

# Motion: Newton's Three Laws

## **INTRODUCTION TO THE AIMS TEACHING MODULE (ATM)**

→ SECTION 1

Rationale . . . . .	4
Organization and Management . . . . .	5
Features . . . . .	6

## **INTRODUCING MOTION: NEWTON'S THREE LAWS**

→ SECTION 2

Themes . . . . .	11
Overview . . . . .	11
Objectives . . . . .	11

## **PREPARATION FOR VIEWING**

→ SECTION 3

Introduction to the Program . . . . .	13
Introduction to Vocabulary . . . . .	13
Discussion Ideas . . . . .	13
Focus . . . . .	13
<b>Jump Right In</b> . . . . .	14

## **AFTER VIEWING THE PROGRAM**

→ SECTION 4

Suggested Activities . . . . .	15
Vocabulary . . . . .	18
Checking Comprehension . . . . .	19
Term Link . . . . .	20
True or False . . . . .	21
Fill in the Blanks . . . . .	22
Code Words . . . . .	23
Word Search . . . . .	24
Test . . . . .	25

## **ADDITIONAL AIMS MULTIMEDIA PROGRAMS . . . . .27**

## **ANSWER KEYS . . . . .28**



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# Congratulations!

You have chosen a learning program that will actively motivate your students AND provide you with easily accessible and easily manageable instructional guidelines designed to make your teaching role efficient and rewarding.

The AIMS Teaching Module provides you with a video program keyed to your classroom curriculum, instructions and guidelines for use, plus a comprehensive teaching program containing a wide range of activities and ideas for interaction between all content areas. Our authors, educators, and consultants have written and reviewed the AIMS Teaching Modules to align with the Educate America Act: Goals 2000.

This ATM, with its clear definition of manageability, both in the classroom and beyond, allows you to tailor specific activities to meet all of your classroom needs.

## **RATIONALE**

In today's classrooms, educational pedagogy is often founded on Benjamin S. Bloom's "Six Levels of Cognitive Complexity." The practical application of Bloom's Taxonomy is to evaluate students' thinking skills on these levels, from the simple to the complex: Knowledge (rote memory skills), Comprehension (the ability to relate or retell), Application (the ability to apply knowledge outside its origin), Analysis (relating and differentiating parts of a whole), Synthesis (relating parts to a whole), and Evaluation (making a judgment or formulating an opinion).

The AIMS Teaching Module is designed to facilitate these intellectual capabilities, AND to integrate classroom experiences and assimilation of learning with the students' life experiences, realities, and expectations. AIMS' learner verification studies prove that our AIMS Teaching Modules help students to absorb, retain, and to demonstrate ability to use new knowledge in their world. Our educational materials are written and designed for today's classroom, which incorporates a wide range of intellectual, cultural, physical, and emotional diversities.

# **ORGANIZATION AND MANAGEMENT**

To facilitate ease in classroom manageability, the AIMS Teaching Module is organized in four sections. You are reading Section 1, Introduction to the Aims Teaching Module (ATM).

## **SECTION 2,**

### **INTRODUCING THIS ATM**

will give you the specific information you need to integrate the program into your classroom curriculum.

## **SECTION 3,**

### **PREPARATION FOR VIEWING**

provides suggestions and strategies for motivation, language preparedness, readiness, and focus prior to viewing the program with your students.

## **SECTION 4,**

### **AFTER VIEWING THE PROGRAM**

provides suggestions for additional activities plus an assortment of consumable assessment and extended activities, designed to broaden comprehension of the topic and to make connections to other curriculum content areas.

# FEATURES

## INTRODUCING EACH ATM

### SECTION 2

Your AIMS Teaching Module is designed to accompany a video program written and produced by some of the world's most credible and creative writers and producers of educational programming. To facilitate diversity and flexibility in your classroom, your AIMS Teaching Module features these components:

#### **Themes**

The Major Theme tells how this AIMS Teaching Module is keyed into the curriculum. Related Themes offer suggestions for interaction with other curriculum content areas, enabling teachers to use the teaching module to incorporate the topic into a variety of learning areas.

#### **Overview**

The Overview provides a synopsis of content covered in the video program. Its purpose is to give you a summary of the subject matter and to enhance your introductory preparation.

#### **Objectives**

The ATM learning objectives provide guidelines for teachers to assess what learners can be expected to gain from each program. After completion of the AIMS Teaching Module, your students will be able to demonstrate dynamic and applied comprehension of the topic.

## **PREPARATION FOR VIEWING**

### **SECTION 3**

In preparation for viewing the video program, the AIMS Teaching Module offers activity and/or discussion ideas that you may use in any order or combination.

#### **Introduction To The Program**

Introduction to the Program is designed to enable students to recall or relate prior knowledge about the topic and to prepare them for what they are about to learn.

#### **Introduction To Vocabulary**

Introduction to Vocabulary is a review of language used in the program: words, phrases, usage. This vocabulary introduction is designed to ensure that all learners, including limited English proficiency learners, will have full understanding of the language usage in the content of the program.

## **Discussion Ideas**

Discussion Ideas are designed to help you assess students' prior knowledge about the topic and to give students a preview of what they will learn. Active discussion stimulates interest in a subject and can motivate even the most reluctant learner. Listening, as well as speaking, is active participation. Encourage your students to participate at the rate they feel comfortable. Model sharing personal experiences when applicable, and model listening to students' ideas and opinions.

#### **Focus**

Help learners set a purpose for watching the program with Focus, designed to give students a focal point for comprehension continuity.

#### **Jump Right In**

Jump Right In provides abbreviated instructions for quick management of the program.

## **AFTER VIEWING THE PROGRAM**

### **SECTION 4**

After your students have viewed the program, you may introduce any or all of these activities to interact with other curriculum content areas, provide reinforcement, assess comprehension skills, or provide hands-on and in-depth extended study of the topic.

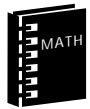
## SUGGESTED ACTIVITIES

The Suggested Activities offer ideas for activities you can direct in the classroom or have your students complete independently, in pairs, or in small work groups after they have viewed the program. To accommodate your range of classroom needs, the activities are organized into skills categories. Their labels will tell you how to identify each activity and help you correlate it into your classroom curriculum. To help you schedule your classroom lesson time, the AIMS hourglass gives you an estimate of the time each activity should require. Some of the activities fall into these categories:



### Meeting Individual Needs

These activities are designed to aid in classroom continuity. Reluctant learners and learners acquiring English will benefit from these activities geared to enhance comprehension of language in order to fully grasp content meaning.



### Curriculum Connections

Many of the suggested activities are intended to integrate the content of the ATM program into other content areas of the classroom curriculum. These cross-connections turn the classroom teaching experience into a whole learning experience.



### Critical Thinking

Critical Thinking activities are designed to stimulate learners' own opinions and ideas. These activities require students to use the thinking process to discern fact from opinion, consider their own problems and formulate possible solutions, draw conclusions, discuss cause and effect, or combine what they already know with what they have learned to make inferences.



### Cultural Diversity

Each AIMS Teaching Module has an activity called Cultural Awareness, Cultural Diversity, or Cultural Exchange that encourages students to share their backgrounds, cultures, heritage, or knowledge of other countries, customs, and language.



### Hands On

These are experimental or tactile activities that relate directly to the material taught in the program. Your students will have opportunities to make discoveries and formulate ideas on their own, based on what they learn in this unit.



### Writing

Every AIMS Teaching Module will contain an activity designed for students to use the writing process to express their ideas about what they have learned. The writing activity may also help them to make the connection between what they are learning in this unit and how it applies to other content areas.



### In The Newsroom

Each AIMS Teaching Module contains a newsroom activity designed to help students make the relationship between what they learn in the classroom and how it applies in their world. The purpose of In The Newsroom is to actively involve each class member in a whole learning experience. Each student will have an opportunity to perform all of the tasks involved in production: writing, researching, producing, directing, and interviewing as they create their own classroom news program.



### Extended Activities

These activities provide opportunities for students to work separately or together to conduct further research, explore answers to their own questions, or apply what they have learned to other media or content areas.



### Link to the World

These activities offer ideas for connecting learners' classroom activities to their community and the rest of the world.



### Culminating Activity

To wrap up the unit, AIMS Teaching Modules offer suggestions for ways to reinforce what students have learned and how they can use their new knowledge to enhance their world view.

## **VOCABULARY**

Every ATM contains an activity that reinforces the meaning and usage of the vocabulary words introduced in the program content. Students will either read or find the definition of each vocabulary word, then use the word in a written sentence.

## **CHECKING COMPREHENSION**

Checking Comprehension is designed to help you evaluate how well your students understand, retain, and recall the information presented in the AIMS Teaching Module. Depending on your students' needs, you may direct this activity to the whole group yourself, or you may want to have students work on the activity page independently, in pairs, or in small groups. Students can verify their written answers through discussion or by viewing the video a second time. If you choose, you can reproduce the answers from your Answer Key or write the answer choices in a Word Bank for students to use. Students can use this completed activity as a study guide to prepare for the test.

## **CONSUMABLE ACTIVITIES**

The AIMS Teaching Module provides a selection of consumable activities, designed to specifically reinforce the content of this learning unit. Whenever applicable, they are arranged in order from low to high difficulty level, to allow a seamless facilitation of the learning process. You may choose to have students take these activities home or to work on them in the classroom independently, in pairs or in small groups.

## **CHECKING VOCABULARY**

The Checking Vocabulary activity provides the opportunity for students to assess their knowledge of new vocabulary with this word game or puzzle. The format of this vocabulary activity allows students to use the related words and phrases in a different context.

## **TEST**

The AIMS Teaching Module Test permits you to assess students' understanding of what they have learned. The test is formatted in one of several standard test formats to give your students a range of experiences in test-taking techniques. Be sure to read, or remind students to read, the directions carefully and to read each answer choice before making a selection. Use the Answer Key to check their answers.

## **ADDITIONAL AIMS MULTIMEDIA PROGRAMS**

After you have completed this AIMS Teaching Module you may be interested in more of the programs that AIMS offers. This list includes several related AIMS programs.

## **ADDITIONAL READING SUGGESTIONS**

AIMS offers a carefully researched list of other resources that you and your students may find rewarding.

## **ANSWER KEY**

Reproduces tests and work pages with answers marked.

# Motion: Newton's Three Laws

## THEMES

*Motion: Newton's Three Laws* introduces students to Sir Issac Newton's basic discoveries about motion. Each of Newton's three laws of motion are discussed, as well as the concepts of velocity, acceleration, frame of reference, speed, and force. The link between action and reaction is also covered, as well as gravity. Finally viewers are exposed to the concepts of centripetal force, projectile motion and vertical motion.

## OVERVIEW

Scientists have always been interested in measuring the motion of objects. The first set of laws governing motion were published by Sir Issac Newton in 1686. He outlined three basic laws of motion. In order to measure motion, we must compare the position of an object to another object or frame of reference. We also must know the distance that an object moves during a given amount of time, or its speed. The first law of motion is known as the Law of Inertia. It states that an object's motion does not change unless a force acts upon it. The second law of motion states that the acceleration of an object is directly proportional to the force exerted on it and inversely proportional to its mass. The third law of motion states that for every force, there is an equal force in the opposite direction.

## OBJECTIVES

- ▶ To learn more about Newton's basic laws of motion.
- ▶ To discuss the concepts of velocity, acceleration, frame of reference, speed, and force.
- ▶ To examine the link between action and reaction.
- ▶ To explore the properties of gravity, centripetal force, projectile motion and vertical motion.

Use this page for your individual notes about planning and/or effective ways to manage this  
AIMS Teaching Module in your classroom.

Our AIMS Multimedia Educational Department welcomes your observations and comments.  
Please feel free to address your correspondence to:

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## INTRODUCTION TO THE PROGRAM

Motion is not an absolute term. It is relative to many factors, including position, mass and the interference of other objects. If we think about it, everything on Earth is in motion. After all, the Earth itself is constantly moving. Since people cannot feel this motion, it took scientists many years to understand it. Sir Issac Newton was the first physicist to understand the basic principles of motion. His writings about the laws of motion were revolutionary. Scientists today still use the laws to better understand our world and universe.

## INTRODUCTION TO VOCABULARY

Before starting the program, write the following words on the board. Ask the class to discuss the meaning of each word, and review the terms that are unfamiliar to students.

**motion** - action which occurs when an object changes its position in space

**force** - any influence upon an object that changes its motion or shape

**potential energy** - energy that is stored

**kinetic energy** - energy associated with motion

## FOCUS

As you begin the program, ask students to consider Newton's place in history. By publishing his laws of motion, he contradicted many of the common beliefs about science. How did Newton's courage change our view of the world? In what ways are Newton's contributions still important? How is he a role model for others intuitive minds?

## DISCUSSION IDEAS

Ask students to list some common examples of motion. Write these examples on the board and explain how each one relates to Newton's laws. Which examples provide a clear illustration of velocity, speed, acceleration and friction? Encourage the class to openly share their ideas.

# JUMP RIGHT IN

## HOW TO USE THE MOTION: NEWTON'S THREE LAWS AIMS TEACHING MODULE

### Preparation

- ▶ Read *Motion: Newton's Three Laws Themes, Overview, and Objectives* to become familiar with program content and expectations.
- ▶ Use **Preparation for Viewing** suggestions to introduce the topic to students.

### Viewing MOTION: NEWTON'S THREE LAWS

- ▶ Set up viewing monitor so that all students have a clear view.
- ▶ Depending on your classroom size and learning range, you may choose to have students view *Motion: Newton's Three Laws* together or in small groups.
- ▶ Some students may benefit from viewing the video more than one time.

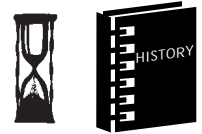
### After Viewing MOTION: NEWTON'S THREE LAWS

- ▶ Select **Suggested Activities** that integrate into your classroom curriculum. If applicable, gather materials or resources.
- ▶ Choose the best way for students to work on each activity. Some activities work best for the whole group. Other activities are designed for students to work independently, in pairs, or in small groups. Whenever possible, encourage students to share their work with the rest of the group.
- ▶ Duplicate the appropriate number of **Vocabulary, Checking Comprehension**, and consumable activity pages for your students.
- ▶ You may choose to have students take consumable activities home, or complete them in the classroom, independently, or in groups.
- ▶ Administer the Test to assess students' comprehension of what they have learned, and to provide them with practice in test-taking procedures.
- ▶ Use the **Culminating Activity** as a forum for students to display, summarize, extend, or share what they have learned with each other, the rest of the school, or a local community organization.

## SUGGESTED ACTIVITIES

### Connection to History

Sir Issac Newton is considered to be one of the greatest thinkers in the history of science. In addition to his discoveries about motion and physics, Newton also made numerous discoveries about light and color, mathematics, and astronomy.



60 Minutes

Ask students to use the Internet, library books and other resources to learn more about Sir Issac Newton. Encourage each student to choose an important discovery made by Newton and learn more about it. Have each student summarize his or her research in a one-page paper.

### Meeting Individual Needs

Ask students to make sentences using the following words. Encourage them to use a dictionary if they are uncertain of the meanings. Make sure that their sentences display an understanding of the words as they relate to the program.



20 Minutes

- inertia - tendency of matter to remain at rest or in motion unless affected by an outside force
- velocity - speed or direction of an object's movement
- acceleration - an increase in an object's velocity in a given amount of time
- momentum - property of a moving object that determines the length of time required to bring it to rest

### Connection to Science

Ask students to summarize each of Newton's three laws of motion. What are some examples of each law?



20 Minutes

(The first law states that any object moving uniformly in a straight line or in a state of rest will remain in uniform motion in a straight line or in a state of rest unless acted upon by an outside force. Examples include gravity pulling down a baseball and the wind blowing a leaf.

The second law states that the change which any force makes on an object depends on the size of the force and the mass of the object. Examples include a soccer ball being kicked and a bullet being fired.

The third law states that for every action there is an opposite and equal reaction. Examples include a jet taking off and a drum vibrating the air when it is struck with a drumstick.)

## Critical Thinking

Newton's third law of motion states that for every action there is an opposite and equal reaction. This fact is so basic to everything we do that we usually overlook it. How does this law apply to the act of walking on the ground? What would happen if someone was walking down the street and this law suddenly did not hold true? What are some other common examples of this law?



20 Minutes

(When we walk on the ground, our feet push on the ground and propel us. Likewise, the ground pushes against our feet with equal force. If it did not, we would sink into the ground. In other words, the ground offers resistance to our footsteps. Other examples of the third law of motion include a space shuttle launching, a basketball bouncing, a gun kicking back when fired, and the movement of oars propelling a boat through water.)

## Hands On

Perform the following demonstration for students to explain the significance of weight and friction. Place a book on the floor and create an incline by placing one end of a second book on top of the first book. Roll a small empty jar down the incline and measure the distance the jar rolls before coming to a stop. A baby food jar will work well. Next, roll a larger empty jar down the incline and measure the distance the jar rolls before coming to a stop. Which distance was greater? Why? (The heavy jar will roll farther because it has greater mass.)



20 Minutes

Fill the large jar halfway with water and repeat the above experiment. Which jar rolls farther? What could be the reason? (This time, the smaller jar rolls farther, even though the large jar has even more weight than before. As the water sloshes inside the large jar, it creates friction which slows down the movement of the large jar.)

## Connection to Language Arts

In addition to many scientific discoveries, Sir Issac Newton also gave us a word that is commonly used in the realm of science. The "newton" is a unit of measurement. Ask students if they know how this unit was devised. What does it measure? When is it used?



10 Minutes

(A newton is the unit of force that is capable of moving an object with a mass of one kilogram one meter per second. It is commonly used in the fields of physics to measure the properties of various objects.)

### Extended Activity

The following experiment is a fun way to understand a significant aspect of motion. Ask several students to bring roller skates or in-line skates to class. Only students who are comfortable on skates should actively participate in the demonstration. Allow the class to go outside or to an area where the floor will not be damaged by the skates. Ask two students wearing skates to stand on a hard, flat surface, such as a sidewalk. Have the students face one another and place their palms together. Tell them to push each other slowly and gently. It may take a few tries to get the hang of it. What happens? Repeat the experiment with different pairs of students? Does a trend seem to govern the outcome? If so, what is the trend? Which law of motion does this experiment prove?

(If both students have similar or equal weights, they will roll backward at an even velocity. If the students have unequal weights, the lighter student will roll back farther. This is a demonstration of the third law of motion.)



40 Minutes

### In the Newsroom

Many stories in the news are indirectly related to the laws of motion. Stories relating to space exploration, weather phenomena, geology, transportation and sporting events are just a few examples. Ask each student to locate an article that relates in some way to the laws of motion. Which law or laws is the story related to? How does the story prove the law or laws?

Have students present a summary of their articles to the class. If possible, allow students to videotape their presentations for a "Laws of Motion News Show."



Extended Time

### Culminating Activity

Using what they have learned in the unit, ask each student to create a collage illustrating each of Newton's Laws of Motion. Encourage them to find examples of each law of motion in magazine or newspaper photographs. If they wish, they may create their own diagrams or illustrations to further explain each law. In addition, ask them to label each section of the poster by writing a summary of each law. Display the posters on a wall labeled, "Laws of Motion in Everyday Life."



60 Minutes

**VOCABULARY**

The following terms are from *Motion: Newton's Three Laws*. Fill in the number of each term next to its closest definition.

- |                      |               |
|----------------------|---------------|
| 1. acceleration      | 6. mass       |
| 2. centripetal force | 7. reaction   |
| 3. force             | 8. resistance |
| 4. gravity           | 9. trajectory |
| 5. inertia           | 10. velocity  |

- \_\_\_ speed or direction of an object's movement
- \_\_\_ field force that draws all objects in Earth's sphere toward the center of Earth
- \_\_\_ quantity of matter in a body as measured by its relation to inertia
- \_\_\_ any influence upon an object that changes its motion or shape
- \_\_\_ an acceleration or deceleration of force that retards, hinders or opposes motion
- \_\_\_ a perpendicular force that causes an object to move in a circular path with uniform speed
- \_\_\_ path of an object in flight
- \_\_\_ an increase in an object's velocity in a given amount of time
- \_\_\_ tendency of matter to remain at rest or in motion unless affected by an outside force
- \_\_\_ response to an influence or force

**CHECKING COMPREHENSION**

Read the following sentences and circle the letter of the word that best fills each blank.

Scientists have always been interested in measuring the motion of objects. The first set of laws governing motion were published by \_\_\_1\_\_\_ in 1686. In a book called \_\_\_2\_\_\_, he outlined three basic laws of motion. In order to measure motion, we must compare the position of an object to another object or \_\_\_3\_\_\_. We also must know the distance that an object moves during a given amount of time, or its \_\_\_4\_\_\_. The first law of motion is known as the Law of \_\_\_5\_\_\_. It states that an object's motion does not change unless \_\_\_6\_\_\_ acts upon it. One such example is \_\_\_7\_\_\_, which draws all objects toward the center of the Earth. The second law of motion states that the \_\_\_8\_\_\_ of an object is directly proportional to the force exerted on it and inversely proportional to its \_\_\_9\_\_\_. The third law of motion states that for every force, there is \_\_\_10\_\_\_ force in the opposite direction.

1. A. Newton  
B. Hertz  
C. Galileo  
D. Aristotle
2. A. *Matteria*  
B. *Republic*  
C. *Principia*  
D. *Force and Motion*
3. A. average mass  
B. frame of reference  
C. inertia  
D. terminal velocity
4. A. trajectory  
B. resistance  
C. force  
D. speed
5. A. Inertia  
B. Acceleration  
C. Gravity  
D. Projectile Motion
6. A. a force  
B. an apex  
C. velocity  
D. a frame of reference
7. A. motion  
B. acceleration  
C. trajectory  
D. gravity
8. A. mass  
B. speed  
C. acceleration  
D. reference
9. A. density  
B. mass  
C. volume  
D. resistance
10. A. centrifugal  
B. projectile  
C. a greater  
D. an equal

**TERM LINK**

Write the letter of each term next to the group of words which best describes it.

- A. apex
- B. Aristotle
- C. frame of reference
- D. Galileo
- E. motion
- F. Newton
- G. *Principia*
- H. projectile motion
- I. speed
- J. terminal velocity

- \_\_\_ combination of horizontal and vertical motion
- \_\_\_ English scientist who developed an understanding of motion
- \_\_\_ Greek philosopher who incorrectly proposed that the speed at which an object falls is proportional to the mass of the object
- \_\_\_ Italian astronomer and physicist who tried to measure the rate at which objects fell to Earth
- \_\_\_ maximum speed that can be achieved by a falling object
- \_\_\_ highest vertical point in a projectile's trajectory
- \_\_\_ perspective from which an observer views the position of an object
- \_\_\_ change in an object's position, which is based on the position of the observer and measured in terms of speed, acceleration and velocity
- \_\_\_ outlined Newton's three laws of motion
- \_\_\_ distance an object moves in a given amount of time

**TRUE OR FALSE**

Place a T next to statements that are true and an F next to statements that are false.

1. \_\_\_ Average speed is the distance an object covers divided by the time it takes to travel that distance.
2. \_\_\_ Newton's second law is also called the Law of Inertia.
3. \_\_\_ Gravity and wind are two forces which can affect the constant speed of an object.
4. \_\_\_ Acceleration refers to the speed and direction of an object's movement.
5. \_\_\_ Whenever the velocity of an object changes, it decelerates.
6. \_\_\_ Acceleration is usually measured in meters per second squared.
7. \_\_\_ No force in nature exists without an equal and opposite reaction force.
8. \_\_\_ An object at rest has no forces acting upon it.
9. \_\_\_ On Earth, an object's velocity increases 9.8 meters per second.
10. \_\_\_ As an object moves in a circular path, its direction always remains constant.

### FILL IN THE BLANKS

Use the list of words below to fill in the blanks.

acceleration  
apex  
centripetal  
force  
gravity  
mass  
projectile  
resistance

1. A football being thrown is an example of a \_\_\_\_\_ motion.
2. As a baseball leaves its thrower's hand, it travels both vertically and horizontally until it reaches its \_\_\_\_\_ .
3. An inward perpendicular force that causes an object to move in a circular path with uniform speed is known as a \_\_\_\_\_ force.
4. In order for an object to be accelerated, a \_\_\_\_\_ must act upon that object.
5. Aristotle proposed that the speed at which an object falls is proportional to the \_\_\_\_\_ of the object.
6. \_\_\_\_\_ due to Earth's gravity is represented by the symbol G.
7. Wind is a form of \_\_\_\_\_ that acts upon a skydiver as he falls to Earth.
8. \_\_\_\_\_ draws all objects to the center of the Earth.

**NUMBER CODE**

Use the code below to read the hidden word in each sentence.

A = 1

K = 8

S = 15

C = 2

L = 9

T = 16

E = 3

M = 10

U = 17

F = 4

N = 11

V = 18

G = 5

O = 12

Y = 19

H = 6

P = 13

I = 7

R = 14

1. When the 18-3-9-12-2-7-16-19 of an object increases, the object is accelerating.

\_\_\_\_\_

2. The 10-1-15-15 of an object times its velocity is known as momentum.

\_\_\_\_\_

3. The energy of motion is also known as 8-7-11-3-16-7-2 energy.

\_\_\_\_\_

4. Acceleration must overcome the 7-11-3-14-16-7-1 of an object.

\_\_\_\_\_

5. Kinetic energy is given up when an object 15-16-14-7-8-3-15 another object.

\_\_\_\_\_

6. Forces acting upon a single 13-12-7-11-16 are known as concurrent.

\_\_\_\_\_

7. The resistance of motion is a factor known as 4-14-7-2-16-7-12-11.

\_\_\_\_\_

8. Motion in a 15-16-14-1-7-5-6-16 line is known as rectilinear motion.

\_\_\_\_\_

**WORD SEARCH**

The following words can be found in the maze below. The letters may be arranged horizontally, vertically, diagonally or backward.

apex  
force  
gravity  
inertia  
mass  
motion  
reaction  
resistance  
trajectory  
velocity

g	b	d	n	k	q	p	n	k	o	r	e
A	M	P	L	I	T	U	D	E	t	I	o
I	H	h	q	g	T	R	O	U	G	H	r
S	I	E	k	b	q	n	P	j	b	S	I
E	h	s	R	d	p	g	P	r	j	P	e
I	a	e	p	T	n	x	L	b	I	E	n
S	m	p	e	m	Z	p	E	q	d	C	g
M	h	c	a	z	m	C	R	E	S	T	s
I	o	D	E	C	I	B	E	L	q	R	o
C	m	h	j	a	s	d	j	I	g	U	m
v	F	R	E	Q	U	E	N	C	Y	M	j
w	c	n	c	p	r	p	s	E	V	A	W

**TEST**

Circle the phrase which best answers each question.

1. Which of these is not a factor in describing the motion of an object?

- frame of reference
- type of object
- rate of movement
- position

2. The speed and direction of an object's movement is known as:

- acceleration.
- inertia.
- vertical motion.
- velocity.

3. For every force, there is an equal force in:

- a vertical direction.
- a horizontal direction.
- the opposite direction.
- the same direction.

4. The maximum speed that can be achieved by an object falling to Earth is:

- center of gravity.
- deceleration point.
- rate of acceleration.
- terminal velocity.

5. Swinging a ball on a rope in a circular motion is an example of:

- acceleration.
- centripetal force.
- projectile motion.
- gravity.

**TEST (CONTINUED)**

6. A projectile is subject to the force that propels it and to:

- terminal velocity.
- inertia.
- frame of reference.
- gravity.

7. The motion of a projectile is its:

- acceleration.
- velocity.
- speed.
- trajectory.

8. Motion is measured in terms of:

- speed.
- acceleration.
- velocity.
- all of the above.

9. Which of these is not a basic type of motion?

- horizontal
- inertia
- circular
- projectile

10. The first three laws describing motion were published by:

- Galileo.
- Aristotle.
- Einstein.
- Newton.

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## ANSWER KEY for page 18

### VOCABULARY

The following terms are from *Motion: Newton's Three Laws*. Fill in the number of each term next to its closest definition.

- |                      |               |
|----------------------|---------------|
| 1. acceleration      | 6. mass       |
| 2. centripetal force | 7. reaction   |
| 3. force             | 8. resistance |
| 4. gravity           | 9. trajectory |
| 5. inertia           | 10. velocity  |

- 10 speed or direction of an object's movement
- 4 field force that draws all objects in Earth's sphere toward the center of Earth
- 6 quantity of matter in a body as measured by its relation to inertia
- 3 any influence upon an object that changes its motion or shape
- 8 an acceleration or deceleration of force that retards, hinders or opposes motion
- 2 a perpendicular force that causes an object to move in a circular path with uniform speed
- 9 path of an object in flight
- 1 an increase in an object's velocity in a given amount of time
- 5 tendency of matter to remain at rest or in motion unless affected by an outside force
- 7 response to an influence or force

## ANSWER KEY for page 19

### CHECKING COMPREHENSION

Read the following sentences and circle the letter of the word that best fills each blank.

Scientists have always been interested in measuring the motion of objects. The first set of laws governing motion were published by \_\_\_1\_\_\_ in 1686. In a book called \_\_\_2\_\_\_, he outlined three basic laws of motion. In order to measure motion, we must compare the position of an object to another object or \_\_\_3\_\_\_. We also must know the distance that an object moves during a given amount of time, or its \_\_\_4\_\_\_. The first law of motion is known as the Law of \_\_\_5\_\_\_. It states that an object's motion does not change unless \_\_\_6\_\_\_ acts upon it. One such example is \_\_\_7\_\_\_, which draws all objects toward the center of the Earth. The second law of motion states that the \_\_\_8\_\_\_ of an object is directly proportional to the force exerted on it and inversely proportional to its \_\_\_9\_\_\_. The third law of motion states that for every force, there is \_\_\_10\_\_\_ force in the opposite direction.

- A. Newton  
B. Hertz  
C. Galileo  
D. Aristotle
- A. *Matteria*  
B. *Republic*  
 C. *Principia*  
D. *Force and Motion*
- A. average mass  
 B. frame of reference  
C. inertia  
D. terminal velocity
- A. trajectory  
B. resistance  
C. force  
 D. speed
- A. Inertia  
B. Acceleration  
C. Gravity  
D. Projectile Motion
- A. a force  
B. an apex  
C. velocity  
D. a frame of reference
- A. motion  
B. acceleration  
C. trajectory  
 D. gravity
- A. mass  
B. speed  
 C. acceleration  
D. reference
- A. density  
 B. mass  
C. volume  
D. resistance
- A. centrifugal  
B. projectile  
C. a greater  
 D. an equal

## ANSWER KEY for page 20

### TERM LINK

Write the letter of each term next to the group of words which best describes it.

- A. apex
- B. Aristotle
- C. frame of reference
- D. Galileo
- E. motion
- F. Newton
- G. *Principia*
- H. projectile motion
- I. speed
- J. terminal velocity

- H combination of horizontal and vertical motion
- F English scientist who developed an understanding of motion
- B Greek philosopher who incorrectly proposed that the speed at which an object falls is proportional to the mass of the object
- D Italian astronomer and physicist who tried to measure the rate at which objects fell to Earth
- J maximum speed that can be achieved by a falling object
- A highest vertical point in a projectile's trajectory
- C perspective from which an observer views the position of an object
- E change in an object's position, which is based on the position of the observer and measured in terms of speed, acceleration and velocity
- G outlined Newton's three laws of motion
- I distance an object moves in a given amount of time

## ANSWER KEY for page 21

### TRUE OR FALSE

Place a T next to statements that are true and an F next to statements that are false.

1. T Average speed is the distance an object covers divided by the time it takes to travel that distance.
2. F Newton's second law is also called the Law of Inertia.
3. T Gravity and wind are two forces which can affect the constant speed of an object.
4. F Acceleration refers to the speed and direction of an object's movement.
5. F Whenever the velocity of an object changes, it decelerates.
6. T Acceleration is usually measured in meters per second squared.
7. T No force in nature exists without an equal and opposite reaction force.
8. F An object at rest has no forces acting upon it.
9. T On Earth, an object's velocity increases 9.8 meters per second.
10. F As an object moves in a circular path, its direction always remains constant.

## ANSWER KEY for page 22

### FILL IN THE BLANKS

Use the list of words below to fill in the blanks.

acceleration  
apex  
centripetal  
force  
gravity  
mass  
projectile  
resistance

1. A football being thrown is an example of a projectile motion.
2. As a baseball leaves its thrower's hand, it travels both vertically and horizontally until it reaches its apex .
3. An inward perpendicular force that causes an object to move in a circular path with uniform speed is known as a centripetal force.
4. In order for an object to be accelerated, a force must act upon that object.
5. Aristotle proposed that the speed at which an object falls is proportional to the mass of the object.
6. Acceleration due to Earth's gravity is represented by the symbol G.
7. Wind is a form of resistance that acts upon a skydiver as he falls to Earth.
8. Gravity draws all objects to the center of the Earth.

## ANSWER KEY for page 23

### NUMBER CODE

Use the code below to read the hidden word in each sentence.

A = 1

C = 2

E = 3

F = 4

G = 5

H = 6

I = 7

K = 8

L = 9

M = 10

N = 11

O = 12

P = 13

R = 14

S = 15

T = 16

U = 17

V = 18

Y = 19

1. When the 18-3-9-12-2-7-16-19 of an object increases, the object is accelerating.

**velocity**

---

2. The 10-1-15-15 of an object times its velocity is known as momentum.

**mass**

---

3. The energy of motion is also known as 8-7-11-3-16-7-2 energy.

**kinetic**

---

4. Acceleration must overcome the 7-11-3-14-16-7-1 of an object.

**inertia**

---

5. Kinetic energy is given up when an object 15-16-14-7-8-3-15 another object.

**strikes**

---

6. Forces acting upon a single 13-12-7-11-16 are known as concurrent.

**point**

---

7. The resistance of motion is a factor known as 4-14-7-2-16-7-12-11.

**friction**

---

8. Motion in a 15-16-14-1-7-5-6-16 line is known as rectilinear motion.

**straight**

---

# ANSWER KEY for page 24

## WORD SEARCH

The following words can be found in the maze below. The letters may be arranged horizontally, vertically, diagonally or backward.

- apex
- force
- gravity
- inertia
- mass
- motion
- reaction
- resistance
- trajectory
- velocity

	g	b	d	n	k	q	p	n	k	o	r	e
A	M	P	L	I	T	U	D	E	t	l	o	
I	H	h	q	g	T	R	O	U	G	H	r	
S	I	E	k	b	q	n	P	j	b	S	I	
E	h	s	R	d	p	g	P	r	j	P	e	
I	a	e	p	T	n	x	L	b	l	E	n	
S	m	p	e	m	Z	p	E	q	d	C	g	
M	h	c	a	z	m	C	R	E	S	T	s	
I	o	D	E	C	I	B	E	L	q	R	o	
C	m	h	j	a	s	d	j	l	g	U	m	
v	F	R	E	Q	U	E	N	C	Y	M	j	
w	c	n	c	p	r	p	s	E	V	A	W	

## ANSWER KEY for page 25

### TEST

Circle the phrase which best answers each question.

1. Which of these is not a factor in describing the motion of an object?

- frame of reference
- type of object
- rate of movement
- position

2. The speed and direction of an object's movement is known as:

- acceleration.
- inertia.
- vertical motion.
- velocity.

3. For every force, there is an equal force in:

- a vertical direction.
- a horizontal direction.
- the opposite direction.
- the same direction.

4. The maximum speed that can be achieved by an object falling to Earth is:

- center of gravity.
- deceleration point.
- rate of acceleration.
- terminal velocity.

5. Swinging a ball on a rope in a circular motion is an example of:

- acceleration.
- centripetal force.
- projectile motion.
- gravity.

## ANSWER KEY for page 26

### TEST (CONTINUED)

6. A projectile is subject to the force that propels it and to:

- terminal velocity.
- inertia.
- frame of reference.
- gravity.

7. The motion of a projectile is its:

- acceleration.
- velocity.
- speed.
- trajectory.

8. Motion is measured in terms of:

- speed.
- acceleration.
- velocity.
- all of the above.

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- horizontal
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