TRB^3

Elementary Science Teacher Resource Book

A PROFESSIONAL DEVELOPMENT RESOURCE FOR TEACHING CORE CURRICULUM

GRADE 3

LITERACY -- STRATEGIES – ASSESSMENT

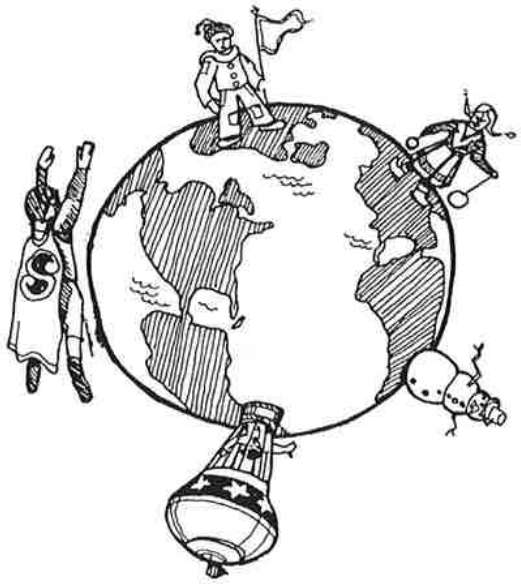
Utah State Office of Education

Forces cause changes in the speed or direction of the motion of an object. The greater the force placed on an object, the greater the change in motion. The more massive an object is, the less effect a given force will have upon the motion of the object. Earth's gravity pulls objects toward it without touching them.

11. Standard IV

STANDARD IV: Students will understand that objects near Earth are pulled toward Earth by gravity.

Objective 1: Demonstrate that gravity is a force.
Objective 2: Demonstrate the effects of gravity on the motion of an object.



11.1 Student Literacy
11.2 Strategies
11.3 Assessment

Science Benchmark

Forces cause changes in the speed or direction of the motion of an object. The greater force placed on an object, the greater the change in motion. The more massive an object is, the less effect a given force will have upon he motion of the object. Earth's gravity pulls objects toward it without touching them.

STANDARD III: Students will understand the relationship between the force applied to an object and resulting motion of the object.

Objective 1: Demonstrate how forces cause changes in speed or direction of objects.

a. Show that objects at rest will not move unless a force is applied to them.
b. Compare the forces of pushing and pulling.
c. Investigate how forces applied through simple machines affect the direction and/or amount of resulting force.

Objective 2: Demonstrate that the greater the force applied to an object, the greater the change in speed or direction of the object.

a. Predict and observe what happens when a force is applied to an object (e.g., wind, flowing water).
b. Compare and chart the relative effects of a force of the same strength on objects of different weight (e.g., the breeze from a fan will move a piece of paper but may not move a piece of cardboard)
c. Compare the relative effects of forces of different strengths on an object (e.g., strong wind affects an object differently than a breeze).
d. Conduct a simple investigation to show what happens when objects of various weights collide with one another (e.g., marbles, balls).
e. Show how these concepts apply to various activities (e.g., batting a ball, kicking a ball, hitting a golf ball with a golf club) in terms of force, motion, speed, direction, and distance (e.g., slow, fast, hit hard, hit soft).

STANDARD IV: Students will understand that objects near Earth are pulled toward Earth by gravity.

Objective 1: Demonstrate that gravity is a force.

a. Demonstrate that a force is required to overcome gravity.
b. Use measurement to demonstrate that heavier objects require more force than lighter ones to overcome gravity.

Objective 2: Describe the effects of gravity on the motion of an object.

a. Compare how the motion of an object rolling up or down a hill changes with the incline of the hill.
b. Observe, record, and compare the effect of gravity on several objects in motion (e.g., a thrown ball and a dropped ball falling to Earth).
c. Pose questions about gravity and forces.

Science language students should use:	distance, force, gravity, weight, motion, speed, direction, simple machine

Intended Learning Outcomes for Third Grade Science

The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should learn as a result of science instruction. They are an essential part of the science Core Curriculum and provide teachers with a standard for evaluation of student learning in science. Instruction should include significant science experiences that lead to student understanding using the ILOs.

The main intent of science instruction in Utah is that students will value and use science as a process of obtaining knowledge based upon observable evidence.

By the end of third grade students will be able to:

1. **Use Science Process and Thinking Skills**
    a. Observe simple objects and patterns and report their observations.
    b. Sort and sequence data according to a given criterion.
    c. Make simple predictions and inferences based upon observations.
    d. Compare things and events.
    e. Use instruments to measure length, temperature, volume, and weight using appropriate units.

2. **Manifest Scientific Attitudes and Interests**
    a. Demonstrate a sense of curiosity about nature.
    b. Voluntarily read or look at books and other materials about science.
    c. Pose questions about objects, events, and processes.

3. **Understand Science Concepts and Principles**
    a. Know science information specified for their grade level
    b. Distinguish between examples and non-examples of science concepts taught.
    c. Explain science concepts and principles using their own words and explanations.

4. **Communicate Effectively Using Science Language and Reasoning**
    a. Record data accurately when given the appropriate form and format (e.g., table, graph, chart).
    b. Report observation with pictures, sentences, and models.
    c. Use scientific language appropriate to grade level in oral and written communication.
    d. Use available reference sources to obtain information.

3rd Grade Science

Utah State Core Science Curriculum Standard IV: Students will understand the relationship between the force applied to an object and resulting motion of the object.

Desired Results

Benchmark/Enduring Understandings

Earth's gravity pulls objects toward it without touching them. Gravity is force that affects the motion of an object.

Essential Questions (Things students need to know)	**Skills (Things students need to be able to do)**
A. How do you know gravity is a force? B. What must you do to overcome gravity? C. How does the motion of a ball change as it rolls up a hill then down? D. What direction does gravity pull objects?	A. Use measurement to demonstrate that heavier objects require more force than lighter ones to overcome gravity. B. Describe the effects of gravity on the? C. Observe, record, and compare the effect of gravity on several objects in motion. D. Pose questions about gravity and force.

Assessment Evidence

- Pre-assessment/Invitation to Learn/Varied Activity Assessment
- Multiple Choice/Constructed Response
- Performance Assessment – How Far?
- Student demonstrates use of spring scale, "How Far?"

Instructional Activities

I I'm Falling For You (A)
II Jump (A, B)
III Draggin' Me Down (C, D)
IV Roller Coaster Fun (C, D)

11.1 Student Literacy

Science Benchmark: 03 : 04

Forces cause changes in the speed or direction of the motion of an object. The greater the force placed on an object, the greater the change in motion. The more massive an object is, the less effect a given force will have upon the motion of the object. Earth's gravity pulls objects toward it without touching them.

Standard IV:

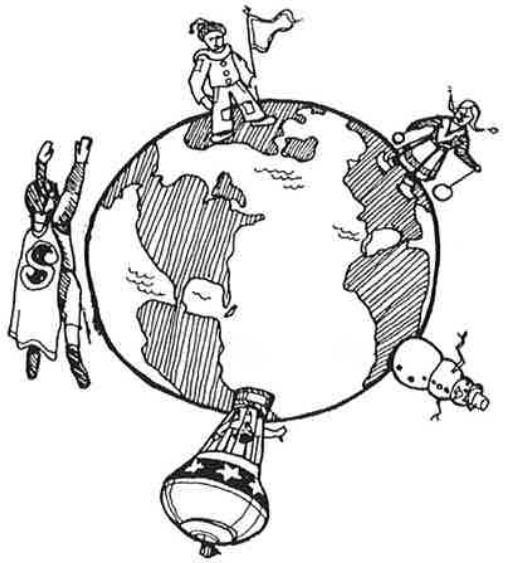
Students will understand that objects near Earth pare pulled toward Earth by gravity.

STUDENT BACKGROUND INFORMATION

Gravity – What Goes Up, Must Come Down

Jump up in the air and you will fall back down again. Try to stay up above the ground. Pretend you are a super hero getting ready to save the world from evil. Flap your arms a little and see if it helps. Can't do it? That's because of an invisible *force* called *gravity*. You can't see it, but it is a powerful force that affects all things on Earth.

Earth's gravity is strong and pulls objects without touching them. As you stand still or run as fast as you can, Earth's gravity is pulling down on you all the time. Skyscrapers, elephants, apples, and even you cannot get away from Earth's gravity. Even when you jump up into the air and you are not touching the ground, Earth's gravity will pull you back!



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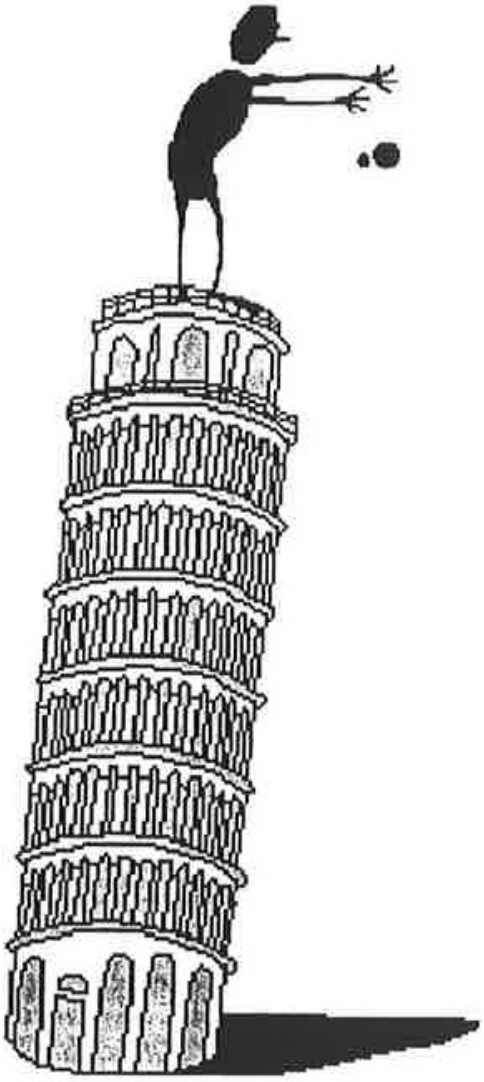
force – *a push or pull*

gravity – *the force that pulls objects on or near Earth toward its center.*

Grade	Benchmark	Standard	Page
03	03 : 04	04	11.1.1

The measurement of the force it takes to work against gravity is called *weight*. You can measurer weight on a scale. If you try to pick up heavy objects, you might need to be as strong as a super hero to lift them. Lifting overcomes the pull of gravity. Heavier objects need to have a strong force to lift them. Try lifting a bag of cement and see if it's easy or hard. Can you get it to move, even when you pretend to be a super hero? Try something lighter, like a book. You can lift lighter objects without huffing and puffing. But be careful! Gravity is very strong and once you stop lifting, gravity will pull the object back to the ground no matter how heavy or light it may be. Make sure your feet are not in gravity's path! Even super heroes can smash their toes!

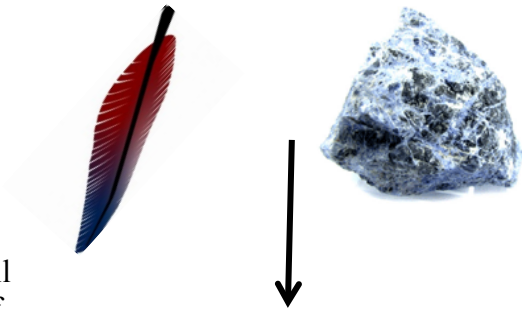


For many years, people thought that heavier objects would fall faster than lighter ones. Galileo, a famous scientist, asked: "Do all objects fall at the same speed?" A legend says that he dropped two different sized iron cannonballs off the Tower of Pisa. To his surprise, they both reached the ground at the same time. This answered his question. It also showed the importance of using experiments to find out answers to questions.

Gravity is always working. It is a constant force, which means it never stops. Before a bird or an airplane or even a super hero can fly, they must use other forces to help them overcome the gravity.

Weight – *a measure of the force of gravity on an object*

Very light objects, such as feathers, or seeds, fall slowly or even float through the air. So why don't they crash to the ground? They are so light that the air can hold them up and work against the force of gravity. That's the reason that a rock and a feather will not fall and hit the ground at the same speed. Air slows down all falling objects on Earth. If you were to take lots of feathers and wad them into a large ball and drop it with the rock, they would fall at the same rate. Gravity pulls all objects toward the center of Earth no matter how much they weigh. Air can slow an object, but it can't stop gravity.

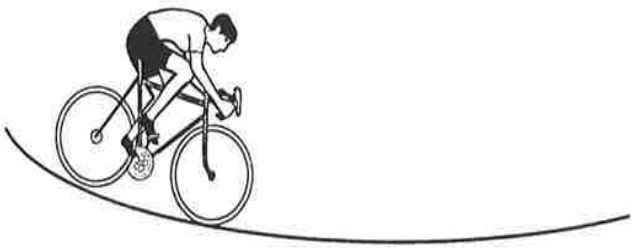


When objects are moving, gravity still pulls them toward Earth. If you drop a softball straight down, gravity will pull it straight down to the ground. What happens when you throw the same ball to your friend? The ball doesn't drop straight down. Instead, it moves forward in a curved path. A curve line is a part of a circle. When you let go of the ball it continues moving forward. But invisible gravity begins to use its force as soon as you throw the ball and pulls and ball downward at the same time it zooms to your friend. Because of the path forward and the work of gravity, the ball follows a curved path to the ground.

Have you ever ridden your bike down a hill and felt like you were flying? You almost feel like a super hero ready to take off and fight the enemies of Earth. Your secret to going so fast is the force of gravity pulling you. It pulls as you travel and helps you go faster and faster. Gravity adds to your speed as you zoom down. The steeper the hill, the faster you travel. Gravity makes objects move faster the farther they fall.

Gravity is not on your side if you want to go up the hill. It seems to pull on you from behind making your work harder. Think about how much fun it is to go sledding in the snow on a steep hill. It's always fun to zoom down screaming and speeding along. It's not so much fun, however, to make the long climb back up the hill as gravity holds you back while you pull against its force.

Gravity is something that is part of our lives, but because it is invisible we don't think of it very often. Questions about it can help us find interesting answers and information that help us understand the world around us. Think about all the plants that grow in your yard. Does gravity have an effect on how they grow? Do roots always grow down and stems grow up? How about swinging on a swing at recess? Does gravity help you go high or slow you down? Think about everyday things you do and see if gravity makes a difference.



Science Language that Students Should Know and Use

1. **force:** a push or pull

2. **gravity:** the force that pulls objects on or near the earth toward its surface.

3. **weight:** the measure of the force of gravity upon an object.

Resources

Books:

- *Gravity Works, by B. K. Hixson, Published by Loose in the Lab, 2001*
- *Janice VanCleav's Gravity*, by Janice VanCleave, Published by John Wiley & Sons, 1993.
- *Why Doesn't the Earth Fall Up?*, by Vicki Cobb, Published by Lodestar Books, 1988.
- *The Super Science Book of Forces*, by Jerry Wellington, Published by Thomson Learning, 1994.
- *The Science of Gravity*, by John Stringer, Published by Steck-Vaughn Company, 2000.
- *Forces,* by Graham Peacock, Published by Thomson Learning, 1994.
- *Eyewitness Science Series: Force and Motion*, by Peter Laferty, Published by Dorling Kinersley, Inc. 1992
- *Super Science Projects About Energy and Motion,* by Allan B. Cobb, Published by the Rosen Publishing Group, 2000.
- *Experiments with Motion,* by Robert Gardner, Published by Enslow Publishers, Inc., 1995.
- *The Spinning Blackboard & Other Dynamic Experiments on Force and Motion,* by Paul Doherty and Dkon Rathjen, Published by John Wiley & Sons, 1991.

Web Sources

- http://spaceprojects.arc.nasa.gov/SspaceProjects/SSBRP/gravity.htm

11.2 Strategies

Investigation One – I'm Falling For You!

Standard IV Students will understand that objects near Earth are pulled toward Earth by Gravity.
Objective 1 Demonstrate that gravity is a force.
Intended Learning Outcomes 1. Use a science process and thinking skills 2. Manifest scientific attitudes and interests 3. Understand science concepts and principles 4. Communicate effectively using science language and reasoning

Standard IV

Objective 1

Background Information

Gravity is an invisible force that pulls together any two objects. It pulls us down toward our planet, Earth, and holds us connected to it. To prevent confusion in students who may think, based on this definition, that gravity is the same as magnetic forces, the force of gravity is presented as the force that pulls objects on or near Earth toward its surface.

In this activity, students will experience gravity just like Galileo did during his experiments. For background purposes, it should be noted that there is no concrete evidence that Galileo successfully performed this experiment. Because of air resistance, the likelihood of the musket ball and the cannon ball actually landing at the same time is doubtful. However, through many other additional experiments with controlled processes, Galileo is considered the scientist who first understood this physical force.

Gravity pulls on all objects, no matter what their mass, with equal acceleration towards Earth. That is why an apple falls from a tree, or why rain falls from the sky. Ignoring friction or air resistance, any two objects will reach the ground at the same time if they are dropped from the same height and at the same time. In this activity, experiments will demonstrate that the force of gravity on Earth is the same for all objects.

It is also important to demonstrate and explain that a baseball and a piece of paper will not hit the ground at the same time because of air resistance. As objects move through air, friction slows the objects. The more surface area an object has, the more air resistance it will have. This might be easier to visualize if you tell students that a baseball and a wadded up piece of paper will fall at the same time.

Pre-Assessment/Invitation to Learn

1. Teacher will ask the students these questions: "If I dropped a basketball and a marble, which one would hit the ground first? Make a prediction. Why did you choose that answer?"
2. Drop both items from a high vantage point. Allow students to observe but not to engage in a lengthy discussion.
3. Repeat the experiment three times to model good experimentation.
4. Make a comment such as, "That was odd, don't you think? The basketball is heavier than the marble, isn't it?"
5. Pretend to think about this question. Then tell all students, "I think this is something we need to experiment with and try to figure out in our groups."

Instructional Procedure

Materials
- Marbles
- Ping pong balls
- Eraser
- Pencil
- Feather
- Paperclip
- Sheet of paper
- Data collection sheet
- Baseball

1. Divide children into small groups.
2. Hand out the data collection sheets and materials to students.
3. Allow students approximately 10 minutes for the experiment.
4. Answer any questions that may arise as you help groups experiment.
5. Report predictions and findings from students' charts. Put on a large classroom chart. Students will discover that objects similar in shape, but with different weights hit the ground at the same time. However, they will also discover that the unfolded sheet of paper will hit the ground later than the ping pong ball. Or perhaps the feather will fall much slower than the marble. Help lead students to the knowledge that *mass should not affect the rate at which objects fall, but shape definitely makes a difference.*
6. Ask, "Does gravity change?" (No. Gravity remains constant. Shape changes; gravity does not.)
7. Ask, "Why is it important to know about gravity?" Help students discover that without gravity we would fly off the earth. Gravity helps us understand how things move around us in our physical world. It also helps plants to grow.
8. Have students complete a paragraph that states three important facts they have learned from their experimentation about gravity (For Science Journal). Example: Gravity is an invisible force. Earth's gravity pulls everything toward its center. Heavy and light objects that are about the same shape fall at an equal speed.

Curriculum Extension

Science –

- Students could test objects of varying shapes and sizes, or different weights. (Light object, empty soda can versus heavy object, a full soda can.) (*ILO 1*)
- Explore the influence that air resistance has on the force of gravity when Objects fall. (*ILO 2*)

Language Arts –

- Writing Workshop topic such as "How would it be different if there were no gravity?" (*Standard VIII, Objective 6*)

Math –

- Place the objects in sequence according to their weight from lightest to heaviest. (*Standard 1, Objective 3*)
- Order and compare the weights of the objects by plotting them on a number line. (*Standard 1, Objective 3*)
- Compare the relationship ("<", ">", and "=") between the weights of the objects. (*Standard 1, Objective 3*)
- Make a grid of the floor tiles (flight path) and indicate where the paper airplanes landed. (*Standard III, Objective 1*)

Assessment Suggestion

- Rubric for Activity Completion:
  - Group Work 25 pts.
  - Completion of Worksheet Activity 25 pts.
  - Class Discussion 25 pts.
  - Written Journaling 25 pts.

- Response questions:
  1. Is gravity everywhere?
  2. Is gravity a force? What does that mean?
  3. Describe the observations made using the vocabulary words, gravity, speed, motion, distance, and force.

Resources

Web sites:

- www.lessonplanspage.com/ScienceSSMars7
- www.enc.org/weblinks/science/0.1578.1%2DGravity.00shtm

Books:

- *Gravity* by Dan Greenberg (Newbridge Education Publishing)
- *The Magic School Bus Plays Ball* by Joanne Cole (Scholastic Inc.)
- *Gravity: Simple Experiments for Young Scientists* by Larry While (Millbrook Press)
- *Bowled Over: The Case of the Gravity Goof-Up* by Chuck Harwood (McGraw Hill Trade)
- *Why Doesn't the Earth Fall Up? by Vicki Cobb (Lodestar Books)*
- *Which Way Is Up?* by Gail Kay Haines (Simon & Schuster)
- *The Science Book of Gravity* by Neil Ardley, Published by Gulliver Books, 1992

Videos:

- *Gravity is Attractive: What is Gravity?*

Laser Discs:

- *Windows on Science, Primary Vol. 3 Force and Motion* Lessons 12 + 13

Homework & Family Connections

Defying Gravity

1. Challenge the students to design and make a paper airplane that will defy gravity by flying the straightest and furthest path.
2. Have the students bring their airplanes to school the next day for test flights.
3. Have one student at a time fly their airplane. This is best done in a hall with tile on the floor.
4. Record the results. To determine each student's result: Count how many tiles out from the starting line. Then subtract the number of tiles off course (to the left or right).
5. Analyze which airplanes were the most successful in meeting the criteria and why.
6. Are there some variables in the experiment that could possibly influence the results? How could we control those variables?

I’m Falling For You

Data Collection Sheet

Objects Dropped		Which will hit the ground first?	Which object actually hit the ground first?
ping pong ball	marble		
flat paper	feather		
pencil	paper clip		
crumpled paper	eraser		
paper clip	ping pong ball		

Investigation Two - Jump

Standard IV Students will understand that objects near Earth are pulled toward Earth by Gravity.
Objective 1 Demonstrate that gravity is a force.
Intended Learning Outcomes 1. Use science process and thinking skills. 2. Manifest scientific attitudes and interests 3. Understand science concepts and principles 4. Communicate effectively using science language and reasoning

Standard IV

Objective 1

Background Information

A force is required to overcome gravity. When a person jumps, he applies a force that is able to briefly overcome the pull of gravity. The more weight a person has, the more force is required to lift him. If you are carrying a weight, you need more force to jump. In this activity, students will see how high they can jump without extra weight and with extra weight.

Pre-Assessment/Invitation to Learn

Ask students how high they can jump. Show them the meter sticks and have them guess. Then ask them how holding a weight will affect the height of their jump. Tell them they are going to find out the answers to these questions.

Materials
- Meter or yard sticks
- Masking tape
- Weights (books, canned food, bags of sand, etc.)

Instructional Procedure

1. Have meter sticks taped to the walls with the 0 down on the floor.
2. Each student needs a partner to watch his or her jump and write down how high it is.
3. Each jump should be as high as the student can go.
4. Each student is to jump 3 times.
5. The student who is observing should sit on the floor and watch the jumping student's feet. She/he should note the highest point of the set of three jumps.
6. Students should make their second jumps holding the weights. They can start with small amounts of weight and move up or just try one time with a heavy weight. They should record their data.
7. The students should record their data and take turns jumping. They can record data on paper like this:

    1. First jumps: 1. 2. 3.

    2. Jumps with weights: 1. 2. 3.

8. Finish the activity by asking if any students were able to jump as high with weights. Ask them how their legs felt when they jumped with the weights. See if students can summarize that more weight requires more force to lift.

Curriculum Extensions

Language Arts –

- Read about the height that some animals can jump compared to their weight. Compare them with each other. (*Standard VII, Objective 3*)
- Watch a video clip of watching a rocket or the space shuttle go up into space. Notice the force that it takes to lift it up. Have the students write what they see happening. Ask them questions to answer about the lift-off. (*Standard VII, Objective 3*)

Math –

- Measurement of how high each child jumps. The first time compare how high each child jumps the second time. Subtract the numbers to see the difference. (*Standard IV, Objective 2*)
- Have a standing broad jump activity to see how far each can jump. (*Standard IV, Objective 2*)

Assessment suggestion

- Check to see that the math is correct as the students subtract one jump from another.
- Have the students write in their journals the conclusions they come up with as to why they can't jump the same height or higher with weights in their hands.
- Review with the students that gravity has more of a pulling force with heavy objects that are on the ground than light objects on the ground. It takes more energy to lift them off the ground.

Resources

Books:

- *Gravity Works* by B. K. Hixson
- *Forces* by Graham Peacock

Investigation Three – Draggin' Me Down

Standard IV
Students will understand that objects near Earth are pulled toward Earth by Gravity.

Objective 1
Demonstrate that gravity is a force.

Intended Learning Outcomes
1. Use science process and thinking skills.
2. Manifest scientific attitudes and interests
3. Understand science concepts and principles
4. Communicate effectively using science language and reasoning

Standard IV

Objective 1

Teacher Background

Gravity is a force that constantly exists between two objects. The one with greater mass appears to pull the other. Earth's pull is strong and will affect an object rolling up or down a hill. Racing a car down a ramp from different levels will allow students to observe how gravity controls the speed of objects. The father an object falls, the faster gravity will make it go. It will also travel a short distance until air resistance works to slow it down. If students try rolling the ball or car up a ramp, they will observe that gravity slows the object and then pulls it back to the earth.

Materials
- Scissors
- Shoe box with lid
- Toy car, marble, or small ball
- Measuring tape or yard stick.

Pre-Assessment/Invitation to Learn

1. Show a Windows on Science program about inclined planes and the movement of objects down different ramps demonstrating the motion of
2. Show a picture of a roller coaster. Discuss the excitement of riding on a roller coaster at the amusement park. As it travels downward, everyone screams with excitement at the speed and movement on the small track. Climbing up the steep hills slows the cars down and helps build the excitement for the next plunge. It leaves your heart pounding and excitement drumming in your ears as your stomach seems to fly out your screaming mouth. Thanks to gravity, a roller coaster is loads of fun!
   Teacher tells students:
   "During science today, you will become researchers for an incredible new roller coaster being designed called the Beamer Screamer. Your group needs to research gravity and be able to explain to the construction crew how gravity helps the ride be exciting or boring."

Instructional Procedure

1. Divide children into small groups.
2. Have each group cut away most of one end and one side of the shoe box.
3. Cut two clots in the end that is left.
4. Cut the edges off the lid to make a ramp that will slide into the slits you made in the box.
5. Place the ramp into the lowest slot of the box. Place the car, marble, or small ball at the top of the ramp and release it.
6. Record your results. Time your car counting how long it takes to reach the finish line, and then measure its total length traveled.
7. Change the incline of the ramp in the box and repeat the activity.
8. Record the results again.
9. Move the ramp to the highest slot and continue experimentation, recording results.
10. Repeat the activity, this time rolling the ball up the ramp from different levels.
11. Discuss results as a class and generate principles about gravity.

Curriculum Extensions

Science –

- Change the type of car used on the ramp to see if speed or distance changes. (*ILO 1*)
- Locate a "Marble Game" toy from Discover Toys to put in a center and have students create their own marble maze. Observe how gravity affects the speed of the marbles (*ILO 1*)

Assessment Suggestion

- Response questions:
  1. What happens to the car when you release it on the lowest ramp?
  2. What happens to the car when released on the highest ramp?
  3. Describe the observations made using the vocabulary words gravity, speed, motion, distance, and force.

Resources

Books:

- *How Do You Lift a Lion?* by Robert E. Wells (Albert Whitman & Company)
- *The Way Things Work* by David Macauley (Dorling Kindersley)
- *Simple Machines* by Deborah Hodge (Ontario Science Center)
- *Machines – Spectacular Science Projects* by Janice VanCleave (John Wiley and Sons, Inc.
- *Physics Lab in the Hardware Store* by Bob Friedhoffer (Franklin Watts)
- *Playground Physics – Simple Machines* by Bob DeWeese (Evan-Moor)
- *Science Experiments With Simple Machines* by Sally Nanivell-Aston (Franklin Watts)

Videos:

- Science Alliance #3, Machines

Laser Discs:

- Windows on Science, Primary Vol. e, Work and Machines Lessons 2-10

Web sites:

- http://www.fi.edu/qu97/spotlight3/spotlight3.html
- http://www.ed.uri.edu/SMART96/ELEMSC/SMARTmachines/machine.html
- http://www.stemnet.nf.ca/CITE/machinessimple.htm
- http://mikids.com/Smachines.htm
- http://www.mos.org/sln/Leonardo/InventorsToolbox.html
- http://www.san-marino.k12.ca.us/~summer1/machines/simplemachines.html
- http://www.northcanton.sparcc.org/~greentown/simpmach.htm

Investigation Four – Roller Coaster Fun

Standard IV
Students will understand that objects near Earth are pulled toward Earth by gravity.

Objective 2
Identify the effect of gravity on the motion of an object.

Intended Learning Outcomes
1. Use science process and thinking skills
2. Manifest science attitudes and interests
3. Understand science concepts and principles
4. Communicate effectively using science language and reasoning

Standard IV

Objective 2

Teacher Background

Gravity is the force that pulls objects toward Earth. Gravity pulls you down when you jump off the chair, but you're fighting gravity when you jump back up. Gravity is pulling the ball/marble down the track, but the ball/marble is fighting Gravity when it goes uphill. The speed of the ball has to be great enough to get the ball down a hill and back up to the top of the next hill.

Invitation to Learn

Chair Jumping
1. Stand on the seat of the chair.
2. Jump off the chair.
3. Jump back up onto the seat of the chair.
4. Discuss which was easier: jumping off or jumping back up onto the seat of the chair.

Materials

- Sturdy chair
- One pipe insulator (split in half length wise) (per group of 2-4 students)
- Balls of various masses (e.g., steel, glass, cork, wood, rubber) (per group of 2-4 students)
- Masking tape (one roll per group of 2-4 students)

Instructional Procedure

Preparation

Tape the two halves of the pipe insulator together.

Activity

1. Divide the class into cooperative learning groups of 2-4 students per group.
2. Design a roller coaster and tape the design to the wall.
3. Place on ball at the beginning of the track.
4. Let go of the ball and observe what happens as the ball rolls up and down.
5. Repeat steps 3 and 4 with different balls and marbles.
6. Modify your track and repeat steps 3 through 5.
7. Analyze the results – Which ball worked best? Why? Which track design worked best? Why

Curriculum Extensions

Math –

- Draw a line segment illustrating the shape of your roller coaster. Identify the starting and ending point. (*Standard III, Objective 1*)

Science –

- Challenge the students to put two 20 ft. lengths of pipe insulator together and construct a successful roller coaster design. (*ILO 1*)

Art –

- Make mazes or ramps out of cardboard tubing. (*Standard III, Objective 2*)

Assessment Suggestion

- In their journals, have the students draw a picture of the roller coaster built by their group. Have the students write about their design and why it works relating to the force of gravity.
  Did the student(s) work cooperatively in their group(s)?
  Were the students able to analyze any defect(s) in their design and come up with a proper solution(s)?
  Were the students able to construct a successful roller coaster?

Resources

Books:

- *Looking Inside Sports Aerodynamics (X-Ray Vision)* by Ron Schultz (Larousse Kingfisher Chambers)
- *Experiments with Gravity (True Books)* by Savatore Tocci, Tovert Gardner, Nancy R. Vargus (Scholastic Library Publishing)
- *The Science Book of Gravity* by Neil Ardley (Bulliver Books)

Videos:

- Roller Coaster!

Laser Discs:

- Windows on Science, Primary Vol. 3, Force and Motion Lesson 11

Websites:

- http://www.enc.org/weblinks/science/0.1578.1%2DGravity.00shtm
- http://www.lessonplanspage.com/ScienceSSmars7

Homework & Family Connections

Have the students design and build OR make an illustration of a roller coaster, ramp, or maze at home. Have the students bring the roller coaster, ramps, and mazes to school and set-up an amusement park.

11.3 Assessment

Multiple Choice

1. What is gravity?

   A. a substance
   B. a motion
   C. a force
   D. an object

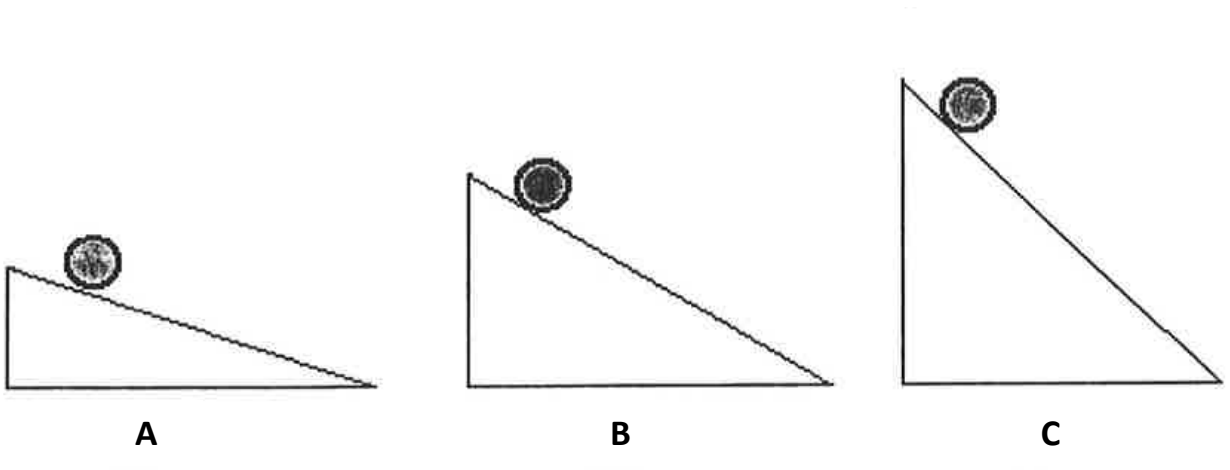
2. What must you do to overcome gravity?

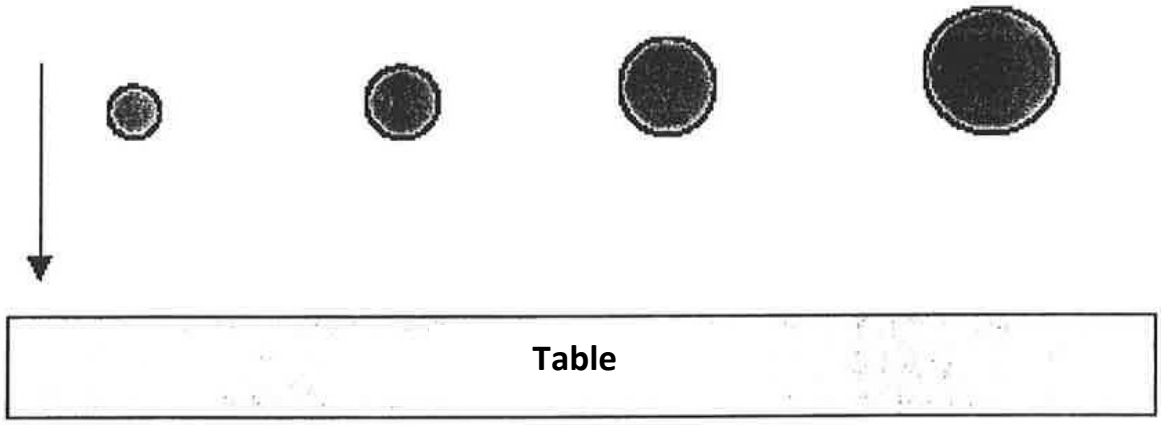
   A. push or pull
   B. fall
   C. add weight
   D. check distance

3. Which object would be most difficult to lift against gravity?

   A. a marble
   B. a soccer ball
   C. a chair
   D. a car

4. Which ball would you expect to have the most speed when it hits the bottom of the ramp





5. The balls shown above are all dropped at the same time onto the table. How will they strike the table?

   A. A will strike first, then B, then C, and then D.
   B. D will strike first, then C, then B, and then A.
   C. B and C will strike first, then A and D.
   D. They will all hit at the same time.

6. How does Earth's gravity affect objects near Earth?

   A. It pushes them away.
   B. It pulls them in.
   C. It makes them larger.
   D. It makes them move faster.

Constructed Response

1. Why is the statement "What goes up, must come down" usually true?

2. A piece of paper is dropped from the table to a floor. What are three questions you could have about this?

Answers to Questions for Grade 3 – Standard 4

Multiple Choice

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

Constructed Response

1. Anything that is pushed upward against gravity is usually pulled back down by Earth's gravity. (There are exceptions that bright students may know of, such as rockets going fast enough to leave Earth's gravity)

2. Questions may include:

   What caused the paper to fall downward?

   Why is gravity invisible?

   What causes gravity?

   Do all things have gravity?

   Does the size of the paper make any difference in how it falls?

   Does the weight of the paper make any difference in how it falls?

   Would a pencil fall differently from the paper?

Performance Assessment

Title: How Far?

Activity Description
Students will design a ramp to roll a marble and measure the distance the marble rolls.

Materials Needed:
Each group of students will need a set of materials to build the ramp. Use any items you have. They will need blocks, cans or boxes to get height and something long and flat (w rulers taped together works well) for the ramp. Each group of students should have the same materials. Masking tape helps to hold the apparatus together.

- A marble
- Meter sticks or pre-measured distances on the floor marked with masking rape.
- Marbles can roll 20 meters on a hard floor, so a hallway may be needed.

Prior to Assessment
Students need to know that gravity is a force than can create motion.

Time Needed:
One hour

Procedure:
1. Students should be grouped in teams of 3-4 and given a tray with the materials they will use to construct their ramp. The materials should be same for each group.
2. Explain to students that the task is to build a ramp that will send the marble the farthest distance along the floor. An assumption is made that the longer the marble goes, the more speed it has.
3. Show students the "launching" area and give them time to build the ramp. Allow them to test it as they work.
4. When teams are ready, have the contest begin. The winning team may go on to challenge other classes within your school.
5. After clean-up discuss with the students the design of the winning ramp and how gravity affects the speed and downward motion of the marble. The winning ramp will probably be the tallest, launching the marble with the most force due to gravity.

Scoring Guide:
1. Students participate in group work……. …… 5 pts.
2. Students test marbles with ramp ……. 5 pts.
3. Students participate in class discussion …….. 5 pts.