedures and let the groups carry them out independently.
    - Option 3: Work together as a class to formulate the procedures for answering the question. Groups work independently to complete the investigation.
    - Option 4: Work together as a class to formulate the procedures for answering the question. Then, work together as a class to carry out the procedures and complete the investigation.
- Make sure the groups that formulate their own procedures write them down in detail in their science notebooks.

**NOTE: Make sure students understand that the ramp will stay the same height. What they will change is the placement of the marble on the ruler. For example, they will roll the marble from the 0 point on the ruler, then the 5 cm point, then 10 cm, etc.

Testing the Effects of Forces
Teacher Facilitation Notes, p. 3

Explore: Ramp and Roll, continued

- Based on the chosen option, either record the procedures on the explore slide before the groups complete the investigation or after they are finished.
- Review the investigations by completing the data table on the slide. Call on one group to give their data as you fill in the table. Let the other groups compare their data to this group's.
- Have students answer the questions on the communicating results slide. Discuss as desired.

Explain: The Effects of Force on Motion

- Call on volunteers to read each slide. Discuss as desired.
- Make sure students understand all of the relevant terms throughout the reading.
- On the slide about systems, review the system used in the explore to investigate forces. Ask the following questions:
  - How is the setup that we used in this investigation a system?
  - What are the parts of the system?
  - How did changing the system affect the distance the cup slid?
  - What would happen if you removed one part of the system? Would it still work the same? (For example, if you removed the books and just laid the ruler on the floor, would the marble still roll into the cup?)
- Do a Think-Pair-Share activity for the questions slide.
  - Have each student answer the questions in their science notebooks.
  - Pair up the students and let them discuss their answers to the questions. (They may change or add to their answers if they wish.)
  - Discuss the answers as a class.
- If desired, have students define terms such as *force*, *motion, magnetism, gravity, friction, position, location, system,* etc., in their science notebooks. They should define these terms in their own words based on experiences–not definitions from a dictionary or glossary.

Testing the Effects of Forces
Teacher Facilitation Notes, p. 4

Elaborate: 3 . . . 2 . . . 1 Blast Off!

- Perform a simple demonstration to activate student thinking for this activity:
  - Hold up a non-inflated balloon by the neck and ask students what will happen if you release it. (It will simply fall to the floor or table.)
  - Let go of the balloon and discuss what happened.
  - Now blow up the balloon part way (less than half full of air). Ask students to predict what will happen if you let go of the balloon now.
  - Let go of the balloon and discuss what happened.
  - Blow up the balloon as much as you can. Ask students to predict if the balloon will fly farther, the same distance, or less distance than the balloon that was half full of air. Ask them to explain their predictions.
  - Release the balloon and discuss what happened.
  - Why is the air pushed out of the balloon? Why does the balloon move forward?
  - How does the amount of air in the balloon affect how far the balloon flies when it is released?
- Review the concept of circumference as it applies to measuring how much air is in the balloon. Make sure students understand that the more air in the balloon, the greater the force when the air comes out of its neck.
- Read and discuss the slides detailing this activity.
- Have the student groups work independently to complete their balloon rockets.
- Allow time for groups to demonstrate their rockets and for discussion.

Evaluate: Testing the Effects of Forces on Objects

- Use the Flippity activities as desired with the class.
- Have each student complete the evaluation for the lesson.

Testing the Effects of Forces

Name: KEY

Evaluation

1. Which experimental investigation listed below will best determine how friction affects the speed of a rolling object?

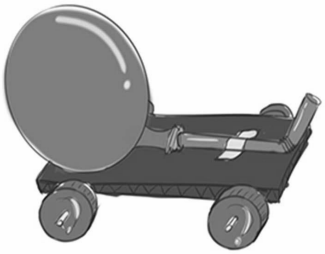
   A Roll 3 identical objects across a dark, rough surface.

   B Roll 3 identical objects across a smooth, shiny surface.

   C Roll 3 identical objects across 3 different surfaces.

   D Roll 3 different objects across 3 different surfaces.

2. A student constructed a balloon car to test the effects of force on an object. She inflated the balloon with 3 breaths and then measured how far the vehicle traveled. Then, she inflated the balloon with two breaths and measured how far it traveled. What variable is the student testing (the independent variable)?



   F Number of breaths

   G Size of the wheels

   H Surface on which the vehicle travels

   J Distance the vehicle travels

3. If the girl added more books to the wagon she is pulling, which of the following would be true?

   A The girl would need to apply less force to make the wagon move.

   B The girl would need to apply more force to make the wagon move.

   C The girl's mass would increase giving her more energy to pull the wagon.

   D The wagon would move faster because of the added mass.

Testing the Effects of Forces

Name: KEY

Evaluation

4. A student began to push one magnet toward another as shown in the illustration. What will probably happen as the magnets get closer to each other?

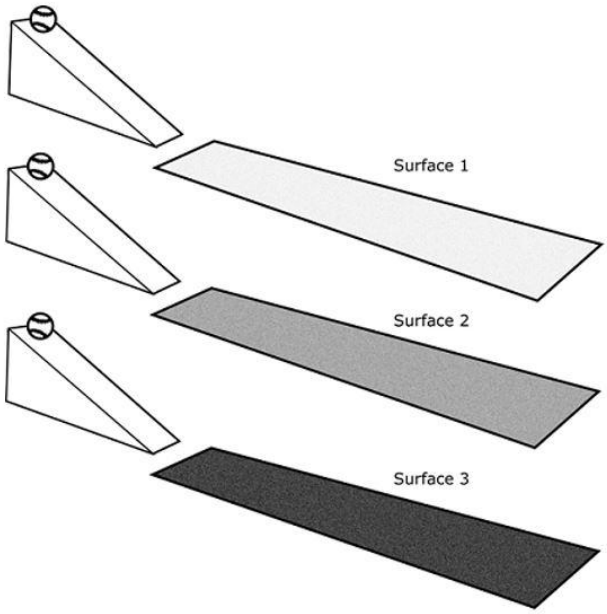
F The magnet on the left will pull the magnet on the right toward it.

G The magnet on the left will push away the other magnet.

H The magnet on the right will move toward the magnet on the left.

J The magnet on the right will be attracted to the magnet on the left.

5. Some students set up the experiment pictured below. What question were the students most likely investigating?



A How does ramp height affect the distance a marble rolls away?

B How does the mass of a marble affect the distance it rolls down a ramp?

C How does friction affect the distance a marble rolls away from a ramp?

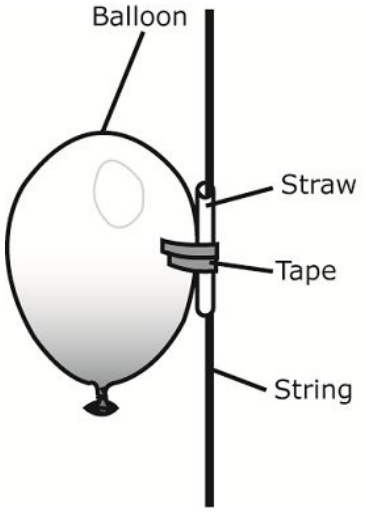
D How does the color of a surface affect the distance a marble rolls away from a ramp?

Testing the Effects of Forces

Name: KEY

Evaluation

6. A lab group is given 5 meters of string, a drinking straw, a balloon, and some tape. The students use these materials to demonstrate the motion of a balloon rocket as shown. On the first trial, the balloon moved up the string about 15 cm. What would most likely make the balloon rocket move up higher on the string?



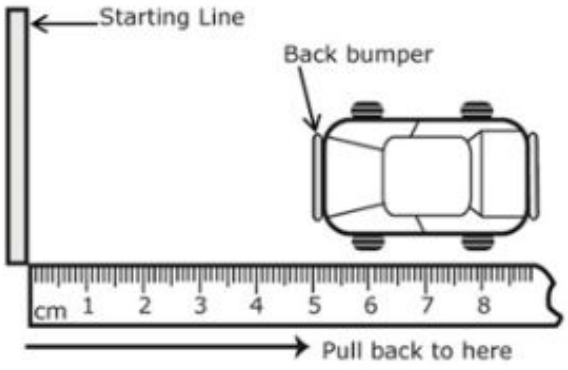
F Holding the string more loosely

G Wrapping the tape all the way around the balloon

H Using a straw that is bigger around

J Inflating the balloon with more air

7. Some students designed an investigation to test the distance a pull-back car traveled after being pulled back different lengths. The data they collected is shown in the table. The students concluded that the farther the car is pulled back, the farther forward it will travel when released. What evidence do the students have for this conclusion?



Starting Pull-Back Point	Distance Traveled			Average Distance Traveled
	Trial 1	Trial 2	Trial 3	
5 cm	14 cm	15 cm	13 cm	14 cm
10 cm	19 cm	19 cm	18 cm	19 cm
15 cm	22 cm	25 cm	23 cm	23 cm
20 cm	31 cm	28 cm	30 cm	29 cm

A When pulled back 5 cm, the car traveled forward an average of 14 cm.

B When pulled back 10 cm, the car traveled forward an average of 19 cm.

C When pulled back 15 cm, the car traveled forward an average of 23 cm.

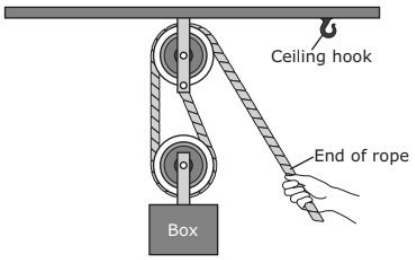
D When pulled back 20 cm, the car traveled forward an average of 29 cm.

Testing the Effects of Forces

Name: KEY

Evaluation

8. The illustration shows a pulley system that can be used to lift a box. Which of these should the person do to lift the box?



F Drop the rope to allow the box to move up.

G Pull the end of the rope downward.

H Tie the end of the rope to the ceiling hook.

J Push the rope toward the top pulley.

9. Three marbles are launched from a spoon catapult like the one shown. Each marble is a different size. The table shows the distances each marble traveled in three trials.

Marble Size	Distance Traveled (cm)			
	Trial 1	Trial 2	Trial 3	Average
Small	98	99	98	99
Medium	49	46	47	47
Large	14	20	17	17

What conclusion can be supported by the results shown in the table?

A Large marbles fly the longest distances.

B Medium marbles travel farther than small marbles.

C Small marbles travel the farthest distance.

D All marbles travel the same distance from a catapult.

10. A student predicts that the distance an object moves depends on how hard it is pushed. He designs an experiment to test his prediction. Which of the following is the most important data to collect during the experiment?

F The size of the object

G The distance the object moves

H The weight of the object

J The temperature of the object

Testing the Effects of Forces

Name: KEY

Engage:

The data table below shows the results of a student investigation to answer the question *How does the height of a ramp affect the distance a car travels?*

	Distance Car Traveled from End of Ramp			
	Trial #1	**Trial #2**	**Trial #3**	**Trial #4**
Ramp A 1 Textbook High	41 cm	38 cm	40 cm	39.7 cm
Ramp B 2 Textbooks High	65 cm	70 cm	68 cm	68.7 cm

Directions: Use the data in the table to complete the C - E - R below.

Question:	**Claim:**
How did the height of the height of the ramp affect the distance the car traveled?	**Sample Answer: The car traveled a greater distance from a higher ramp than a lowe ramp.**
Evidence: **Sample Answer: The average distance the car traveled on the higher ramp was 68.7 cm while it was only 39.7 cm on the lower ramp.**	**Reasoning:** **Sample Answer: The car on the higher ramp goes faster than the one on the lower ramp. This means that it can travel farther before friction stops it than the one on the lower ramp.**

Testing the Effects of Forces

Name: _____

Engage:

The data table below shows the results of a student investigation to answer the question *How does the height of a ramp affect the distance a car travels?*

	Distance Car Traveled from End of Ramp			
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Ramp A 1 Textbook High	41 cm	38 cm	40 cm	39.7 cm
Ramp B 2 Textbooks High	65 cm	70 cm	68 cm	68.7 cm

Directions: Use the data in the table and your knowledge of science to complete the C - E - R below.

Question:	**Claim:**
How did the height of the height of the ramp affect the distance the car traveled?	
Evidence:	**Reasoning:**

Testing the Effects of Forces

Name: _____

Explore: Ramp and Roll

Task: Design a simple experimental investigation to answer a given question.

Question: How does the position of a marble on a ramp affect the distance it can push a foam cup away from the end of the ramp?

1. Think about the question for this investigation. Write your **hypothesis** as an *if . . ., then* statement on the lines below.

_____

_____

2. Identify the variables in this investigation:

Independent Variable: (What you will change; cause) _____

_____

Dependent Variable: (What changes as a result; effect) _____

_____

Controlled Variables: (What stays exactly the same) _____

_____

3. Briefly describe the **procedures** you will follow to answer the question.

_____

_____

_____

_____

_____

_____

_____

_____

Testing the Effects of Forces

Name: _____

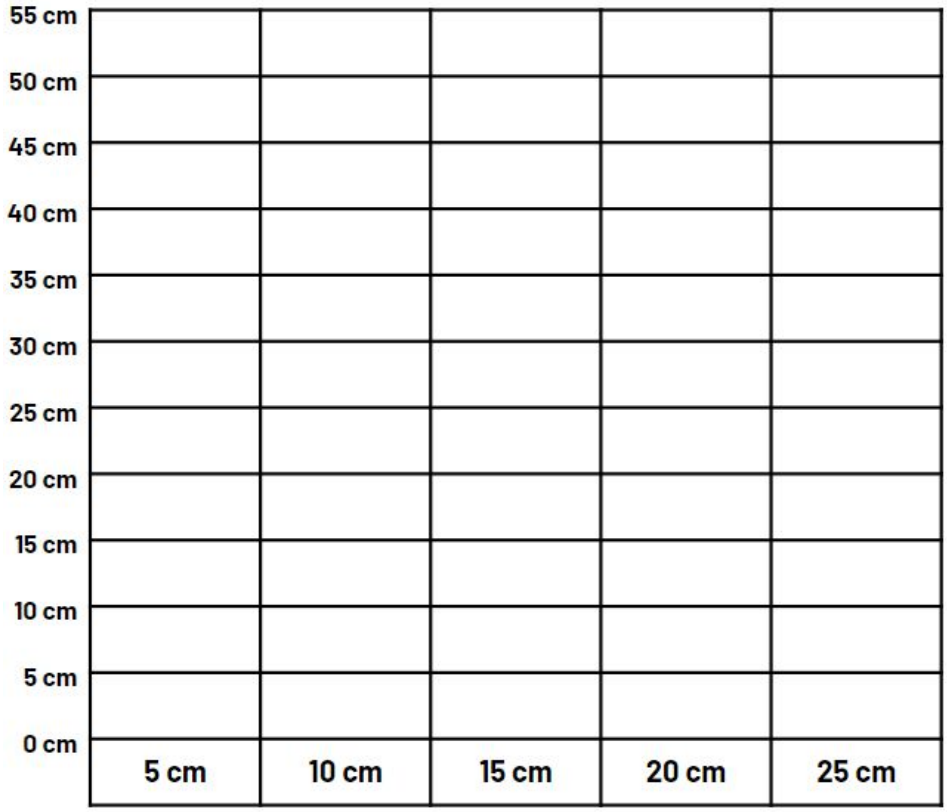
Explore: Ramp and Roll, page 2

4. **Directions:** Record your quantitative data in the table.

Distance Cup Moved From End of Ramp

Position on Ramp	Distance Trial 1	Distance Trial 2	Distance Trial 3	Average Distance
5 cm				
10 cm				
15 cm				
20 cm				
25 cm				

5. **Directions:** Use your data to complete the graph below. Be sure to give it a title and label the x- and y-axis.



Testing the Effects of Forces

Name: _____

Explore: Ramp and Roll, page 2

6. When you applied the independent variable (the position of the marble on the ramp), what happened to the dependent variable (the distance away from the ramp the cup traveled)?

_____

_____

_____

_____

7. Did this experiment prove or disprove your hypothesis? Explain.

_____

_____

_____

_____

8. What can you conclude from the results of this investigation? Explain.

_____

_____

_____

_____

9. What other questions might you want to explore on this topic?

_____

_____

_____

_____

_____

Testing the Effects of Forces

Name: _____

Elaborate: 3 . . . 2 . . . 1 . . . Blast Off!

Challenge: Design and construct a balloon rocket system that tests the effects of different amounts of force on the balloon.

Question: How does the amount of gas (air) released from the back of a balloon rocket affect its forward movement?

1. **Hypothesis:** Write a hypothesis about what you think will happen when you conduct the experiment. _____

   _____

2. **Independent Variable:** What will you change on purpose during the experiment to help you answer the question? _____

   _____

3. **Dependent Variable:** What might happen as a result of changing the independent variable? _____

   _____

4. **Controlled Variables:** What will you keep exactly the same in your experiment? _____

   _____

5. Briefly describe the **procedures** you will follow to answer the question.

   _____

   _____

   _____

   _____

   _____

   _____

   _____

Testing the Effects of Forces

Name: _____

Elaborate: 3 . . . 2 . . . 1 . . . Blast Off!

6. **Qualitative Data:** Write your observations of how the balloon rocket moves and the system functions._____

_____

7. **Quantitative Data:** Complete the table to record your measurements (the circumference of the balloon and the distanced the balloon travels along the string.) Be sure to give the table a title and label the x- and y-axis.

8. **Results**: What happened to the distance the ball traveled when the amount of gas in the balloon increased? _____

_____

9. **Conclusions:** What conclusions can you draw from your results? Was your hypothesis proved or disproved? Be sure to use data from the experiment to justify your conclusions.

_____

_____

_____

_____

_____

Testing the Effects of Forces

Name: _____

Evaluation

1. Which experimental investigation listed below will best determine how friction affects the speed of a rolling object?

   A Roll 3 identical objects across a dark, rough surface.

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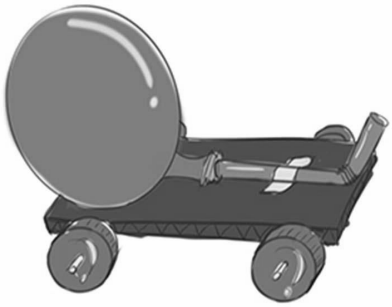

   F Number of breaths

   G Size of the wheels

   H Surface on which the vehicle travels

   J Distance the vehicle travels

3. If the girl added more books to the wagon she is pulling, which of the following would be true?

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Testing the Effects of Forces

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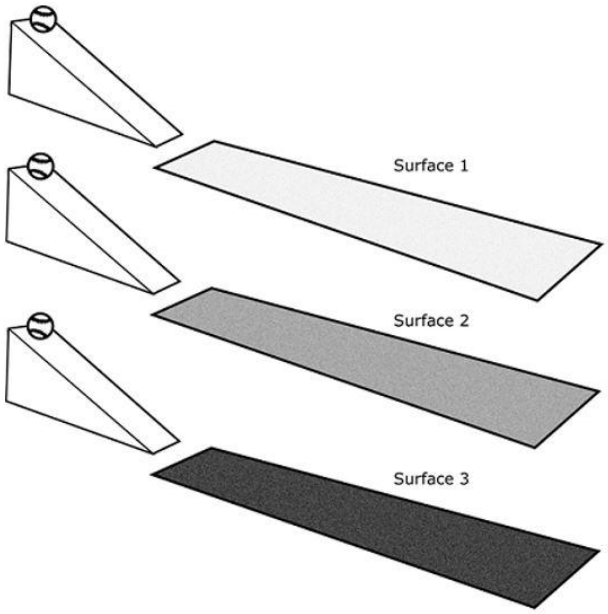

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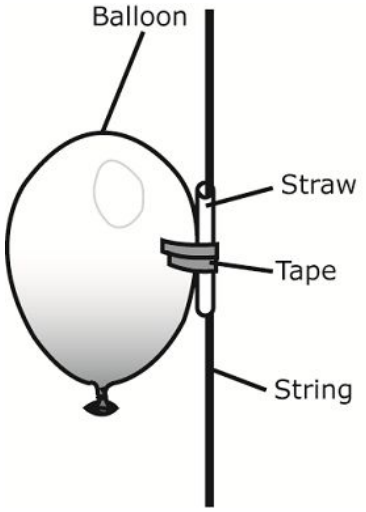

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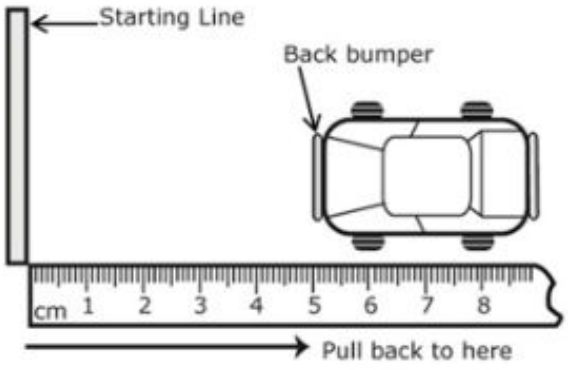

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Name: _____

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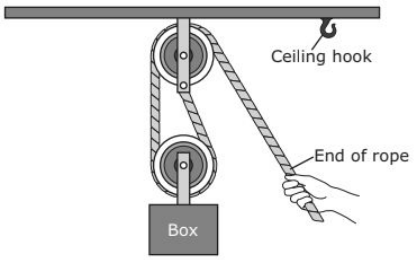

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10. A student predicts that the distance an object moves depends on how hard it is pushed. He designs an experiment to test his prediction. Which of the following is the most important data to collect during the experiment?

F The size of the object

G The distance the object moves

H The weight of the object

J The temperature of the object