Student's Name _____ Date _____ Class _____

Student Sheet: Self-Assessment

Directions: Use the space provided to prepare a KWL chart. In the first column, write things you already know about energy, forces, and motion. In the second column, write things you want to know. Leave the last column blank. You will fill in things you learned at the end of the unit.

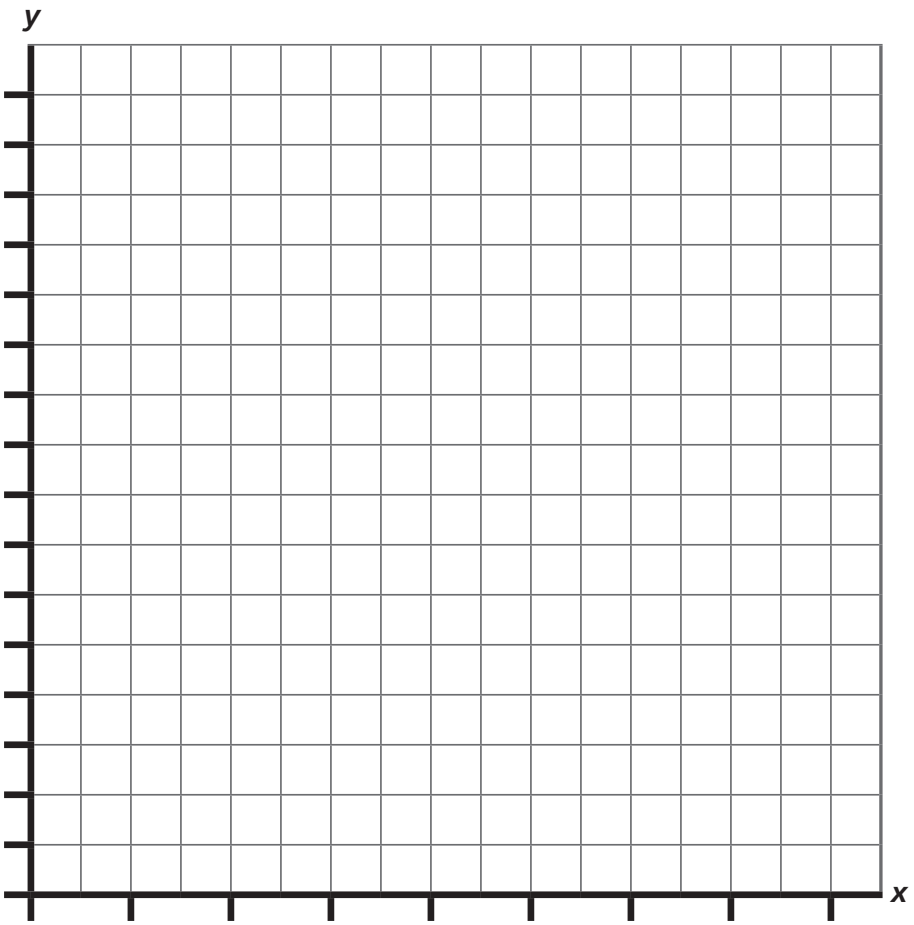
K	W	L
What I Know	**What I Want to Know**	**What I Learned**

Student's Name _____ Date _____ Class _____

Student Sheet 1.2: Graphing Motion (1 of 2)

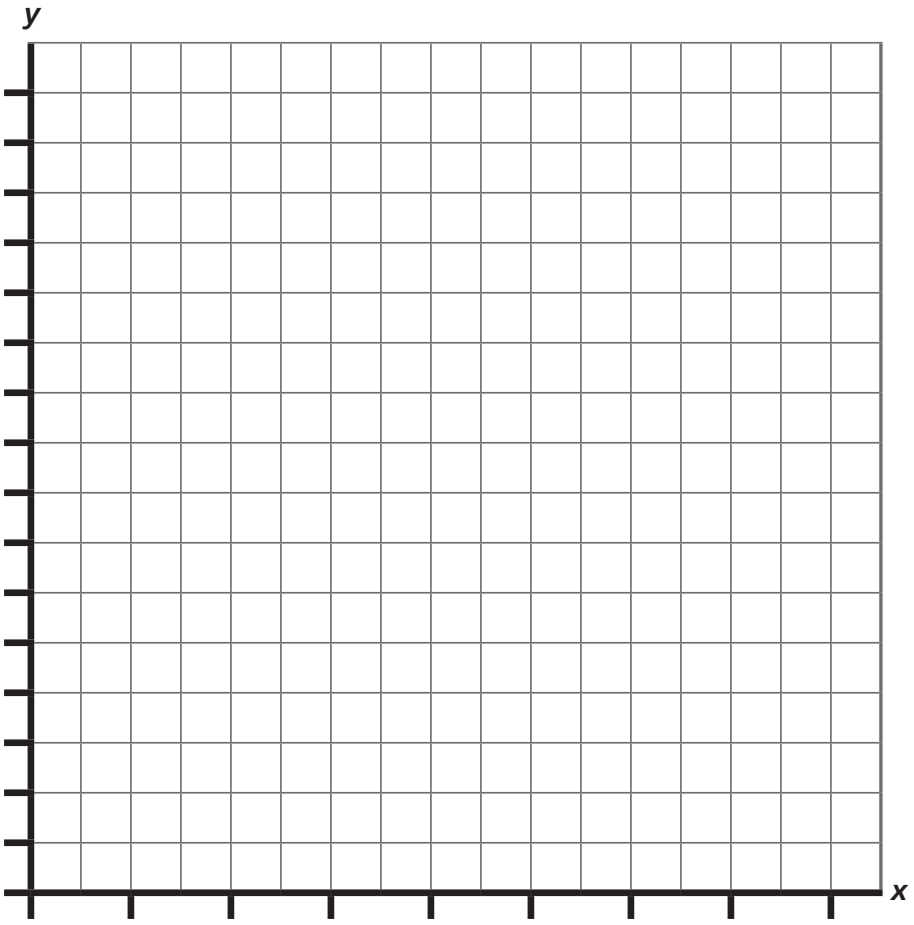
Directions: Use data provided in Investigation 1.2 to construct a graph of position (along the y axis) versus time (along the x axis). Each graph should have the following features:

- Title for the graph
- x-axis title and y-axis title
- Labeled tic marks on both axes
- A dot for each data point



Student's Name _____ Date _____ Class _____

Student Sheet 1.2: Graphing Motion (2 of 2)



Student's Name _____ Date _____ Class _____

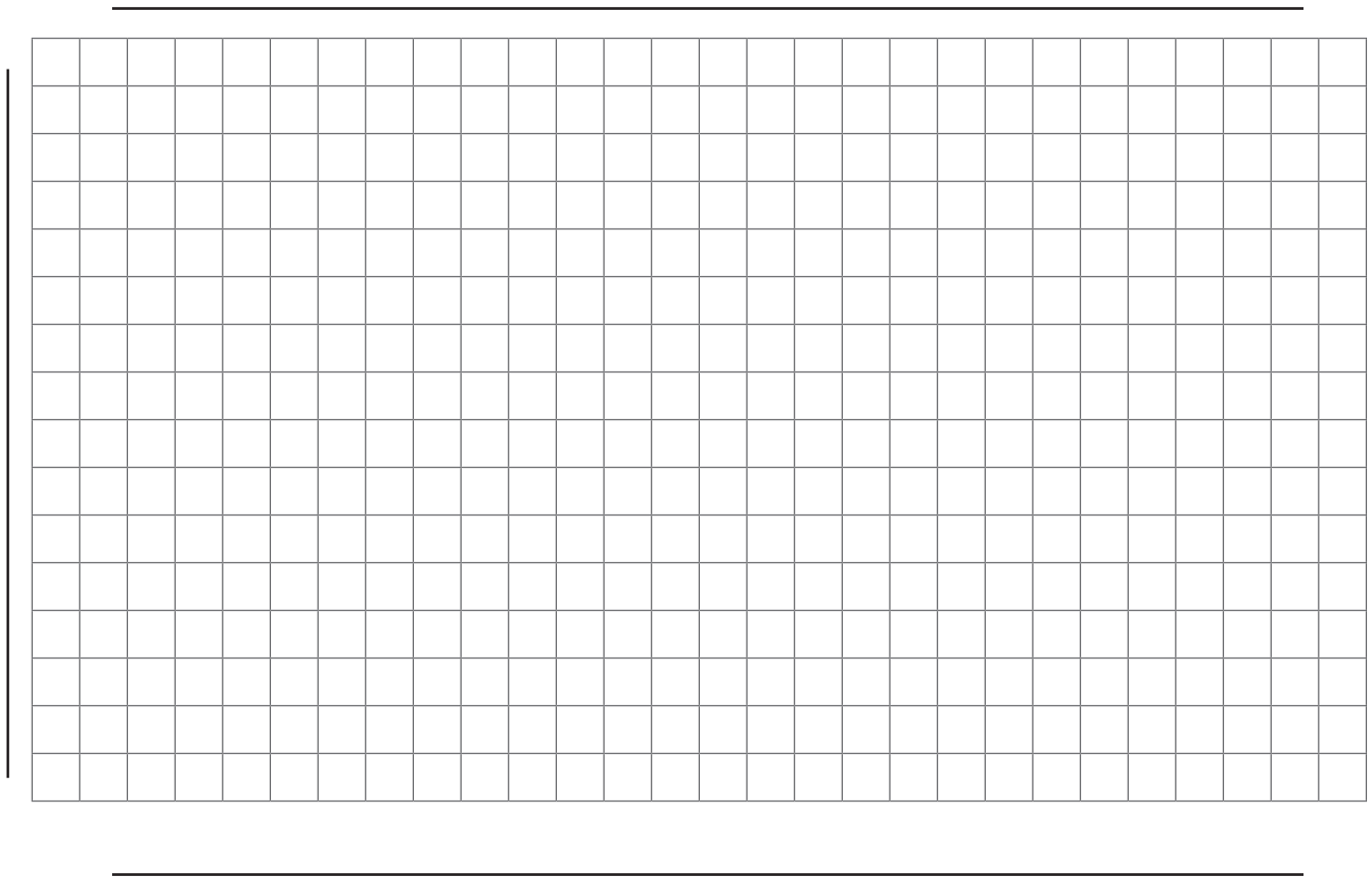
Student Sheet 2.5: Relationship Between Mass and Weight

Directions: Use the table below to record data during your investigation.

Table 1

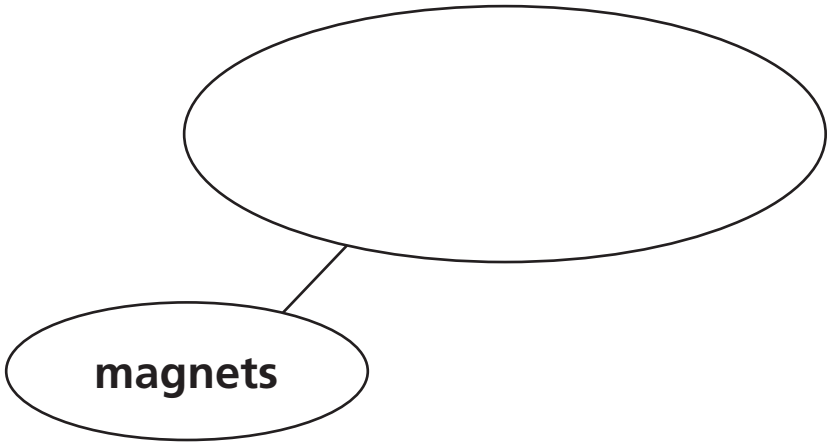
Number of Washers	Mass (kg)	Weight (N)
0	0.0	0.0

Use the grid below to create a graph of the relationship between mass and weight.



Student's Name _____ Date _____ Class _____

Student Sheet 3.GS: Magnet Concept Map



Student's Name _____ Date _____ Class _____

Student Sheet 3.1: Predicting the Effect of Magnetism on Materials (page 1 of 2)

Name of Item Tested	Prediction About Effect of Magnet on Item	Reasons for Prediction	How Item Was Tested	How Item Responded During Test

Student's Name _____ Date _____ Class _____

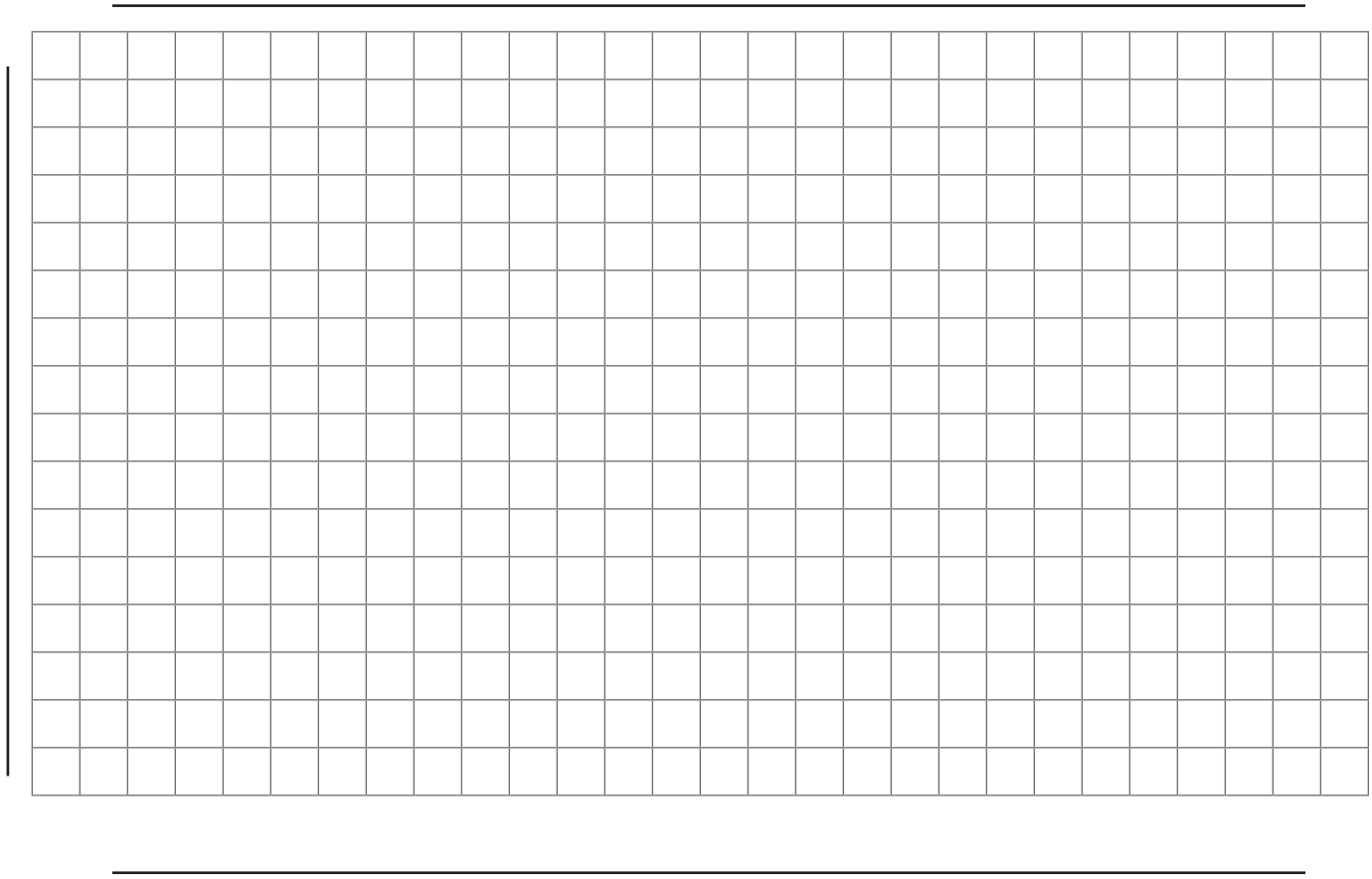
Student Sheet 3.1: Predicting the Effect of Magnetism on Materials (page 2 of 2)

Name of Item Tested	Prediction About Effect of Magnet on Item	Reasons for Prediction	How Item Was Tested	How Item Responded During Test

Student's Name _____ Date _____ Class _____

Student Sheet 3.2: Measuring Magnets

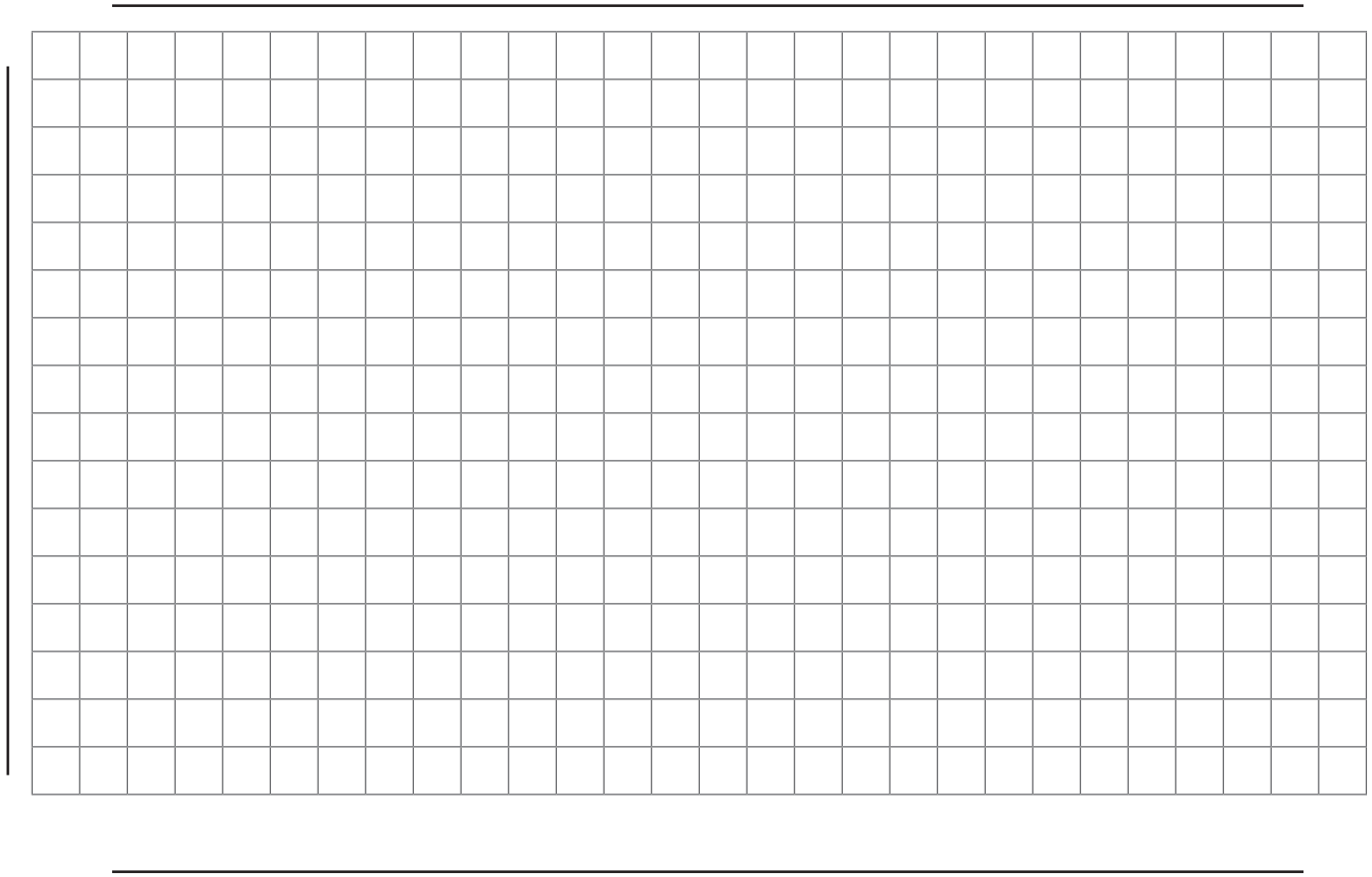
Directions: Use the grid below to create a graph of the relationship between mass and weight.



Student's Name _____ Date _____ Class _____

Student Sheet 5.1: Observing Gravitational Potential and Kinetic Energy

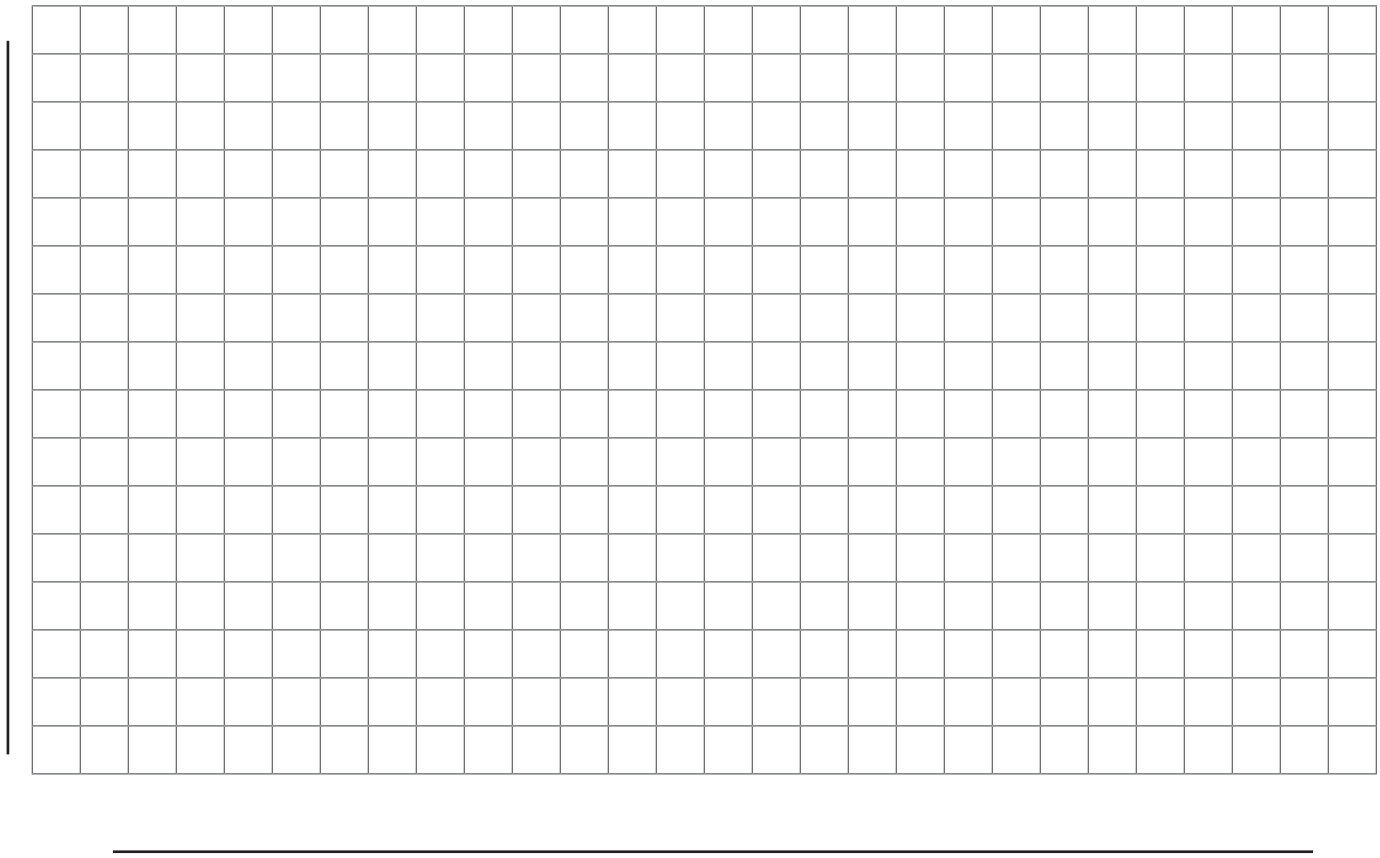
Directions: Use the grid below to create a graph.



Student's Name _____ Date _____ Class _____

Student Sheet 5.2: Analyzing Potential and Kinetic Energy

Directions: Use the grid below to create a graph.



Student's Name _____ Date _____ Class _____

Student Sheet 9.WA: *Energy, Forces, and Motion* Written Assessment Answer Sheet (page 1 of 3)

Multiple Choice

Directions: Circle the letter of your answer choice.

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**

Constructed Response

6. (a) _____

_____

_____

_____

_____

_____

(b) _____

_____

_____

_____

_____

_____

(c) _____

_____

_____

_____

_____

_____

Student's Name _____ Date _____ Class _____

Student Sheet 9.WA: *Energy, Forces, and Motion* Written Assessment Answer Sheet (page 2 of 3)

7. (a) _____

_____

_____

_____

(b) _____

_____

_____

_____

8. _____

_____

_____

_____

_____

9. (a) _____

_____

_____

_____

_____

_____

Student's Name _____ Date _____ Class _____

Student Sheet 9.WA: *Energy, Forces, and Motion* Written Assessment Answer Sheet (page 3 of 3)

9. (b) _____

(c) _____

_____

_____

_____

10. (a)

(b) _____

_____

_____

_____

Lesson Master 1.2: Suggestions for Making the Position Versus Time Graph

1. Give the graph a title that describes the data being displayed.
2. Cover as much space on the graph as possible with plotted data.
3. Label the horizontal x axis "Time (s)" and label the vertical y axis "Position (m)."
4. Set the scale for each axis with even divisions, letting the highest measured value in the data fit on the axis.
5. Make sure all spaces on the x- and y-axis scales are equal, even if they are not marked in the same intervals.
6. Make scaling of the axes start from zero at the intersection of the axes (called the origin) and increase in value, moving right on the x axis and upward on the y axis.
7. Plot the location of each data point on the graph with a small dot.
8. Instead of connecting each data point, use the overall spread of points to construct a line. Follow the trend in data, or the general direction of your data points to draw a line. Notice that some or all of the plotted points may not fall on the line.

Lesson Master 2.5:
Suggestions for Making the Relationship Between Mass and Weight Graph

1. Give the graph a title that describes the data being displayed.
2. Cover as much space on the graph as possible with plotted data.
3. Label the horizontal x-axis "Mass (g)" and label the vertical y-axis "Weight (N)."
4. Set the scale for each axis with even divisions, letting the highest measured value in the data fit on the axis.
5. Make sure all spaces on the x- and y-axis scales are equal, even if they are not marked in the same intervals.
6. Make scaling of the axes start from zero at the intersection of the axes (called the origin) and increase in value, moving right on the x axis and upward on the y axis.
7. Plot the location of each data point on the graph with a small dot.
8. Instead of connecting each data point, use the overall spread of points to construct a line. Follow the trend in data or the general direction of your data points to draw a line. Notice that some or all of the plotted points may not fall on the line.

Lesson Master 8.2: Design Challenge Scoring Rubrics (page 1 of 3)

Highest Velocity				
Criterion	**1**. Beginning	**2**. Developing	**3**. Proficient	**4**. Exemplary
Performance of Design Challenge Task	Group designed a roller coaster in which the marble achieved a velocity less than 15 m/s.	Group designed a roller coaster in which the marble achieved a velocity greater than 15 m/s.	Group designed a roller coaster in which the marble achieved a velocity greater than 30 m/s.	Group designed a roller coaster in which the marble achieved a velocity greater than 45 m/s.
Creativity	Group used the prototype created in Getting Started with no modifications.	Group used the prototype created in Getting Started with only minor modifications.	Group created a new iteration for the design challenge or used the prototype created in Getting Started with significant modifications.	Group created a successful iteration for the design challenge that utilized a novel approach or unique materials.

Grading Rubric				
Criterion	**1**. Beginning	**2**. Developing	**3**. Proficient	**4**. Exemplary
Written Instructions and Schematics	Group did not present written instructions or schematics pertaining to the design challenge.	Group presented either written instructions or schematics that were unclear or incomplete but pertained to the design challenge.	Group presented either written instructions or schematics that were clear and pertained to the design challenge.	Group presented written instructions and schematics that were clear, detailed, and pertained to the design challenge.
Design Implementation	Group constructed a roller coaster that did not pertain to the design challenge.	Group constructed a roller coaster that somewhat pertained to the design challenge.	Group constructed a roller coaster that met the criteria of the design challenge.	Group constructed an iteration that exceeded the criteria of the design challenge.
Testing and Data Collection	Group did not use appropriate procedures to test their design, did not collect data, and did not document changes to their design.	Group did not use appropriate procedures to test their design but collected relevant data and/or documented changes to their design.	Group used appropriate procedures to test their design. Team collected relevant data or documented changes to their design.	Group used appropriate procedures to test their design, collected relevant data, and documented changes to their design.
Reflection and Presentation	Group presented methods and results in an incomplete and unclear manner and did not reflect on choices.	Group presented methods or results in an unclear manner or did not reflect on choices based on scientific principles.	Group presented methods or results adequately. Group reflected on choices based on scientific principles most of the time.	Group presented methods or results clearly and accurately. Group always reflected on choices based on scientific principles.

Largest Loop				
Criterion	**1**. Beginning	**2**. Developing	**3**. Proficient	**4**. Exemplary
Performance of Design Challenge Task	Group designed a roller coaster with a loop, but the marble did not successfully traverse the loop.	Group designed a roller coaster with a loop diameter of less than 0.25 m, and the marble successfully traversed the loop.	Group designed a roller coaster with a loop diameter between 0.25 m and 0.5 m, and the marble successfully traversed the loop.	Group designed a roller coaster with a loop diameter greater than 0.5 m, and the marble successfully traversed the loop.
Creativity	Group used the prototype created in Getting Started with no modifications.	Group used the prototype created in Getting Started with only minor modifications.	Group created a new iteration for the design challenge or used the prototype created in Getting Started with significant modifications.	Group created a successful iteration for the design challenge that utilized a novel approach or unique materials.

Grading Rubric				
Criterion	**1**. Beginning	**2**. Developing	**3**. Proficient	**4**. Exemplary
Written Instructions and Schematics	Group did not present written instructions or schematics pertaining to the design challenge.	Group presented either written instructions or schematics that were unclear or incomplete but pertained to the design challenge.	Group presented either written instructions or schematics that were clear and pertained to the design challenge.	Group presented written instructions and schematics that were clear, detailed, and pertained to the design challenge.
Design Implementation	Group constructed a roller coaster that did not pertain to the design challenge.	Group constructed a roller coaster that somewhat pertained to the design challenge.	Group constructed a roller coaster that met the criteria of the design challenge.	Group constructed an iteration that exceeded the criteria of the design challenge.
Testing and Data Collection	Group did not use appropriate procedures to test their design, did not collect data, and did not document changes to their design.	Group did not use appropriate procedures to test their design but collected relevant data and/or documented changes to their design.	Group used appropriate procedures to test their design. Team collected relevant data or documented changes to their design.	Group used appropriate procedures to test their design, collected relevant data, and documented changes to their design.
Reflection and Presentation	Group presented methods and results in an incomplete and unclear manner and did not reflect on choices.	Group presented methods or results in an unclear manner or did not reflect on choices based on scientific principles.	Group presented methods or results adequately. Group reflected on choices based on scientific principles most of the time.	Group presented methods or results clearly and accurately. Group always reflected on choices based on scientific principles.

Highest Hills				
Criterion	**1**. Beginning	**2**. Developing	**3**. Proficient	**4**. Exemplary
Performance of Design Challenge Task	Group designed a roller coaster with two hills, but the marble did not successfully traverse the first hill (or the height of the first hill was less than 30 cm).	Group designed a roller coaster in which the marble successfully traversed one hill with a height of 30 cm or more but did not successfully traverse a second hill.	Group designed a roller coaster in which the marble successfully traversed one hill with a height of 30 cm or more and a second hill with a height of 20 cm or more.	Group designed a roller coaster in which the marble successfully traversed one hill with a height of 40 cm or more and a second hill with a height of 30 cm or more.
Creativity	Group used the prototype created in Getting Started with no modifications.	Group used the prototype created in Getting Started with only minor modifications.	Group created a new iteration for the design challenge or used the prototype created in Getting Started with significant modifications.	Group created a successful iteration for the design challenge that utilized a novel approach or unique materials.

Grading Rubric				
Criterion	**1**. Beginning	**2**. Developing	**3**. Proficient	**4**. Exemplary
Written Instructions and Schematics	Group did not present written instructions or schematics pertaining to the design challenge.	Group presented either written instructions or schematics that were unclear or incomplete but pertained to the design challenge.	Group presented either written instructions or schematics that were clear and pertained to the design challenge.	Group presented written instructions and schematics that were clear, detailed, and pertained to the design challenge.
Design Implementation	Group constructed a roller coaster that did not pertain to the design challenge.	Group constructed a roller coaster that somewhat pertained to the design challenge.	Group constructed a roller coaster that met the criteria of the design challenge.	Group constructed an iteration that exceeded the criteria of the design challenge.
Testing and Data Collection	Group did not use appropriate procedures to test their design, did not collect data, and did not document changes to their design.	Group did not use appropriate procedures to test their design but collected relevant data and/or documented changes to their design.	Group used appropriate procedures to test their design. Team collected relevant data or documented changes to their design.	Group used appropriate procedures to test their design, collected relevant data, and documented changes to their design.
Reflection and Presentation	Group presented methods and results in an incomplete and unclear manner and did not reflect on choices.	Group presented methods or results in an unclear manner or did not reflect on choices based on scientific principles.	Group presented methods or results adequately. Group reflected on choices based on scientific principles most of the time.	Group presented methods or results clearly and accurately. Group always reflected on choices based on scientific principles.

Lesson Master 9.PA: Design Challenge Scoring Rubrics

Produce Transport				
Criterion	**1. Beginning**	**2. Developing**	**3. Proficient**	**4. Exemplary**
Performance of Design Challenge Task	Group modified produce, or design transported 10 pieces of fruit or fewer.	Group design transported greater than 10 pieces of fruit.	Group design transported greater than 15 pieces of fruit.	Group design transported greater than 20 pieces of fruit.
Creativity	Group used the prototype with no modifications.	Group used the prototype with only minor modifications.	Group used the prototype with significant modifications.	Group used the prototype with modifications that utilized a novel approach or unique materials.

Grading Rubric				
Criterion	**1. Beginning**	**2. Developing**	**3. Proficient**	**4. Exemplary**
Written Instructions and Schematics	Group did not present written instructions or schematics pertaining to the design challenge.	Group presented either written instructions or schematics that were unclear or incomplete but pertained to the design challenge.	Group presented either written instructions or schematics that were clear and pertained to the design challenge.	Group presented written instructions and schematics that were clear, detailed, and pertained to the design challenge.
Design Implementation	Group constructed a model that did not pertain to the design challenge.	Group constructed a model that somewhat pertained to the design challenge.	Group constructed a model that met the criteria of the design challenge.	Group constructed a model that exceeded the criteria of the design challenge.
Testing and Data Collection	Group did not test their design.	Group did not use appropriate procedures to test their design and did not collect relevant data.	Group used appropriate procedures to test their design but did not collect relevant data.	Group used appropriate procedures to test their design and collected relevant data.
Reflection and Presentation	Group presented methods and results in an incomplete and unclear manner and did not reflect on choices.	Group presented methods or results in an unclear manner or did not reflect on choices based on scientific principles.	Group presented methods or results adequately. Group reflected on choices based on scientific principles most of the time.	Group presented methods or results clearly and accurately. Group always reflected on choices based on scientific principles.

Lesson Master 9.WA: *Energy, Forces, and Motion* Assessment Questions (page 1 of 6)

Multiple Choice

Directions: Use Student Sheet 9.WA: *Energy, Forces, and Motion Written Assessment Answer Sheet* to circle the letter of your response to each multiple-choice question, and then clearly explain your reason for choosing it. Make no marks on this sheet.

1. A boy rides a skateboard from point X to point Z. Which statement best describes how energy changes as he moves?

A. Kinetic energy of his motion from point X to point Y is converted to a force that moves him up the hill to point Z.

B. Potential energy of his motion from point X to point Y is converted to a force that moves him up the hill to point Z.

C. Kinetic energy of his motion from point X to point Y is changed to potential energy and heat energy as he moves up the hill to point Z.

D. Potential energy of his motion from point X to point Y is changed to kinetic energy and heat energy as he moves up the hill to point Z.

2. A cardboard box is placed on the floor. The box is then given a brief push. The force of the push is greater than the frictional forces acting on the box. What will the box do immediately after the push?

A. Speed up because the pushing force continues to increase.

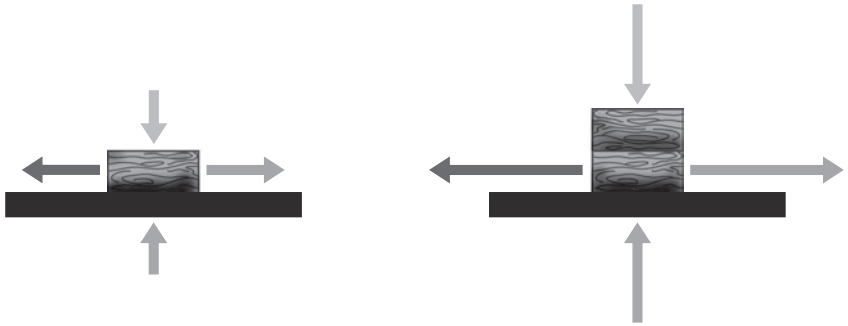
B. Speed up because of the difference in magnitude of the two forces.

C. Move at a constant speed because the force of the push is constant.

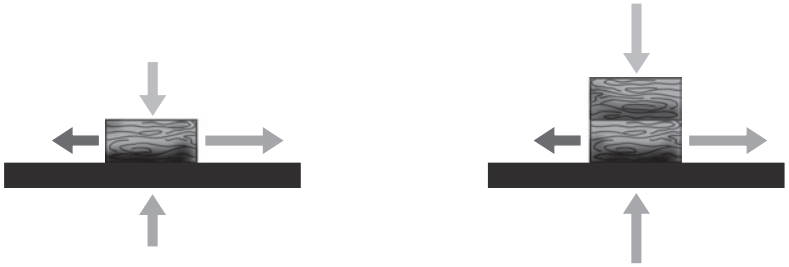
D. Slow down and then move at a lower constant speed because of the frictional forces.

3. You pull a wooden block at a steady speed across a tabletop. If you place another identical wooden block on top of the first block and pull the two blocks at a steady speed, which set of diagrams can be used to correctly model the forces acting on the blocks?

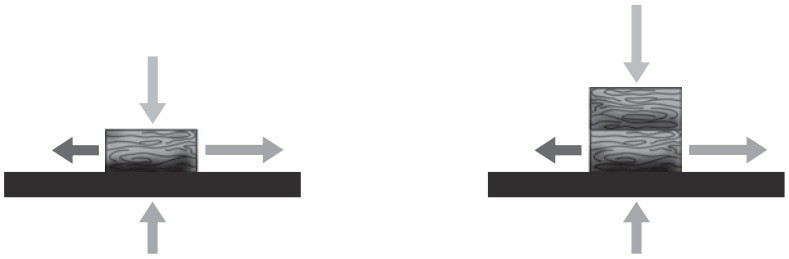
A.



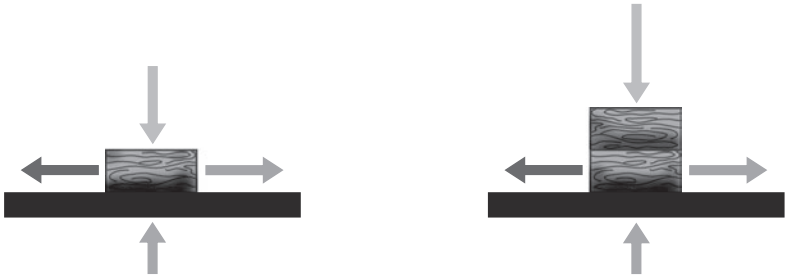
B.



C.



D.



4. An earthquake knocks both a dictionary and a comic book from the top shelf of a bookshelf. The dictionary has a greater mass than the comic book. Both books are knocked off the shelf at the same time. What can be said about the gravitational potential energy of the two books?

A. The gravitational potential energy of both books increased as they fell toward the ground.

B. The gravitational potential energy of both books would be the same because they fell from the same height.

C. The dictionary had a greater gravitational potential energy than the comic book because it had a greater mass.

D. The comic book had a greater gravitational potential energy than the dictionary because it fell faster toward the ground.

5. A student uses a squirt gun to shoot water at various objects positioned 1 meter away. The data table below shows the results.

Object	**Results**
Marble	Marble rolls 50 cm away and stops.
Tennis ball	Ball rolls 20 cm away and stops.
Croquet ball	Ball rolls 5 cm away and stops.
Basketball	Ball does not move.

What can be said about forces that are acting as water strikes these objects?

A. The basketball is the only case in which the forces between the water and object were balanced.

B. The greatest amount of force was absorbed by the marble and the least by the basketball, as shown by the distances they traveled.

C. The water applied a force to each object, but only the basketball applied the same amount of force to the water in the opposite direction.

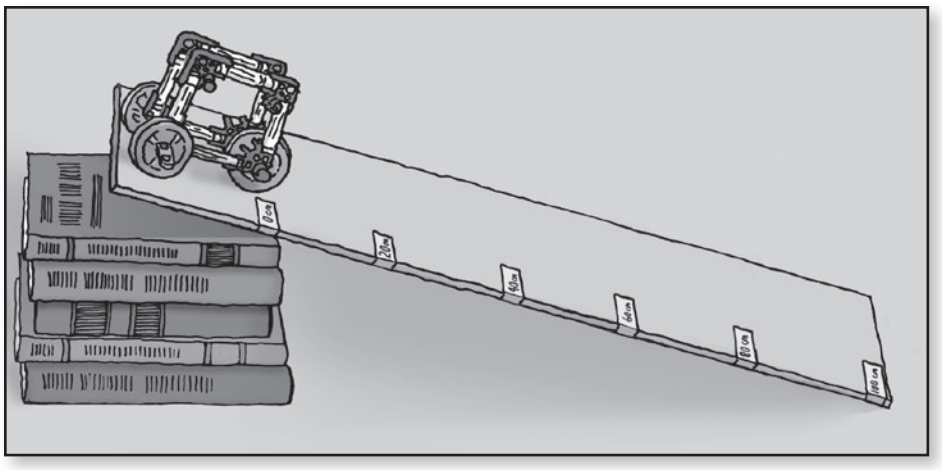
D. The water applied a force to each object and each object applied the same amount of force to the water but in the opposite direction.

Lesson Master 9.WA: *Energy, Forces, and Motion* Assessment Questions (page 4 of 6)

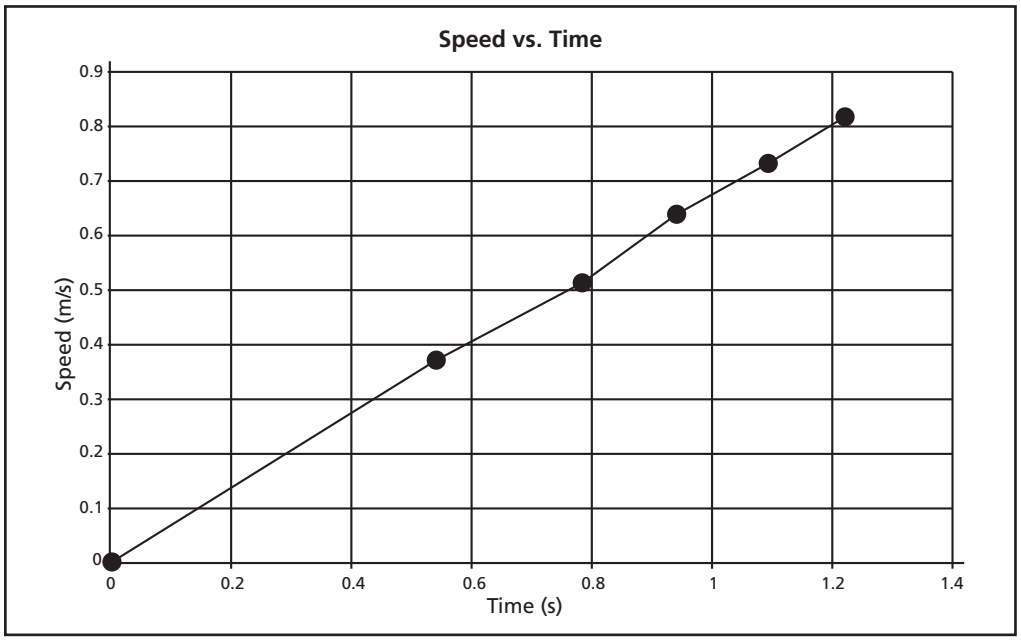
Constructed Response

Directions: Use Student Sheet 9.WA: *Energy, Forces, and Motion Written Assessment Answer Sheet* to write your answers to each question on the lines provided. Make no marks on this sheet.

6. A group of students made a car using plastic parts. Then, they set up an inclined plane (ramp), as shown in the illustration below.



The students placed the car at the top of the ramp and released it so that it rolled down the ramp. After completing three timed trials, the students calculated average time and average speed. Next, they constructed a graph of average speed versus average time, as shown below.



a. What can you conclude about the relationship of average speed and average time of travel as the car rolls down the ramp? Why? Describe how you interpreted the data in the graph.

b. What can you infer about the forces acting on the car as it rolls down the ramp?

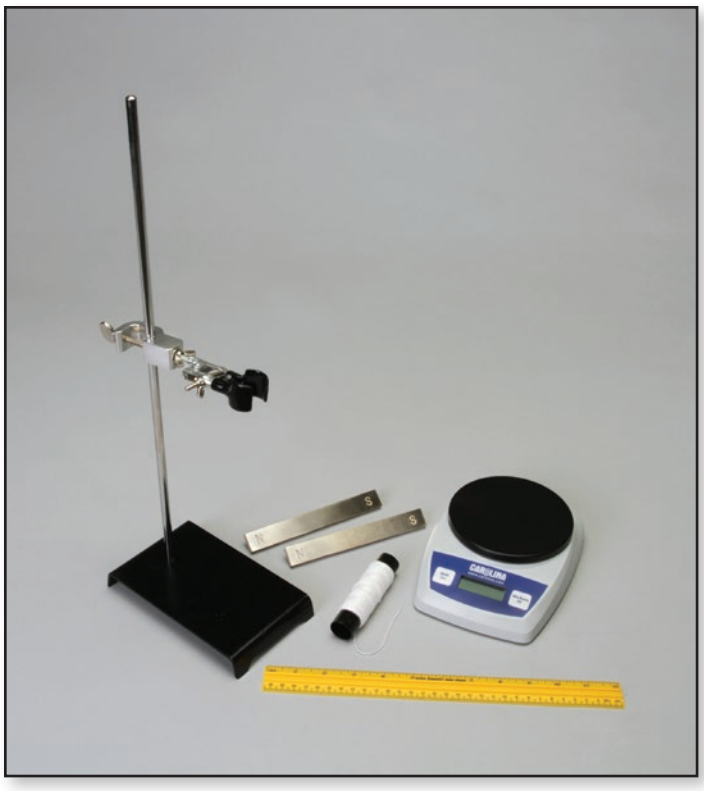
c. Imagine that the car is allowed to roll down the ramp onto a flat floor. Construct a prediction (or draw a diagram) that includes information about both the distance and the speed the car will travel. Label your diagram with information about forces and energy at two different locations.

7. Describe at least two modifications that could be made to the investigation in question 6 to increase the amount of:

a. Potential energy in the car

b. Kinetic energy in the car

8. The image below shows materials for an investigation.

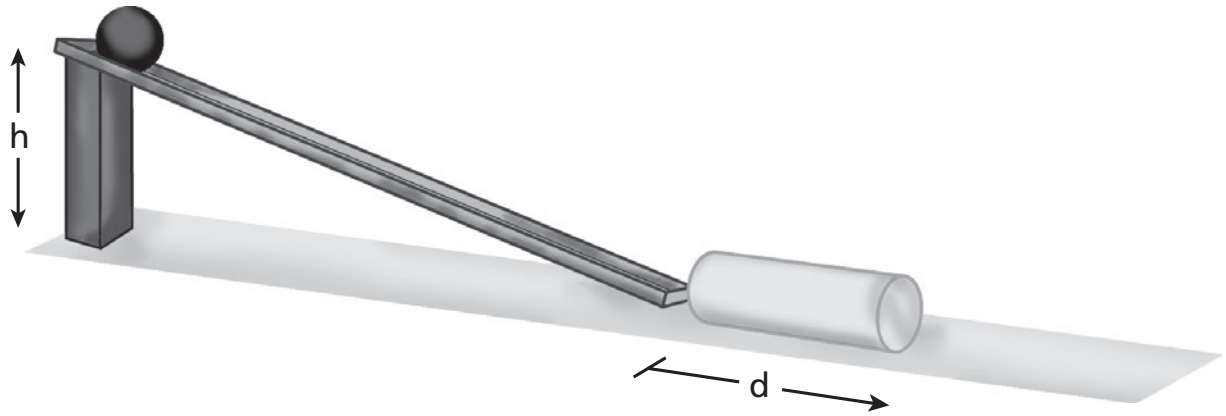


Describe a stepwise plan for collecting numerical data as evidence for the following claim:

"One object can exert force on another object without touching it."

You may use any of the materials shown, but do not add any that are not shown. Your plan should include a description of how you will use the materials and the type of numerical data that you will collect.

9. The image below shows an experimental setup.

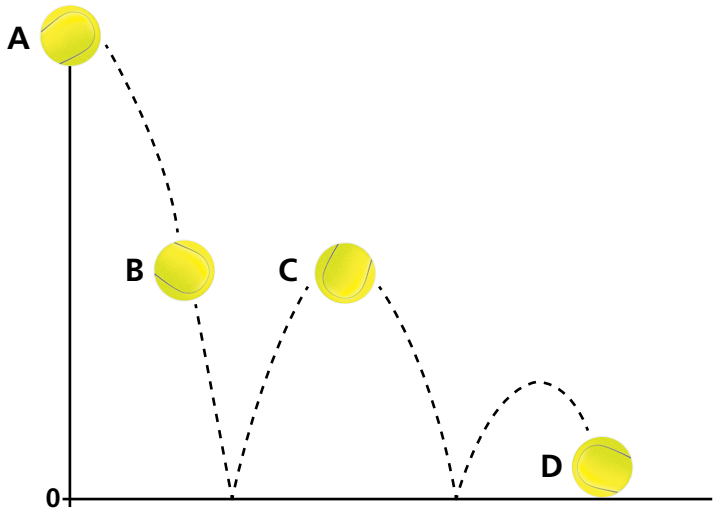


a. Use this setup to describe a plan for investigating the relationship between the mass of an object and its kinetic energy if the same force is applied. Your plan should include a description of any variables that you will change, variables that you will observe, and variables that you will keep constant. Provide an explanation for your choices.

b. Create a data table for collecting data during your planned investigation.

c. Discuss at least one possible weakness in your investigation plan. Provide an explanation for why this could be a weakness.

10. The image below is a labeled diagram showing a bouncing tennis ball. The tennis ball is at rest at point A, point C, and point D.



a. Create a graphical representation showing the potential and kinetic energy of the ball at points A–D.

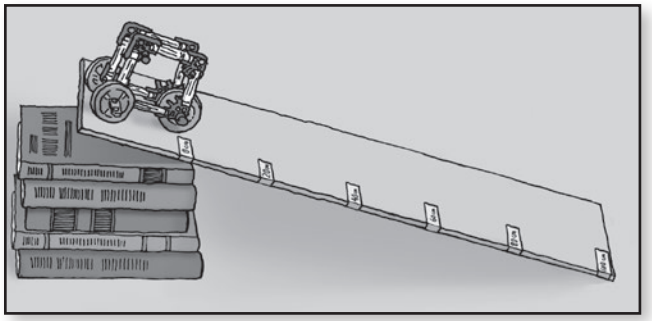
b. Write a written explanation of the potential and kinetic energy of the ball at points A–D.

Multiple Choice

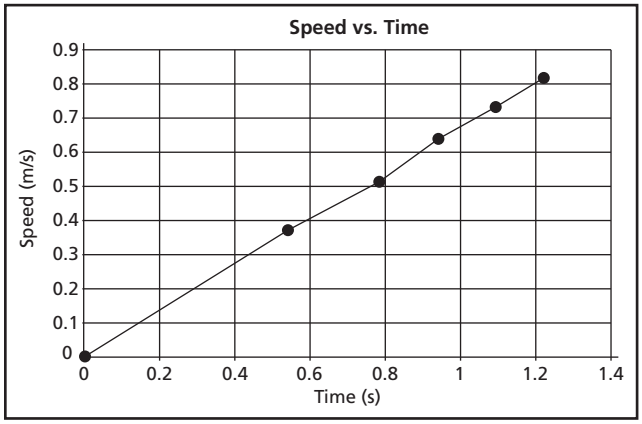
1. C **2.** B **3.** A **4.** C **5.** D

Constructed Response

6. A group of students made a car using plastic parts. Then, they set up an inclined plane (ramp), as shown in the illustration below.



The students placed the car at the top of the ramp and released it so that it rolled down the ramp. After completing three timed trials, the students calculated average time and average speed. Next, they constructed a graph of average speed versus average time, as shown below.



a. What can you conclude about the relationship of average speed and average time of travel as the car rolls down the ramp? Why? Describe how you interpreted the data in the graph.

The speed of the car increases as it rolls down the ramp because the line on the graph shows that speed increases as time increases.

b. What can you infer about the forces acting on the car as it rolls down the ramp?

There must be an unbalanced force on the car. Gravity is pulling the car down the ramp. Friction opposes the motion of the car down the ramp. The pull of gravity is greater than the friction on the car, resulting in an unbalanced force down the ramp. This unbalanced force makes the car speed up.

c. Imagine that the car is allowed to roll down the ramp onto a flat floor. Construct a prediction (or draw a diagram) that includes information about both the distance and the speed the car will travel. Label your diagram with information about forces and energy at two different locations.

As the car rolls across the floor, it will begin to slow down and will eventually come to a stop. The force of friction acts against the forward motion of the car. The work done by the force of friction will transform the kinetic energy of the car into heat. When the car has stopped, all the kinetic energy of the car will have been transformed into heat.

7. Describe at least two modifications that could be made to the investigation in question 6 to increase the amount of:

a. Potential energy in the car

The following modifications would increase the potential energy in the car:

- *Increase the height of the ramp.*
- *Increase the mass of the car.*

b. Kinetic energy in the car

The following modifications would increase the kinetic energy in the car:

- *Increase the mass of the car.*
- *Increase the speed of the car by adding a motor or pushing the car down the ramp.*

8. The image below shows materials for an investigation.

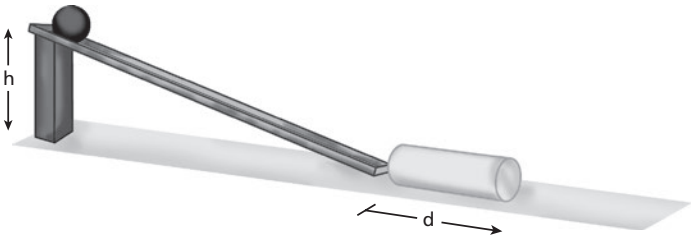
Describe a stepwise plan for collecting numerical data as evidence for the following claim:

"One object can exert force on another object without touching it."

You may use any of the materials shown, but do not add any that are not shown. Your plan should include a description of how you will use the materials and the type of numerical data that you will collect.

Place the balance directly under the clamp. Zero the balance and then place one bar magnet on the balance to measure its weight (force due to gravity). Tie a piece of string around the magnet and slowly lower the magnet toward the magnet on the balance. Take readings on the balance at different heights of the magnet above it. Height measurements can be taken using the ruler. At some height, the reading on the balance will begin to decrease, showing that the force of the magnet becomes strong enough to pull the second magnet up from the balance pan.

9. The image below shows an experimental setup.



a. Use this setup to describe a plan for investigating the relationship between the mass of an object and its kinetic energy if the same force is applied. Your plan should include a description of any variables that you will change, variables that you will observe, and variables that you will keep constant. Provide an explanation for your choices.

I will vary the mass of the ball, keep the height of the ramp and the cylinder resting at the bottom of the ramp constant, and observe how the distance "d" changes as the ball strikes the cylinder and causes it to move. Keeping the height of the ramp constant will allow me to keep the force applied to the ball the same. Changing the mass of the ball will allow me to see how mass affects the kinetic energy of the ball. I can observe kinetic energy by seeing how far the cylinder is pushed by the ball when it collides with it at the bottom of the ramp. The greater the kinetic energy of the ball, the greater is the kinetic energy that it will transfer to the cylinder, and the greater is the distance the cylinder will move.

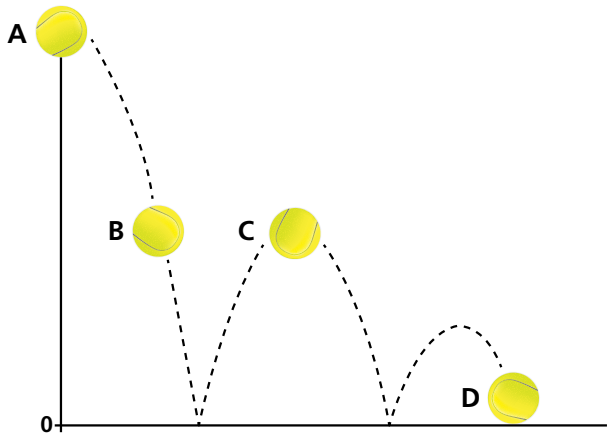
b. Create a data table for collecting data during your planned investigation.

Mass of ball	Trial 1 Distance cylinder moves	Trial 2 Distance cylinder moves	Trial 3 Distance cylinder moves	Average Distance cylinder moves

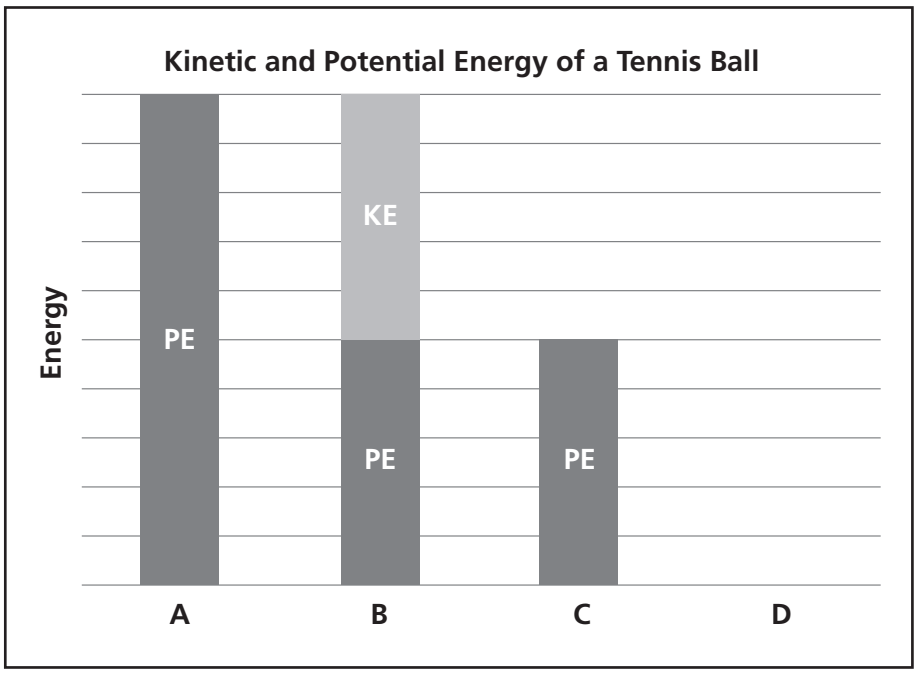
c. Discuss at least one possible weakness in your investigation plan. Provide an explanation for why this could be a weakness.

Answers may vary.

10. The image below is a labeled diagram showing a bouncing tennis ball. The tennis ball is at rest at point A, point C, and point D.



a. Create a graphical representation showing the potential and kinetic energy of the ball at points A–D.



b. Write a written explanation of the potential and kinetic energy of the ball at points A–D.

At point A, the ball has the highest potential energy because it is at the highest point. At points B and C, the ball has less potential energy. At point D, the ball is at the lowest point and has the least potential energy. At points A, C, and D, the ball has no kinetic energy because it is at rest. At point, B, the ball has kinetic energy because is it is in motion.