Chapter Resources

Motion

Includes:

Reproducible Student Pages

- **ASSESSMENT**
  - ✔ Chapter Tests
  - ✔ Chapter Review

- **HANDS-ON ACTIVITIES**
  - ✔ Lab Worksheets for each Student Edition Activity
  - ✔ Laboratory Activities
  - ✔ Foldables—Reading and Study Skills activity sheet

- **MEETING INDIVIDUAL NEEDS**
  - ✔ Directed Reading for Content Mastery
  - ✔ Directed Reading for Content Mastery in Spanish
  - ✔ Reinforcement
  - ✔ Enrichment
  - ✔ Note-taking Worksheets

- **TRANSPARENCY ACTIVITIES**
  - ✔ Section Focus Transparency Activities
  - ✔ Teaching Transparency Activity
  - ✔ Assessment Transparency Activity

- **Teacher Support and Planning**
  - ✔ Content Outline for Teaching
  - ✔ Spanish Resources
  - ✔ Teacher Guide and Answers
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**Additional Assessment Resources available with Glencoe Science:**

- ExamView® Pro TestMaker
- Assessment Transparencies
- Performance Assessment in the Science Classroom
- Standardized Test Practice Booklet
- MindJogger Videoquizzes
- Vocabulary PuzzleMaker at: gpscience.com
- Interactive Chalkboard
- The Glencoe Science Web site at: gpscience.com
- An interactive version of this textbook along with assessment resources are available online at: mhn.com
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Hands-On Activities
Mini LAB  Describing the Motion of a Car

Procedure
1. Mark your starting point on the floor with tape.
2. At the starting line, give your toy car a gentle push forward. At the same time, start your stopwatch.
3. Stop timing when the car comes to a complete stop. Mark the spot at the front of the car with another pencil. Record the time for the entire trip.
4. Use a meterstick to measure the distance to the nearest tenth of a centimeter and convert it to meters.

Data and Observations

<table>
<thead>
<tr>
<th>Toy Car Trip</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trip time</strong></td>
</tr>
<tr>
<td>Distance in cm</td>
</tr>
<tr>
<td>Distance in m</td>
</tr>
</tbody>
</table>

Analysis
Calculate the speed. How would the speed differ if you repeated your experiment in exactly the same way but the car traveled in the opposite direction?
Mini LAB

Observing Inertia in Action

Procedure
1. Create an inclined plane between 25° and 50° using a board and textbooks. Place a stop block (brick or other heavy object) at the end of the plane.
2. Place a small object in a cart and allow both to roll down the plane. Record the results in the table below.
3. Secure the object in the cart with rubber bands (seat belts). Allow both to roll down the plane again. Record the results.

Data and Observations

<table>
<thead>
<tr>
<th></th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object in cart without “safety belt”</td>
<td></td>
</tr>
<tr>
<td>Object in cart with “safety belt”</td>
<td></td>
</tr>
</tbody>
</table>

Analysis
1. Explain the forces acting on the object in both runs.

2. Explain why it is important to wear safety belts in a car.
Force and Acceleration

Lab Preview

Directions: Answer these questions before you begin the Lab.

1. Why do you think goggles are listed as a safety precaution for this lab?

2. According to Newton’s first law of motion, what does it take to cause an object to begin moving from a state of rest?

If you stand at a stoplight, you will see cars stopping for red lights and then taking off when the light turns green. What makes the cars slow down? What makes them speed up? Can a study of unbalanced forces lead to a better understanding of these everyday activities?

Real-World Question

How does an unbalanced force on a book affect its motion?

Materials

tape
paper clip
10-N spring scale
large book
your science book
triple beam balance
*electronic balance
*Alternate materials

Goals

■ Observe the effect of force on the acceleration of an object.
■ Interpret the data collected for each trial.

Safety Precautions

Proper eye protection should be worn at all times while performing this lab.

Procedure

1. With a piece of tape, attach the paper clip to your textbook so that the paper clip is just over the edge of the book.

2. Use Table 1 in the Data and Observations section to record your observations.

3. If available, use a large balance to find the mass of your science book.

4. Place the book on the floor or on the surface of a long table. Use the paper clip to hook the spring scale to the book.

5. Pull the book across the floor at a slow but constant velocity. While pulling, read the force you are pulling with on the spring scale and record it in your table.

6. Repeat step 5 two more times, once accelerating slowly and once accelerating quickly. Be careful not to pull too hard. Your spring scale will read only up to 10 N.

Data and Observations

Table 1

<table>
<thead>
<tr>
<th>Force-Acceleration Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>One book</td>
</tr>
<tr>
<td>Two books</td>
</tr>
</tbody>
</table>

Conclude and Apply

1. Organize the pulling forces from greatest to least for each set of trials. Do you see a relationship between force and acceleration? Explain your answer.

2. Explain. How did adding the second book change the results?

Communicating Your Data

Compare your conclusions with those of other students in your class. For more help, refer to the Science Skill Handbook.
Lab Preview

Directions: Answer these questions before you begin the Lab.

1. Why do you think goggles are recommended for this lab?

2. Do you think it would take more force to move a baseball or a basketball? Why?

Think about a small ball. How many ways could you exert a force on the ball to make it move? You could throw it, kick it, roll it down a ramp, blow it with a large fan, etc. Do you think the distance and speed of the ball’s motion will be the same for all of these forces? Do you think the acceleration of the ball would be the same for all of these types of forces?

Real-World Question
How will the motion of a small toy car vary when different forces are applied to it?

Form a Hypothesis
Based on your reading and observations, state a hypothesis about which force that is exerted will cause the toy car to go fastest.

Possible Materials
- small toy car
- ramps or boards of different lengths
- springs or rubber bands
- string
- stopwatch
- meterstick or tape measure
- graph paper

Goals
- Identify several forces that you can use to propel a small toy car across the floor.
- Demonstrate the motion of the toy car using each of the forces.
- Graph the position versus time for each force.
- Compare the motion of the toy car resulting from each force.

Safety Precautions

Test Your Hypothesis

Make a Plan
1. As a group, agree upon the hypothesis and decide how you will test it. Identify what results will confirm the hypothesis that you have written.

2. List the steps you will need to test your hypothesis. Be sure to include a control run. Be specific. Describe exactly what you will do in each step. List your materials.

3. Prepare a data table on a separate sheet of paper to record your observations.

4. Read the entire experiment to make sure all steps are in logical order and will lead to a conclusion.

5. Identify all constants, variables, and controls of the experiment. Keep in mind that you will need to have measurements at multiple points. These points are needed to graph your results. You should make sure to have several data points taken after you stop applying the force and before the car starts to slow down. It might be useful to have several students taking measurements, making each responsible for one or two points.
Follow Your Plan
1. Make sure your teacher approves your plan before you start.
2. Carry out the experiment as planned.
3. While doing the experiment, record your observations and complete the data tables you created.

Analyze Your Data
1. **Graph** the position of the car versus time for each of the forces you applied. How can you use the graphs to compare the speeds of the toy car?

2. **Calculate** the speed of the toy car over the same time interval for each of the forces that you applied. How do the speeds compare?

Conclude and Apply
1. **Evaluate** Did the speed of the toy car vary depending upon the force applied to it?

2. **Determine** For any particular force, did the speed of the toy car change over time? If so, how did the speed change? Describe how you can use your graphs to answer these questions.

3. **Draw Conclusions** Did your results support your hypothesis? Why or why not?

Communicating Your Data

**Compare** your data to those of other students. **Discuss** how the forces you applied might be different from those others applied and how that affected your results.
Pushing People Around

When we push something, we unconsciously compensate for how much mass it has. We know that if an object has a larger mass it will require more force to get it moving and if it has a small mass it will require less force. But how much difference is there? In this experiment, we will see what variables affect acceleration.

**Strategy**
You will see what happens when you use a constant force to pull a skater.
You will examine the relationship between force, acceleration, and mass.

**Materials**
tape
meter stick
roller skates
skating safety equipment (helmet, pads)
spring balance
stopwatch

**Procedure**

1. Mark positions on the floor at intervals of 0 m, 5 m, 10 m, and 15 m with the tape. The floor should be smooth, straight, and level.
2. Have one student stand on the 0-m mark with the skates on. A second student stands behind the mark and holds the skater. The skater holds the spring balance by its hook.
3. The third student holds the other end of the spring balance and exerts a constant pulling force on the skater. When the skater is released, the puller must maintain a constant force throughout the distance. Measure the time to each of the marks. Record this in the Data and Observations section along with the spring balance readings at each mark.
4. Repeat steps 2 and 3 for two different skaters in order to vary the mass. Keep the force the same. Make sure the skaters hold their skates parallel and do not try to change direction during the trial.
5. Repeat steps 2, 3, and 4 with a different constant force. Use the same three skaters. Record these results in the Data and Observations section.
**Laboratory Activity 1 (continued)**

**Data and Observations**

**Table 1**

<table>
<thead>
<tr>
<th>Trial</th>
<th>Distance (m)</th>
<th>Force (N)</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2**

<table>
<thead>
<tr>
<th>Trial</th>
<th>Distance (m)</th>
<th>Force (N)</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Questions and Conclusions

1. Until the time of Galileo and Newton, people believed that, disregarding friction, a constant force was required to produce a constant speed. Do your observations confirm or reject this notion?

2. What happens to the speed as you proceed farther along the measured distance?

3. What happens to the rate of increase in speed—the acceleration—as you proceed farther along the measured distance?

4. When the force is the same, how does the acceleration depend upon the mass?

5. When the mass of the skater is the same, how does the acceleration depend upon the force?

6. Suppose a 4-N force is applied to the skater and no movement results. How can this be explained?

Strategy Check

_____ Can you pull someone with a constant force?

_____ Can you explain the relationship between force, mass, and acceleration?
Name    Date    Class

**Laboratory Activity**

**Motion of a Bowling Ball**

It takes time to walk somewhere. Sometimes you move quickly, while other times you move slowly. Other objects might show variation in their movement as well. In this lab, you will graph the movement of a bowling ball and consider how its motion relates to other kinds of motion.

**Strategy**

You will make a distance versus time graph of a bowling ball as it rolls. You will relate the motion of the bowling ball to other types of motion.

**Materials**

- bowling ball
- stopwatches (5–10)
- large pillow

**Procedure**

1. Line up with other students at equally spaced distances of 1 m. Your teacher will mark the distances.
2. At the far end of the hall, set up the pillow or other large, soft object. This will prevent the ball from rolling too far.
3. Start your stopwatch when your teacher rolls the ball slowly.
4. When the ball passes you, stop your stopwatch. As the ball passes the other students, they will do the same.
5. Record all of your times in Table 1.
6. Clear your stopwatch to prepare for another trial. This time, your teacher will roll the ball faster.
7. Record your times in Table 2.
8. Graph the data for both tables, putting the data from Table 1 into Graph 1, and the data from Table 2 into Graph 2. Place the distance on the vertical axis, and the time on the horizontal axis.

**Data and Observations**

<table>
<thead>
<tr>
<th>Trial 1</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>Time</td>
<td></td>
</tr>
<tr>
<td>0 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>Time</td>
<td></td>
</tr>
<tr>
<td>0 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Questions and Conclusions

1. What do you notice about the graphs of the two trials?

2. On a distance versus time graph, what does the slope of the line tell you?

3. On a distance versus time graph, what does a flat (horizontal) line mean?

4. Imagine a bowling ball dropped from a great height. How would the motion of this bowling ball relate to the bowling balls in the lab?

5. What was the speed of the bowling ball in the first trial? In the second trial?
Laboratory Activity 2 (continued)

6. What distance did the bowling balls travel? What is their displacement?

________________________________________________________________________

________________________________________________________________________

7. How are distance and displacement related?

________________________________________________________________________

________________________________________________________________________

Strategy Check

_______ Can you graph the speed of an object in motion?
Motion

Directions: Use this page to label your Foldable at the beginning of the chapter.

What Motion?
How far?
How fast?
In what direction?
Meeting Individual Needs
Directions: Complete the concept map using the terms below.

velocity | position | speed | direction

An object’s acceleration

which depends on its

1.

which depends on its

2. and 3.

which is its rate of change of

4.

Directions: Circle the term in parentheses that correctly completes the sentence.

5. Newton’s first law of motion states that an object’s velocity will not change unless it is acted upon by (balanced/unbalanced) forces.

6. The greater a boulder’s mass, the (greater/less) inertia it has.

7. Displacement depends on an object’s distance and (speed/direction) compared to a starting point.

8. An automobile that slows down when approaching a stop sign has (negative, positive) acceleration.
Section 1 • Describing Motion

Directions: For each of the following, write the letter of the term or phrase that best completes the sentence.

1. A sprinter runs 200 m west and 100 m east. Her displacement is _____.
   a. 300 m        b. 100 m west

2. Speed can be calculated by dividing distance by _____.
   a. time        b. displacement

3. The speed of a motorcycle at a particular moment is its _____ speed.
   a. average        b. instantaneous

4. Earth’s plates move only a few _____ per year.
   a. centimeters        b. meters

5. Two cars are each traveling at 72 km/h. One car is traveling northeast, and the other is traveling south. The two cars have different _____.
   a. velocities        b. speeds

Directions: Look at the graph. Match the letters in the graph to the sentences below.

Graph of Ruth’s Motion

6. Ruth stops for 10 minutes to speak to a friend.
7. She walks at a constant speed of 80 m/min.
8. She jogs 600 m in 5 minutes.
Directions: Complete the paragraph by filling in the blanks using the terms listed below.

<table>
<thead>
<tr>
<th>acceleration</th>
<th>velocity</th>
<th>direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>negative</td>
<td>positive</td>
<td>time</td>
</tr>
</tbody>
</table>

Acceleration occurs when an object’s 1. ________________ changes. When an object speeds up, it has 2. ________________ acceleration. When an object’s final velocity is less than its initial velocity, however, it has 3. ________________ acceleration. An object that is changing 4. ________________ is accelerating, even if its speed remains the same. Acceleration can be calculated by dividing the change in velocity by the 5. ________________ interval in which the change occurred. The SI unit of 6. ________________ is m/s².

Directions: Match the terms in Column II with the descriptions in Column I. Write the letter of the correct term in the blank at the left.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>_______</td>
<td>a. force</td>
</tr>
<tr>
<td>_______</td>
<td>b. net force</td>
</tr>
<tr>
<td>_______</td>
<td>c. unbalanced forces</td>
</tr>
<tr>
<td>_______</td>
<td>d. balanced forces</td>
</tr>
<tr>
<td>_______</td>
<td>e. inertia</td>
</tr>
<tr>
<td>_______</td>
<td>f. Newton’s first law of motion</td>
</tr>
</tbody>
</table>

7. result in a net force of zero
8. the tendency of an object to resist any change in its motion
9. cause an object’s velocity to change
10. a push or pull that can change an object’s motion
11. states that an object at rest will remain at rest unless acted upon by a net unbalanced force
12. the combined force on an object
Across
4. the rate of change of velocity
7. the tendency of an object to resist any change in its motion
8. a push or pull that is exerted on an object
9. the distance and direction of an object from a starting point
10. Equal, but opposite, forces are said to result in a(n) ______ force of zero.
11. type of force that can change the velocity of a body at rest or in motion

Down
1. the distance an object travels per unit of time
2. forces on an object that are equal in strength but opposite in direction
3. a measure of how far an object has moved from a starting point
5. ______ speed is equal to the total distance traveled divided by the total time of travel.
6. includes both the speed of an object and the direction it is moving
7. The rate of change in position at a given point in time is ______ speed.
Instrucciones: Completa el mapa conceptual usando los siguientes términos.

<table>
<thead>
<tr>
<th>velocidad</th>
<th>posición</th>
<th>rapidez</th>
<th>dirección</th>
</tr>
</thead>
</table>

La aceleración de un cuerpo es la tasa de cambio de rapidez, que depende de su dirección.

1. 

2. 

3. 

4. 

Instrucciones: Haz un círculo alrededor del término que complete correctamente la oración.

5. La primera ley de movimiento de Newton establece que la velocidad de un cuerpo no cambia a menos que una fuerza (equilibrada/desequilibrada) actúe sobre él.


7. El desplazamiento depende de la distancia y (velocidad/dirección) de un cuerpo comparadas con las del punto de partida.

8. Un carro que decelera al acercarse a una señal de Pare está demostrando aceleración (negativa, positiva).
**Sección 1 ▪ Describe el movimiento**

**Instrucciones:** Para cada uno de los siguientes, escribe la letra del término o frase que mejor conteste la pregunta.

_____ 1. Un corredor corre 200 m al oeste y 100 m al este. Su desplazamiento es _____.
   a. 300 m  
   b. 100 m al oeste

_____ 2. La rapidez se calcula dividiendo la distancia entre el _____.
   a. tiempo  
   b. desplazamiento

_____ 3. La rapidez de una motocicleta en un momento dado es su rapidez _____.
   a. promedio  
   b. instantánea

_____ 4. Las placas de la Tierra se mueven solamente unos cuantos _____ al año.
   a. centímetros  
   b. metros

_____ 5. Dos autos viajan a 72 km/h. Uno viaja hacia el noreste y el otro viaja hacia el sur. Los dos autos tienen diferente _____.
   a. velocidad  
   b. rapidez

**Instrucciones:** Observa la gráfica. Coordina las letras de la gráfica con las siguientes oraciones.

_____ 6. Ruth se detiene durante 10 minutos para conversar con un amigo.

_____ 7. Camina con una rapidez constante de 80 m/min.

_____ 8. Corre 600 m en 5 minutos.
Instrucciones: Completa el párrafo llenando los espacios en blanco con los siguientes términos.

<table>
<thead>
<tr>
<th>aceleración</th>
<th>velocidad</th>
<th>dirección</th>
</tr>
</thead>
<tbody>
<tr>
<td>negativa</td>
<td>positiva</td>
<td>tiempo</td>
</tr>
</tbody>
</table>

Ocurre aceleración cuando cambia el(la) 1. ________________ de un cuerpo. Cuando un cuerpo se mueve más rápidamente, muestra aceleración 2. ________________. Sin embargo, cuando la velocidad final de un cuerpo es menor que su velocidad inicial, su aceleración es 3. ________________. Un cuerpo que cambia su 4. ________________ está acelerando, aunque su rapidez permanezca igual. La aceleración puede calcularse dividiendo el cambio en la velocidad entre el intervalo de 5. ________________ durante el cual ocurrió el cambio. La unidad SI de 6. ________________ es m/s².

Instrucciones: Coordina los términos de la Columna II con las descripciones de la Columna I. Escribe la letra del término correcto en los espacios a la izquierda.

Columna I

____ 7. resulta en una fuerza neta de cero
____ 8. tendencia de un cuerpo a resistir cualquier cambio en su movimiento
____ 9. hace que cambie la velocidad de un cuerpo
____ 10. empuje o jalón que cambia el movimiento de un cuerpo
____ 11. establece que un cuerpo en reposo permanecerá en reposo a menos que una fuerza neta desequilibrada actúe sobre él
____ 12. la combinación de fuerzas sobre un cuerpo

Columna II

a. fuerza
b. fuerza neta
c. fuerzas desequilibradas
d. fuerzas equilibradas
e. inercia
f. primera ley del movimiento de Newton
**Introducción:** Usa las pistas para completar el crucigrama.

**Términos claves**

**Horizontales**
3. tendencia de un cuerpo a resistir cambios en su movimiento
5. distancia que un cuerpo viaja, por unidad de tiempo
7. las fuerzas que son iguales pero opuestas resultan en una fuerza de cero.
8. tasa de cambio en la velocidad
9. tipo de fuerza que puede cambiar la velocidad de un cuerpo en reposo o en movimiento.
10. medida de la distancia que se ha movido un cuerpo desde su punto de partida.
11. fuerzas que actúan sobre un cuerpo que son de igual magnitud pero de dirección opuesta.

**Verticales**
1. distancia y dirección de un cuerpo desde su punto de partida
2. empujón o jalón sobre un cuerpo
3. la rapidez es la tasa de cambio en posición en un momento de tiempo dado.
4. incluye tanto la rapidez de un cuerpo como la dirección en la cual se mueve.
6. la velocidad es igual a la distancia total recorrida dividida entre el tiempo total que tomó recorrerla.
**Motion**

**Directions:** The distance-time graph above shows the motion of a student walking to a convenience store for a loaf of bread and returning home. Use the graph to answer questions 1 through 5.

1. In which segment was the student moving at the slowest rate of speed? ________________
2. Which segment indicates that the student might be stopped at the convenience store? ______
3. In which two segments was the student moving at the fastest rate of speed? ________________
4. In which segment might the student be waiting for a traffic light? ________________
5. Which took longer, walking to the store or walking home? ________________

**Directions:** Find the mistakes and omissions in the statements below. Rewrite each statement correctly on the lines provided.

6. You can tell an object has moved because its velocity has changed.
   ____________________________________________________________________________

7. Displacement is how far an object moves.
   ____________________________________________________________________________

8. Average speed is indicated on the speedometer.
   ____________________________________________________________________________

9. A vertical line on a distance-time graph indicates that an object is stationary.
   ____________________________________________________________________________

10. Speed is calculated by multiplying the time of travel by the distance traveled.
    ____________________________________________________________________________

11. A race car driving around a track at 240 km/h has a constant velocity.
    ____________________________________________________________________________
Acceleration

Directions: Answer the following questions on the lines provided.

1. What is acceleration?

2. When is an object accelerating?

3. What is the difference between positive and negative acceleration?

4. State in words how acceleration is calculated.

5. Give two ways the unit for acceleration can be written.

6. What does the slope of a velocity-time graph indicate?

7. An inline skater traveling in a straight line goes from 3 m/s to 9 m/s in 3 s. What is the acceleration?

Directions: On the lines provided, indicate what kind of acceleration is shown in the following graphs.

8.

9.

10.
Motion and Forces

Directions: Answer the following questions on the lines provided.

1. Define force.

2. List three forces being exerted as you complete this Reinforcement exercise.

3. You push on the side of a toy truck rolling along the floor. What will happen to the motion of the truck?

4. What term refers to the sum of all of the forces acting on an object?

5. If the net force on an object is zero, what do you know about all of the forces acting on the object?

6. When several people are pushing on a large rock and it starts to roll, what do you know about the forces acting on the rock?

7. What is inertia?

8. What causes a change in velocity?

9. What determines the amount of inertia an object has?

10. State Newton’s first law of motion.
The 400 Meter Dash

One of the most popular races in track and field athletic events is the 400 m dash. Athletes like the talented Michael Johnson have made this a favorite race of spectators.

The 400 m sprint, or dash, is a foot race that is equal to one lap around the running track. The required distance of an official track is 400 m from start to finish on the inside (near the center) portion of the track. To complete the distance of 400 m on a standard running track, the starting positions of the runners are staggered, with one runner actually starting at the finish line.

At the sound of a starting pistol, the athletes take off from their fixed positions and speed up to advance beyond the other runners. Some runners have a strong “kick,” or an ability to increase their velocity at the end of the race.

The diagram on the right shows the starting positions for eight racers in a 400 m race. Look at the diagram and answer the questions below.

1. The starting positions indicated on the diagram are typical for a 400 m dash. Why are the runners not all starting together in a straight line?

2. At the completion of a race, what is the displacement of the runner in lane 1? Is this the same for all the runners? Explain your answer.

3. If a male runner in the fourth starting position ran the 400 m race in 44.40 s, how would you calculate his average speed? Explain your answer.
Air Traffic Controllers

Air Traffic Controllers (ATCs) have difficult, but extremely important jobs. To keep the skies around airports collision-free, they must watch a radar screen for long periods of time. The radar screen shows them where airplanes are in the sky and tells them the velocity of each plane. In addition to velocity, the screen displays the altitude of the planes. The altitude is the height of the plane from the ground.

An ATC must always know where the planes are, where they are headed, and at what velocity and altitude they are flying. The diagram below shows a typical radar screen an ATC might see. The space between lines represents a distance of 80 km. Two of the planes on the screen, LA639 and LA534, are approaching to land at an airport at the center of the radar screen. Examine the diagram. Try and get a three-dimensional idea of where the planes are in the sky before answering the following questions.

1. The ATC notices that airplanes NJ446 and DL267 are flying at the same speed on intersecting courses. What is the problem and what would you tell the pilots in order to solve the problem? [Hint: It is very difficult for large passenger planes to change altitude quickly.]

2. The planes LA534 and LA639 are coming in for a landing on the same runway which means they are each lowering their altitude. Note that LA534 is traveling at twice the speed of LA 639. What must they do to keep from crashing into each other on the runway?

3. Flights A334, NJ446, and DL267 are all flying at about 965 km per hour. Which plane does the ATC not have to worry about if the planes on the screen continue at their present rates of speed and course?
Crumple Zones

A car crash demonstrates Newton’s first law of motion. Many people are injured or even die in car crashes. The need for lighter and more fuel-efficient cars has caused automobile makers to build cars that are not as sturdy or heavy as they once were. However, new and improved ideas about how to build a car have helped make these new cars safer.

Crumple Zone

One recent improvement has been to design areas in the car called crumple zones. Crumple zones are made to absorb some of the energy from the impact of a crash. These areas are especially important in the front of the car where people receive the most injuries from a crash. In a crash, a car suddenly stops, causing the people inside the car to be hurled through the windshield. Now the fronts of new cars are made so they absorb some of the energy of the crash and reduce the effect of inertia on the people inside.

Some crumple zone designs use specially made metal in the body of the car. In older cars the metal was strong and straight, which pushed it back onto the passengers in a crash.

The new metal is pleated like an accordion along the front and cabin of the car. On impact the metal easily bends and shortens the length of the car. This means an impact from the front or back will crumple the car but probably not hurt the passengers. The idea is to spread the energy of the crash throughout the car.

Side Impact Safety

Another improvement is found on the sides of the car. When a side impact occurs, the bars that make the “cage” of the car interior are now designed to break. In the old designs, the car would be forced out of its path and to the side, but the inertia of the people would keep them moving in the same path. This type of crash can be deadly since it often forces the head of the driver against the side window.

The new designs of cars, including airbags and crumple zones, have been possible with the study of motion and force. These designs are helping many people to survive and walk away from serious accidents.

1. How does Newton’s first law of motion affect people in a car crash?

2. How do the passengers in a moving car get inertia in the first place?

3. What are crumple zones designed to do?
Motion

Section 1  Describing Motion

A. ________—when an object changes its position relative to a reference point
   1. __________—how far an object has moved
   2. ______________—distance and direction of an object’s change in position from the
      starting point

B. __________—distance an object travels per unit of time
   1. ________—any change over time
   2. Calculation for speed: \( \text{speed} = \text{distance} / \text{time} \)
   3. Speed that doesn’t change over time—__________ speed
   4. Speed is usually not constant; usually an object has __________ speed.
   5. ______________—speed of motion when speed is changing:
      \( \text{speed} = \text{total distance} / \text{total travel time} \)
   6. __________________—speed at any given point in time

C. A distance-time ________ displays motion of an object over time.
   1. Plot distance on a(n) ________ axis.
   2. Plot time on a(n) __________ axis.

D. __________—speed and direction of an object’s motion

E. Motion of Earth’s crust—so ________ we don’t notice

Section 2  Acceleration

A. ______________—change in velocity’s rate
   1. __________ acceleration—speed is increasing.
   2. __________ acceleration—speed is decreasing.
   3. When an object changes speed or __________, it is accelerating.

B. Calculating acceleration
   1. Acceleration = ______________ / time
   2. Change in velocity = ______________ – initial velocity
   3. Unit for acceleration—meters per ________ squared
   4. Positive acceleration—positive number with a __________ slope on a velocity-time graph
5. Negative acceleration—negative number with a __________ slope on a velocity-time graph

C. Amusement park acceleration—Roller coasters
   1. Changes in _________ cause acceleration.
   2. Changes in ___________ cause acceleration.

Section 3  Motion and Forces

A. __________—a push or pull that one body applies to another
   1. A force can cause an object’s __________ to change.
   2. When two or more forces combine at the same time, they create a ____________.
   3. Balanced forces are equal in ________ and opposite in ______________.
   4. __________________ are unequal in size and / or are in the same direction.

B. Inertia and Mass
   1. __________—an object’s resistance to any change in motion
   2. Objects with greater ________ have greater inertia.
   3. Newton’s __________________—an object moving at a constant velocity keeps moving at that velocity unless a net force acts on it; an object at rest will stay at rest unless a net force acts on it.

C. Auto crashes—the law of __________ at work
   1. A passenger not wearing a seat belt keeps moving __________ at the car’s speed even after the car stops.
   2. A passenger wearing a seat belt _____________ as the car slows down and stops.
Assessment
Part A. Vocabulary Review

Directions: Write the terms that match each description below in the spaces provided. The boxed letters will complete the sentence in number 13.

1. equal forces acting in opposite directions (2 words)
2. occurs when an object’s velocity decreases (2 words)
3. sum of all forces acting on an object (2 words)
4. total distance divided by total time (2 words)
5. name for the slant of a line on a graph
6. distance divided by time
7. a push or a pull exerted on a body or object
8. distance and direction of an object from its starting point
9. tendency to resist change in motion
10. measure of how far an object has moved
11. speed and direction of motion
12. rate of change of position at a specific point in time (2 words)
13. The rate of change in velocity is called ________________________________.
Part B. Concept Review

Directions: Answer the following questions on the lines provided.

1. Compare and contrast the following.
   a. distance and displacement: ________________________________
   b. speed and velocity: ________________________________

2. Explain the difference between positive and negative acceleration.

3. How are force and motion related?

4. What property of matter is inertia related to?

5. A car travels west for 240 km in 4 h. What is the car’s velocity?

6. An object goes from a speed of 9 m/s to a total stop in 3 s. What is the object’s acceleration?

7. Explain what causes an unrestrained passenger in a car to fly forward when the car stops suddenly.

Directions: Use Figures 1a and 1b to answer questions 8 and 9.

8. Describe the motion of a car as shown by the distance-time graph in Figure 1a.

9. Describe the motion of a biker as shown by the velocity-time graph in Figure 1b.
Transparency Activities
How about a rematch?

In Aesop’s fable “The Tortoise and the Hare,” a tortoise and a hare have a race. The hare bounds far ahead of the tortoise and then, sure of victory, lies down to rest under a tree. The tortoise passes the resting hare and wins the race.

1. Which animal ran faster?
2. How does the motion of a car racing on an oval track change?
Many people enjoy cross-country and downhill skiing for recreation and for exercise. For others, skiing is a competitive sport. In ski races, fractions of a second can make the difference between winning and finishing second.

1. Describe how the skier’s velocity changes during the race.
2. Why does the skier’s velocity increase as he races downhill?
3. How does being in a tuck position affect a skier’s motion?
Yanked Around

Have you ever been involved in a tug-of-war? If both teams tug equally on the rope, then the rope does not move. But if one team gets the upper hand, they will pull the other team over the line. You have to pull pretty hard to win!

1. The photo shows one team pulling but not moving very much. In which direction must the other team be pulling? Why?
2. If one team tugs the other over the line, what can you infer about the pulls exerted by the two teams?
3. How do the weights of the tug-of-war teams affect the match?
Graphing Motion

Distance (m)

Time (min)

Distance/Time Graph

Teaching Transparency Activity
Teaching Transparency Activity  (continued)

1. What information is recorded on the x-axis of the line graph shown?

2. How many minutes does each line on the x-axis represent?

3. In what units is distance measured on the graph?

4. The lines represent three swimmers. What do the slopes of the lines tell you about the swimmers?

5. Which swimmer swam the fastest? Which swimmer stopped for ten minutes?

6. How far did the blue swimmer travel in 15 minutes?

7. How much farther than the slowest swimmer did the fastest swimmer travel in 20 minutes?
Motion

Assessment Transparency Activity

Directions: Carefully review the diagrams and answer the following questions.

1. Some students planned four games of tug-of-war and tried to predict the outcome of each game. What factor would be important for the students to know in order to make an accurate prediction of the outcome?
   A the type of ground surface
   B the number of people on each team
   C the average height of each person
   D the mass of the rope

2. If all other factors are equal, which picture shows two teams that are the most equal?
   F 1  G 2  H 3  J 4

3. If all other factors are equal, which picture shows two teams that are the least equal?
   A 1  B 2  C 3  D 4