Things in Motion

Teacher's Guide

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A Message from our Company . . .

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National Standards Correlations

Benchmarks for Science Literacy

(Project 2061 – AAAS, c. 1993)

Grades 3–5

By the end of the fifth grade, students should know that:

4B The Earth

- Things on or near the earth are pulled toward it by the earth's gravity.

4F Motion

- Something that is moving may move steadily or change its direction. The greater the force is, the greater the change in motion will be. The more massive an object is, the less effect a given force will have.
- How fast things move differs greatly. Some things are so slow that their journey takes a long time; others move too fast for people to even see them.

4G Forces of Nature

- The earth's gravity pulls any object toward it without touching it.

National Science Education Standards

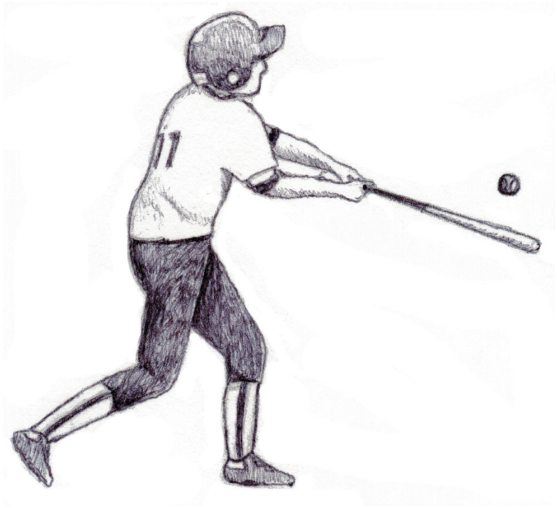
(Content Standards: K–4, National Academy of Sciences, c. 1996)

Physical Science – Content Standard B:

As a result of their activities in grades K-4, all students should develop an understanding of:

- The position of an object can be described by locating it relative to another object or the background.

- The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.



Student Learning Objectives

Upon viewing the video and completing the enclosed student activities, students will be able to do the following:

- Identify a moving object and describe its movement as related to its frame of reference.
- Provide examples of forces in everyday life such as a push or pull.
- Describe the force of gravity and provide an example of gravity at work.
- Differentiate between mass and weight of an object.
- Define the force of friction, and provide an example of friction at work.
- Describe how friction may be increased or decreased.
- Define the term inertia.
- Compute the speed of a moving object.
- Differentiate between speed and velocity.
- Describe the process of acceleration, and provide an example of an accelerating object.

Assessment

Preliminary Test (p. 15):

The Preliminary Test is an assessment tool designed to gain an understanding of students' preexisting knowledge. It can also be used as a benchmark upon which to assess student progress based on the objectives stated on the previous pages.

Post-Test (p. 16):

The Post-Test can be utilized as an assessment tool following student completion of the program and student activities. The results of the Post-Test can be compared against the results of the Preliminary Test to assess student progress.

Video Review (p. 17):

The Video Review can be used as an assessment tool or as a student activity. There are two sections. The first part contains questions displayed during the program. The second part consists of a five question video quiz to be answered at the end of the video.

Introducing the Program

Before viewing the program, ask students to describe some examples of ways they have observed or experienced things in motion today. Examples may include riding a bus, walking, writing, getting out of bed, etc. Write their examples on the board. Next, ask students to describe the nature of the examples. For example, when riding a bus, the vehicle started, sped up, slowed down, and eventually stopped.

Write the following terms on the board: force, gravity, inertia, mass, weight, friction, speed, and acceleration. Tell the students to pay close attention to the program so they can learn the meaning of these words as related to things in motion. Following the program write the definition of the words next to the appropriate term.

Program Viewing Suggestions

The student master "Video Review" is provided (p. 17) for distribution to students. You may choose to have your students complete this Master while viewing the program or do so upon its conclusion.

The program is approximately 14 minutes in length and includes a five-question video quiz. Answers are not provided to the Video Quiz in the video, but are included in this guide on page 13. You may choose to grade student quizzes as an assessment tool or to review the answers in class.

The video is content-rich with numerous vocabulary words. For this reason you may want to periodically stop the video to review and discuss new terminology and concepts.

Activities Across the Curriculum

Math

• **Rolling Races** - **(Materials: small objects that roll such as marbles, small cars, ping pong balls, thread spools, a board, and items to make an incline).** Ask students to predict which objects will reach the bottom of the incline first. Also predict the time it will take each item to roll to the finish. Design a graph to display the data collected from the *rolling races*. Students can use the data to compute the average time, the range of times, etc.

• **Race Results** - **(Materials: Race results from newspapers and other resources)**. How fast they move! Look in the newspaper or other resources to find race results for car racing, skiing, ice skating, biking, etc. Or look up past Olympic race results. Guide students to use the data to calculate average race speeds, fastest racers, who wins the most races, or distances accumulated. Ask the students to display data in graphs and charts. Students could also study how different variables affect race results such as weather, scientific advances, or better training procedures.

• **How Fast Can You Go?** - **(Materials: A measuring tape that includes meters, objects to build a simple obstacle course on a playground area, and a stopwatch).** Design or plan an obstacle course for a large room or outside area. Decide on a sequence of movements to be made throughout the course. For example, jump to the chair, skip to the hoop, crawl through the hoop and run to the slide, etc. After the course has been determined, measure how many meters the entire course is including obstacles that are climbed over. Using a stopwatch, record the finishing time for each student or team completing the course. Then use the formula for speed on page 20 of this guide to calculate the speed at which each student or team completed the obstacle course. Students could also compute the average class time to complete the course and average speed of the class.

Writing

• **No Gravity! -** Ask the students to imagine life without gravity. Write about waking up one day and the force of gravity is gone! Describe your day and the accommodations you would need to make.

• **Air Sports** - Ask the students to describe a baseball, soccer, hockey, football, lacrosse or field hockey game without gravity. Write new rules for the game.

• **Moving Along** - What is your favorite way of moving along? Is it walking, running, dancing, riding a bike, riding in a train, plane, or car? Write a poem about your favorite way of getting around.

• **Where Will You Live?** - In the future we may have a choice to live on another planet! Choose a planet where you would like to live. Write a letter to a friend living on Earth. In the letter describe both the joys and hardships involved in living on your planet. Include answers to the following questions in your letter: What do you eat?, Are there sports on your planet?, Do you have any pets?, What does your home look like?, Does your planet have any enemies?, and What is your favorite activity on your new planet?. Be imaginative and creative in your writing!

Art

• **Rolling Colors - (Materials: marbles, several paint colors, paper cups, spoons, heavy box tops such as: a copy paper box top, paper, and tape).** Tape paper to the inside of the box tops. Put paint in several cups. Add a few marbles to each cup of paint. Spoon several marbles onto the paper in the box tops. Move the marbles by tilting the top back and forth. Continue until all the paint colors have been used. Replace the marbles into the paint cups and remove the painting!

• **Rolling Sculpture - (Materials: cardboard tubes, wood scraps, tape, glue, scissors, small balls or marbles, cans, craft sticks, paper cups - any items that could be used to build a sculpture).** Guide small groups of students to design a sculpture with varying inclines for the balls or marbles to travel through.

• **Shaking Paint - (Materials: cups of paint, brushes, paper, tape, smocks, newspaper, box bottoms at least seven inches high).** Cover the work area with newspaper. Tape the paper to the bottom of the box. *Dilute* the paint with a small amount of water. Instruct students to dip the brush in the paint and *gently* shake onto the paper. Continue dipping and shaking paint until the painting is complete!

• **Swinging Mobiles** - Create a mobile using string, cardboard, a hanger, and recycled items. Hang the mobile in an open window and watch it swing!

• **Dancing Fingers** - Finger paint to different types of music. Let your fingers *dance* across the paper!

Social Studies

• **Great Scientists!** - Read the class a book about Sir Issac Newton or Galileo Galilei. Use the resource guide on page eight for some ideas. Guide the students to write and act out short skits depicting a specific discovery or event in the lives of these great scientists!

• **Moving and Grooving Through the Years** - Create a time line of dance styles throughout history. Guide groups of students to research a specific time era. The students could then present the dance history of the specific era and maybe even perform a few dance steps!

• **Inventors of Future Transportation** - How do we get from here to there - point A to point B? Discuss the past and present modes of transportation in the United States. Guide students to brainstorm transportation ideas for the future. Then, have each group take one idea and write a description of the transportation mode along with an illustration.

Safety

Always use caution when experimenting with moving objects. Moving things may move in unexpected ways. Therefore, use safety glasses or safety goggles to prevent eye injury. Take care to direct moving objects to avoid injury to other people and away from breakable objects.

Suggested Resources

Children's Literature Books

Allen, Tony. *Isaac Newton*. Des Plaines, IL: Heineman Library, 2001.

Byrd, Robert. *Leonardo, Beautiful Dreamer*. New York: Dutton Juvenile, 2003.

Cobb, Vicki. *Truth on Trial: The Story of Galileo Galilei*. New York: Putnam Publishing Group, 1979.

Fisher, L. E. *Galileo*. New York: Simon and Schuster Children's, 1992.

MacLeod, Elizabeth. *Albert Einstein: A Life of a Genius*. Tonawanda, New York: Kids Can Press, 2003.

Salas-Purdie, Laura and Emily C.S. Reynolds (illustrator). *Discovering Nature's Laws: A Story About Isaac Newton.* Minneapolis: Lerner Publishing Group, 2004.

Sis, Peter. *Starry Messenger: Galileo Galilei.* New York: Farrar, Straus and Girous, 2000. (re-print).

Tiner-Hudson, Jon and Bill Biel (illustrator). *Isaac Newton: The True Story of His Life as Inventor, Scientist and Teacher.* Fenton, MI: Mott Media, 1976.

References (Informational Books)

Angliss, Sarah. *Forces and Motion.* Boston: Houghton Mifflin Company, 2001.

Dalton-Devine, Cindy, et.al. *Gravity, (How Can I Experiment Series).* Vero Beach, FL: Rourke Publishing, LLC, 2001.

DiSpezio, Michael Anthony and Leary, Catherine. *Awesome Experiments In Force and Motion*. New York: Sterling Publishing Company, 1999.

Goodstein, Madeline P. *Science Fair Success Using Newton's Laws of Motion.* Berkeley Heights, NJ: Enslow Publishers, Incorporated, 2002.

Lafferty, Peter. *Eyewitness: Force and Motion*. New York: DK Publishing, Inc., 1999.

Prasad, Kamai and Aurore Simomet (illustrator). *Why Can't I Jump Very High? A Book About Gravity*. Santa Rosa, CA: Science Square Publishing, 2004.

Smith, Alastair, et.al. *Energy, Forces and Motion.* (Internet Linked Library of Science). Duluth, GA: Usborne Publishing, 2002.

White, Larry and Laurie Hamilton (illustrator). *Gravity: Simple Experiments for Young Scientists.* Brookfield, CT: Millbrook Press, 1996.

Video Script

1. Have you ever had the thrill of ridding on a spinning Ferris wheel?
2. Maybe you have enjoyed riding on a horse.
3. Or perhaps you have had the unpleasant experience of getting carsick.
4. Maybe you have had the experience of flying in a plane.
5. Perhaps you have ice skated on a frozen pond…
6. …or caught a ball!
7. What do all these things have in common?
8. That is right! They all involve moving things.
9. During the next few minutes we are going to take a look at how and why objects move.
10. As we explore things in motion.
11. **Graphic Transition- Things on the Move**
12. How do you know something has moved?
13. You know something has moved because its location or position has changed.
14. For example, you know this deer moved because it is in a new position.
15. The reason you know something has changed its position is because the objects around it do not move.
16. You can tell these vehicles are moving because the buildings behind them are not moving.
17. These stationary objects are referred to as a frame of reference.
18. **Graphic Transition- Force**
19. What do you need to do in order to move this wheelbarrow uphill?
20. That is right! You either need to push it or pull it.
21. Similarly these dogs are pulling this sled.
22. And this snowplow is pushing snow.
23. When an object, including a person, is pushed or pulled, it moves.
24. Pulling and pushing are examples of forces.
25. A force can cause an object to start moving, stop moving or change direction.
26. **Graphic Transition- The Force of Gravity**
27. What force pulls this sled downhill,…
28. …causes rain to fall to the ground . . .
29. …and pull this ski jumper back to Earth?
30. Gravity!
31. **You Decide!** What is gravity?
32. Gravity is the force that pulls objects toward the center of the earth.
33. Gravity keeps us on Earth.
34. If gravity did not exist, when you jumped you would go flying off into space.
35. Gravity is also the force which attracts planets to the sun and keeps them in orbit.
36. Gravity can be measured in terms of the amount of force it exerts on a mass.
37. Mass is the amount of matter or material in an object.
38. The mass of this car is the same whether it is on Earth or the moon.
39. But on the moon the car has less weight.
40. Weight is a measure of the force that gravity exerts on an object.

Video Script

41. The force of gravity is less on the moon than on the earth,
42. …causing objects to weigh less on the moon than on the earth.
43. **Graphic Transition- Friction**
44. Why does this rolling ball eventually come to a stop?
45. Why does this canoe slow down when the person stops paddling?
46. And what allows these bugs to climb up and down this window.
47. The answer lies in something called friction. Friction is a force that works against motion.
48. Friction causes moving objects to slow down and eventually stop.
49. Friction occurs where two objects touch, such as where the bottom of this box rubs against the floor,…
50. …or where car tires meet the pavement.
51. Without friction our feet would not grip the ground.
52. Friction enables rock climbers to climb cliffs.
53. And friction enables this chameleon to cling to this swaying branch.
54. Rough surfaces, such as the ground, tend to produce greater friction,...
55. …than smooth surfaces such as ice.
56. **You Compare!** Does a road or a bumpy lawn create more friction for a bicycle?
57. The bumpy lawn creates more friction for the bicycle rider than this smooth road which makes bicycling easier.
58. In many cases friction can cause tremendous heat.
59. Even friction created from rubbing your hands together produces heat.
60. It is often necessary to reduce friction. For example, oil is used in car engines to reduce the friction between moving parts, allowing the engine to remain cooler.
61. And wax is applied to the bottom of skis . . .
62. . . . to help them glide better on the snow.
63. In some cases it is necessary to increase friction.
64. Sand is often put on icy roads to help get better traction.
65. And baseball players often wear gloves to help increase friction between their hands and the bat, enabling them to have better control.
66. **Graphic Transition- Inertia**
67. This baseball stays in motion until the player stops it in his glove.
68. And these snowflakes keep falling downward until they hit the ground.
69. This model rocket stays at rest until it is launched skyward.
70. Inertia is the tendency of an object to stay in motion…
71. …or to stay at rest until a force acts upon it.
72. All objects, whether they are moving or at rest have inertia.
73. To start something moving,…
74. …or to stop something from moving, a force is needed to overcome inertia.
75. Inertia is the reason why it is so important to wear seat belts.
76. When a car is moving along and comes to a sudden stop, your body keeps moving forward due to inertia.
77. The seat belt holds your body in place, thus preventing serious injuries.

Video Script

78. Graphic Transition- Speed and Velocity
79. This powerboat is moving much faster…
80. …than these train cars.
81. How do you measure how fast something is going?
82. Speed is a measure of the amount of distance covered per unit of time.
83. Put another way, speed equals distance divided by time.
84. For example, this sign warns drivers to limit their speed to 35 miles per hour.
85. This means that they should not drive any faster than a rate of 35 miles during one hour of driving.
86. While speed can be measured in miles per hour it can also be measured in metric units of kilometers per hour.
87. For example, this helicopter can travel over 90 kilometers per hour.
88. You Compute! If a car travels 80 kilometers in two hours, what is its speed?
89. The answer is computed by dividing 80 kilometers by two hours to get an answer of 40 kilometers per hour.
90. Velocity is the speed of an object as well as the direction in which it is traveling.
91. For example, the velocity of the water in this stream is 20 kilometers per hour north.
92. And the velocity of this hot air balloon is 40 kilometers per hour southeast.
93. Graphic Transition - Acceleration
94. You Predict! What will happen when you push down on the gas pedal in this car?
95. The car increases its speed or accelerates.
96. You can feel a car accelerating…
97. …and you can see the result of acceleration by the moving needle of this speedometer.
98. Acceleration is a change in velocity.
99. Generally speaking, when the velocity of a moving object is increased such as this rocket it is referred to as a positive acceleration.
100. Similarly, the person on this bicycle is positively accelerating down this hill.
101. But acceleration can work the other way, or negatively!
102. For example, when this skier turns his skis and slows down he is negatively accelerating.
103. As is this car when it stops for this stop sign.
104. Deceleration is a term often used to describe a decrease in velocity.
105. Graphic Transition – Summing Up
106. During the past few minutes we have taken a look at many of the fascinating features of things in motion.
107. We discussed how movement is visible due to frame of reference.
108. And we took a look at how force starts an object moving, or stops it.
109. We looked at how the force of friction works against motion.
110. And how friction affects our everyday lives.
111. Inertia is the tendency of an object to stay in motion…
112. …or to stay at rest until a force acts upon it.

Video Script

113. We also described velocity as the speed of an object in a given direction.
114. Finally we discussed that acceleration is the change in velocity of an object.
115. So the next time you take a ride on a bike…
116. …throw a ball…
117. …or ride in a car…
118. …think about what we have talked about during the past few minutes. You just might think about things in motion a little differently.

Fill in the correct word to complete the sentence. Good luck and let us get started.

1. A push is a type of _____.
2. _____ is the force keeping us on Earth.
3. _____ causes objects to slow down.
4. Velocity is the _____ of an object in a certain direction.
5. _____ describes a decrease in velocity.

Answers can be found on page 13.

Answer Key to Student Assessments

Pre-Test (p. 15)

1. false
2. true
3. false
4. true
5. true
6. Some examples of force in motion are; a wagon being pulled or pushed, a snow plow pushing snow, a dog pulling a sled, a gardener pushing a wheelbarrow, a child throwing a snowball.
7. Friction can be increased by adding sand on an icy road. This helps motorists get better traction. Baseball players often wear gloves to increase friction between their hands and the bat. Skateboards have rough sand-like paper on the surface to increase friction between the board and a skater so the skater does not fall off!
8. b. negative acceleration
9. d. decrease friction
10. c. gravity
11. a. velocity
12. d. a, b, and c

Post-Test (p. 16)

1. false
2. true
3. false
4. true
5. true
6. If gravity did not exist, objects and humans would go flying into space. Gravity keeps us on Earth. Anything that was not attached would go flying into the air.
7. Friction can be reduced for downhill and cross country skiers by applying certain waxes. Oil can be used in engines to reduce friction between moving parts. Swimmers sometimes wear bathing caps and shave their hair to reduce friction while swimming.
8. d. deceleration
9. a. mass
10. b. gravity
11. c. increase friction
12. b. force

Video Review (p. 17)

1. Gravity is the force that pulls objects toward the center of the Earth.
2. The bumpy lawn creates more friction for the bicycle rider.
3. The answer is computed by dividing 80 kilometers by two hours to get an answer of 40 kilometers per hour.
4. The car increases its speed or accelerates.

Video Quiz (p. 17)

1. A push is a type of ***force***.
2. ***Gravity*** is the force keeping us on Earth.
3. ***Friction*** causes objects to slow down.
4. Velocity is the ***speed*** of an object in a certain direction.
5. ***Deceleration*** describes a decrease in velocity.

Answer Key to Student Activities

Vocabulary (p. 18)

1. frame of reference
2. push
3. gravity
4. mass
5. weight
6. friction
7. inertia
8. velocity
9. acceleration

You know something has moved because the objects around it do not move. These stationary objects are referred to as a ***frame of reference***. A ***push*** or a pull are examples of forces which cause objects to move. Another example of a force is ***gravity***, which pulls objects toward the center of Earth. Gravity can be measured in terms of the amount of force it exerts on a ***mass***. And ***weight*** is a measure of the force of gravity on a mass. ***Friction*** is a force that causes moving objects to slow down and eventually stop. The tendency of an object to stay at rest or to stay in motion until something causes it to move is called ***inertia***. Speed is a measure of how fast an object is moving or the amount of distance covered per a unit of time. ***Velocity*** is the speed of an object in a given direction. And when an object's velocity increases this is referred to as ***acceleration***. Deceleration describes a decrease in velocity.

Resisting Gravity (p. 19)

Example: When the flat sheets are dropped, they float to the floor at the same speed. When one is crumpled and the other flat, the crumpled paper falls much faster. Air resistance is greater on objects with more surface area. The crumpled paper has less surface area than the flat sheet therefore causing it to fall faster even though its mass has not changed.

Marble Madness (p. 20)

1. The marble rolls the fastest when five books are used.
2. The marble rolls the slowest when two books are used.
3. The more books that are used, the faster the marble rolls.
4. **Possible examples**: thickness of the books, the weight of the marble used, and the incline of the cardboard tube can all affect the speed of the marble.
5. The average speed is found by adding the speed of all four rolls and dividing by four (the number of rolls).

Fun with Friction (p. 22)

1. The sandpaper surface creates the most friction.
2. The plain desktop creates the least friction.
3. Rough surfaces create more friction than smooth surfaces.
4. **Examples**: Wheels reduce friction and help objects move. Oil in car engines reduces friction between moving parts. Treads on the bottom of shoes increase friction for better footing. Sand is used on icy roads to increase friction so cars can travel safely on them.

Out of this World (p. 24)

Journal entries will vary from student to student.

Pre-Test

Name _____

Write true or false next to each statement.

1. _____ Gravity is the force that pushes objects away from earth.
2. _____ Friction causes moving objects to slow down or stop.
3. _____ Objects have inertia only when they are moving.
4. _____ Friction can usually cause heat.
5. _____ Rough surfaces such as sandpaper tend to produce more friction.

Write a short answer for each of the following.

6. Give three examples of force in motion:

_____

_____

_____

_____

7. Describe two examples of how friction can be increased:

_____

_____

_____

_____

Circle the best answer for each of the following questions.

8. A skier turning her skies and slowing down is an example of:

a. *gravity* ***b.*** *negative acceleration* ***c.*** *mass* ***d.*** *positive acceleration*

9. Oil is used in car engines to:

a. *increase friction* ***b.*** *decrease speed* ***c.*** *decrease velocity* ***d.*** *decrease friction*

10. _____ is the force that attracts planets to the sun and keeps them in orbit.

a. *friction* ***b.*** *motion* ***c.*** *gravity* ***d.*** *acceleration*

11. _____ is the speed of an object as well as the direction in which it is traveling.

a. *velocity* ***b.*** *gravity* ***c.*** *acceleration* ***d.*** *friction*

12. A force such as pushing can cause an object to:

a. *move* ***b.*** *stop* ***c.*** *change direction* ***d.*** *a, b, and c*

Post-Test

Name _____

Write true or false next to each statement.

1. _____ Smooth surfaces such as ice tend to cause greater friction.
2. _____ Gravity is the force that pulls objects toward the center of the earth.
3. _____ Friction causes moving objects to speed up and go faster.
4. _____ All objects, whether they are moving or at rest, have inertia.
5. _____ A force can cause an object to start moving, stop moving or change direction.

Write a short answer for each of the following.

6. What would happen if gravity did not exist on earth?

_____

_____

_____

7. Describe two examples of how friction can be reduced.

_____

_____

_____

Circle the best answer for each of the following questions.

8. The term used to describe a decrease in velocity is:

a. *acceleration* ***b.*** *force* ***c.*** *motion* ***d.*** *deceleration*

9. _____ is the amount of matter or material in an object.

a. *mass* ***b.*** *gravity* ***c.*** *force* ***d.*** *weight*

10. What force causes rain to fall to the ground?

a. *friction* ***b.*** *gravity* ***c.*** *pushing* ***d.*** *speed*

11. Sand is often put on icy roads to:

a. *decrease friction* ***b.*** *keep friction the same* ***c.*** *increase friction* ***d.*** *increase motion*

12. A push or a pull of an object is a type of:

a. *weight* ***b.*** *force* ***c.*** *frame of reference* ***d.*** *speed*

Video Review

Name _____

While you watch the video, answer these questions:

You Decide!

1. What is gravity?

_____

_____

_____

You Compare!

2. Does a road or a bumpy lawn create more friction for a bicycle?

_____

_____

_____

You Compute!

3. If a car travels 80 kilometers in two hours, what is its speed?

You Predict!

4. What will happen when you push down on the gas pedal in this car?

_____

_____

_____

After you watch the video, test your knowledge with these questions:

1. A push is a type of _____.
2. _____ is the force keeping us on Earth.
3. _____ causes objects to slow down.
4. Velocity is the _____ of an object in a certain direction.
5. _____ describes a decrease in velocity.

Vocabulary

Name _____

Use these words to fill in the blanks next to the sentences below.

Words					
mass	*frame of reference*	*inertia*	*weight*	*push*	
friction	*acceleration*	*velocity*	*gravity*		

1. _____ Refers to stationary objects behind a moving object.
2. _____ A force that causes an object to move.
3. _____ Force that pulls objects toward the center of Earth.
4. _____ The amount of matter in an object.
5. _____ A measure of the force that gravity exerts on an object.
6. _____ A force that works against moving things.
7. _____ The tendency of an object to stay at rest or to stay in motion.
8. _____ The amount of distance an object covers per unit of time in a certain direction.
9. _____ A change in velocity.

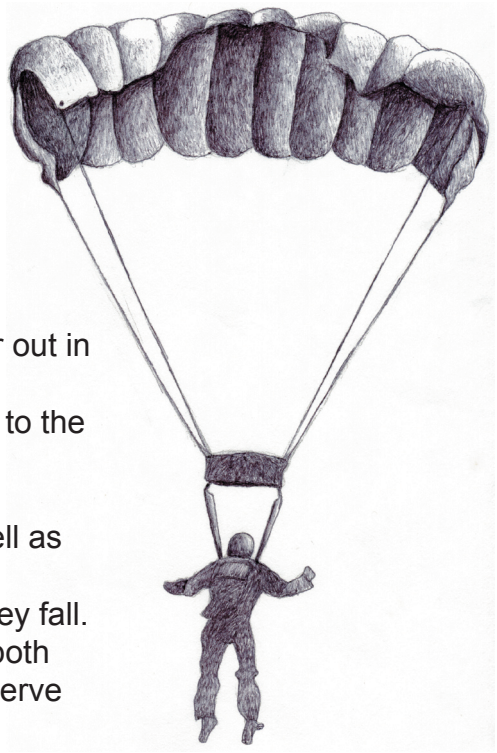
Use the correct word from above to complete the sentences in the following paragraph.

You know something has moved because the objects around it do not move. These stationary objects are referred to as a _____ ____ _____. A _____ or a pull are examples of forces which cause objects to move . Another example of a force is _____, which pulls objects toward the center of Earth. Gravity can be measured in terms of the amount of force it exerts on a _____. And _____ is a measure of the force of gravity on a mass. _____ is a force that causes moving objects to slow down and eventually stop. The tendency of an object to stay at rest or to stay in motion until something causes it to move is called _____. Speed is a measure of how fast an object is moving or the amount of distance covered per a unit of time. _____ is the speed of an object in a given direction. And when an object's velocity increases this is referred to as _____. Deceleration describes a decrease in velocity.

Resisting Gravity

Name _____

In the early 1600's, a scientist by the name of Galileo made a startling observation. Scientists had thought that heavier objects fell faster than lighter ones. Galileo believed otherwise. He stated that all objects fell to Earth at the same speed even though they have different masses. The force of gravity pushes down on objects but at the same time air pushes up on the object. Air resistance is the reason why objects appear to drop at different rates. A tennis ball and feather have different surface areas and therefore fall at different rates. A feather has more surface area which creates more resistance and falls slower than the ball. If you were to drop them while in space where there is little air, you would see that they fall at exactly the same speed despite their weight difference.



Materials:
2 sheets of paper
stool

Directions:
1. Label the sheets of paper 1 and 2.
2. Stand on the stool and hold the two sheets of paper out in front of you.
3. Let go of the sheets of paper and watch as they fall to the ground.
4. Crumple one of the sheets of paper.
5. Stand on the stool with the flat piece of paper as well as the crumpled paper.
6. Drop the two sheets of paper and watch them as they fall.
7. Crumple up the second sheet of paper. Now drop both pieces of crumpled paper at the same time and observe what happens.
8. Use different objects such as, stones, marbles, and balls to compare the rate at which they fall.

Critical Thinking:
Describe what happens each time you drop the sheets of paper. Which sheet hits the ground first? Why? What part of the experiment proves that objects fall to Earth at the same speed?

Marble Madness

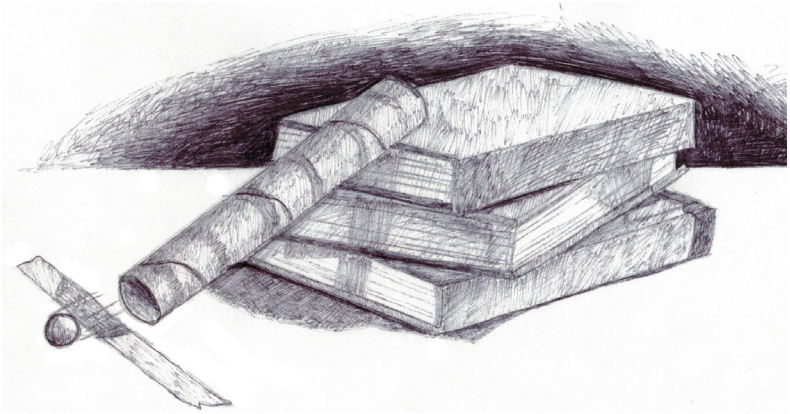
Name _____

Description: Objects in motion move at different rates. Speed is the calculation of how fast an object moves over a measured distance. Long distances are measured in miles per hour (mph) or kilometers per hour (km/h). If a car moves at 35 mph, it means that in one hour of time the car will have traveled 35 miles. Similarly, a car moving at 35 km/h means that the vehicle travels 35 kilometers every hour. Speed can be calculated in a simple equation where distance is divided by time:

$$\text{Speed (S)} = \frac{\text{Distance (d)}}{\text{Time (t)}}$$

In the following activity, you will practice calculating speed by measuring the amount of time it takes a marble to travel a set distance.

Materials:
marble
4 textbooks
meterstick
masking tape
cardboard tube (used)
stopwatch



Directions:

1. Stack the five books on top of each other.
2. Lean the cardboard tube against the textbooks and secure it with a small piece of tape.
3. Make a line of tape where the tube meets the floor. This is the starting point.
4. From this line, measure a length of one meter and make another line of tape. This is the finish line.
5. Hold the marble at the top of the cardboard tube. Let the marble roll down through the tube. Start the stopwatch when the marble hits the tape at the bottom of the tube and stop it when it crosses the other line of tape. Record the time in the chart on the following page.
6. Repeat step 5 three more times but take away one book after each roll. If the marble does not reach the finish line, measure how far it rolled until it stopped and use that number as your distance in the equation.
7. Calculate the speed of the marble for the four different rolls in the chart using the speed equation.
8. Answer the questions on the following page.

Marble Madness

Name _____

Number of books	Time: seconds	Distance (1 meter)	Speed = Distance (meters) / Time (seconds)
(Example) 5	1 second	1 meter	1 meter / 1 second = 1 meter per second
5			
4			
3			
2			

Questions:

1. What was the number of books that caused the marble to roll the fastest?

2. What was the number of books that caused the marble to roll the slowest?

3. How does the number of books affect the speed of the marble?

4. List three variables that might affect the speed of the marble as it rolls.

5. What is the average speed of the marble?

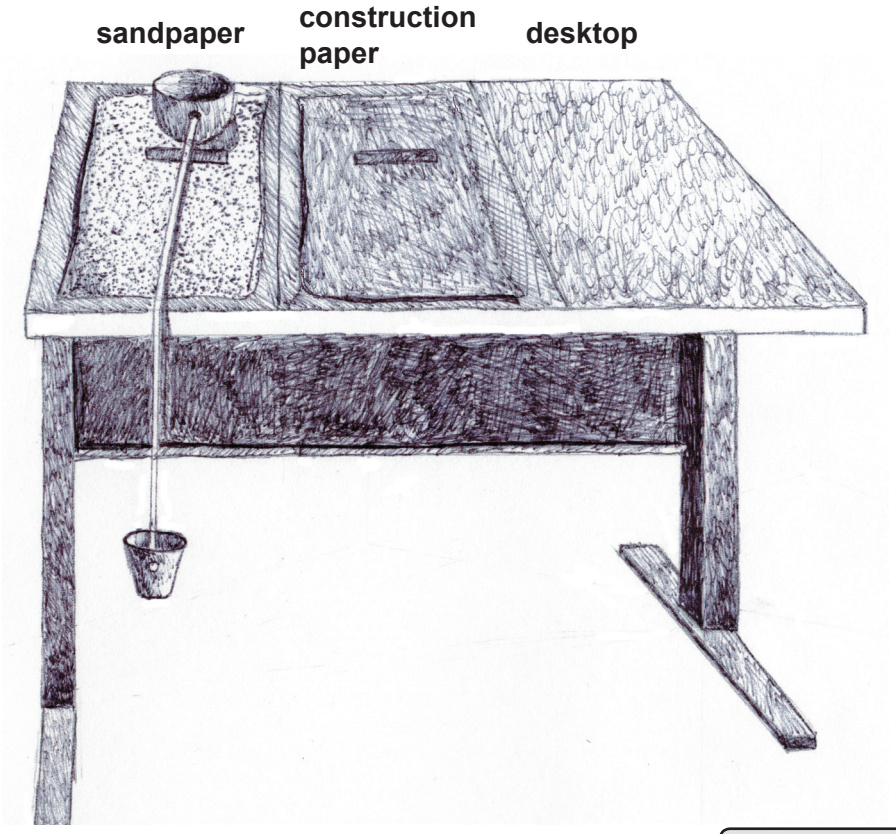
Fun with Friction

Name _____

What keeps people on Earth? What causes a car to continue moving once a foot is taken off the gas pedal, and what causes the car to eventually come to a stop? Forces are at work in all these situations. The force of gravity keeps people on Earth. Inertia is the force that keeps objects moving once they start, and friction is the force that causes objects to finally stop. Forces are important for life on Earth.

The force of friction opposes objects in motion. This means that without friction, moving objects would have a hard time stopping. Friction occurs wherever two objects touch. Balls that roll over the ground come to a stop due to friction created where the ball and ground meet. Different surfaces create different amounts of friction.

Materials:
fiberglass desktop or another smooth surface
sandpaper
construction paper
masking tape
string
gram weights
10 oz. can of soup
paper bowl, big enough to hold the can of soup
paper



Fun with Friction

Name _____

Directions:

1. Divide the desk into thirds.
2. Tape the sandpaper and construction paper to the desktop so that the three different surfaces have equal amounts of space.
3. Using the tape, make a *starting line* six inches (about 5 cm) from one end of the desk.
4. Measure the string so that it reaches from one end of the desk and over the other end by a foot (about 30 cm).
5. Make a small hole halfway up the paper bowl and two holes across from each other at the top of the cup.
6. Securely attach the string to the bowl and place it at the line of tape on one of the surfaces.
7. Attach the other end of the string to the cup by inserting it through both holes and tying it at the top.
8. Hang the cup over the side of the desk at the opposite end from the starting line, or the *finish line*.
9. Place the unopened can of soup in the bowl.
10. Gently place a weight in the cup one at a time until the bowl is moved from the starting line to the finish line.
11. Record how much weight it took to move the bowl to the finish line.
12. Do the experiment over the other two surfaces and record the amount of weight it took for each one.
13. Answer the questions below.

Questions:

1. Which surface creates the most friction?

2. Which surface creates the least friction?

3. Which type of surface creates more friction; a smooth one or a rough one?

4. What are four examples of how friction is increased or decreased in everyday life?

Out of This World

Name _____

Imagine that you have just received news that you were accepted to be an astronaut candidate. You begin thinking about how exciting it will be to travel to outer space. You realize that you will be one of the few people who have had the chance to see the breathtaking view of Earth from space. While in space, you will experience what life is like without gravity. You will be part of a team that will conduct scientific experiments and gather valuable information for researchers who remained on Earth. Ideas begin forming in your head about how wonderful a trip to space will be. Then you remember that before you get to space there are many months, even years, of difficult training. An astronaut's job is demanding as much as it is rewarding.

The training for an astronaut candidate begins in the space shuttle. Since the shuttle will be your home and life support for the trip it is important that each member of the team knows the basics of how it operates. This time is also very important for your team to get to know each other since you will depend on one another for many tasks.

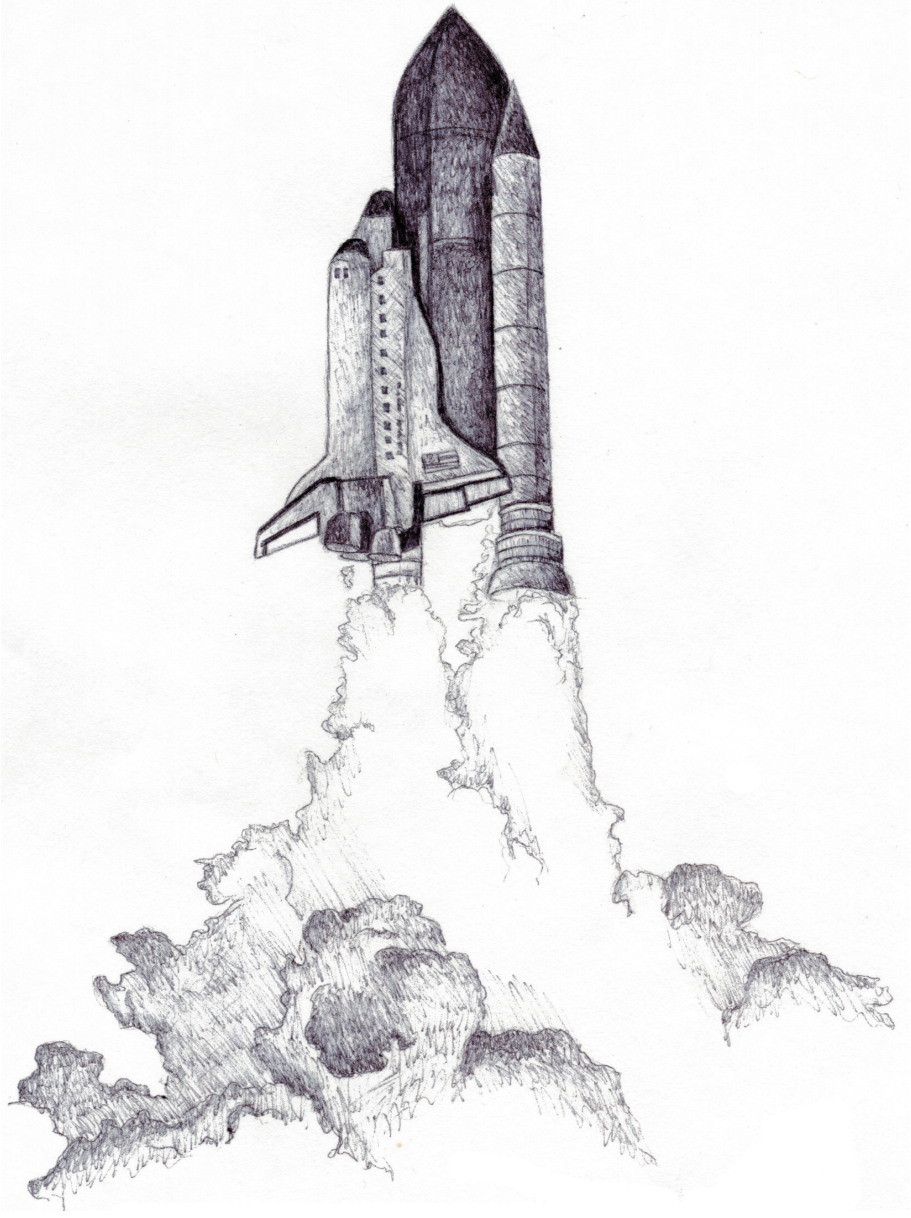
Next, you will be given a technical assignment in the mission control center. This is where the missions are managed. The control center is the heart of any mission and your responsibilities are very important for the safety and success of missions. You stay at this training level for a period of time (sometimes years) in order to gain experience and prove that you are ready to be assigned to a space flight.

Once you are assigned to an expedition, the real training begins. For approximately 18 months you will live and breathe space skills. You will learn Russian in order to communicate with others in the International Space Station. During this time you will travel back and forth between NASA Johnson Space Center in Houston, Texas, and the Gagarin Cosmonaut Training Center in Star City, Russia. The trips will inform you and your crew members on the daily procedures that need to be conducted when in space and the equipment that is used for them. These tasks include checking complicated systems as well as learning how to eat in a low-gravity environment. You also will learn how to fix anything that may break while in space. Emergency procedures are practiced over and over so that if anything goes wrong while in space, the crew will know exactly what to do. These procedures are practiced in a replica of the real Space Station and Space Shuttle. This allows you to become familiar with the same equipment that you will be working with in space.

Another part of training takes place in a six million gallon pool that creates a similar environment to the one you will be working in outside of the Space Station. The pool simulates the feeling of weightlessness. You will practice moving around in spacesuits and how to work with tools when in the spacesuits. Working in space is very difficult and astronauts have to be well prepared for it.

Out of This World

Name _____

Over the course of your training period you will learn many skills needed to survive in space and how to conduct experiments for scientists on Earth. As you get closer to your flight you will practice pretend flights, preparing for the real one. By the time you set foot in the real Space Shuttle, you will have spent about 1300 hours training for your mission and will be extremely skilled for your trip to outer space.

Creative Writing:
On a separate piece of paper, write a journal entry about one of your training days. Decide whether you are in the beginning or advanced stages of astronaut training . Name what skills you are learning and how they will be useful. Discuss what you find challenging in the training and what you like best. Write about your teammates and how well or how poorly you work together. Describe your thoughts about going to space and what you hope to learn while you are on your mission.