



ELEMENTARY  
**CORE Academy**  
UTAH STATE OFFICE OF EDUCATION & UTAH STATE UNIVERSITY



**3** **RD**  
**GRADE**



ELEMENTARY CORE ACADEMY • ELEMENTARY CORE ACADEMY • ELEMENTARY CORE ACADEMY

**PARTICIPANT  
HANDBOOK**

**2005**



**UtahState**  
**UNIVERSITY**

**ELEMENTARY CORE ACADEMY**  
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Dear CORE Academy Teachers:

Thank you for your investment in children and in building your own expertise as you participate in the CORE Academy. I hope your involvement helps you to sustain a laser-like focus on student achievement.

Teachers in Utah are superb. By participating in the Academy, you join a host of teachers throughout the state who understand that teaching targeted on the core curricula, across a spectrum of subjects, will produce results of excellence. The research is quite clear: the closer the match of explicit instruction to core standards, the better the outcome on core assessments.

I personally appreciate your excellence and your desire to create wonderful classrooms of learning for students. Thank you for your dedication. I feel honored to associate with you and pledge my support to lead education in ways that benefit all of our children.

Sincerely,



Patti Harrington, Ed.D.  
State Superintendent  
of Public Instruction

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# Funding Sources

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Appreciation is expressed for the tremendous educational input and monetary commitment of several organizations for the successful delivery of the Elementary CORE Academy. This year's Elementary CORE Academy was developed and funded through a variety of sources. The Utah State Office of Education (USOE), in collaboration with Utah State University (USU) and local school districts of Utah, have supported kindergarten through sixth grade teachers with professional development experiences that will enhance the educational experience for Utah children.

Major funding for the Academy comes from the following sources:

## **Federal/State Funds:**

- Utah State Office of Education
  - Staff Development Funds
  - Special Education Services Unit
- ESEA Title II
- Utah Math Science Partnership
- WestED Eisenhower Regional Consortium

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- Utah State Office of Education Special Education Services

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Additionally, numerous school districts, individual schools, and principals in Utah have sponsored teachers to attend the Academy. Other educational groups such as the Utah Division of Water Resources, National Energy Foundation, Utah Energy Office, and the Utah Mining Association have assisted in the development and delivery of resources in the Academy.

Most important is the thousands of teachers who take time from their summer to attend these professional development workshops. It is these teachers who make this program possible.

## ***Goals of the Elementary CORE Academy***

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### ***Overall***

The purpose of the Elementary CORE Academy is to create high quality teacher instruction and improve student achievement through the delivery of professional development opportunities and experiences for teachers across Utah.

### ***The Academy will provide elementary teachers in Utah with:***

1. Models of exemplary and innovative instructional strategies, tools, and resources to meet newly adopted Core Curriculum standards, objectives, and indicators.
2. Practical models and diverse methods of meeting the learning needs of all children, with instruction implementation aligned to the Core Curriculum.
3. Meaningful opportunities for collaboration, self-reflection, and peer discussion specific to innovative and effective instructional techniques, materials, teaching strategies, and professional practices in order to improve classroom instruction.

Learning a limited set of facts will not prepare a student for real experiences encountered in today's world. It is imperative that educators have continued opportunities to obtain instructional skills and strategies that provide methods of meeting the needs of all students. Participants of the Academy experience will be better equipped to meet the challenges faced in today's classrooms.

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***Third Grade  
Mathematics and  
Science  
Core Curriculum***



# Utah Elementary Mathematics Core Curriculum

## Introduction

Most students enter school confident in their own abilities; they are curious and eager to learn more. They make sense of the world by reasoning and problem solving. Young students are active, resourceful individuals who construct, modify, and integrate ideas by interacting with the physical world as well as with peers and adults. They learn by doing, collaborating, and sharing their ideas. Students' abilities to communicate through language, pictures, sound, movement, and other symbolic means develop rapidly during these years.

Young students are building beliefs about what mathematics is, about what it means to know and do mathematics, and about themselves as mathematical learners. Mathematics instruction needs to include more than short-term learning of rote procedures. Students must use technology and other mathematical tools, such as manipulative materials, to develop conceptual understanding and solve problems as they do mathematics. Students, as mathematicians, learn best with hands-on, active experiences throughout the instruction of the mathematics curriculum.

Recognizing that no term captures completely all aspects of expertise, competence, knowledge, and facility in mathematics, the term *mathematical proficiency* has been chosen to capture what it means to learn mathematics successfully. Mathematical proficiency has five strands: computing (carrying out mathematical procedures flexibly, accurately, efficiently, and appropriately), understanding (comprehending mathematical concepts, operations, and relations), applying (ability to formulate, represent, and solve mathematical problems), reasoning (using logic to explain and justify a solution to a problem), and engaging (seeing mathematics as sensible, useful, and doable, and being able to do the work).

The most important observation about the five strands of mathematical proficiency is that they are interwoven and interdependent. This observation has implications for how students acquire mathematical proficiency, how teachers develop that proficiency in their students, and how teachers are educated to achieve that goal. At any given moment during a mathematics lesson or unit, one or two strands might be emphasized. But all the strands must eventually be addressed so that the links among them are strengthened. The integrated and balanced development of all five strands of mathematical proficiency should guide the teaching and learning of

- **Mathematics instruction needs to include more than short-term learning of rote procedures.**



school mathematics. Instruction should not be based on extreme positions that students learn solely by internalizing what a teacher or book says or solely by inventing mathematics on their own.

The Elementary Mathematics Core describes what students should know and be able to do at the end of each of the K-6 grade levels. It was developed, critiqued, and revised by a community of Utah mathematics teachers, university mathematics educators, State Office of Education specialists, mathematicians, and an advisory committee representing a wide variety of people from the community. The Core reflects the current philosophy of mathematics education that is expressed in national documents developed by the National Council of the Teachers of Mathematics, the American Association for the Advancement of Science, and the National Research Council. This Mathematics Core has the endorsement of the Utah Council of Teachers of Mathematics Association. The Core reflects high standards of achievement in mathematics for all students.

## ***Organization of the Elementary Mathematics Core***

The Core is designed to help teachers organize and deliver instruction.

- The INTENDED LEARNING OUTCOMES (ILOs) describe the goals for mathematical skills and attitudes. They are found at the beginning of each grade level, are an integral part of the Core, and should be included as part of instruction.
- A STANDARD is a broad statement of what students are expected to understand. Several Objectives are listed under each Standard.
- An OBJECTIVE is a more focused description of what students need to know and be able to do at the completion of instruction. If students have mastered the Objectives associated with a given Standard, they have mastered that Standard at that grade level. Several Indicators are described for each Objective.
- An INDICATOR is a measurable or observable student action that enables one to assess whether a student has mastered a particular Objective. Indicators are not meant to be classroom activities, but they can help guide classroom instruction.

## **Guidelines Used in Developing the Elementary Mathematics Core**

### **The Core is:**

#### **Consistent With the Nature of Learning**

The main intent of mathematics instruction is for students to value and use mathematics as a process to understand the world. The Core is designed to produce an integrated set of Intended Learning Outcomes for students.

#### **Coherent**

The Core has been designed so that, wherever possible, the ideas taught within a particular grade level have a logical and natural connection with each other and with those of earlier grades. Efforts have also been made to select topics and skills that integrate well with one another and with other subject areas appropriate to grade level. In addition, there is an upward articulation of mathematical concepts, skills, and content. This spiraling is intended to prepare students to understand and use more complex mathematical concepts and skills as they advance through the learning process.

#### **Developmentally Appropriate**

The Core takes into account the psychological and social readiness of students. It builds from concrete experiences to more abstract understandings. The Core focuses on providing experiences with concepts that students can explore and understand in depth to build the foundation for future mathematical learning experiences.

#### **Reflective of Successful Teaching Practices**

Learning through play, movement, and adventure is critical to the early development of the mind and body. The Core emphasizes student exploration. The Intended Learning Outcomes are central in each standard. The Core is designed to encourage instruction with students working in cooperative groups. Instruction should include recognition of the role of mathematics in the classroom, school, and community.

#### **Comprehensive**

The Elementary Mathematics Core does not cover all topics that have traditionally been in the elementary mathematics curriculum; however, it provides a comprehensive background in mathematics. By emphasizing depth rather than breadth, the Core seeks to empower students rather than intimidate them with a collection of isolated and

### **The Core is:**

- **Consistent**
- **Coherent**
- **Developmentally Appropriate**
- **Reflective of Successful Teaching Practices**
- **Comprehensive**
- **Feasible**
- **Useful and Relevant**
- **Reliant Upon Effective Assessment Practices**
- **Engaging**

eminently forgettable facts. Teachers are free to add related concepts and skills, but they are expected to teach all the standards and objectives specified in the Core for their grade level.

### **Feasible**

Teachers and others who are familiar with Utah students, classrooms, teachers, and schools have designed the Core. It can be taught with easily obtained resources and materials. A Teacher Handbook is also available for teachers and has sample lessons on each topic for each grade level. The Teacher Handbook is a document that will grow as teachers add exemplary lessons aligned with the new Core.

### **Useful and Relevant**

This curriculum relates directly to student needs and interests. Relevance of mathematics to other endeavors enables students to transfer skills gained from mathematics instruction into their other school subjects and into their lives outside the classroom.

### **Reliant Upon Effective Assessment Practices**

Student achievement of the standards and objectives in this Core is best assessed using a variety of assessment instruments. Performance tests are particularly appropriate to evaluate student mastery of mathematical processes and problem-solving skills. Teachers should use a variety of classroom assessment approaches in conjunction with standard assessment instruments to inform instruction. Sample test items, keyed to each Core Standard, may be located on the “Utah Mathematics Home Page” at <http://www.usoe.k12.ut.us/curr/math>. Observation of students engaged in instructional activities is highly recommended as a way to assess students’ skills as well as attitudes toward learning. The nature of the questions posed by students provides important evidence of their understanding of mathematics.

### **Engaging**

In the early grades, children are forming attitudes and habits for learning. It is important that instruction maximizes students’ potential and gives them understanding of the intertwined nature of learning. Effective elementary mathematics instruction engages students actively in enjoyable learning experiences. Instruction should be as thrilling an experience for a child as seeing a rainbow, growing a flower, or describing a toad. In a world of rapidly expanding knowledge and technology, all students must gain the skills they will need to understand and function responsibly and successfully in the world. The Core provides skills in a context that enables students to experience the joy of learning.

# Intended Learning Outcomes for Third Grade Mathematics

The main intent of mathematics instruction is for students to value and use mathematics and reasoning skills to investigate and understand the world.

The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should learn as a result of mathematics instruction. They are an essential part of the Mathematics Core Curriculum and provide teachers with a standard for evaluation of student learning in mathematics. Significant mathematics understanding occurs when teachers incorporate ILOs in planning mathematics instruction.

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

**1. Demonstrate a positive learning attitude toward mathematics.**

- a. Display a sense of curiosity about numbers and patterns.
- b. Pose mathematical questions about objects, events, and processes.
- c. Demonstrate persistence in completing tasks.
- d. Apply prior knowledge and processes to construct new knowledge.
- e. Maintain an open and questioning mind toward new ideas and alternative points of view.

**2. Become mathematical problem solvers.**

- a. Determine the approach, materials, and strategies to be used in setting up a problem.
- b. Model problem situations in a variety of ways.
- c. Develop understanding of new mathematical concepts and vocabulary by answering questions such as: What made you think that? Did anyone think of this in a different way? Where have we seen a problem like this before?
- d. Construct and use concrete, pictorial, symbolic, and graphical models to represent problem situations.
- e. Know when to select and how to use grade-appropriate mathematical tools and methods as a natural and routine part of the problem-solving process.
- f. Build new mathematical knowledge through problem solving.
- g. Solve problems in both mathematical and everyday contexts.
- h. Recognize that there may be multiple ways to solve a problem.

- **ILOs describe the skills and attitudes students should learn as a result of mathematics instruction.**



**3. Reason mathematically.**

- a. Draw logical conclusions and make generalizations.
- b. Determine the approach, materials, and strategies to be used in solving problems.
- c. Use models, known facts, and relationships to explain reasoning.
- d. Make precise calculations and check the validity of the results in the context of the problem.
- e. Analyze mathematical situations by recognizing and using patterns and relationships.
- f. Justify answers and solution processes.

**4. Communicate mathematically.**

- a. Represent mathematical ideas with objects, pictures, and symbols.
- b. Express mathematical ideas to peers, teachers, and others through oral and written language.
- c. Engage in mathematical discussions through brainstorming, asking questions, and sharing strategies for solving problems.
- d. Explain mathematical work and justify reasoning and conclusions.

**5. Make mathematical connections.**

- a. Use one mathematical idea to extend understanding of another.
- b. Recognize the role of mathematics in the classroom, school, and community.
- c. Explore problems and describe and confirm results using various representations.

**6. Represent mathematical situations.**

- a. Create and use representations to organize and communicate mathematical ideas.
- b. Represent mathematical concepts using concrete, pictorial, and symbolic models.

# Third Grade Mathematics Core Curriculum

**Standard I: Students will acquire number sense and perform operations with whole numbers and simple fractions.**

*Objective 1:* Represent whole numbers in a variety of ways.

- Model, read, and write *whole numbers* up to 10,000 using base ten models, pictures, and symbols.
- Write a *numeral* when given the number of thousands, hundreds, tens, and ones.
- Write a number up to 9,999 in expanded form (e.g., 6,539 is 6 thousands, 5 hundreds, 3 tens, 9 ones or  $6000+500+30+9$ ).
- Identify the place and the value of a given digit in a four-digit numeral.
- Demonstrate multiple ways to represent numbers using models and symbolic representations (e.g., fifty is the same as two groups of 25, the number of pennies in five dimes, or 75-25).

*Objective 2:* Identify relationships among whole numbers.

- Use a variety of strategies to determine whether a number is even or odd.
- Identify the number that is ten more, ten less, 100 more, or 100 less than any *whole number* up to 1,000.
- Compare the relative size of numbers (e.g., 31 is large compared to 4, about half as big as 60, close to 27).
- Compare whole numbers up to four digits using the symbols  $<$ ,  $>$ , and  $=$ .
- Order and compare whole numbers on a number line.

*Objective 3:* Model and illustrate meanings of the operations of addition, subtraction, multiplication, and division and describe how they relate.

- Model addition and subtraction of two- and three-digit *whole numbers* in a variety of ways.
- Model multiplication of a one-digit *factor* by a one-digit factor using various methods (e.g., repeated addition, rectangular *arrays*, manipulatives, pictures) and connect the representation to an *algorithm*.

**Standard I:**  
Students will acquire number sense and perform operations with whole numbers and simple fractions.



- c. Model division as sharing equally and as repeated subtraction using various methods (e.g., rectangular arrays, manipulatives, number lines, pictorial representations).
- d. Demonstrate, using objects, that multiplication and division are inverse operations (e.g.,  $3 \times 4 = 12$ ; thus,  $12 \div 4 = 3$  and  $12 \div 3 = 4$ ).
- e. Select and write an addition, subtraction, or multiplication sentence to solve a problem related to the students' environment, and write a story problem that relates to a given equation.
- f. Demonstrate the effect of place value when multiplying whole numbers by 10.

*Objective 4:* Use fractions to communicate parts of the whole.

- a. Identify the denominator of a fraction as the number of equal parts in the whole region or set.
- b. Identify the numerator of a fraction as the number of equal parts being considered.
- c. Divide *regions* and sets of objects into equal parts using a variety of objects, models, and illustrations.
- d. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, sixths, and eighths.
- e. Determine which of two fractions is greater using models or illustrations.

*Objective 5:* Solve whole number problems using addition, subtraction, multiplication, and division in vertical and horizontal notation.

- a. Use a variety of methods and tools to facilitate computation (e.g., estimation, mental math strategies, paper and pencil, calculator).
- b. Find the sum of any two *addends* with three or fewer digits, including monetary amounts, and describe the process used.
- c. Find the *difference* of two-digit *whole numbers* and describe the process used.
- d. Find the *products* for multiplication facts through ten times ten and describe the process used.

**Standard II: Students will use patterns and relations to represent mathematical situations.**

*Objective 1:* Recognize and create patterns with given attributes.

- a. Create and extend *repeating* and *growing patterns* using objects, numbers, and tables.
- b. Record results of patterns created using manipulatives, pictures, and numeric representations and describe how they are extended.

*Objective 2:* Recognize and represent mathematical situations using patterns and symbols.

- a. Recognize that symbols such as  $\square$ ,  $\triangle$ , or  $\diamond$  in an addition, subtraction, or multiplication equation, represent a value that will make the statement true (e.g.,  $5+7=\triangle$ ,  $\square-3=6$ ,  $\diamond=2\times 4$ ).
- b. Solve equations involving equivalent expressions (e.g.,  $6+4 = \square+7$ ).
- c. Use the  $>$ ,  $<$ , and  $=$  symbols to compare two *expressions* involving addition and subtraction (e.g.,  $4+6 \square 3+2$ ;  $3+5 \diamond 16-9$ ).
- d. Demonstrate that grouping three or more *addends* does not change the sum (e.g.,  $3+(2+7)=12$ ,  $(7+3)+2=12$ ) and changing the order of *factors* does not change the *product* (e.g.,  $3\times 7=21$ ,  $7\times 3=21$ ).
- e. Use a variety of manipulatives to model the *identity property of addition* (e.g.,  $3+0=3$ ), the identity property of multiplication (e.g.,  $7\times 1=7$ ), and the *zero property of multiplication* (e.g.,  $6\times 0=0$ ).

**Standard II:**  
Students will use patterns and relations to represent mathematical situations.

**Standard III:**  
Students will use spatial reasoning to describe, identify, and create geometric shapes.

**Standard III: Students will use spatial reasoning to describe, identify, and create geometric shapes.**

*Objective 1:* Describe, identify, and create geometric shapes.

- a. Identify and draw *points, lines, line segments,* and *endpoints*.
- b. Identify and draw *lines of symmetry* on triangles, squares, circles, and rectangles.
- c. Determine whether an angle is *right, obtuse,* or *acute* by comparing the angle to the corner of a rectangle.
- d. Classify *polygons* (e.g., *quadrilaterals,* pentagons, hexagons, octagons) by the number of sides and corners.
- e. Identify, make, and describe cubes (e.g., a cube has six square *faces,* eight *vertices,* and twelve *edges*).

*Objective 2:* Describe spatial relationships.

- a. Give directions to reach a location.
- b. Use coordinates (A, 1) or regions to locate positions on a map.
- c. Demonstrate and use horizontal and vertical lines.

*Objective 3:* Visualize and identify geometric shapes after applying transformations.

- a. Demonstrate the effect of a *slide (translation)* or *flip (reflection)* on a figure, using manipulatives.
- b. Determine whether two polygons are *congruent* by sliding, flipping, or turning to physically fit one object on top of the other.
- c. Identify *two-dimensional* shapes (*nets*) that will fold to make a cube.
- d. Create a *polygon* that results from combining other polygons.

**Standard IV: Students will understand and use measurement tools and techniques.**

*Objective 1:* Identify and describe measurable attributes of objects and units of measurement.

- a. Recognize the two systems of measurement: *metric* and *customary*.
- b. Describe the relationship between metric units of length (i.e., centimeter, meter).
- c. Describe the relationship among customary units of length (i.e., inch, foot, yard) and the relationship between customary units of *capacity* (i.e., cup, quart).
- d. Estimate length, capacity, and weight using metric and customary units.

*Objective 2:* Use appropriate techniques and tools to determine measurements.

- a. Measure the length of objects to the nearest centimeter, meter, half-inch, foot, and yard.
- b. Measure *capacity* using cups and quarts, and measure weight using pounds.
- c. Determine the value of a combination of coins and bills that total \$5.00 or less and write the monetary amounts using the dollar sign and decimal notation.
- d. Identify the number of hours in a day, the number of days in a year, and the number of weeks in a year.
- e. Read, tell, and write time to the quarter-hour.
- f. Identify any given day of the month (e.g., the third Wednesday of the month is the 18th).
- g. Read and record the temperature to the nearest ten degrees using a Fahrenheit thermometer.
- h. Estimate and measure the *perimeter* and *area* of rectangles by measuring with nonstandard units.

**Standard IV:  
Students will  
understand and  
use measurement  
tools and  
techniques.**

**Standard V:**  
Students will collect and organize data to make predictions and identify basic concepts of probability.

**Standard V: Students will collect and organize data to make predictions and identify basic concepts of probability.**

*Objective 1:* Collect, organize, and display data to make predictions.

- a. Collect, read, represent, and interpret data using tables, graphs, and charts, including keys (e.g., pictographs, bar graphs).
- b. Make predictions based on a data display.

*Objective 2:* Identify basic concepts of probability.

- a. Describe the results of events using the terms “certain,” “equally likely,” and “impossible.”
- b. Predict outcomes of simple activities (e.g., a bag contains three red marbles and five blue marbles. If one marble is selected, is it more likely to be red or blue?).

# Utah Elementary Science Core Curriculum

## Introduction

Science is a way of knowing, a process for gaining knowledge and understanding of the natural world. The Science Core Curriculum places emphasis on understanding and using skills. Students should be active learners. It is not enough for students to read about science; they must do science. They should observe, inquire, question, formulate and test hypotheses, analyze data, report, and evaluate findings. The students, as scientists, should have hands-on, active experiences throughout the instruction of the science curriculum.

The Elementary Science Core describes what students should know and be able to do at the end of each of the K–6 grade levels. It was developed, critiqued, piloted, and revised by a community of Utah science teachers, university science educators, State Office of Education specialists, scientists, expert national consultants, and an advisory committee representing a wide variety of people from the community. The Core reflects the current philosophy of science education that is expressed in national documents developed by the American Association for the Advancement of Science, the National Academies of Science. This Science Core has the endorsement of the Utah Science Teachers Association. The Core reflects high standards of achievement in science for all students.

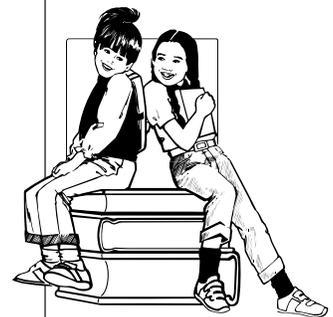
## Organization of the Elementary Science Core

The Core is designed to help teachers organize and deliver instruction.

The Science Core Curriculum’s organization:

- Each grade level begins with a brief course description.
- The INTENDED LEARNING OUTCOMES (ILOs) describe the goals for science skills and attitudes. They are found at the beginning of each grade, and are an integral part of the Core that should be included as part of instruction.
- The SCIENCE BENCHMARKS describe the science content students should know. Each grade level has three to five Science Benchmarks. The ILOs and Benchmarks intersect in the Standards, Objectives and Indicators.

- **Science is a way of knowing, a process for gaining knowledge and understanding of the natural world.**



### **Guidelines**

- **Reflects the Nature of Science**
- **Coherent**
- **Developmentally Appropriate**
- **Encourages Good Teaching Practices**
- **Comprehensive**
- **Feasible**
- **Useful and Relevant**
- **Encourages Good Assessment Practices**
- **The Most Important Goal**

- A **STANDARD** is a broad statement of what students are expected to understand. Several Objectives are listed under each Standard.
- An **OBJECTIVE** is a more focused description of what students need to know and be able to do at the completion of instruction. If students have mastered the Objectives associated with a given Standard, they are judged to have mastered that Standard at that grade level. Several Indicators are described for each Objective.
- An **INDICATOR** is a measurable or observable student action that enables one to judge whether a student has mastered a particular Objective. Indicators are not meant to be classroom activities, but they can help guide classroom instruction.

## ***Eight Guidelines Were Used in Developing the Elementary Science Core***

### **Reflects the Nature of Science**

Science is a way of knowing, a process of gaining knowledge and understanding of the natural world. The Core is designed to produce an integrated set of Intended Learning Outcomes (ILOs) for students. Please see the Intended Learning Outcomes document for each grade level core.

As described in these ILOs, students will:

1. Use science process and thinking skills.
2. Manifest science interests and attitudes.
3. Understand important science concepts and principles.
4. Communicate effectively using science language and reasoning.
5. Demonstrate awareness of the social and historical aspects of science.
6. Understand the nature of science.

### **Coherent**

The Core has been designed so that, wherever possible, the science ideas taught within a particular grade level have a logical and natural connection with each other and with those of earlier grades. Efforts have also been made to select topics and skills that integrate well with one another and with other subject areas appropriate to grade level. In addition, there is an upward articulation of science concepts, skills, and content. This spiraling is intended to prepare students to understand and use more complex science concepts and skills as they advance through their science learning.

### **Developmentally Appropriate**

The Core takes into account the psychological and social readiness of students. It builds from concrete experiences to more abstract understandings. The Core describes science language students should use that is appropriate to each grade level. A more extensive vocabulary should not be emphasized. In the past, many educators may have mistakenly thought that students understood abstract concepts (such as the nature of the atom), because they repeated appropriate names and vocabulary (such as electron and neutron). The Core resists the temptation to tell about abstract concepts at inappropriate grade levels, but focuses on providing experiences with concepts that students can explore and understand in depth to build a foundation for future science learning.

### **Encourages Good Teaching Practices**

It is impossible to accomplish the full intent of the Core by lecturing and having students read from textbooks. The Elementary Science Core emphasizes student inquiry. Science process skills are central in each standard. Good science encourages students to gain knowledge by doing science: observing, questioning, exploring, making and testing hypotheses, comparing predictions, evaluating data, and communicating conclusions. The Core is designed to encourage instruction with students working in cooperative groups. Instruction should connect lessons with students' daily lives. The Core directs experiential science instruction for all students, not just those who have traditionally succeeded in science classes. The vignettes listed on the "Utah Science Home Page" at <http://www.usoe.k12.ut.us/curr/science> for each of the Core standards provide examples, based on actual practice, that demonstrate that excellent teaching of the Science Core is possible.

### **Comprehensive**

The Elementary Science Core does not cover all topics that have traditionally been in the elementary science curriculum; however, it does provide a comprehensive background in science. By emphasizing depth rather than breadth, the Core seeks to empower students rather than intimidate them with a collection of isolated and eminently forgettable facts. Teachers are free to add related concepts and skills, but they are expected to teach all the standards and objectives specified in the Core for their grade level.

### **Feasible**

Teachers and others who are familiar with Utah students, classrooms, teachers, and schools have designed the Core. It can be taught with easily obtained resources and materials. A Teacher Resource Book (TRB) is available for elementary grades and has sample lessons on each topic for each grade level. The TRB is a document that will grow as teachers add exemplary lessons aligned with the new Core. The middle grade levels have electronic textbooks available at the Utah State Office of Education's "Utah Science Home Page" at <http://www.usoe.k12.ut.us/curr/science>.

### **Useful and Relevant**

This curriculum relates directly to student needs and interests. It is grounded in the natural world in which we live. Relevance of science to other endeavors enables students to transfer skills gained from science instruction into their other school subjects and into their lives outside the classroom.

### **Encourages Good Assessment Practices**

Student achievement of the standards and objectives in this Core are best assessed using a variety of assessment instruments. One's purpose should be clearly in mind as assessment is planned and implemented. Performance tests are particularly appropriate to evaluate student mastery of science processes and problem-solving skills. Teachers should use a variety of classroom assessment approaches in conjunction with standard assessment instruments to inform their instruction. Sample test items, keyed to each Core Standard, may be located on the Utah Science Home Page. Observation of students engaged in science activities is highly recommended as a way to assess students' skills as well as attitudes in science. The nature of the questions posed by students provides important evidence of students' understanding of science.

### **The Most Important Goal**

Elementary school reaches the greatest number of students for a longer period of time during the most formative years of the school experience. Effective elementary science instruction engages students actively in enjoyable learning experiences. Science instruction should be as thrilling an experience for a child as seeing a rainbow, growing a flower, or holding a toad. Science is not just for those who have traditionally succeeded in the subject, and it is not just for those who will choose science-related careers. In a world of rapidly expanding knowledge and technology, all students must gain the skills they will need to understand and function responsibly and successfully in the world. The Core provides skills in a context that enables students to experience the joy of doing science.

# Third Grade Science Core Curriculum

In third grade students learn about **interactions, relationships, relative motion, and cause and effect**. They study the movement of Earth and the moon. They begin to learn of forces that move things; they learn of heat and light. Third graders observe, classify, predict, measure, and record.

Third graders should be encouraged to be curious. They should be helped and encouraged to pose their own questions about objects, events, processes, and results. Effective teachers provide students with hands-on science investigations in which student inquiry is an important goal. Teachers should provide opportunities for all students to experience many things. Third graders should use their senses as they feel the warmth of the sun on their face, watch the moon as it seems to move through broken clouds, sort and arrange their favorite rocks, look for patterns in rocks and flowers, observe a snail move ever so slowly up the side of a terrarium, test materials for slipping and sliding, measure the speed of rolling objects, and invent ways to resist gravity. They should come to enjoy science as a process of learning about the world.

Third grade Core concepts should be integrated with concepts and skills from other curriculum areas. Reading, writing, and mathematics skills should be emphasized as integral to the instruction of science. Personal relevance of science in students' lives is always an important part of helping students to value science, and should be emphasized at this grade level.

This Core was designed using the American Association for the Advancement of Science's *Project 2061: Benchmarks For Science Literacy* and the National Academy of Science's *National Science Education Standards* as guides to determine appropriate content and skills.

The third grade Science Core has three online resources designed to help with classroom instruction; they include *Teacher Resource Book* –a set of lesson plans, assessment items and science information specific to third grade; *Sci-ber Text* –an electronic science text book specific to the Utah Core; and the science test item pool. This pool includes multiple-choice questions, performance tasks, and interpretive items aligned to the standards and objectives of the third grade curriculum. These resources are all available on the Utah Science Home Page at: <http://www.usoe.k12.ut.us/curr/science>

- **Personal relevance of science in students' lives is always an important part of helping students to value science, and should be emphasized at this grade level.**



**SAFETY PRECAUTIONS:**

The hands–on nature of this science curriculum increases the need for teachers to use appropriate precautions in the classroom and field. Teachers must adhere to the published guidelines for the proper use of animals, equipment, and chemicals in the classroom. These guidelines are available on the Utah Science Home Page.

# 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.
- f. Conduct a simple investigation when given directions.
- g. Develop and use simple classification systems.
- h. Use observations to construct a reasonable explanation.

## 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.

- Instruction should include significant science experiences that lead to student understanding using the ILOs.



**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.

# Third Grade Science Standards

## Science Benchmark

Earth orbits around the sun, and the moon orbits around Earth. Earth is spherical in shape and rotates on its axis to produce the night and day cycle. To people on Earth, this turning of the planet makes it appear as though the sun, moon, planets, and stars are moving across the sky once a day. However, this is only a perception as viewed from Earth.

**Standard I: Students will understand that the shape of Earth and the moon are spherical and that Earth rotates on its axis to produce the appearance of the sun and moon moving through the sky.**

*Objective 1:* Describe the appearance of Earth and the moon.

- Describe the shape of Earth and the moon as spherical.
- Explain that the sun is the source of light that lights the moon.
- List the differences in the physical appearance of Earth and the moon as viewed from space.

*Objective 2:* Describe the movement of Earth and the moon and the apparent movement of other bodies through the sky.

- Describe the motions of Earth (i.e., the rotation [spinning] of Earth on its axis, the revolution [orbit] of Earth around the sun).
- Use a chart to show that the moon orbits Earth approximately every 28 days.
- Use a model of Earth to demonstrate that Earth rotates on its axis once every 24 hours to produce the night and day cycle.
- Use a model to demonstrate why it seems to a person on Earth that the sun, planets, and stars appear to move across the sky.

## Science language students should use:

model, orbit, sphere, moon, axis, rotation, revolution, appearance

## Standard I:

Students will understand that the shape of Earth and the moon are spherical and that Earth rotates on its axis to produce the appearance of the sun and moon moving through the sky.



**Standard II:**  
Students will understand that organisms depend on living and nonliving things within their environment.

**Science Benchmark**

For any particular environment, some types of plants and animals survive well, some survive less well and some cannot survive at all. Organisms in an environment interact with their environment. Models can be used to investigate these interactions.

**Standard II: Students will understand that organisms depend on living and nonliving things within their environment.**

*Objective 1:* Classify living and nonliving things in an environment.

- a. Identify characteristics of living things (i.e., growth, movement, reproduction).
- b. Identify characteristics of nonliving things.
- c. Classify living and nonliving things in an environment.

*Objective 2:* Describe the interactions between living and nonliving things in a small environment.

- a. Identify living and nonliving things in a small environment (e.g., terrarium, aquarium, flowerbed) composed of living and nonliving things.
- b. Predict the effects of changes in the environment (e.g., temperature, light, moisture) on a living organism.
- c. Observe and record the effect of changes (e.g., temperature, amount of water, light) upon the living organisms and nonliving things in a small-scale environment.
- d. Compare a small-scale environment to a larger environment (e.g., aquarium to a pond, terrarium to a forest).
- e. Pose a question about the interaction between living and nonliving things in the environment that could be investigated by observation.

**Science language students should use:**

environment, interaction, living, nonliving, organism, survive, observe, terrarium, aquarium, temperature, moisture, small-scale

**Science Benchmark**

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

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

**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

**Science Benchmark**

Light is produced by the sun and observed on Earth. Living organisms use heat and light from the sun. Heat is also produced from motion when one thing rubs against another. Things that give off heat often give off light. While operating, mechanical and electrical machines produce heat and/or light.

**Standard V: Students will understand that the sun is the main source of heat and light for things living on Earth. They will also understand that the motion of rubbing objects together may produce heat.**

*Objective 1:* Provide evidence showing that the sun is the source of heat and light for Earth.

- a. Compare temperatures in sunny and shady places.
- b. Observe and report how sunlight affects plant growth.
- c. Provide examples of how sunlight affects people and animals by providing heat and light.
- d. Identify and discuss as a class some misconceptions about heat sources (e.g., clothes do not produce heat, ice cubes do not give off cold).

*Objective 2:* Demonstrate that mechanical and electrical machines produce heat and sometimes light.

- a. Identify and classify mechanical and electrical sources of heat.
- b. List examples of mechanical or electrical devices that produce light.
- c. Predict, measure, and graph the temperature changes produced by a variety of mechanical machines and electrical devices while they are operating.

*Objective 3:* Demonstrate that heat may be produced when objects are rubbed against one another.

- a. Identify several examples of how rubbing one object against another produces heat.
- b. Compare relative differences in the amount of heat given off or force required to move an object over lubricated/non-lubricated surfaces and smooth/rough surfaces (e.g., waterslide with and without water, hands rubbing together with and without lotion).

**Science language students should use:**

mechanical, electrical, temperature, degrees, lubricated, misconception, heat source, machine

**Standard V:**

**Students will understand that the sun is the main source of heat and light for things living on Earth. They will also understand that the motion of rubbing objects together may produce heat.**



# K-6 Elementary Mathematics Core Curriculum in Table Format

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
<p><b>Standard I:</b> Students will understand simple number concepts and relationships.</p> <p><b>Objective I:</b> <b>Identify and use whole numbers.</b></p> <ol style="list-style-type: none"> <li>Relate a <i>numeral</i> to the number of objects in a set (e.g., <math>\square \square \square = 3</math>).</li> <li>Construct models of numbers to 10 with physical objects or manipulatives.</li> <li>Make pictorial representations of numbers to 10 (e.g., draw four circles, draw six squares).</li> <li>Recognize and write numerals from 0 to 10.</li> <li>Manipulate objects to demonstrate and describe multiple ways of representing a number (e.g., 5 can be 3 and 2 more, 5 can also be 2 and 2 and 1).</li> </ol>	<p><b>Standard I:</b> Students will acquire number sense and perform simple operations with whole numbers.</p> <p><b>Objective I:</b> <b>Represent whole numbers in a variety of ways.</b></p> <ol style="list-style-type: none"> <li>Relate number words to the <i>numerals</i> that represent the quantities 0 to 10.</li> <li>Sort objects into groups of tens and ones and write the numeral representing the set.</li> <li>Represent <i>whole numbers</i> up to 100 in groups of tens and ones using objects.</li> <li>Write a numeral when given the number of tens and ones.</li> <li>Write a numeral to 99 in <i>expanded form</i> (e.g., 39 is 3 tens and 9 ones or 30+9).</li> <li>Use zero to represent the number of elements in the empty set or as a placeholder in a two-digit numeral.</li> </ol>	<p><b>Standard I:</b> Students will acquire number sense and perform operations with whole numbers.</p> <p><b>Objective I:</b> <b>Represent whole numbers in a variety of ways.</b></p> <ol style="list-style-type: none"> <li>Relate number words to the <i>numerals</i> that represent the quantities 0-100.</li> <li>Represent <i>whole numbers</i> up to 1,000 in groups of hundreds, tens, and ones using base ten models, and write the numeral representing the set.</li> <li>Read and write a three-digit numeral, relating it to a set of objects and a pictorial representation.</li> <li>Write a numeral to 999 in <i>expanded form</i> (e.g., 539 is 5 hundreds, 3 tens, 9 ones or 500+30+9).</li> <li>Identify the place and the value of a given digit in a three-digit numeral (e.g., the two in 281 means 2 hundreds or 200).</li> <li>Demonstrate multiple ways to represent numbers using symbolic representations (e.g., thirty is the same as two groups of 15, the number of pennies in three dimes, or 58-28).</li> </ol>	<p><b>Standard I:</b> Students will acquire number sense and perform operations with whole numbers and simple fractions.</p> <p><b>Objective I:</b> <b>Represent whole numbers in a variety of ways.</b></p> <ol style="list-style-type: none"> <li>Model, read, and write <i>whole numbers</i> up to 10,000 using base ten models, pictures, and symbols.</li> <li>Write a <i>numeral</i> when given the number of thousands, hundreds, tens, and ones.</li> <li>Write a number up to 9,999 in expanded form (e.g., 6,539 is 6 thousands, 5 hundreds, 3 tens, 9 ones or 6,000+500+30+9).</li> <li>Identify the place and the value of a given digit in a four-digit numeral.</li> <li>Demonstrate multiple ways to represent numbers using models and symbolic representations (e.g., fifty is the same as two groups of 25, the number of pennies in five dimes, or 75-25).</li> </ol>	<p><b>Standard I:</b> Students will acquire number sense and perform operations with whole numbers, simple fractions, and decimals.</p> <p><b>Objective I:</b> <b>Represent whole numbers and decimals in a variety of ways.</b></p> <ol style="list-style-type: none"> <li>Model, read, and write numerals from tenths to 100,000.</li> <li>Write a <i>whole number</i> up to 99,999 in <i>expanded form</i> (e.g., 76,539 is 7 ten-thousands, 6 one-thousands, 5 hundreds, 3 tens, 9 ones or 70,000+6,000+500+30+9).</li> <li>Identify the place and the value of a given digit in a five-digit numeral, including decimals to tenths.</li> <li>Demonstrate multiple ways to represent whole numbers by using models and symbolic representations (e.g., <math>108=2 \times 50+8</math>; <math>108=10^2 + 8</math>).</li> <li>Classify whole numbers from 2 to 20 as <i>prime</i> or <i>composite</i> and 0 and 1 as neither prime nor composite, using models.</li> <li>Represent repeated factors using <i>exponents</i> up to three (e.g., <math>8=2 \times 2 \times 2</math>).</li> </ol>	<p><b>Standard I:</b> Students will acquire number sense and perform operations with whole numbers, simple fractions, and decimals.</p> <p><b>Objective I:</b> <b>Represent whole numbers and decimals in a variety of ways.</b></p> <ol style="list-style-type: none"> <li>Model, read, and write numerals from hundredths to one million.</li> <li>Write a <i>whole number</i> up to 999,999 in <i>expanded form</i> (e.g., 876,539 = 8 hundred-thousands, 7 ten-thousands, 6 thousands, 5 hundreds, 3 tens, 9 ones or <math>8 \times 100,000 + 7 \times 10,000 + 6 \times 1,000 + 5 \times 100 + 3 \times 10 + 9</math>).</li> <li>Demonstrate multiple ways to represent whole numbers by using models and symbolic representations (e.g., <math>108=2 \times 50+8</math>; <math>108=10^2 + 8</math>).</li> <li>Classify whole numbers from 2 to 20 as <i>prime</i> or <i>composite</i> and 0 and 1 as neither prime nor composite, using models.</li> <li>Represent repeated factors using <i>exponents</i> up to three (e.g., <math>8=2 \times 2 \times 2=2^3</math>).</li> </ol>	<p><b>Standard I:</b> Students will acquire number sense and perform operations with rational numbers.</p> <p><b>Objective I:</b> <b>Represent whole numbers and decimals in a variety of ways.</b></p> <ol style="list-style-type: none"> <li>Change <i>whole numbers</i> with <i>exponents</i> to <i>standard form</i> (e.g., <math>2^4=16</math>) and recognize that <math>10^0 = 1</math>.</li> <li>Read and write <i>numerals</i> from thousandths to one billion.</li> <li>Write a whole number to 999,999 in <i>expanded form</i> using <i>exponents</i> (e.g., <math>876,539 = 8 \times 10^5 + 7 \times 10^4 + 6 \times 10^3 + 5 \times 10^2 + 3 \times 10^1 + 9 \times 10^0</math>).</li> <li>Express numbers in <i>scientific notation</i> using positive powers of ten.</li> <li>Classify whole numbers to 100 as <i>prime</i>, <i>composite</i>, or neither.</li> <li>Determine the <i>prime factorization</i> for a whole number up to 50.</li> </ol>

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
<p><b>Objective 2:</b> Identify simple relationships among whole numbers.</p> <p>a. Develop strategies for <i>one-to-one</i> correspondence and keeping track of quantities.</p> <p>b. Compare two sets of objects to determine whether they have the same, fewer, or more elements.</p> <p>c. Order sets of objects from 1 to 9.</p> <p>d. Estimate quantities less than 10.</p>	<p><b>Objective 2:</b> Identify simple relationships among whole numbers.</p> <p>a. Identify the number that is one more or one less than any <i>whole number</i> from 1 to 99.</p> <p>b. Use the vocabulary "greater than," "less than," and "equal to" when comparing sets of objects or numbers.</p> <p>c. Order sets of objects and numbers from 0 to 20.</p> <p>d. Use ordinal numbers 1st through 5th (i.e., 1st, 2nd, 3rd, 4th, 5th).</p>	<p><b>Objective 2:</b> Identify simple relationships among whole numbers.</p> <p>a. Identify the number that is one more, one less, ten more, or ten less than any <i>whole number</i> up to 100.</p> <p>b. Write number sentences using the terms "greater than," "less than," or "equal to," to compare numbers.</p> <p>c. Order four whole numbers less than 100 from least to greatest and from greatest to least.</p> <p>d. Use <i>ordinal numbers</i> 1st through 10th.</p>	<p><b>Objective 2:</b> Identify relationships among whole numbers.</p> <p>a. Use a variety of strategies to determine whether a number is even or odd.</p> <p>b. Identify the number that is ten more, ten less, 100 more, or 100 less than any <i>whole number</i> up to 1,000.</p> <p>c. Compare the relative size of numbers (e.g., 100 is large compared to 4, about half as big as 60, close to 27).</p> <p>d. Compare whole numbers up to four digits using the symbols &lt;, &gt;, and =.</p> <p>e. Order and compare whole numbers on a number line.</p>	<p><b>Objective 2:</b> Identify relationships among whole numbers and decimals.</p> <p>a. Identify the number that is 100 more, 100 less, 1,000 more, or 1,000 less than any <i>whole number</i> up to 10,000.</p> <p>b. Compare the relative size of numbers (e.g., 100 is small compared to a million, but large compared to 5).</p> <p>c. Compare whole numbers up to five digits using the symbols &lt;, &gt;, and =.</p> <p>d. Identify a whole number that is between two given whole numbers.</p> <p>e. Order and compare whole numbers and decimals to tenths on a number line.</p>	<p><b>Objective 2:</b> Identify relationships among whole numbers, fractions, decimals, and percents.</p> <p>a. Order and compare <i>whole numbers</i>, fractions (including mixed numbers), and decimals using a variety of methods and symbols.</p> <p>b. Rewrite mixed numbers and improper fractions from one form to the other.</p> <p>c. Find the least common denominator for two fractions.</p> <p>d. Represent commonly used fractions as decimals and percents in various ways (e.g., objects, pictures, calculators).</p>	<p><b>Objective 2:</b> Identify relationships among whole numbers, fractions, decimals, and percents.</p> <p>a. Find the <i>greatest common factor</i> and <i>least common multiple</i> for two numbers using a variety of methods (e.g., list of multiples, prime factorization).</p> <p>b. Order and compare <i>rational numbers</i>, including mixed numbers, using a variety of methods and symbols.</p> <p>c. Locate positive rational numbers on a number line.</p> <p>d. Convert common fractions, decimals, and percents from one form to another (e.g., <math>3/4 = 0.75 = 75\%</math>).</p>

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
<p><b>Objective 3:</b> Model and illustrate meanings of the operations of addition and subtraction and describe how they relate.</p> <p>a. Demonstrate the joining and separating of sets of objects to solve problems.</p> <p>b. Describe the joining or separating of sets with informal language when using models.</p> <p>c. Record pictorially the results from the joining or separating of sets.</p>	<p><b>Objective 3:</b> Model and illustrate meanings of the operations of addition and subtraction and describe how they relate.</p> <p>a. Demonstrate the joining and separating of sets with twelve or fewer objects and record the results with pictures or symbols.</p> <p>b. Model two meanings of subtraction: separating of sets ("take away") and comparison of sets ("how many more/fewer") using objects, pictorial representations, and symbols.</p> <p>c. Use correct vocabulary and symbols to describe addition (i.e., add, "and," plus, +, sum), subtraction (i.e., subtract, minus, -, take away, how many more/fewer), and equals (i.e., =, same as).</p> <p>d. Use zero in addition and subtraction sentences.</p>	<p><b>Objective 3:</b> Model and illustrate meanings of the operations of addition and subtraction, and describe how they relate.</p> <p>a. Demonstrate the joining and separating of sets with eighteen or fewer objects and record the results with pictures or symbols.</p> <p>b. Model three meanings of subtraction: separating of sets ("take away"), comparison of sets ("how many more/fewer"), and missing addends using objects, pictorial representations, and symbols.</p> <p>c. Separate a given set of objects into two, three, five, or ten groups of equal size.</p> <p>d. Model addition and subtraction of two-digit whole numbers in a variety of ways.</p> <p>e. Select an addition or subtraction sentence to solve a problem involving joining or separating of sets with eighteen or fewer objects.</p> <p>f. Recognize that addition number sentences have related subtraction sentences (e.g., <math>8-5=3</math>, <math>3+5=8</math>).</p>	<p><b>Objective 3:</b> Model and illustrate meanings of the operations of addition, subtraction, and multiplication, and describe how they relate.</p> <p>a. Model addition and subtraction of two- and three-digit whole numbers in a variety of ways.</p> <p>b. Model multiplication of a one-digit factor by a one-digit factor using various methods (e.g., repeated addition, rectangular arrays, manipulatives, pictures) and connect the representation to an algorithm.</p> <p>c. Model division as sharing equally and as repeated subtraction using various methods (e.g., rectangular arrays, manipulatives, number lines, pictorial representations).</p> <p>d. Demonstrate, using objects, that multiplication and division are inverse operations (e.g., <math>3 \times 4 = 12</math>; thus, <math>12 \div 4 = 3</math> and <math>12 \div 3 = 4</math>).</p> <p>e. Select and write an addition, subtraction, or multiplication sentence to solve a problem related to the students' environment, and write a story problem that relates to a given equation.</p> <p>f. Demonstrate the effects of place value when multiplying whole numbers by 10.</p>	<p><b>Objective 3:</b> Model and illustrate meanings of the four operations and describe how they relate.</p> <p>a. Use models to represent multiplication of a one- or two-digit factor by a two-digit factor (up to 30) using a variety of methods (e.g., rectangular arrays, manipulatives, pictures) and connect the representation to an algorithm.</p> <p>b. Recognize that division by zero is not possible (e.g., <math>6 \div 0</math> is undefined).</p> <p>c. Select and write a multiplication or division sentence to solve a problem related to the students' environment and write a story problem that relates to a given equation.</p> <p>d. Represent division of a two-digit dividend by a one-digit divisor, including whole number remainders, using various methods (e.g., rectangular arrays, manipulatives, pictures) and connect the representation to an algorithm.</p> <p>e. Demonstrate that multiplication and division are inverse operations (e.g., <math>3 \times 4 = 12</math>; thus, <math>12 \div 4 = 3</math> and <math>12 \div 3 = 4</math>).</p> <p>f. Describe the effect of place value when multiplying whole numbers by 10 and 100.</p>	<p><b>Objective 3:</b> Model and illustrate meanings of operations and describe how they relate.</p> <p>a. Identify the <i>dividend</i>, <i>divisor</i>, and <i>quotient</i> regardless of the division symbol used.</p> <p>b. Determine whether a whole number is divisible by 2, 3, 5, 9, and/or 10, using the <i>rules of divisibility</i>.</p> <p>c. Represent remainders as <i>whole numbers</i>, decimals, or fractions and describe the meaning of remainders as they apply to problems from the students' environment (e.g., If there are 53 people, how many vans are needed if each van holds 8 people?).</p> <p>d. Model addition, subtraction, and multiplication of fractions and decimals in a variety of ways (e.g., using objects and a number line).</p> <p>e. Select or write the number sentences that can be used to solve a two-step problem.</p> <p>f. Model different strategies for whole number multiplication (e.g., partial product, lattice) and division (e.g., partial quotient).</p> <p>g. Describe the effect on place value when multiplying and dividing whole numbers and decimals by 10, 100, and 1,000.</p>	<p><b>Objective 3:</b> Model and illustrate meanings of operations and describe how they relate.</p> <p>a. Represent division of a multi-digit dividend by two-digit divisors, including decimals, using models, pictures, and symbols.</p> <p>b. Model addition, subtraction, and division of fractions and decimals in a variety of ways (e.g., objects, a number line).</p> <p>c. Apply <i>rules of divisibility</i>.</p> <p>d. Select or write a number sentence that can be used to solve a multi-step problem and write a word problem when given a two-step expression or equation.</p>

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
	<p><b>Objective 4:</b> Use fractions to identify parts of the whole.</p> <p>a. Share sets of up to ten objects between two students and identify each part as half.</p> <p>b. Divide geometric shapes into equal parts, identifying halves and fourths.</p>	<p><b>Objective 4:</b> Use fractions to identify parts of the whole.</p> <p>a. Separate geometric shapes and sets of objects into halves, thirds, and fourths using a variety of models and illustrations.</p> <p>b. Specify a region of a geometric shape (e.g., as “<math>\frac{1}{2}</math> out of <math>\frac{1}{2}</math> equal parts” when given four or fewer equal parts).</p> <p>c. Represent the unit fractions <math>\frac{1}{2}</math>, <math>\frac{1}{3}</math>, and <math>\frac{1}{4}</math> with objects, pictures, and symbols.</p>	<p><b>Objective 4:</b> Use fractions to communicate parts of the whole.</p> <p>a. Identify the denominator of a fraction as the number of equal parts in the whole region or set.</p> <p>b. Identify the numerator of a fraction as the number of equal parts being considered.</p> <p>c. Divide regions and sets of objects into equal parts using a variety of models and illustrations.</p> <p>d. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, sixths, and eighths.</p> <p>e. Determine which of two fractions is greater using models or illustrations.</p>	<p><b>Objective 4:</b> Use fractions to communicate parts of the whole.</p> <p>a. Divide regions and sets of objects into equal parts using a variety of models and illustrations.</p> <p>b. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, fifths, sixths, eighths, and tenths.</p> <p>c. Relate fractions to decimals that represent tenths.</p> <p>d. Determine which of two fractions is greater using models or illustrations.</p> <p>e. Find equivalent fractions for one-half, one-third, and one-fourth using manipulatives and pictorial representations.</p>	<p><b>Objective 4:</b> Use fractions to communicate parts of the whole.</p> <p>a. Divide regions, sets of objects, and line segments into equal parts using a variety of models and illustrations.</p> <p>b. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, fifths, sixths, eighths, tenths, twelfths, and sixteenths.</p> <p>c. Represent the simplest form of a fraction in various ways (e.g., objects, pictorial representations, symbols).</p> <p>d. Represent mixed numbers and improper fractions in various ways (e.g., rulers, objects, number lines, symbols).</p> <p>e. Rename whole numbers as fractions with different denominators (e.g., <math>5=5/1</math>, <math>3=6/2</math>, <math>1=7/7</math>).</p> <p>f. Model and calculate equivalent forms of a fraction and describe the process used.</p>	<p><b>Objective 4:</b> Use fractions and percents to communicate parts of the whole.</p> <p>a. Divide regions, sets of objects, and line segments into equal parts using a variety of models and illustrations.</p> <p>b. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, fifths, sixths, eighths, tenths, twelfths, and sixteenths.</p> <p>c. Write a fraction or ratio in simplest form.</p> <p>d. Name equivalent forms for fractions (halves, thirds, fourths, fifths, tenths), ratios, percents, and decimals, including repeating or terminating decimals.</p> <p>e. Relate percents less than 1% or greater than 100% to equivalent fractions, decimals, whole numbers, and mixed numbers.</p>

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
	<p><b>Objective 5:</b> Solve whole number problems using addition and subtraction in horizontal and vertical notation.</p> <ol style="list-style-type: none"> <li>Compute addition and subtraction facts to twelve.</li> <li>Add three whole numbers with sums to twelve.</li> </ol>	<p><b>Objective 5:</b> Solve whole number problems using addition and subtraction in vertical and horizontal notation.</p> <ol style="list-style-type: none"> <li>Use a variety of methods and tools to facilitate computation (e.g., estimation, mental math strategies, paper and pencil, calculator).</li> <li>Compute accurately with basic number combinations for addition and subtraction facts to eighteen.</li> <li>Add three <i>whole numbers</i> with <i>sums</i> to eighteen.</li> <li>Find the sum of two-digit whole numbers and describe the process used.</li> </ol>	<p><b>Objective 5:</b> Solve whole number problems using addition, subtraction, multiplication, and division in vertical and horizontal notation.</p> <ol style="list-style-type: none"> <li>Use a variety of methods and tools to facilitate computation (e.g., estimation, mental math strategies, paper and pencil, calculator).</li> <li>Find the sum of <i>addends</i> with three or fewer digits, including monetary amounts, and describe the process used.</li> <li>Find the <i>difference</i> of two-digit <i>whole numbers</i> and describe the process used.</li> <li>Find the <i>product</i> for multiplication facts through ten times ten and describe the process used.</li> </ol>	<p><b>Objective 5:</b> Solve whole number problems using addition, subtraction, multiplication, and division in vertical and horizontal notation.</p> <ol style="list-style-type: none"> <li>Determine when it is appropriate to use estimation, mental math strategies, paper and pencil, or a calculator.</li> <li>Find the sum and difference of four-digit numbers, including monetary amounts, and describe the process used.</li> <li>Multiply two- and three-digit <i>factors</i> by a one-digit <i>factor</i> and describe the process used.</li> <li>Divide a two-digit <i>whole number dividend</i> by a one-digit <i>divisor</i>, with a <i>remainder</i> of zero and describe the process used.</li> </ol>	<p><b>Objective 5:</b> Solve problems using the four operations with whole numbers, decimals, and fractions.</p> <ol style="list-style-type: none"> <li>Determine when it is appropriate to use estimation, mental math strategies, paper and pencil, or a calculator.</li> <li>Use estimation strategies to determine whether results obtained using a calculator are reasonable.</li> <li>Multiply up to a three-digit <i>whole number</i> by a one- or two-digit whole number.</li> <li>Divide up to a three-digit whole number <i>dividend</i> by a one-digit <i>divisor</i>.</li> <li>Add and subtract decimals with digits to the hundredths place (e.g., <math>35.42+7.2</math>; <math>75.2-13.45</math>).</li> <li>Add, subtract, and multiply fractions.</li> <li>Simplify <i>expressions</i>, without <i>exponents</i>, using the <i>order of operations</i>.</li> </ol>	<p><b>Objective 5:</b> Solve problems using the four operations with whole numbers, decimals, and fractions.</p> <ol style="list-style-type: none"> <li>Determine when it is appropriate to use estimation, mental math strategies, paper and pencil, or a calculator.</li> <li>Use estimation strategies to determine whether results obtained using a calculator are reasonable.</li> <li>Multiply up to a three-digit <i>factor</i> by a one- or two-digit factor including decimals.</li> <li>Divide up to a three-digit <i>dividend</i> by a one- or two-digit <i>divisor</i> including decimals.</li> <li>Add and subtract decimals to the thousandths place (e.g., <math>34.567+3.45</math>; <math>65.3-5.987</math>).</li> <li>Add, subtract, multiply, and divide fractions and mixed numbers.</li> <li>Solve problems using ratios and proportions.</li> <li>Simplify <i>expressions</i>, with <i>exponents</i>, using the <i>order of operations</i>.</li> </ol>

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
<p><b>Standard II:</b> Students will identify and use patterns to represent mathematical situations.</p> <p><b>Objective 1:</b> Identify and sort objects according to common attributes.</p> <p>a. Sort objects into groups by color, shape, size, number, or other attributes.</p> <p>b. Identify which attribute was used to sort objects into a group.</p> <p>c. Find multiple ways to sort and classify a group of objects.</p>	<p><b>Standard II:</b> Students will identify and use patterns and relations to represent mathematical situations.</p> <p><b>Objective 1:</b> Recognize and represent patterns with one or two attributes.</p> <p>a. Sort and classify objects by one or two attributes.</p> <p>b. Identify, create, and label simple patterns using manipulatives, pictures, and symbolic notation (e.g., ABAB... , <math>\square \triangle \square \triangle \dots</math>).</p> <p>c. Identify patterns in the environment.</p> <p>d. Identify horizontal and vertical patterns on hundreds charts.</p> <p>e. Use patterns to establish skip counting by twos to 20 and by fives and tens to 100.</p> <p>f. Count backward from 10 to 0 and identify the pattern.</p>	<p><b>Standard II:</b> Students will identify and use patterns and relations to represent mathematical situations.</p> <p><b>Objective 1:</b> Recognize and represent patterns having multiple attributes.</p> <p>a. Sort, classify, and label objects by three or more attributes.</p> <p>b. Identify and label repeating and growing patterns using objects, pictures, and symbolic notation (e.g., ABAABBAABB...).</p> <p>c. Identify repeating and growing patterns in the environment.</p> <p>d. Construct models and skip count by twos, threes, fives, and tens and relate to repeated addition.</p>	<p><b>Standard II:</b> Students will use patterns and relations to represent mathematical situations.</p> <p><b>Objective 1:</b> Recognize, describe, and use patterns and identify the attributes.</p> <p>a. Create and extend repeating and growing patterns using objects, numbers, and tables.</p> <p>b. Record results of patterns created using manipulatives, pictures, and numeric representations and describe how they are extended.</p>	<p><b>Standard II:</b> Students will use patterns and relations to represent mathematical situations.</p> <p><b>Objective 1:</b> Recognize, analyze, and use patterns and describe their attributes.</p> <p>a. Represent and analyze repeating and growing patterns using objects, pictures, numbers, and tables.</p> <p>b. Recognize and extend multiples and other number patterns using a variety of methods.</p>	<p><b>Objective 6:</b> Model and illustrate integers.</p> <p>a. Identify, read, and locate integers on a number line.</p> <p>b. Describe situations where integers are used in the students' environment.</p>	<p><b>Objective 6:</b> Model, illustrate, and perform the operations of addition and subtraction of integers.</p> <p>a. Recognize that the sum of an integer and its opposite is zero.</p> <p>b. Model addition and subtraction of integers using manipulatives and a number line.</p> <p>c. Add and subtract integers.</p>
<p><b>Standard II:</b> Students will identify and use patterns and relations to represent mathematical situations.</p> <p><b>Objective 1:</b> Identify and sort objects according to common attributes.</p> <p>a. Sort objects into groups by color, shape, size, number, or other attributes.</p> <p>b. Identify which attribute was used to sort objects into a group.</p> <p>c. Find multiple ways to sort and classify a group of objects.</p>	<p><b>Standard II:</b> Students will identify and use patterns and relations to represent mathematical situations.</p> <p><b>Objective 1:</b> Recognize and represent patterns with one or two attributes.</p> <p>a. Sort and classify objects by one or two attributes.</p> <p>b. Identify, create, and label simple patterns using manipulatives, pictures, and symbolic notation (e.g., ABAB... , <math>\square \triangle \square \triangle \dots</math>).</p> <p>c. Identify patterns in the environment.</p> <p>d. Identify horizontal and vertical patterns on hundreds charts.</p> <p>e. Use patterns to establish skip counting by twos to 20 and by fives and tens to 100.</p> <p>f. Count backward from 10 to 0 and identify the pattern.</p>	<p><b>Standard II:</b> Students will identify and use patterns and relations to represent mathematical situations.</p> <p><b>Objective 1:</b> Recognize and represent patterns having multiple attributes.</p> <p>a. Sort, classify, and label objects by three or more attributes.</p> <p>b. Identify and label repeating and growing patterns using objects, pictures, and symbolic notation (e.g., ABAABBAABB...).</p> <p>c. Identify repeating and growing patterns in the environment.</p> <p>d. Construct models and skip count by twos, threes, fives, and tens and relate to repeated addition.</p>	<p><b>Standard II:</b> Students will use patterns and relations to represent mathematical situations.</p> <p><b>Objective 1:</b> Recognize, describe, and use patterns and identify the attributes.</p> <p>a. Create and extend repeating and growing patterns using objects, numbers, and tables.</p> <p>b. Record results of patterns created using manipulatives, pictures, and numeric representations and describe how they are extended.</p>	<p><b>Standard II:</b> Students will use patterns and relations to represent mathematical situations.</p> <p><b>Objective 1:</b> Recognize, analyze, and use patterns and describe their attributes.</p> <p>a. Represent and analyze repeating and growing patterns using objects, pictures, numbers, and tables.</p> <p>b. Recognize and extend multiples and other number patterns using a variety of methods.</p>	<p><b>Objective 6:</b> Model and illustrate integers.</p> <p>a. Identify, read, and locate integers on a number line.</p> <p>b. Describe situations where integers are used in the students' environment.</p>	<p><b>Objective 6:</b> Model, illustrate, and perform the operations of addition and subtraction of integers.</p> <p>a. Recognize that the sum of an integer and its opposite is zero.</p> <p>b. Model addition and subtraction of integers using manipulatives and a number line.</p> <p>c. Add and subtract integers.</p>

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
<p><b>Objective 2:</b> Identify and use patterns to describe numbers or objects.</p> <p>a. Use patterns to count orally from 1 to 20 and backward from 10 to 0.</p> <p>b. Identify simple patterns in the environment.</p> <p>c. Predict what comes next in an established pattern and justify thinking.</p> <p>d. Duplicate, extend, and create simple patterns using objects and pictorial representations.</p>	<p><b>Objective 2:</b> Recognize and represent relations using mathematical symbols.</p> <p>a. Recognize that “=” indicates a relationship in which the quantities on each side of an equation are equal.</p> <p>b. Recognize that symbols such as <math>\square</math>, <math>\triangle</math>, or <math>\diamond</math> in an addition or subtraction equation represent a missing value that will make the statement true (e.g., <math>\square + 3 = 6</math>, <math>5 + 7 = \triangle</math>, <math>4 = 5 - \diamond</math>).</p> <p>c. Demonstrate that changing the order of addends does not change the sum (e.g., <math>3+2=5</math> and <math>2+3=5</math>).</p>	<p><b>Objective 2:</b> Recognize and represent mathematical patterns using symbols.</p> <p>a. Recognize that symbols such as <math>\square</math>, <math>\triangle</math>, or <math>\diamond</math> in an addition, subtraction, or multiplication equation, represent a value that will make the statement true (e.g., <math>5+7=\triangle</math>, <math>\square-3=6</math>, <math>\diamond=2\times4</math>).</p> <p>b. Solve equations involving equivalent expressions (e.g., <math>6+4=\square+7</math>).</p> <p>c. Use the <math>&gt;</math>, <math>&lt;</math>, and <math>=</math> symbols to compare two expressions involving addition and subtraction (e.g., <math>4+6 \square 3+2</math>; <math>3+5 \diamond 16-9</math>).</p> <p>d. Demonstrate that grouping three or more addends does not change the sum (e.g., <math>(2+3)+7=12</math>, <math>2+(3+7)=12</math>).</p>	<p><b>Objective 2:</b> Recognize, represent, and solve mathematical patterns and symbols.</p> <p>a. Solve equations involving equivalent expressions (e.g., <math>6\times2=\square\times3</math> or <math>6\square=9+9</math>).</p> <p>b. Use the <math>&lt;</math>, <math>&gt;</math>, <math>=</math> symbols to compare two expressions involving addition, subtraction, multiplication, and division (e.g., <math>5\times4 \diamond 9\div3</math>).</p> <p>c. Recognize that a given variable maintains the same value throughout an equation or expression (e.g., <math>\square+\square=8</math>; <math>\square=4</math>).</p> <p>d. Demonstrate that changing the order of factors does not change the product (e.g., <math>2\times3=6</math>, <math>3\times2=6</math>) and that the grouping of three or more factors does not change the product (e.g., <math>(2\times3)\times1=6</math>; <math>2\times(3\times1)=6</math>).</p> <p>e. Demonstrate the distribution of multiplication over addition using a rectangular array (e.g., <math>8\times14=8</math> rows of 10 plus 8 rows of 4).</p>	<p><b>Objective 2:</b> Represent, solve, and analyze mathematical situations using algebraic symbols.</p> <p>a. Recognize a variety of symbols for multiplication and division including <math>\times</math>, <math>\div</math>, <math>\cdot</math>, and <math>*</math> as symbols for multiplication and <math>\div</math>, <math>\cdot</math>, and a fraction bar (<math>/</math> or <math>-</math>) as division symbols.</p> <p>b. Recognize that a variable (<math>\diamond</math>, <math>n</math>, <math>x</math>) represents an unknown quantity.</p> <p>c. Solve one-step equations involving whole numbers and a single variable (e.g., <math>n+7=3</math>).</p> <p>d. Recognize that the answer to a multiplication problem involving a factor of zero is equal to zero (e.g., <math>0\times45=0</math>).</p> <p>e. Use expressions or one-step equations to represent real-world situations.</p> <p>f. Use the associative, commutative, and distributive properties to compute with whole numbers.</p>	<p><b>Objective 2:</b> Represent, solve, and analyze mathematical situations using algebraic symbols.</p> <p>a. Recognize that a number in front of a variable indicates multiplication (e.g., <math>3y</math> means 3 times the quantity <math>y</math>).</p> <p>b. Solve two-step equations involving whole numbers and a single variable (e.g., <math>3x+4=19</math>).</p> <p>c. Recognize that “<math>\approx</math>” indicates a relationship in which the quantities on each side are approximately of equal value (e.g., <math>\pi \approx 3.14</math>).</p> <p>d. Recognize that an exponent can be represented in the following ways: <math>4^3</math> or <math>4\cdot3</math>.</p> <p>e. Evaluate expressions and formulas, substituting given values for the variables (e.g., <math>2x+4</math>; <math>x=2</math>; therefore, <math>2(2)+4=8</math>).</p> <p>f. Recognize that if the product is zero, then one or more factors equal zero (i.e., if <math>ab=0</math> then either <math>a=0</math> or <math>b=0</math> or <math>a</math> and <math>b=0</math>).</p>	

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
<p><b>Standard III:</b> Students will identify and create simple geometric shapes and describe spatial relationships.</p> <p><b>Objective 1:</b> Identify and create simple geometric shapes.</p> <ol style="list-style-type: none"> <li>Identify circles, triangles, rectangles, and squares.</li> <li>Combine shapes to create <i>two-dimensional</i> objects.</li> <li>Draw circles, triangles, rectangles, and squares.</li> <li>Recognize circles, triangles, rectangles, and squares in the students' environment.</li> </ol>	<p><b>Standard III:</b> Students will describe, identify, and create and simple geometric shapes and describe spatial relationships.</p> <p><b>Objective 1:</b> Describe, identify, and create simple geometric shapes.</p> <ol style="list-style-type: none"> <li>Identify, name, draw, create, and sort circles, triangles, rectangles, and squares.</li> <li>Identify circles, triangles, rectangles, and squares in the students' environment.</li> <li>Recognize that combining simple geometric shapes can create more complex geometric shapes.</li> </ol>	<p><b>Standard III:</b> Students will describe, identify, and create geometric shapes and describe spatial relationships.</p> <p><b>Objective 1:</b> Describe, identify, and create geometric shapes.</p> <ol style="list-style-type: none"> <li>Identify, name, draw, sort, and compare circles, triangles, and <i>parallelograms</i>.</li> <li>Identify and name spheres, cones, and cylinders.</li> <li>Find and identify familiar geometric shapes in the students' environment.</li> <li>Determine whether a circle, triangle, square, or rectangle has a <i>line of symmetry</i>.</li> </ol>	<p><b>Standard III:</b> Students will use spatial reasoning to describe, identify, and create geometric shapes.</p> <p><b>Objective 1:</b> Describe, identify, and create geometric shapes.</p> <ol style="list-style-type: none"> <li>Identify and draw <i>points, lines, line segments</i>, and <i>endpoints</i>.</li> <li>Identify and draw <i>lines of symmetry</i> on triangles, squares, circles, and rectangles.</li> <li>Determine whether an angle is <i>right, obtuse</i>, or <i>acute</i> by comparing the angle to the corner of a rectangle.</li> <li>Classify polygons (e.g., <i>quadrilaterals</i>, pentagons, hexagons, octagons) by the number of sides and corners.</li> <li>Identify, make, and describe cubes (e.g., a cube has 6 square <i>faces</i>, 8 <i>vertices</i>, and 12 <i>edges</i>).</li> </ol>	<p><b>Standard III:</b> Students will use spatial reasoning to recognize, describe, and identify geometric shapes.</p> <p><b>Objective 1:</b> Describe, identify, and analyze characteristics and properties of geometric shapes.</p> <ol style="list-style-type: none"> <li>Identify and draw <i>parallel lines</i> and <i>intersecting lines</i>.</li> <li>Identify and draw lines of symmetry on a variety of <i>polygons</i>.</li> <li>Identify and describe <i>quadrilaterals</i> (i.e., rectangles, squares, <i>rhombuses</i>, <i>trapezoids</i>, kites).</li> <li>Identify <i>right, obtuse</i>, and <i>acute</i> angles.</li> <li>Compare two polygons to determine whether they are <i>congruent</i> or <i>similar</i>.</li> <li>Identify and describe <i>cylinders</i> and <i>rectangular prisms</i>.</li> </ol>	<p><b>Standard III:</b> Students will use spatial reasoning to recognize, describe, and identify geometric shapes and principles.</p> <p><b>Objective 1:</b> Describe, identify, and analyze characteristics and properties of geometric shapes.</p> <ol style="list-style-type: none"> <li>Identify and draw <i>perpendicular lines</i>.</li> <li>Draw, label, and describe rays and describe an angle as two rays sharing a common endpoint.</li> <li>Label an angle as acute, <i>obtuse</i>, <i>right</i>, or <i>straight</i>.</li> <li>Identify and describe <i>equilateral, isosceles, scalene, right, acute</i>, and <i>obtuse</i> triangles.</li> <li>Identify the <i>vertex</i> of an angle or the <i>vertices</i> of a polygon.</li> <li>Compare <i>corresponding angles</i> of two triangles and determine whether the triangles are <i>similar</i>.</li> <li>Identify and describe <i>pyramids</i> and <i>prisms</i>.</li> </ol>	<p><b>Standard III:</b> Students will use spatial and logical reasoning to recognize, describe, and identify geometric shapes and principles.</p> <p><b>Objective 1:</b> Identify and analyze characteristics and properties of geometric shapes.</p> <ol style="list-style-type: none"> <li>Identify the <i>midpoint</i> of a <i>line segment</i>.</li> <li>Identify concave and <i>convex polygons</i>.</li> <li>Identify the center, <i>radius, diameter</i>, and <i>circumference</i> of a circle.</li> <li>Identify the number of <i>faces, edges</i>, and <i>vertices</i> of <i>pyramids</i> and <i>prisms</i>.</li> </ol>

<p><b>Kindergarten</b></p> <p><b>Objective 2:</b> Describe simple spatial relationships.</p> <p>a. Visualize how to fit a shape into a design.</p> <p>b. Use and demonstrate words to describe position with objects (i.e., on, over, under, above, below, top, bottom, up, down, in front of, behind, next to, beside).</p> <p>c. Use and demonstrate words to describe distance with objects (i.e., far, near).</p>	<p><b>1st Grade</b></p> <p><b>Objective 2:</b> Describe simple spatial relationships.</p> <p>a. Use and demonstrate words to describe position (i.e., between, before, after, middle, left, right).</p> <p>b. Use and demonstrate words to describe distance (i.e., closer, farther).</p>	<p><b>2nd Grade</b></p> <p><b>Objective 2:</b> Describe spatial relationships.</p> <p>a. Create and use verbal or written instructions to move within the environment.</p> <p>b. Find and name locations using coordinates (A, 1).</p> <p>c. Identify shapes in various orientations (e.g., <math>\Delta</math> and <math>\nabla</math>).</p>	<p><b>3rd Grade</b></p> <p><b>Objective 2:</b> Describe spatial relationships.</p> <p>a. Give directions to reach a location.</p> <p>b. Use coordinates (A, 1) or regions to locate positions on a map.</p> <p>c. Demonstrate and use horizontal and vertical lines.</p>	<p><b>4th Grade</b></p> <p><b>Objective 2:</b> Specify locations and describe spatial relationships using grids and maps.</p> <p>a. Locate positions on a map of Utah using coordinates or regions.</p> <p>b. Give the <i>coordinates</i> or <i>regions</i> of a position on a map of Utah.</p>	<p><b>5th Grade</b></p> <p><b>Objective 2:</b> Specify locations and describe spatial relationships using coordinate geometry.</p> <p>a. Locate points defined by ordered pairs in the first <i>quadrant</i>.</p> <p>b. Write an ordered pair for a point in the first quadrant.</p> <p>c. Specify possible paths between locations on a <i>coordinate grid</i> and compare distances of the various paths.</p>	<p><b>6th Grade</b></p> <p><b>Objective 2:</b> Specify locations and describe spatial relationships using coordinate geometry.</p> <p>a. Graph points defined by ordered pairs in all four quadrants.</p> <p>b. Write the ordered pair for a point in any quadrant.</p>
			<p><b>Objective 3:</b> Visualize and identify geometric shapes after applying transformations.</p> <p>a. Demonstrate the effect of a slide (translation) or flip (reflection) on a figure, using manipulatives.</p> <p>b. Determine whether two polygons are <i>congruent</i> by sliding, flipping, or turning to physically fit one object on top of the other.</p> <p>c. Identify <i>two-dimensional</i> shapes (nets) that will fold to make a cube.</p> <p>d. Create a <i>polygon</i> that results from combining other polygons.</p>	<p><b>Objective 3:</b> Visualize and identify geometric shapes after applying transformations.</p> <p>a. Identify a <i>slide</i> (<i>translation</i>) or <i>flip</i> (<i>reflection</i>) on a figure using manipulatives.</p> <p>b. Relate <i>cubes</i>, <i>cylinders</i>, <i>cones</i>, and <i>rectangular prisms</i> to the <i>two-dimensional</i> shapes (<i>nets</i>) from which they were created.</p>	<p><b>Objective 3:</b> Visualize and identify geometric shapes after applying transformations.</p> <p>a. Identify a <i>slide</i> (<i>translation</i>) or <i>flip</i> (<i>reflection</i>) on a figure across a line.</p> <p>b. Demonstrate the effect of a <i>turn</i> (<i>rotation</i>) on a figure using manipulatives.</p> <p>c. Relate <i>pyramids</i> and <i>prisms</i> to the <i>two-dimensional</i> shapes (<i>nets</i>) from which they were created.</p>	<p><b>Objective 3:</b> Visualize and identify geometric shapes after applying transformations.</p> <p>a. <i>Turn</i> (<i>rotate</i>) a shape around a point and identify the location of the new vertices.</p> <p>b. <i>Slide</i> (<i>translate</i>) a polygon either horizontally or vertically on a coordinate grid and identify the location of the new vertices.</p> <p>c. <i>Flip</i> (<i>reflect</i>) a shape across either the x- or y-axis and identify the location of the new vertices.</p>

<p><b>Kindergarten</b></p> <p><b>Standard IV:</b> Students will understand and use simple measurement tools and techniques.</p> <p><b>Objective 1:</b> Identify measurable attributes of objects and units of measurement.</p> <p>a. Identify clocks and calendars as tools that measure time. b. Identify a day, week, and month on a calendar. c. Identify pennies, nickels, dimes, and quarters as units of money.</p>	<p><b>1st Grade</b></p> <p><b>Standard IV:</b> Students will understand and use simple measurement tools and techniques.</p> <p><b>Objective 1:</b> Identify measurable attributes of objects and units of measurement.</p> <p>a. Identify the appropriate tools for measuring length, weight, capacity, temperature, and time. b. Identify the values of a penny, nickel, dime, and quarter. c. Estimate the length of an object by comparing to a nonstandard unit (e.g., How many new pencils wide is your desk?).</p>	<p><b>2nd Grade</b></p> <p><b>Standard IV:</b> Students will understand and use measurement tools and techniques.</p> <p><b>Objective 1:</b> Identify measurable attributes of objects and units of measurement.</p> <p>a. Sequence a series of events of a day in order by time (e.g., breakfast at 7:00, school begins at 9:00). b. Identify the name and value of a penny, nickel, dime, quarter, and dollar. c. Estimate length, capacity, and weight using customary units.</p>	<p><b>3rd Grade</b></p> <p><b>Standard IV:</b> Students will understand and use measurement tools and techniques.</p> <p><b>Objective 1:</b> Identify and describe measurable attributes of objects and units of measurement.</p> <p>a. Recognize the two systems of measurement: <i>metric</i> and <i>customary</i>. b. Describe the relationship between metric units of length (i.e., centimeter, meter). c. Describe the relationship among customary units of length (i.e., inch, foot, yard) and the relationship between customary units of capacity (i.e., cup, quart).</p> <p>d. Estimate length, capacity, and weight using metric and customary units.</p>	<p><b>4th Grade</b></p> <p><b>Standard IV:</b> Students will understand and use measurement tools and techniques.</p> <p><b>Objective 1:</b> Identify and describe measurable attributes of objects and units of measurement.</p> <p>a. Describe the relationship among <i>metric</i> units of length (i.e., millimeter, centimeter, meter), between metric units of capacity (i.e., milliliter, liter), and between metric units of weight (i.e., gram, kilogram). b. Identify a mile as a measure of distance and its relationship to other <i>customary</i> units of length. c. Describe the relationship among customary units of capacity (i.e., cup, pint, quart, gallon). d. Estimate length, capacity, and weight using metric and customary units.</p>	<p><b>5th Grade</b></p> <p><b>Standard IV:</b> Students will understand and apply measurement tools and techniques.</p> <p><b>Objective 1:</b> Identify and describe measurable attributes of objects and units of measurement.</p> <p>a. Describe the relationship among <i>metric</i> units of length (i.e., millimeter, centimeter, meter, kilometer). b. Describe the relationship among <i>customary</i> units of weight (i.e., ounce, pound). c. Identify the correct units of measurement for <i>volume</i>, <i>area</i>, and <i>perimeter</i> in both metric and customary systems. d. Estimate length, volume, weight, and area using metric and customary units. e. Convert units of measurement within the metric system and convert units of measurement within the customary system.</p>	<p><b>6th Grade</b></p> <p><b>Standard IV:</b> Students will understand and apply measurement tools and techniques.</p> <p><b>Objective 1:</b> Identify and describe measurable attributes of objects and units of measurement.</p> <p>a. Compare a meter to a yard, a liter to a quart, and a kilometer to a mile. b. Identify <i>pi</i> as the ratio of the <i>circumference</i> to <i>diameter</i> of a circle. c. Explain how the size of the unit used in measuring affects the precision. d. Estimate length, volume, weight, and area using <i>metric</i> and customary units.</p>

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
<p><b>Objective 2:</b> Use appropriate techniques and tools to determine measurements.</p> <p>a. Compare two objects (e.g., shorter/longer, heavier/lighter, larger/smaller, more/less).</p> <p>b. Find the length of an object using nonstandard units (e.g., pencils, paper clips).</p> <p>c. Name the days of the week in order.</p> <p>d. Sort pennies, nickels, dimes, and quarters.</p>	<p><b>Objective 2:</b> Use appropriate techniques and tools to determine measurements.</p> <p>a. Compare objects, using nonstandard units, according to their length, weight, or volume (e.g., pencils/length, books/weight, boxes/volume).</p> <p>b. Read and tell time to the nearest hour.</p> <p>c. Name the days of the week, months of the year, and seasons in order.</p> <p>d. Determine the value of a set of the same coins that total 25¢ or less (e.g., a set of 14 pennies equals 14¢, a set of 5 nickels equals 25¢, a set of 2 dimes equals 20¢).</p>	<p><b>Objective 2:</b> Use appropriate techniques and tools to determine measurements.</p> <p>a. Compare and order objects, using nonstandard units, according to their length, weight, or capacity.</p> <p>b. Measure length using inches and feet, weight using pounds, and capacity using cups.</p> <p>c. Determine the value of a set of up to five coins that total \$1.00 or less (e.g., two quarters and one dime equals 60¢; three dimes, one nickel, and one penny equals 36¢).</p> <p>d. Read, tell, and write time to the hour and half-hour.</p> <p>e. Use a calendar to determine the day of the week and date.</p> <p>f. Determine the perimeter of a square, triangle, and rectangle by measuring with nonstandard units.</p>	<p><b>Objective 2:</b> Use appropriate techniques and tools to determine measurements.</p> <p>a. Measure the length of objects to the nearest centimeter, meter, half-inch, foot, and yard.</p> <p>b. Measure capacity using milliliters, liters, cups, pints, quarts, and gallons and measure weight using grams, kilograms, and pounds.</p> <p>c. Read, tell, and write time to the nearest minute, identifying a.m. and p.m.</p> <p>d. Read and record the temperature to the nearest degree, in Fahrenheit, using a thermometer.</p> <p>e. Determine the value of a combination of coins and bills that total \$20.00 or less.</p> <p>f. Count back change for a single-item purchase and determine the amount of change to be received from a multiple-item purchase.</p> <p>g. Determine possible perimeters, in whole units, for a rectangle with a fixed area and determine possible areas when given a rectangle with a fixed perimeter.</p>	<p><b>Objective 2:</b> Determine measurements using appropriate tools and formulas.</p> <p>a. Measure length to the nearest 1/8 of an inch and to the nearest centimeter.</p> <p>b. Measure volume and weight using metric and customary units.</p> <p>c. Measure angles using a protractor.</p> <p>d. Calculate elapsed time within a.m. or p.m. time periods.</p> <p>e. Read and record the temperature to the nearest degree (above and below zero) when using a thermometer with a Celsius or Fahrenheit scale.</p> <p>f. Calculate the perimeter of rectangles and triangles.</p> <p>g. Calculate the area of squares and rectangles using a formula.</p>	<p><b>Objective 2:</b> Determine measurements using appropriate tools and formulas.</p> <p>a. Measure length to the nearest one-sixteenth of an inch and to the nearest millimeter.</p> <p>b. Estimate and measure an angle to the nearest degree.</p> <p>c. Calculate the circumference of a circle using a given formula.</p> <p>d. Calculate elapsed time across a.m. and p.m. time periods.</p> <p>e. Calculate the areas of triangles, rectangles, and parallelograms using given formulas.</p> <p>f. Calculate the surface area and volume of right, rectangular prisms using given formulas.</p>	

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
<p><b>Standard V:</b> Students will collect and draw conclusions from data and understand basic concepts of probability.</p> <p><b>Objective 1:</b> Collect, organize, and display simple data.</p> <ol style="list-style-type: none"> <li>Collect, organize, and record data using objects and pictures.</li> <li>Represent data in a variety of ways (e.g., graphs made from people, <i>pictographs</i>, bar graphs) and interpret the data (e.g., more people like red than blue).</li> </ol>	<p><b>Standard V:</b> Students will collect and draw conclusions from data and understand basic concepts of probability.</p> <p><b>Objective 1:</b> Collect, organize, and display simple data.</p> <ol style="list-style-type: none"> <li>Collect physical objects to use as data.</li> <li>Collect, represent, and interpret data using tables, tally marks, <i>pictographs</i>, and bar graphs.</li> </ol>	<p><b>Standard V:</b> Students will collect and organize data to make predictions and identify basic concepts of probability.</p> <p><b>Objective 1:</b> Collect, organize, and display data to make predictions.</p> <ol style="list-style-type: none"> <li>Collect, read, represent, and interpret data using tables, graphs, and charts, including keys (e.g., <i>pictographs</i>, bar graphs).</li> <li>Make predictions based on a data display.</li> </ol>	<p><b>Standard V:</b> Students will collect and organize data to make predictions and use basic concepts of probability.</p> <p><b>Objective 1:</b> Collect, organize, and display data to make predictions and answer questions.</p> <ol style="list-style-type: none"> <li>Identify a question that can be answered by collecting data.</li> <li>Collect, read, and interpret data from tables, graphs, charts, surveys, and observations.</li> <li>Represent data using tables, line plots, line graphs, and bar graphs.</li> <li>Identify and distinguish between <i>clusters</i> and <i>outliers</i> of a data set.</li> </ol>	<p><b>Standard V:</b> Students will collect, analyze, and draw conclusions from data and apply basic concepts of probability.</p> <p><b>Objective 1:</b> Formulate and answer questions using statistical methods to compare data.</p> <ol style="list-style-type: none"> <li>Formulate a question that can be answered by collecting data.</li> <li>Collect, compare, and display data using an appropriate format (i.e., <i>line plots</i>, bar graphs, <i>pictographs</i>, circle graphs, line graphs).</li> <li>Identify minimum and <i>maximum</i> values for a set of data.</li> <li>Identify or calculate the <i>mean</i>, <i>mode</i>, and <i>range</i>.</li> <li>Propose and justify inferences based on data.</li> </ol>	<p><b>Standard V:</b> Students will collect, analyze, and draw conclusions from data and apply basic concepts of probability.</p> <p><b>Objective 1:</b> Design investigations to reach conclusions using statistical methods to make inferences based on data.</p> <ol style="list-style-type: none"> <li>Design investigations to answer questions by collecting and organizing data in a variety of ways (e.g., bar graphs, line graphs, frequency tables, stem and leaf plots).</li> <li>Collect, compare, and display data using an appropriate format (i.e., bar graphs, line graphs, <i>line plots</i>, circle graphs, scatter plots).</li> <li>Compare two similar sets of data on the same graph and compare two graphs representing the same set of data.</li> <li>Recognize that changing the scale influences the appearance of a display of data.</li> <li>Develop and evaluate inferences and predictions based on data.</li> </ol>	

Kindergarten	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	6th Grade
<p><b>Objective 2:</b>  <b>Determine the likelihood of events.</b>                      a. Describe events encountered in books read as possible or not possible.                      b. Describe events as likely or unlikely (e.g., It is likely to snow today. It is unlikely an elephant will be in school).</p>	<p><b>Objective 2:</b>  <b>Determine the likelihood of an event.</b>                      a. Compare events to decide which are more likely, less likely, and equally likely.                      b. Relate past events to future events (e.g., The sun set about 6:00 last night, so it will set about the same time tonight).</p>	<p><b>Objective 2:</b>  <b>Determine the likelihood of an event.</b>                      a. Predict events that will be the same in one day or one week.                      b. Predict the outcome when there are only two possible outcomes (e.g., tossing a coin).</p>	<p><b>Objective 2:</b>  <b>Identify basic concepts of probability.</b>                      a. Describe the results of events using the terms “certain,” “equally likely,” and “impossible.”                      b. Predict outcomes of simple activities (e.g., a bag contains three red marbles and five blue marbles. If one marble is selected, is it more likely to be red or blue?).</p>	<p><b>Objective 2:</b>  <b>Use basic concepts of probability.</b>                      a. Describe the results of investigations involving random outcomes as simple ratios (e.g., 4 out of 9, 4/9).                      b. Predict outcomes of simple experiments, including with and without replacement, and test the predictions.</p>	<p><b>Objective 2:</b>  <b>Apply basic concepts of probability.</b>                      a. Describe the results of investigations involving random outcomes using a variety of notations (e.g., 4 out of 9, 4/9, 4:9).                      b. Recognize that outcomes of experiments and samples are fractions between 0 and 1.                      c. Predict the probability of an outcome in a simple experiment.</p>	<p><b>Objective 2:</b>  <b>Apply basic concepts of probability.</b>                      a. Write the results of a probability experiment as a fraction, ratio, or percent between zero and one.                      b. Compare experimental results with anticipated results (e.g., experimental: 7 out of 10 tails; whereas, anticipated 5 out of 10 tails).                      c. Compare individual, small group, and large group results for a probability experiment.</p>



# Mathematics Glossary

acute angle	An angle with a measure less than $90^\circ$ .
addend	Any number being added. In $32+4=36$ , 32 and 4 are <i>addends</i> .
algorithm	A step-by-step method for computing.
area	The measure, in square units, of the inside of a plane figure.
array	An arrangement of objects in equal rows.
Associative Property	Changing the grouping of three or more <i>addends</i> does not change the <i>sum</i> . Changing the grouping of three or more <i>factors</i> does not change the <i>product</i> .
attribute	A characteristic of an object, such as color, shape, size, etc.
capacity	The maximum amount that can be contained by an object. Often refers to measurement of a liquid.
chord	Any <i>line segment</i> that joins two <i>points</i> on a circle.
circumference	The <i>perimeter</i> of a circle.
cluster	Data that are grouped together.
Commutative Property	Changing the order of the <i>addends</i> does not change the <i>sum</i> . Changing the order of the <i>factors</i> does not change the <i>product</i> .
composite number	A number greater than 0 that has more than two different factors. The number 9 is a <i>composite number</i> because it has three <i>factors</i> : 1, 3, and 9.
concave polygon	A <i>polygon</i> with one or more diagonals that have points outside the polygon.
cone	A solid bounded by a circular base and a curved surface with one <i>vertex</i> .
congruent	Having exactly the same size and shape.
convex polygon	A <i>polygon</i> with all interior angles measuring less than $180^\circ$ . All diagonals of a <i>convex polygon</i> are inside the figure.

coordinate grid	A <i>two-dimensional</i> system in which the <i>coordinates</i> of a point are its distances from two intersecting, usually <i>perpendicular</i> , straight lines called axes.
coordinates	An ordered pair of numbers that identify a point on a coordinate plane or grid.
corresponding angles	Angles in the same position from one line to another.
cube (solid figure)	A regular solid with six congruent square faces.
customary system	A system of measurement used in the U.S. The system includes units for measuring length, capacity, and weight.
cylinder	A three-dimensional figure with two circular bases that are <i>parallel</i> and <i>congruent</i> .
diameter	A <i>chord</i> that goes through the center of a circle.
difference	The amount that remains after one quantity is subtracted from another.
Distributive Property	When one of the <i>factors</i> of a <i>product</i> is a <i>sum</i> , multiplying each <i>addend</i> before adding does not change the <i>product</i> . For example: $6 \times (2 + 3) = (6 \times 2) + (6 \times 3)$
dividend	A number that is divided by another number.
divisor	The number by which another number is divided.
e.g.	This abbreviation means “for example.” When used in the Core, <i>e.g.</i> is not limited to the examples given.
edge	The <i>line segment</i> where two <i>faces</i> of a solid figure meet.
elapsed time	The amount of time that passes between two times.
endpoint	A point at either end of a <i>line segment</i> , arc, or a point at one end of a <i>ray</i> .
equilateral triangle	A triangle with all sides the same length.
expanded form	A way to write numbers that shows the place value of each digit. $263 = 200 + 60 + 3$ or 263 is 2 hundreds, 60 tens, and 3 ones.
exponent	The number that tells how many equal <i>factors</i> there are.

expression	A variable or combination of variables, numbers, and operation symbols that represents a mathematical relationship. 6, $2 + 3$ , $x$ , $x + 4$ , and $x + 2y$ are all <i>expressions</i> .
face	A plane figure that serves as one side of a solid figure. The <i>faces</i> of a <i>cube</i> are squares.
factors	The <i>whole numbers</i> that are multiplied to get a <i>product</i> . In $6 \times 3 = 18$ , 6 and 3 are factors of 18.
flip	A transformation creating a mirror image of a figure on the opposite side of a line. A <i>flip</i> is also called a <i>reflection</i> .
greatest common factor	The greatest number that is a <i>factor</i> of every number in a set of numbers. 3 is the <i>greatest common factor</i> of 9 and 15.
growing pattern	A pattern that grows or increases.
horizontal line	A line that is <i>parallel</i> to the horizon. A <i>horizontal line</i> is straight across.
i.e.	This abbreviation means “that is to say.” When used in the Core, <i>i.e.</i> is limited to the specific examples given.
Identity Property of Addition	If you add zero to a number, the <i>sum</i> is the same as that number. For example, $8 + 0 = 8$ .
Identity Property of Multiplication	If you multiply a number by one, the <i>product</i> is the same as that number. For example, $18 \times 1 = 18$ .
integers	<i>Whole numbers</i> and their opposites.
intersect	To meet or cross.
isosceles triangle	A triangle that has exactly two <i>congruent</i> sides.
least common multiple	The least common multiple of a set of two or more numbers. For example, the <i>least common multiple</i> of 3 and 5 is 15.
line	A set of connected points continuing without end in both directions.
line of symmetry	A line that divides a figure into two <i>congruent</i> halves that are mirror images of each other.
line plot	A graph showing frequency of data on a number line.

line segment	A part of a line with two <i>endpoints</i> .
mean	A number found by dividing the sum of two or more numbers by the number of <i>addends</i> . The <i>mean</i> is often referred to as the average.
metric system	A system of measurement based on tens. The basic unit of length is the meter. The basic unit of mass is the gram. The basic unit of <i>capacity</i> is the liter.
midpoint	The point on a <i>line segment</i> that divides it into two <i>congruent</i> segments.
mode	The number that appears most frequently in a set of numbers. There may be one, more than one, or no mode.
net	A <i>two-dimensional</i> shape that can be folded into a three-dimensional figure is a <i>net</i> of that figure.
numeral	A symbol used to represent a number.
obtuse angle	An angle with a measure greater than $90^\circ$ and less than $180^\circ$ .
obtuse triangle	A triangle with one <i>obtuse angle</i> .
one-to-one correspondence	The relationship between the spoken word and the written symbol.
Order of Operations	A set of rules that tells the order in which to compute.
ordinal number	A <i>whole number</i> that names the position of an object in sequence. First, second, and third are <i>ordinal numbers</i> .
outlier	A number in a set of data that is much larger or smaller than most of the other numbers in the set.
parallel lines	Lines in the same plane that are always the same distance apart.
parallelogram	A <i>quadrilateral</i> with two pairs of <i>parallel</i> and <i>congruent</i> sides.
perimeter	The distance around a figure.
perpendicular	Forming <i>right angles</i> .

pi	The ratio of the <i>circumference</i> of any circle to its <i>diameter</i> , approximately equal to 3.14.
pictograph	A graph that uses pictures to show data.
plane	A flat surface that extends infinitely in all directions.
point	An exact location in space represented by a dot.
polygon	A closed plane figure made by <i>line segments</i> .
prime factorization	A way to show a number as the <i>product</i> of <i>prime factors</i> . The <i>prime factorization</i> of 12 is $2 \times 2 \times 3$ .
prime number	A <i>whole number</i> greater than 0 that has exactly two different <i>factors</i> , 1 and itself. 5 is a <i>prime number</i> because its only <i>factors</i> are 1 and 5.
prism	A three-dimensional figure that has two <i>congruent</i> and <i>parallel</i> faces that are <i>polygons</i> . The rest of the faces are <i>parallelograms</i> .
product	The answer to a multiplication problem. For example, $6 \times 3 = 18$ , 18 is the <i>product</i> of $6 \times 3$ .
pyramid	A polyhedron whose base is a <i>polygon</i> and whose other <i>faces</i> are triangles that share a common <i>vertex</i> .
quadrants	The four sections of a <i>coordinate grid</i> that are separated by the axes.
Quadrilateral	A four-sided <i>polygon</i> .
quotient	The answer to a division problem.
radius	The segment, or the length of the segment, from the center of a circle to any point on the circle.
Range	The difference between the greatest number and the least number in a set of numbers.
rational number	A number that can be expressed as a ratio of two non-zero <i>integers</i> .
ray	A part of a line that has one <i>endpoint</i> and goes on forever in one direction.
rectangular prism	A <i>prism</i> with six rectangular faces.
reflection	A transformation creating a mirror image of a figure on the opposite side of a line. A <i>reflection</i> is also called a <i>flip</i> .

region	A part of a plane.
remainder	In <i>whole number</i> division, when you have divided as far as you can without using decimals, what has not been divided yet is the remainder.
repeating pattern	A pattern of a group of items that repeats over and over.
rhombus	A <i>parallelogram</i> with all four sides equal in length.
right angle	An angle that measures exactly $90^\circ$ .
right triangle	A triangle that has one $90^\circ$ angle.
rotation	The transformation that occurs when a figure is turned a certain angle and direction around a point. A rotation is also called a turn.
Rules of Divisibility	Patterns that make it easier to tell whether one number is <i>divisible</i> by another.
scalene triangle	A triangle that has no <i>congruent</i> sides.
scientific notation	A form of writing numbers as the <i>product</i> of a power of 10 and a decimal number greater than or equal to 1 and less than 10.
similar figures	Figures that have the same shape, but not necessarily the same size.
slide	A transformation that slides a figure a given distance in a given direction. A <i>slide</i> is also called a <i>translation</i> .
square number	A number that is the result of multiplying an <i>integer</i> by itself. Any <i>square number</i> of dots can be arranged in a square array.
standard form	A number written with one digit for each place value. The <i>standard form</i> for the number three thousand three is 3,003.
straight angle	An angle with a measure of $180^\circ$ .
sum	The answer to an addition problem. In $32+4=36$ , 36 is the <i>sum</i> .
surface area	The total <i>area</i> of the <i>faces</i> (including bases) and curved surfaces of a solid figure.
translation	A transformation that slides a figure a given distance in a given direction. A <i>translation</i> is also called a <i>slide</i> .

trapezoid	A <i>quadrilateral</i> with one pair of <i>parallel</i> sides and one pair of sides that are not parallel.
turn	The transformation that occurs when a figure is turned a certain angle and direction around a point. A <i>turn</i> is also called a <i>rotation</i> .
two-dimensional	A figure that has length and width, but not height. Having <i>area</i> , but not <i>volume</i> . The image on a movie screen is two-dimensional.
vertex	The point at which two <i>line segments</i> , <i>lines</i> , or <i>rays</i> meet to form an angle.
vertical line	A line that has right angles to the horizon. A <i>vertical line</i> is straight up and down.
vertices	Plural of <i>vertex</i> .
volume	The number of cubic units it takes to fill a figure.
whole number	Any of the numbers 0, 1, 2, 3, 4, 5, and so on.
Zero Property of Multiplication	The <i>product</i> of any number and zero is zero. For example, $8 \times 0 = 0$ .



# *Facilitated Activities*



# Using Graphic Organizers

## Background Information

Teachers will read the student background material provided in the Teacher Resource Book (TRB<sup>3</sup>) and highlight the key concepts that a limited English proficient student or a student with special needs might be expected to understand. They will then create a graphic organizer to help students comprehend the information.

## Research Basis

McCoy, J.D., Ketterlin-Geller, R. (2004). "Rethinking Instructional Delivery for Diverse Student Populations: Serving All Learners with Concept-Based Instruction." *Intervention in School & Clinic*. 40,2, p88, 8p.

When students arrive at content classes reading below grade level, teachers are challenged to deliver complex content. Also, students often study facts without reaching larger concepts. Overt identification of concepts and their characteristics and the deliberate use of graphic organizers reduce the reading comprehension demands placed on students with low abilities.

Langford, P.A., Rizzo, S.K., Roth, J.M. (2003). Improving Student Comprehension in Content Areas through the Use of Reading Strategies. Dissertations/Theses. Full Text from ERIC ED478769.

This study was an action research project designed to improve students' reading comprehension. Students in the targeted kindergarten, second, and third grade classes exhibited a lack of reading comprehension, which interfered with their academic achievement. According to the literature, advance organizers enabled students to remember important information.

Rasinski, T.V., Padak, N.D., Church, B.W., Fawcett, G., Hendershot, J., Henry, J.M. et al. (Eds.). (2000). *Teaching Comprehension and Exploring Multiple Literacies: Strategies from The Reading Teacher*. Newark, DE: International Reading Association. ISBN 0872072819

Whatever grade level, content, or texts that educators teach, their ultimate goal is to develop their students' understanding of what they read. The 29 articles in this anthology were published in *The Reading Teacher* from 1993 to 1999 and offer ideas to help students comprehend different types of texts and literacies, from technology literacy to visual, theater, and music literacy.

## ***Instructional Procedures***

### **Materials**

- Heat and Light*
- Sample Graphic Organizer*

1. Provide participants with the student background material *Heat and Light* and ask them to read through and highlight the basic facts or enduring understandings that they would expect a limited English proficient student or a special needs student to understand.
2. Ask participants to brainstorm ideas for making this information more accessible to students.
3. Refer participants to the *Sample Graphic Organizer*. Make suggested additions or changes.

**Science Benchmark: 03 : 05**

Light is produced by the sun and observed on Earth. Living organisms use heat and light from the sun. Heat is also produced from motion when one thing rubs against another. Things that give off heat often give off light. While operating, mechanical and electrical machines produce heat and/or light.

**Standard V:**

Students will understand that the sun is the main source of heat and light for things living on Earth. They will also understand that the motion of rubbing objects together may produce heat.

*STUDENT BACKGROUND INFORMATION*

## *Heat and Light*

Have you ever been inside a cave? An interesting cave to visit is Timpanogos Cave just north of Provo, Utah. The best time to hike to the cave is during the summer when the snow is gone.



The hike is a mile and a half long, with a steep trail to the cave entrance. As you hike up the steep, winding trail, you will notice that the summer sun is hot and bright. You will need to take water with you.

Grade	Benchmark	Standard	Page
03	03 : 05	05	12.1.1

Reprinted from the Utah TRB<sup>3</sup> (2003).

A guide will take you through the cave's tunnels and caverns. Inside the cave it will be very dark except for your guide's flashlight and the electrical lights that have been placed in the cave to help visitors. This cave is beautiful, wet, slippery, and cold. Even when it is very hot outside, most people need to take a jacket to wear inside the cave.



Your guide will ask you to stand still while the lights are off. You will see what it is like to be in total darkness. With no light inside the cave, you cannot see your friends standing near you, your own hands, or anything at all. Most people are happy when the lights are turned back on.

12.1.2

Soon you will come to the other end of the cave tunnel and go outside. It will take a few minutes for your eyes to become used to the bright sunlight that is all around you. The hot summer sun feels good after being inside the cold cave.



### *Where do we get light and heat?*



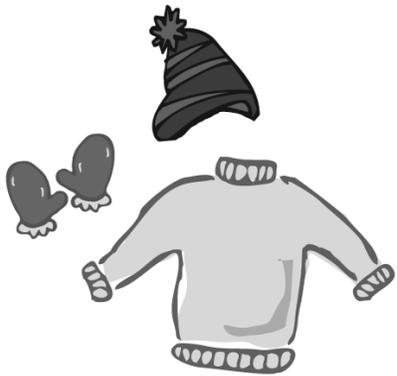
Natural Light

When you are inside a dark cave, even with your eyes wide open, you see nothing. If it is daytime and you are outdoors, you see many objects all around you. You can see the objects because of light bouncing off them. Light is produced by the sun.

12.1.3

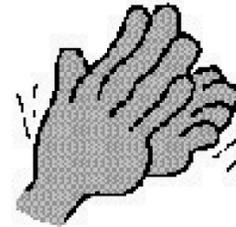
The sun is the main source of heat, warmth, and light for organisms living on Earth. Without the sun's energy, Earth would be completely dark and freezing cold. Living organisms use heat and light from the sun. Plants need sunlight to make food. Animals cannot make their own food. They must eat plants or other animals in order to live. Without sunlight there would be no living things on Earth. Have you ever noticed that house plants bend toward sunlit windows? What will happen to seeds if they are planted and watered but left in a dark room or under a box?

Anything that gives off heat is a *heat source*. The sun is the main source of heat for Earth. Have you noticed that you feel hotter in the sunlight than in the shade? You can measure the difference in *temperature* with a thermometer. A thermometer uses a scale with each unit called a *degree*.



Some people have *misconceptions* about heat sources. For example, ice cubes do not give off cold. When you place an ice cube in your glass of water the ice cube takes heat from the water as it cools. Wool clothing does not produce heat. The loose fibers of the wool clothing trap your body heat and make you feel warmer.

What is true about heat? The motion of rubbing things together may produce heat. On a cold day you can rub your hands together to try to warm them. Can you think of ways heat is produced from motion when one thing rubs against another?



When you are riding your bike and brake, stopping quickly, your brake becomes warm. The motion of rubbing on the brake produced heat. If you cut a piece of wood with a saw, the saw blade becomes warm. When you sand a piece of wood with a piece of sandpaper, the sandpaper becomes warm.

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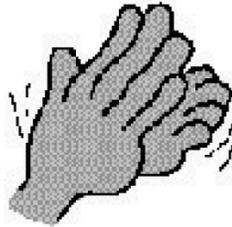
**misconceptions** - *misunderstandings*



**a lubricant**

Imagine walking on a tile floor and slipping on a wet spot. The water *lubricates* the surface, making it easier for you to slide. Lubricants such as oil, water and lotion reduce heat and make it easier for machine parts to move. Oil is added to car engines to reduce the heat made by moving parts in the engine.

Have you noticed that it is harder to turn a door knob with lotion covered hands than it is with dry hands? Here is something you can try. Rub dry, clean hands together for a few minutes. Then try rubbing your hands together with lotion on them. When did your hands warm up more quickly?



While operating, mechanical and electrical machines produce heat and/or light. *Machines* need energy to operate. Machines can be *mechanical* or *electrical*. Mechanical machines can use burning fuel, human strength, flowing water or even horsepower to give them energy. Electrical machines need electricity and usually plug into an electrical outlet or use batteries. Can you make a list of machines and sort or categorize them? Are they mechanical or electrical? Mechanical machines could include; car engines, scissors, staplers, and lawn mowers. Electrical machines include computers, projectors, televisions, electrical pencil sharpeners, and electric motors.

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**electrical** - uses electricity

**lubricate** - to make a slippery surface

**machines** - tools with fixed or moving parts for doing work.

**mechanical** - does not use electricity.

12.1.5



**Mechanical Heat Sources**



**Electrical Heat Sources**

Light sources can also be sorted into electrical and mechanical groups. Can you sort a candle, gas lantern, electric light, flashlight, overhead projector, computer screen, glow stick, or fire into these two groups?

On a cold winter day, students at school could come into the classroom from recess and put their hands on the back of a computer that has been left on. The computer has produced heat and is warm. Have you noticed that it is warmer in the computer lab than in other rooms in the school? How much warmer is the computer room than one without computers? You could guess or predict, then use a thermometer to measure the temperature of each room. Try it!

### **Science Language Students Need to Know and Use**

- 1. degrees** - a unit of measure for temperature on a thermometer
- 2. electrical** - uses electricity
- 3. heat source** - makes things warm
- 4. lubricated** - to make a slippery surface
- 5. machine** - tools with fixed or moving parts for doing work
- 6. mechanical** - does not use electricity
- 7. misconception** - misunderstanding
- 8. temperature** - how warm or cold

## Resources:

### Books:

- Byles, Monica, *Life in the Polar Lands*, “Crow Steals Some Daylight” p. 24-25, Scholastic Inc., ISBN 0-590-46130-3
- Caduto, Michael J., and Bruchac, Joseph; *Keepers of the Earth*, “How Grandmother Spider Stole the Sun” p. 49-51. ISBN 1-55591-027-0
- *The Magic School Bus Gets Eaten: A Book About Food Chains*, ISBN 0-590-48414-1
- *The Magic School Bus Gets Planted: A Book About Photosynthesis*, ISBN 0-590-92246-7
- *The Magic School Bus in the Arctic: A Book About Heat*, ISBN 0-590-18724-4
- *The Magic School Bus Plays Ball: A Book About Forces and Friction*, ISBN 0-590-92240-8
- Throughton, Joanna, *Who Will Be the Sun?* The Wright Group, ISBN 1-55624-498-3

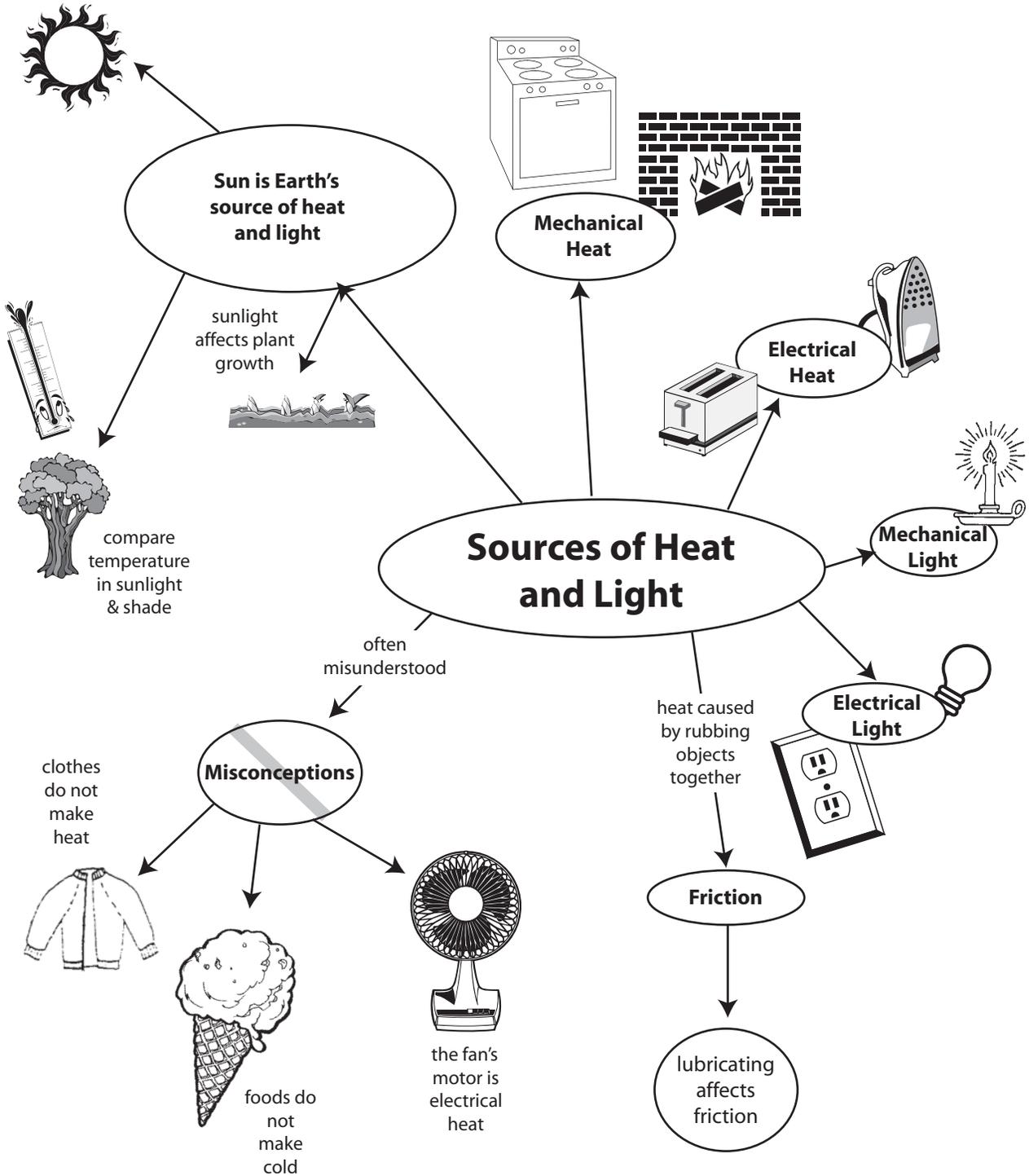
### Solar Folklore and Art

<http://solar-center.stanford.edu/folklore/folklore.html>

### Web Sources:

- <http://www.ajkids.com/> seach heat, light, sun, friction
- <http://umbra.gsfc.nasa.gov/images/latest.html> pictures of the sun
- [http://www.surweb.org/seach/collections\\_imatrix.asp](http://www.surweb.org/seach/collections_imatrix.asp) Timpanogos Cave
- <http://solar-center.stanford.edu/>
- <http://www.nasaexplores.com/cgi-bin/index.pl>

# Sample Graphic Organizer



# Encouraging Student Feedback

## Background Information

Reflection may be described as active, persistent, and careful consideration of a belief or practice. It creates a foundation for assessing situations and making rational decisions and provides educators an opportunity to create connections between theory and practice. This should lead to deeper understandings about one's personal beliefs, best educational practices and instructional decisions. Reflection can improve teaching and learning and validate a teacher's ideals.

## Research Basis

Conderman, G. & Morin, J. (2004). Reflect Upon Your Practice. *Intervention in School & Clinic, 40*(2), p111-115.

The article suggests several ways to reflect upon the teaching profession. There are 20 ideas for teachers to consider in self-reflection. Student interaction and feedback are useful strategies.

Maaka, M.J. (1995). Inviting Success in the Elementary Classroom: Putting Theory into Practice. *American Educational Research Association*, paper presented in San Francisco, CA. Eric Number: ED40635.

This paper presents one teacher's efforts to advance curriculum at an elementary school by continuous monitoring of the effectiveness of her learning and teaching program.

## Instructional Procedures

1. Ask participants to complete the *Reflect Upon the Day* data collection sheet. It should become a part of the participant journal.
2. Conduct a group discussion regarding formal data collection from students and how the practice may allow for improved teacher reflections.

### Materials

- Reflect Upon the Day* data collection sheet

## **Resources**

Black, S. (2001). Thinking about teaching. *American School Board Journal*, 108(11), 42–44.

Koszalka, T., Song, H. D., & Grabrowski, B. (2002). *Examining learning environmental design issues for prompting reflective thinking in web-based PBL*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

## ***Reflect Upon the Day***

<p>Discuss your work habits during the activities. Did you work a little at a time, or did you complete each activity all at once?</p>	
<p>What kind of help did you receive from others?</p>	
<p>Did you use your time wisely? Start on time, work without interruptions, etc.?</p>	
<p>On a scale of 1 to 10, 10 being the most, how much did you learn from these activities?</p>	
<p>What would you do differently as a learner next time?</p>	
<p>What could the presenter have done differently to help you learn more from these activities?</p>	
<p>What did you find most difficult to do or understand in the activities?</p>	
<p>Share any other thoughts that might have made this a better learning experience for you.</p>	

# Journal Jars

## Background Information

Many students solve mathematical problems or perform mathematical tasks in the classroom using only rote memorization of the procedures. The connection between what they are doing and why is often missing, causing a breakdown in understanding. Teaching students to think about their thinking and reasoning is called “metacognition.” Metacognition can help students begin to articulate their thinking processes and lead them to the “why” connection in their processes. Using math journals in the classroom is one way to teach students to “think about their thinking.” Math journals promote reasoning, thinking, and understanding when introduced, modeled, and practiced in a metacognitive way. By using different prompts on varied levels of the critical thinking scale, students can begin to analyze their understanding or lack of it on math procedures, strategies, and concepts. Using a journal jar full of varied levels of critical questioning prompts helps students learn about metacognition in a fun, inviting way.

## Research Basis

Burns, M., Silbey, R. (2001). Math Journals Boost Real Learning. *Instructor*, v110, p18-20.

This article presents suggestions to help elementary school teachers incorporate journal writing in math class, discussing a math journal’s many assets and instructional uses.

Koirala, H. P. (2002). Facilitating Student Learning Through Math Journals. *Research Reports of the International Group for the Psychology of Mathematics*, SE-067-800.

This article discusses the idea that journal writing in math can help students discover gaps in their knowledge and assist teachers in guiding their instruction based on the entries. It is based on the analysis of more than 1,800 journal entries over the past five years.

## Instructional Procedures

Introduce students to metacognition, or thinking about their thinking, with this activity:

1. Begin by writing “Metacognition—thinking about our thinking” on chart paper.

**Materials**

- Journal jar
- 2 pieces of different colored paper for every student
- Critical Thinking Journal Prompts*
- Chart paper
- Marker
- Staplers

2. Tell the students the more attention we pay to our thinking the more we will understand how we think and how we come up with the answers that we do. If we think about the *how*, we will be better able to tell if our answers make sense and are logical (this is one of the steps in problem solving).
3. Ask students to choose between two different activities you have decided on before hand (something such as playing indoor dodgeball or outside kickball). Divide the students according to their choices.
4. Ask some of the students to share how they made their decision between the two choices. Write these on the chart paper. Use questions such as: “Did you consider what your friend’s choices were? Did the weather have anything to do with your choice? Did you think about how recently you had chosen one particular choice. Did you consider how good you were at the choice you chose? Did you think of any other criteria before you chose?” Use these types of questions to help them think about their conscious and subconscious thought processes.
5. Be sure to tell them they are using metacognition as they are thinking about their thinking.
6. Next have the students make a metacognition math journal according to the *Layered Book* directions on page 2-23. Have students write *Metacognition Math Journal* on the cover and decorate it.
7. Introduce the journal jar (have the *Critical Thinking Journal Prompts* copied on different colors of paper for each level of thinking, cut apart and placed in the journal jar). Tell students the journal jar holds questions for them to write about that will help them practice “thinking about their thinking.”
8. Bring out the journal jar and have a student draw a colored piece of paper from the jar (be sure to designate a color since that will determine the level of critical thinking you will be accessing; e.g., Level 1: Knowledge questions are on yellow paper). You can have one student draw for everyone, each individual draw, or a group leader draw for their group. Write the prompt on the board if it is for everyone. Use the lower levels of critical thinking prompts to begin with until the students have gained confidence with their metacognition.
9. Choose a few students to share their journals.

10. Gather and read the journals on a regular rotation schedule. Be sure to respond to them in writing, as well as verbally. Point out sentences that help you see their thinking.

*Note:* A journal should be written at the end of a math exercise or to assess retained knowledge of a concept which has already been taught and may need to be reviewed.

## ***Resources***

### **Book**

*Big Book of Books and Activities*, by Dinah Zike;  
ISBN 1-882796-07-01

### **Web sites**

[http://www.ops.org/reading/blooms\\_taxonomy.html](http://www.ops.org/reading/blooms_taxonomy.html)

<http://killeenroos.com/adm/Blooms/htm>

<http://kcmetro.cc.mo.us/longview/ctac/blooms/htm>

## ***Critical Thinking Journal Prompts***

### **Level 1: Knowledge**

**Exhibits previously learned material by recalling facts, terms, basic concepts and answers.**

Key words to use when making questions on this level:

who, what, why, when, omit, where, which, choose, find, how, define, label, show, spell, list, match, name, relate, tell, recall, select

*Sample Questions:*

- What is addition? Multiplication? Subtraction?, etc.
- List everything you know about addition, subtraction, multiplication, division, etc.
- Name a rule to remember when subtracting across the middle zero.
- What are the most important rules to remember when you add 3-digit numbers?
- List three fractions that are equal.
- Name three types of graphs. Draw a picture of two of them.

### **Level 2: Comprehension**

**Demonstrating understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions and stating main ideas.**

Key words:

compare, contrast, demonstrate, interpret, explain, extend, illustrate, infer, outline, relate, rephrase, translate, summarize, show, classify

*Sample Questions:*

- How would you compare addition and subtraction? Perimeter and area?, etc.
- Explain how to tell the difference between a quarter and a dime. A half dollar and a nickel. How are they the same?
- How is a bar graph like a pictograph? How are they different?
- Explain what is happening when you regroup.
- Explain, in your own words, what a fact family is.
- Which is the true statement?
  - A  $\frac{1}{2}$  hour is the same as 30 minutes.
  - A  $\frac{1}{2}$  hour is the same as 15 minutes.Explain why you chose the answer you did.

### **Level 3: Application**

**Solving problems by applying acquired knowledge, facts, techniques and rules in a different way.**

Key Words:

apply, build, choose, construct, develop, interview, make use of, organize, experiment with, plan, select, solve, utilize, model, identify

*Sample Questions:*

- How would you use a different method to solve an addition problem? A subtraction problem? A multiplication problem?, etc.
- How would you show that you understand place value?
- What would happen if you multiplied instead of divided? Added instead of subtracted?, etc.
- What questions would you ask in an interview with a mathematician?

### **Level 4: Analysis**

**Examining and breaking information into parts by identifying motives or causes; making inferences and finding evidence to support generalizations.**

Key Words:

analyze, categorize, classify, compare, contrast, discover, dissect, divide, examine, inspect, simplify, survey, take part in, test for, distinguish, list, distinction, theme, relationships, function, motive, inference, assumption, conclusion

*Sample Questions:*

- Why do you think it is important to learn your multiplication facts?
- How is weight related to volume?
- Why do you think it is easier to add then multiply?
- How would you distinguish (tell the difference) between a meter and a yard?
- Can you label the parts of an addition equation? Where are the addends? Where is the sum?
- Can you tell the difference between an addition story problem and a subtraction story problem? How?
- What do you think math can be used for?

### **Level 5: Synthesis**

**Compiling information together in a different way by combining elements in a new pattern or proposing alternative solutions.**

Key Words:

build, choose, combine, compile, compose, construct, create, design, develop, estimate, formulate, imagine, invent, make up, originate, plan, predict, propose, solve, solution, suppose, discuss, modify, change, original, improve, adapt, minimize, maximize, delete, theorize, elaborate, test, improve, happen, change

*Sample Questions:*

- How would you improve your addition skills? Multiplication skills? Story problem skills?, etc.
- What would happen if we only had addition and subtraction? Would we be able to multiply or divide?
- Can you invent a new way to measure? Multiply? Divide?, etc.
- Can you construct a model that would change how we tell time?
- Can you think of an original way for us to measure things? Weigh things?, etc.

### **Level 6: Evaluation**

**Presenting and defending opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.**

Key Words:

award, choose, conclude, criticize, decide, defend, determine, dispute, evaluate, judge, justify, measure, compare, mark, rate, recommend, rule on, select, agree, interpret, explain, appraise, prioritize, opinion, support, importance, criteria, prove, disprove, assess, influence, perceive, value, estimate, influence, deduct

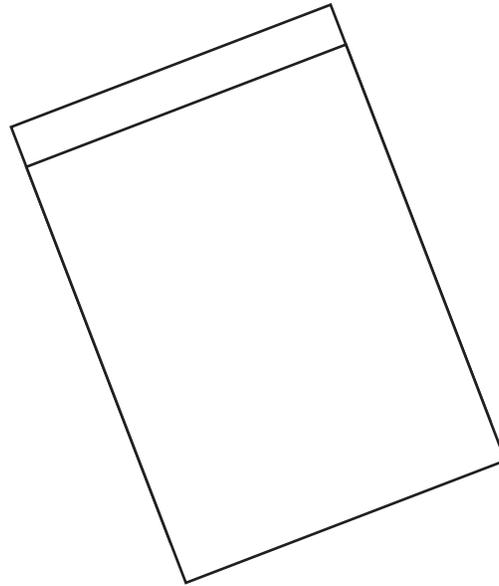
*Sample Questions:*

- Can you assess the value or importance of telling time?
- What is your favorite procedure in math?
- How would you list and decide (prioritize) the most important things to know in math on down to the least important?
- Based on what you know, how would you explain fractions to an alien? Time? How to add numbers? Subtract numbers?, etc.

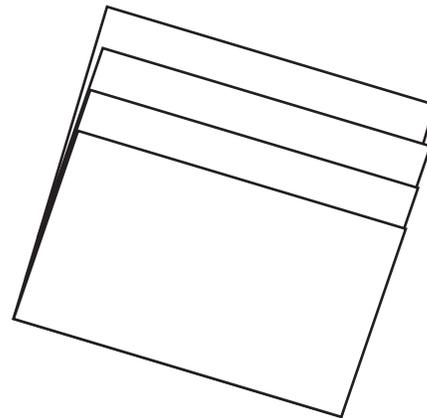
Name \_\_\_\_\_

## Layered Book

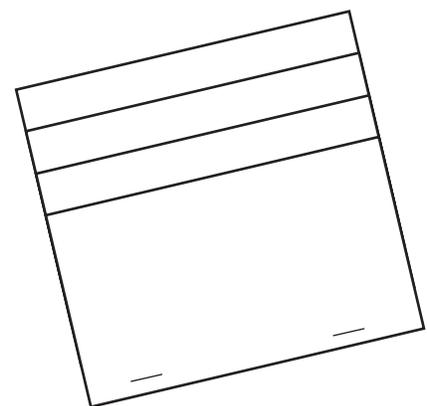
1. Place two sheets of paper (8 1/2" x 11") on top of each other, with the bottom sheet staggered one inch higher than the top sheet.



2. Lift the bottom of both sheets up and align the sides. Make sure the distance between each tab is the same.



3. Fold and crease the bottom edge of the sheets when all tabs are in place.
4. Place two staples along the fold as shown.



Name \_\_\_\_\_

# Getting to Know You Glyph

**Body**

Age

Odd 

Even 

**Face**

Girl 

Boy 

**Mouth**

Favorite Food

Pizza 

Spaghetti 

**Eyes**

Favorite Season

Spring or Summer green

Fall or Winter brown

**Shoes**

Walk to School 

Ride to School 

**Face**

Favorite Subject

Hooked on Reading 

Math 

**Scoring Rubric/Key**

1. Student interprets 2 or fewer correctly
2. Student interprets 3 or 4 items correctly
3. Student interprets 5 or 6 items correctly
4. Fully interpreted correctly

**Hair**

Number of people in your family

1 ★ for each person

Name \_\_\_\_\_

# Getting to Know You Glyph

**Body**

Age

Odd 

Even 

**Face**

Girl 

Boy 

**Mouth**

Favorite Food

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**Hair**

Number of people in your family

1 ★ for each person

***Math  
Standard  
IV-1 & 2  
Activities***



# Inchworm, Inchworm, Oh So Small

**Standard IV:**

Students will understand and use measurement tools and techniques.

**Objective 1:**

Identify and describe measurable attributes of objects and units of measurement.

**Objective 2:**

Use appropriate techniques and tools to determine measurements.

**Intended Learning Outcomes:**

5. Make mathematical connections.

**Content Connections:**

Math III-3, IV-4; Science III-1 & 2

## Math Standard IV

## Objectives 1 & 2

## Connections

### Background Information

Explicit teaching has been proven to be a very important and effective way to teach students. The *what*, *why*, and *how* are discussed very specifically with students. They are given the objective and the relevance of the lesson being taught.

*What:* Students will be able to see the relevance of being able to measure accurately and which tools to use. This will be done through answering questions in a game format. Mental math will be required in answering the questions. This would be a good review after the unit on measurement is taught.

*Why:* Real life situations require a working knowledge of both metric and customary measure.

*How:* Through cooperative learning, we will be exploring the why in discussion as groups and partners and then playing a game that will remind students of the things they have learned. The question cards contain problems that will be solved both mathematically and with previously explored information, such as units of length.

### Research Basis

Hiebert, J. & Carpenter, T. P. (1992). *Handbook of research on mathematics teaching and learning*. Learning and teaching with understanding. (pp. 65 -97).

In an 8-year study, Hiebert and Carpenter have researched learning and understanding. Their studies show these important findings:

- Students need to be able to connect new knowledge to what they already know.
- Students need to be able to construct a coherent structure for the new knowledge.

- Students need to be engaged in inquiry and problem solving.
- Teachers need to take responsibility for validating student ideas and procedures.

## ***Assessment Suggestions***

- Students create questions to ask each other, accompanied by an answer key. This could be done individually or as a team. Questions are then answered by another team. The assessment is based on both the ability to ask and answer their own questions, and to answer the questions provided by the other team.
- Journal entries
- Teacher observation

## ***Invitation to Learn***

There are many children’s picture books available to help illustrate math concepts. One of these is *Inchworm and A Half*. Inchworm goes on a measuring adventure through the garden. All is well until she comes to a place where she is too long to complete the measurement without falling off. What can she do about this predicament?

Read *Inchworm and a Half*.

## ***Instructional Procedures***

### ***Inchworm, Inchworm***

After the invitation to learn, begin the *Inchworm, Inchworm* activity by exploring all the ways we use linear measure in our lives. Discuss this with a partner.

This activity was developed to give students a hands-on way to review and remember what they have been learning about linear measurement. The questions are designed to get students to think about how to solve problems of measurement and help them see how useful this skill will be in their lives.

Preparing the *Inchworm Game Strip* reinforces the inch marks and the foot marks on a ruler or yardstick for students. Coloring each inch a different color helps them remember how big an inch actually is and how long a foot is. This will help them better identify and measure accurately when real life situations require them to measure objects or distances.

### ***Materials***

- Measurement journal
- Inchworm and A Half*
- Inchworm, Inchworm* handout
- An Inchworm Game Strip*
- Crayons
- Inchworm Game Cards*
- Glue stick
- Colored 1” tiles
- Inchworm, Inchworm Answer Key*

Be sure to review the customary units of measure and the metric units before beginning this activity.

Steps for preparing to play *Inchworm, Inchworm*:

1. Have the students learn the *Inchworm, Inchworm* rhyme.
2. Give each student the *Inchworm, Inchworm Game Strip* handouts.
3. Students begin by coloring the 12 inch, 24 inch, and 36 inch sections (feet) the same color.
4. Take a ruler and color six inches each a different color. Do not use the same color as was used for the feet.
5. Once this is done, have students cut out the paper yardstick and the inchworm head. Glue these together with the white tab underneath.
6. Review the rules of the game (p. 3-7).
7. When the game is finished, discuss what the students were able to learn from this activity and then write these ideas in their math journals.

### **Facilitated Journal Activity**

- Students pull slips of paper from a journal jar. These papers contain journal entry starters. The entire class will use the same journal starter for this activity. Other times students could pull their own journal starter from the jar. The instructions for this activity are found in the Facilitated Activities section of this handbook (pp. 2-14 to 2-16).

### ***Curriculum Extensions/Adaptations/Integration***

- Have students come up with their own questions to play the game.
- Use the *Inchworm, Inchworm Answer Key* to make up cards to be used in playing Jeopardy.
- Use laminated cardstock answer cards and question cards to play Concentration.
- Call out the questions and have students answer in teams or pairs orally.
- The inchworm is a true measurement of a yardstick. It could be used in other measuring activities. The game strip could be copied on laminated cardstock and then used as a yardstick without the worm head.

## **Resources**

### **Books**

*Inch by Inch*, by Leo Lionni; ISBN 0688132839

*Jim and the Beanstalk*, by Raymond Briggs; ISBN 0698115775

*Inchworm and A Half*, by Elinor J. Pinczes; ISBN 039582849-X

*Millions to Measure*, by D. M. Schwartz; ISBN 0688129161

*Let's Measure It*, by L. Connelly; ISBN 1574710060

## **Family Connections**

- Have students share the story from the invitation to learn with their families.
- Send the Concentration game and the Jeopardy game home for students to play with family members.

Name \_\_\_\_\_

## ***Inchworm, Inchworm***

Inchworm, Inchworm, oh so small  
One inch worm barely seen at all.

Inchworm, inchworm, how you've grown  
Twelve inch worm now a foot worm known.

Footworm, footworm, what a sight.  
3-foot worm now a yard in height.

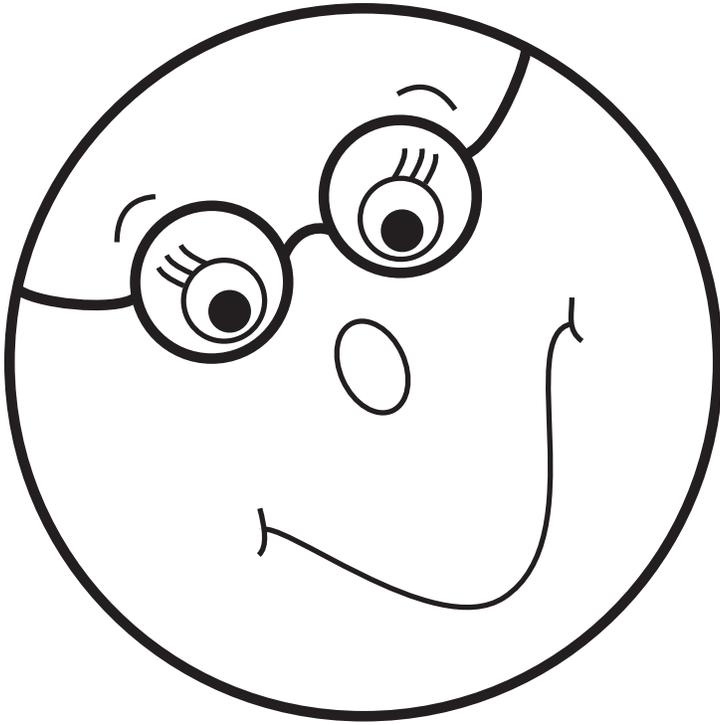
### ***How to play the game:***

1. Each player places his game strip in front of him/her.
2. The question cards are shuffled and stacked in the middle face down.
3. To choose who will go first, the players say a word of the poem in order, one word per player, and continue going around until one player says the "height." This is the player who begins the game. This procedure is similar to eeny, meeny, miney, moe.
4. The game proceeds by that player taking the first question card and reading it aloud. If s/he answers correctly, s/he places a tile on the first inch mark.
5. The player to the right does the same thing, marking his/her own strip if s/he answers correctly, and so on. If a question is answered incorrectly, that player puts the card on the bottom of the question card pile and does not place a tile on his/her inch mark.
6. Play continues in this manner until one player places a tile on the 36 inch mark. The first player to do so wins the game.

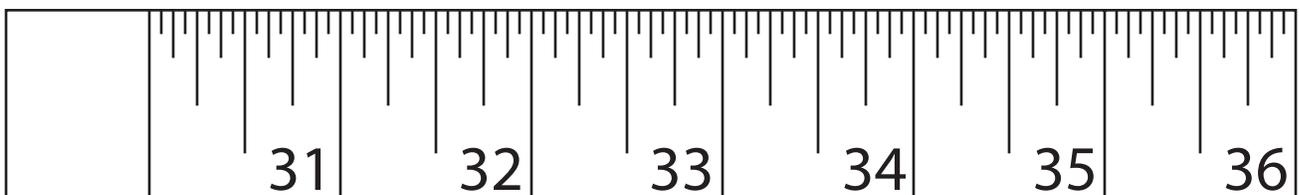
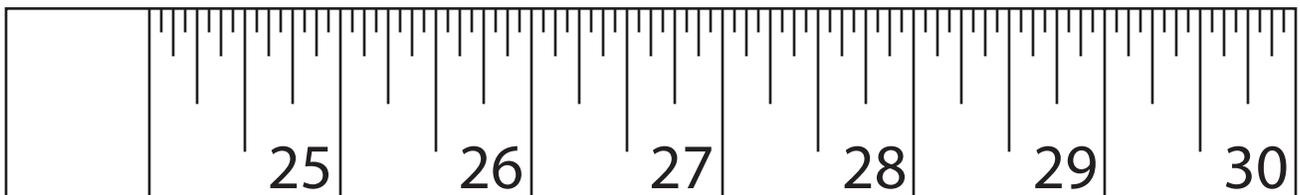
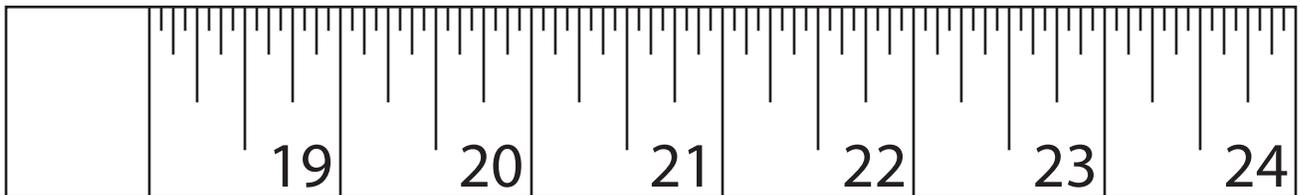
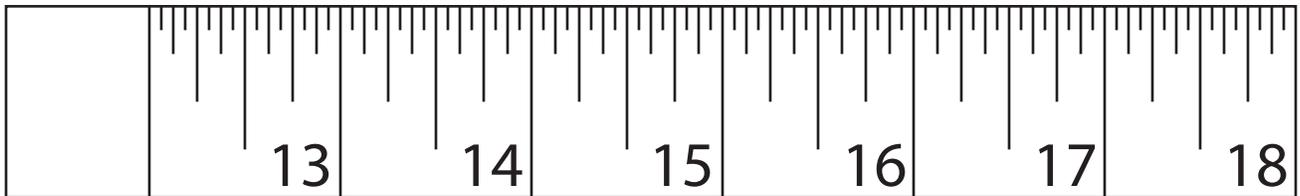
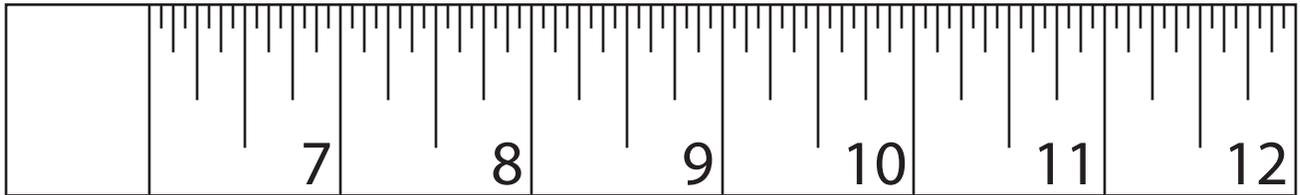
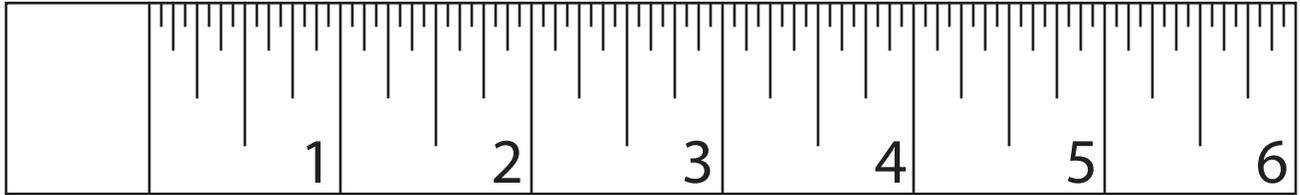
#### ***Materials***

- Inchworm Game Strip*
- Inchworm Game Cards*
- Inchworm, Inchworm Answer Key*
- 1" colored tiles

# ***Inchworm, Inchworm Game Strip***



# ***Inchworm, Inchworm Game Strip, cont.***



## ***Inchworm Game Cards***

<p><b>1. What would you use to measure a pencil? An inch, a foot, or a yard?</b></p>	<p><b>2. About how many inches is a paper clip?</b></p>	<p><b>3. Would it be best to use a standard ruler or a yardstick to measure the classroom door?</b></p>
<p><b>4. How many inches are in a foot?</b></p>	<p><b>5. How many feet are in a yard?</b></p>	<p><b>6. How many inches are in a yard?</b></p>
<p><b>7. Which is longer, an inch or a foot?</b></p>	<p><b>8. What part of your body is about a foot in length?</b></p>	<p><b>9. What part of your body is about an inch long?</b></p>

<p><b>10. Your book measures 12 inches. How long would it be if you added 2 more inches?</b></p>	<p><b>11. How many inches are in two feet?</b></p>	<p><b>12. If you added one foot to 24 inches, how many inches would you have?</b></p>
<p><b>13. A piece of paper is a yard long. You cut off two feet. How many feet would you have left?</b></p>	<p><b>14. What does the word “about” mean?</b></p>	<p><b>15. A standard ruler is how many inches?</b></p>
<p><b>16. What is the perimeter of a square with one side measuring 5 inches?</b></p>	<p><b>17. What is the perimeter of a rectangle if one side is 6 inches and another side is 8 inches?</b></p>	<p><b>18. What does “perimeter” mean?</b></p>

<p><b>19. How do you find the perimeter of a square?</b></p>	<p><b>20. My brother is two times taller than my baby sister. My baby sister is two feet tall. How tall is my brother?</b></p>	<p><b>21. I have a pet boa constrictor that is 5 feet long. Is he longer than a yard?</b></p>
<p><b>22. My eraser is 2 1/2 inches long. If I added 1 inch to it how long would it be?</b></p>	<p><b>23. My shoe lace broke in half. It was 8 inches long. How many inches long is each piece?</b></p>	<p><b>24. If you draw a line 4 1/2 inches long, and then draw it 2 inches longer, how long would it be?</b></p>
<p><b>25. My sister's jump rope is 6 feet long. How many yards is that?</b></p>	<p><b>26. My brother is 6 1/2 feet tall. How many inches is that?</b></p>	<p><b>27. Your foot is 12 inches long. Mine is 16 inches long. How much longer is my foot than yours?</b></p>

<p><b>28.</b> The TV electric cord is 7 feet long. The electric wall outlet is 9 1/2 feet away from the TV. How many more feet of cord do I need to reach the plug?</p>	<p><b>29.</b> My dog is 4 feet tall when he stands on all four paws. My cat is 1 foot tall. How much taller is my dog than my cat?</p>	<p><b>30.</b> A bedroom measures 8 feet by 10 feet. What is the perimeter of the bedroom?</p>
<p><b>31.</b> My electric train set has 12 cars on it. Each one measures 1 foot long. How many feet in length is my train set?</p>	<p><b>32.</b> The front door of our house measures 8 feet from the floor to the top. I am 60 inches tall. How much taller is the door than me?</p>	<p><b>33.</b> How many feet are in 4 yards?</p>
<p><b>34.</b> A yard stick measures 36 inches. How many feet is that?</p>	<p><b>35.</b> On Field Day, my friend jumped 3 feet from the starting line and I jumped 1 yard. How many feet longer did I jump than my friend?</p>	<p><b>36.</b> Today we went to Subs and Such. We got a foot long sandwich. My brother ate 6 inches of the sandwich. How much was left for me to eat?</p>

<p><b>37. Dad bought an 8-foot high front door for our new house. It was supposed to be ten feet high. How many feet less was the door he bought than the size it should have been?</b></p>	<p><b>38. Ms. Hall asked each student on our jump rope team to bring a 4-foot rope to practice for the contest next week. If there are 10 students on our team, how many feet of rope would there be between us in all?</b></p>	<p><b>39. Mr. Jones gave each of us a piece of tape that was 2 inches long. How long would two pieces of tape be if they were put together?</b></p>
<p><b>40. Yesterday we built a 7 foot snowman. It melted 2 feet today while we were at school. How tall is it now?</b></p>	<p><b>41. If an elephant is 7 feet tall and a giraffe is 13 feet tall. How much taller is the giraffe than the elephant?</b></p>	<p><b>42. What is the measurement halfway between the 1 inch and 2 inch lines on a ruler?</b></p>
<p><b>43. Which is longer, a meter or a centimeter?</b></p>	<p><b>44. Would you measure your book by centimeters or meters?</b></p>	<p><b>45. How many centimeters are there in a meter?</b></p>

<p><b>46. If a mirror is 100 centimeters tall, how many meters is that?</b></p>	<p><b>47. Are meters longer or shorter than centimeters?</b></p>	<p><b>48. How many inches does a yardstick have on it?</b></p>
<p><b>49. A table measures 90 centimeters. Is it longer than a meter?</b></p>	<p><b>50. Would you use centimeters or meters to measure a pair of scissors?</b></p>	<p><b>51. The distance from your house to school would best be measured by yards or miles?</b></p>
<p><b>52. A hair brush is better measured by centimeters or meters?</b></p>	<p><b>53. A paintbrush is about 20 centimeters. How long would 3 paintbrushes be all together?</b></p>	<p><b>54. What part of your body is approximately 1 centimeter?</b></p>

## ***Inchworm, Inchworm Answer Key***

1. What would you use to measure a pencil an inch, a foot, or a yard? (an inch)
2. About how many inches is a paper clip? (1 inch)
3. Would it be best to use a standard ruler or a yardstick to measure the classroom door ? (a yardstick)
4. How many inches are in a foot? (12 inches)
5. How many feet are in a yard? (3 feet)
6. How many inches are in a yard? (36 inches)
7. Which is longer an inch or a foot? (a foot)
8. What part of your body is about a foot in length? (from the tips of your fingers to your elbow)
9. What part of your body is about an inch long? (your thumb from the tip to the first knuckle)
10. Your book measures 12 inches. How long would it be if you added 2 more inches? (14 inches)
11. How many inches are in two feet? (24 inches)
12. If you added one foot to 24 inches, how many inches would you have? (36 inches)
13. A piece of paper is a yard long. You cut off two feet. How many feet would you have left? (1 foot)
14. What does the word “about” mean? (not exact but close)
15. A standard ruler is how many inches? (12 inches)
16. What is the perimeter of a square with one side measuring 5 inches? (20 inches)
17. What is the perimeter of a rectangle if one side is 6 inches and another side is 8 inches? (28 inches)
18. What does “perimeter” mean? (The outside edge)
19. How do you find the perimeter of a square? (add all four sides together or multiply one side by 4)
20. My brother is two times taller than my baby sister. My baby sister is two feet tall. How tall is my brother? (4 feet tall)
21. I have a pet boa constrictor that is 5 feet long. Is he longer than a yard? (Yes)
22. My eraser is 2 1/2 inches long. If I added 1 inch to it how long would it be? (3 1/2 inches long)
23. My shoe lace broke in half. It was 8 inches long. How many inches long is each piece? (4 inches)
24. If you draw a line 4 1/2 inches long and then draw it 2 inches longer, how long would it be? (6 1/2 inches long)
25. My sister’s jump rope is 6 feet long. How many yards is that? (2 yards)
26. My brother is 6 1/2 feet tall. How many inches is that? (78 inches)
27. Your foot is 12 inches long. Mine is 16 inches long. How much longer is my foot than yours? (4 inches)
28. The TV electric cord is 7 feet long. The electric wall outlet is 9 1/2 feet away from the TV. How many more feet of cord do I need to reach the plug? (2 1/2 feet)

29. My dog is 4 feet tall when he stands on all four paws. My cat is 1 foot tall. How much taller is my dog than my cat? (3 feet)
30. A bedroom measures 8 feet by 10 feet. What is the perimeter of the bedroom? (36 feet)
31. My electric train set has 12 cars on it. Each one measures 1 foot long. How many feet in length is my train set? (12 feet)
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40. Yesterday we built a 7 foot snowman. It melted 2 feet today while we were at school. How tall is it now? (5 feet tall)
41. If an elephant is 7 feet tall and a giraffe is 13 feet tall. How much taller is the giraffe than the elephant? (6 feet)
42. What is the measurement halfway between the 1 inch and 2 inch lines on a ruler? (1 1/2 inches)
43. Which is longer, a meter or a centimeter? (a meter)
44. Would you measure your book by centimeters or meters? (centimeters)
45. How many centimeters are there in a meter? (100 centimeters)
46. If a mirror is 100 centimeters tall, how many meters is that? (1 meter)
47. Are meters longer or shorter than centimeters? (longer)
48. How many inches does a yardstick have on it? (36 inches)
49. A table measures 90 centimeters. Is it longer than a meter? (no)
50. Would you use centimeters or meters to measure a pair of scissors? (centimeters)
51. The distance from your house to school would best be measured by yards or miles? (miles)
52. A hair brush is better measured by centimeters or meters? (centimeters)
53. A paintbrush is about 20 centimeters. How long would 3 paintbrushes be all together? (60 centimeters)
54. What part of your body is approximately 1 centimeter? (the width of your finger)

# Sliding Along

## Math Standard IV

### Objective 1

#### Connections

<b>Standard IV:</b> Students will understand and use measurement tools and techniques.
<b>Objective 1:</b> Identify and describe measurable attributes of objects and units of measurement.
<b>Intended Learning Outcomes:</b> 2. Become mathematical problem solvers.
<b>Content Connections:</b> Math III-3, IV-4; Science III-1 & 2

### **Background Information**

*What:* This lesson reinforces the student knowledge of linear measure and how it works.

*Why:* Real life situations require a working knowledge of both metric and customary measure.

*How:* We will be exploring the *why* in discussion as groups and partners and then practicing measuring skills in the activity.

### **Research Basis**

Payne, R. K. (2002) *Understanding Learning the How, the Why, the What*. Aha Process, Inc., Highland, TX.

Mental models are how the mind holds abstract information that has no sensory representation. In math specifically, we know that it is about assigning value and order to the universe. Mental models help us to do this. By using mental models we “collapse” the time it takes to learn and retain something.

Carpenter, T., Blanton, M., Cobb, P., Franke, M., Kaput, J., & McClain, K. (2004). *Scaling Up Innovative Practices in Mathematics and Science*. Research Report, National Center For Improving Student Learning and Achievement in Mathematics and Science. 3

“Perhaps the most important feature of learning with understanding is that it is generative: In other words, when students and teachers acquire knowledge with understanding they can apply that knowledge to learn new topics and solve unfamiliar problems. If this does not happen then each topic is viewed as an isolated skill. One way to accomplish this is for a teacher to explicitly teach.”

## Assessment Suggestions

- The *Sliding Ruler* assignment may be used as an assessment tool.
- Journal entries
- Teacher observation

## Invitation to Learn

Distribute a Ziploc® bag of coins to each student and provide a choice of an object from a basket of different items such as a crayon, a pencil, or a paper clip. Ask the students to measure the height of their desks from the floor to the top of the desk using the item they have chosen. They must pay \$.10 a length to be able to use that desk for the rest of the day. Have the students write a journal entry about what they discovered, and then discuss it with a partner.

## Instructional Procedures

Summarize the plot of *How Big Is A Foot?*, highlighting the measurement problem. Then explain what the customary measures and metric measures are. Use a ruler and a yardstick for this. Make sure both standard and metric measures are represented on each.

Explain to the students that sometimes we have to *estimate* the length of an object or a distance. To help them see the relationship between inches, feet, yards, and miles, and then between millimeters, centimeters, and meters, show them these estimates using parts of the body. A millimeter could be compared to the depth of a fingernail. A centimeter could compare to the width of a little finger. An inch is about the length of your thumb from the tip to the first knuckle. A foot is about the length of a third grader's arm from the finger tips to the elbow. Have the students practice this by demonstrating what an approximate measure would look like by holding up their own arm or thumb, etc.

Many times the measuring tool is relative to what is being measured. For example, when measuring distance on a map, a certain length of a line stands for a specific number of miles. To help teach how to measure accurately from a picture or a line that stands for a certain measurement, we are going to do an activity called *Sliding Along*.

### Materials

- How Big Is A Foot?*
- Basket of different kinds of things to measure with (e.g., crayon, pencil, paper clip)

For each student:

- Ziploc® bag of coins
- Standard/metric ruler
- Plastic tie
- Sliding Along* worksheet
- Sliding Synthesis Journal*

### **Sliding Along**

1. Give each student a ruler and a plastic tie. The plastic tie is wrapped around the ruler and pulled fairly tight. Cut off most of the end using scissors, leaving a small point sticking out.
2. Have the students slide the tie along the ruler to see how it works.
3. Use the sliding along ruler to measure different items.
4. Be sure they see that the measuring starts at the end of the ruler and not at the one inch mark.
5. Use the *Sliding Along* worksheet to have the students practice measuring with their sliding along rulers.
6. Students write a response to the activity.
  - What did they learn?
  - How can they use what they have learned in the future?

### **Facilitated Journal Activity:**

Create a *Sliding Synthesis Journal*.

### ***Curriculum Extensions/Adaptations/Integration***

- Have students measure and mark different things each day. They could draw a horizontal line two inches long and put their name on it at the top of an assignment, or measure how many inches it is between lines on an assignment. Doing these activities daily helps reinforce the technique of accurate measuring.
- Turn the tie on the sliding ruler so that the point is on the metric side. Do an activity similar to *Sliding Along* using metric measure.
- Do this activity in pairs. A student who does not understand, or is struggling with measuring accurately, can still participate and have a successful learning experience.
- Activities such as measuring how far an object will travel when different intensities of force are applied could easily be done with the sliding along ruler.

## **Resources**

### **Books**

*Measuring Penny*, by Loreen Leedy; ISBN 0805065725

*Twelve Snails to One Lizard*, by Susan Hightower; ISBN 068904520

*How High is Pepperoni?*, by Nancy Solos and Eric Bailey;  
ISBN 059011526-X

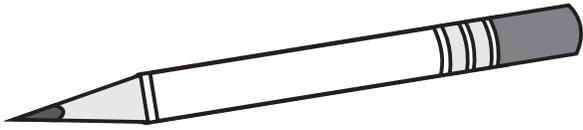
*How Big is a Foot?*, by Rolf Myller; ISBN 044040495-9

## **Family Connections**

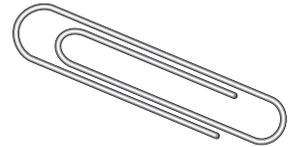
- Have students create a grid to be used to measure things at home.
- Have family members help students make a map of their bedroom. Students measure between different objects, then decide on a representative line that would stand for a unit of length, e.g., one inch would represent one foot. Students then draw a map using the one inch to one foot ratio. Return the maps to school and share with a partner who tries to figure out the distance between each object.

# Sliding Along

Use the picture rulers to measure the objects with your sliding ruler as a guide. The word inches is abbreviated “in.” The word centimeter is abbreviated “cm.”



\_\_\_\_ in.    \_\_\_\_ cm.



\_\_\_\_ in.    \_\_\_\_ cm.



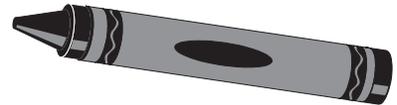
\_\_\_\_ in.    \_\_\_\_ cm.



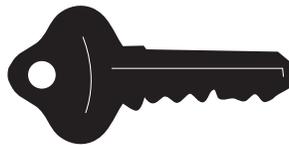
\_\_\_\_ in.    \_\_\_\_ cm.



\_\_\_\_ in.    \_\_\_\_ cm.

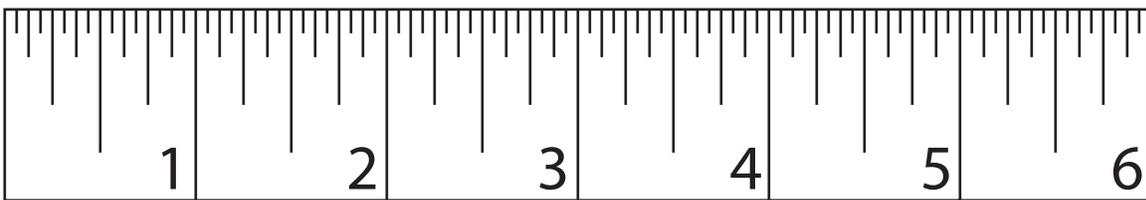


\_\_\_\_ in.    \_\_\_\_ cm.



\_\_\_\_ in.    \_\_\_\_ cm.

Inches



Centimeters



Name \_\_\_\_\_

## *Sliding Synthesis Journal*

<b>What I Did</b>	<b>What I Learned</b>	<b>How I Can Use It</b>

# The Pasture and the Fence

## Math Standard IV

### Objective 2

#### Connections

<b>Standard IV:</b> Students will understand and use measurement tools and techniques.
<b>Objective 2:</b> Use appropriate techniques and tools to determine measurements.
<b>Intended Learning Outcomes:</b> <ol style="list-style-type: none"><li>1. Demonstrate a positive learning attitude toward mathematics.</li><li>2. Become mathematical problem solvers.</li></ol>
<b>Content Connections:</b> Math III-1, IV-2

## Background Information

Students learn best when mental models are incorporated into instruction. These mental models are how the mind holds abstract information (information that has no sensory representation). Mental models are held in the memory as stories, two dimensional drawings, or analogies. Mental models help us teach something in a shorter amount of time, and the memory retains it better. For example, teach a spelling lesson on homophones using pictures to represent the words. The word “hear” with “ear” underlined would be next to a picture of an ear. The word “here” does not have “ear” in it.

*Prior knowledge:* Students need to know perimeter and area before doing this activity.

*What:* This activity helps students learn to measure area and perimeter using square inches instead of a ruler. This knowledge is then transferred to square centimeters.

*Why:* Math is a way of ordering and putting value on our universe. This is done either by numbers, space, or time. Learning how to measure perimeter and area gives order to space. This is a life skill that all students need to have as adults.

*How:* Through the use of a 1” grid and 1” square tiles, students work with partners in creating rectangles of different sizes, then measuring them by counting the tiles for both area and perimeter. A discussion follows to explore what the students learned, and journal entries are logged.

## Research Basis

Payne, R. K. (2002) *Understanding Learning the How, the Why, the What*. Aha Process, Inc., Highland, TX.

Mental models are how the mind holds abstract information that has no sensory representation. In math specifically we know that it is about assigning value and order to the universe. Mental models help us to do this. By using mental models we “collapse” the time it takes to learn and retain something.

Kagan, S., *Cooperative Learning*. (1992). Spencer Kagan’s Cooperative Learning Structures: a comprehensive article written by Jane Joritz-Nakagawa (Aichi University of Education)

More than 122 studies have been done on the effectiveness of cooperative learning. All have come to the same conclusion: students learn and retain knowledge better through working with partners and groups. Recent research links regular cooperative experience in the classroom with gains in a number of areas.

## Assessment Suggestions

- Record sheets
- Journal entries
- A sheet containing rectangles divided into squares could be used to aid students in responding to a question format that is similar to the state assessments.

## Invitation to Learn

Give each student a 3” x 5” card to record answers. Have several charts on the wall so the students can go around the room for a few minutes figuring out mental models of words found on the charts. Record these on a mental model sheet. Have students start on different sides of the room and do this for a few minutes. Some mental models for the words perimeter and area might be:

r peRIMeter  
 peRIMete  
 AR  
 EA  
 peRIMeter  
 peRIMeter

PERIMETER DRAWN AS A FENCE,  
 AREA DRAWN AS GRASS IN A PASTURE

Discuss with the class other ideas for making mental models of these two words.

## ***Instructional Procedures***

### ***Materials***

For each pair:

- 3-1" Grids
- 3-Centimeter Grids
- 1" colored tiles

For each student:

- Journal
- Crayons
- 3" x 5" card
- Layered journal

Before beginning this activity, introduce "layered journals" to your students. Use the journal to explore what they learned from the Invitation to Learn.

1. Explore ways of measuring lengths by using something other than a ruler or a yardstick. Measure with 1" colored tiles for an exact measure of rectangles for both area and perimeter.
2. Explain that squares are rectangles that have four equal sides. Other rectangles have two parallel sides of one length and two parallel sides of another length. Rectangles contain four right angles. Discuss the similarity of an angle, vertex, and corner. All three terms are used in the core curriculum.
3. Draw an illustration of a square that has four equal sides and rectangles with unequal sides. Show what a vertex is and what a right angle looks like. Label these for the students.
4. Give each pair of students a bag of 1" colored tiles, three 1" Grids, and a record sheet for each student.
5. Have the students take out their sliding rulers and measure the tiles.
6. Write on the board how a measurement using 1" tiles would be recorded (e.g., 5 square inches). Also, show the abbreviation for this (5 sq. ins. or 1 sq. in.).
7. Use one of the three 1" Grids for each student to draw on and one to make the tile representations.
8. The record sheet will be used to log the measurements of each of the rectangles that will be made by each pair.
9. Have each student put his/her name on his/her own grid and record sheet.
10. Put the other grid on the table between them.
11. One partner lays 1" tiles on the middle grid to form a rectangle.
12. The other partner must draw the rectangle on his/her grid using a crayon. It must be in the exact location of the tile grid and the same size.
13. Have this same partner record the perimeter and area of the rectangle that s/he drew. This is done by counting the squares on the outside (perimeter) and all the squares on the inside of the

drawing (area). The other partner must also count the tiles to see if this is the correct answer. If it is, the partner who drew the rectangle marks the square on his/her sheet labeled correct with a check.

14. Partners switch and the second partner makes the tile grid. The first partner then copies that grid on his/her own grid with a crayon and takes his/her measurements.

The new tile rectangle must be a different size and in a different location from any other that has been drawn.

Making a tile representation and then transferring it to another grid by drawing the exact figure helps students go from concrete to abstract in forming the idea in their minds.

15. Discuss what the students discovered and then have them record what they have learned in their journals.

### ***Curriculum Extensions/Adaptations/Integration***

- Give the students a measurement orally. Have them place the tiles on the middle grid the size specified.
- This same activity may be done using only crayons with a centimeter grid. Instead of one partner using tiles, s/he would outline the figure on the middle grid with a crayon. The other partner would use that same color to transfer it to his/her own grid. The next figure drawn on the middle grid would be done in a different color. Use the centimeter record sheet for this activity.
- Cut and laminate larger squares measuring 10" x 10". Use different colors and have the students do this activity on the floor. They could either use each square as a 1" square representation or as a 10" square to get an exact measurement. Each square could also represent 1 square centimeter. One partner would lay down the rectangle and the other would do the measuring and recording. Then they would switch.
- Base a writing assignment on the book *Racing Around*. Have students write about a time when they were too young to do something. How did they feel?

## **Resources**

### **Books**

*Racing Around*, by S. Murphy; ISBN 0064462447

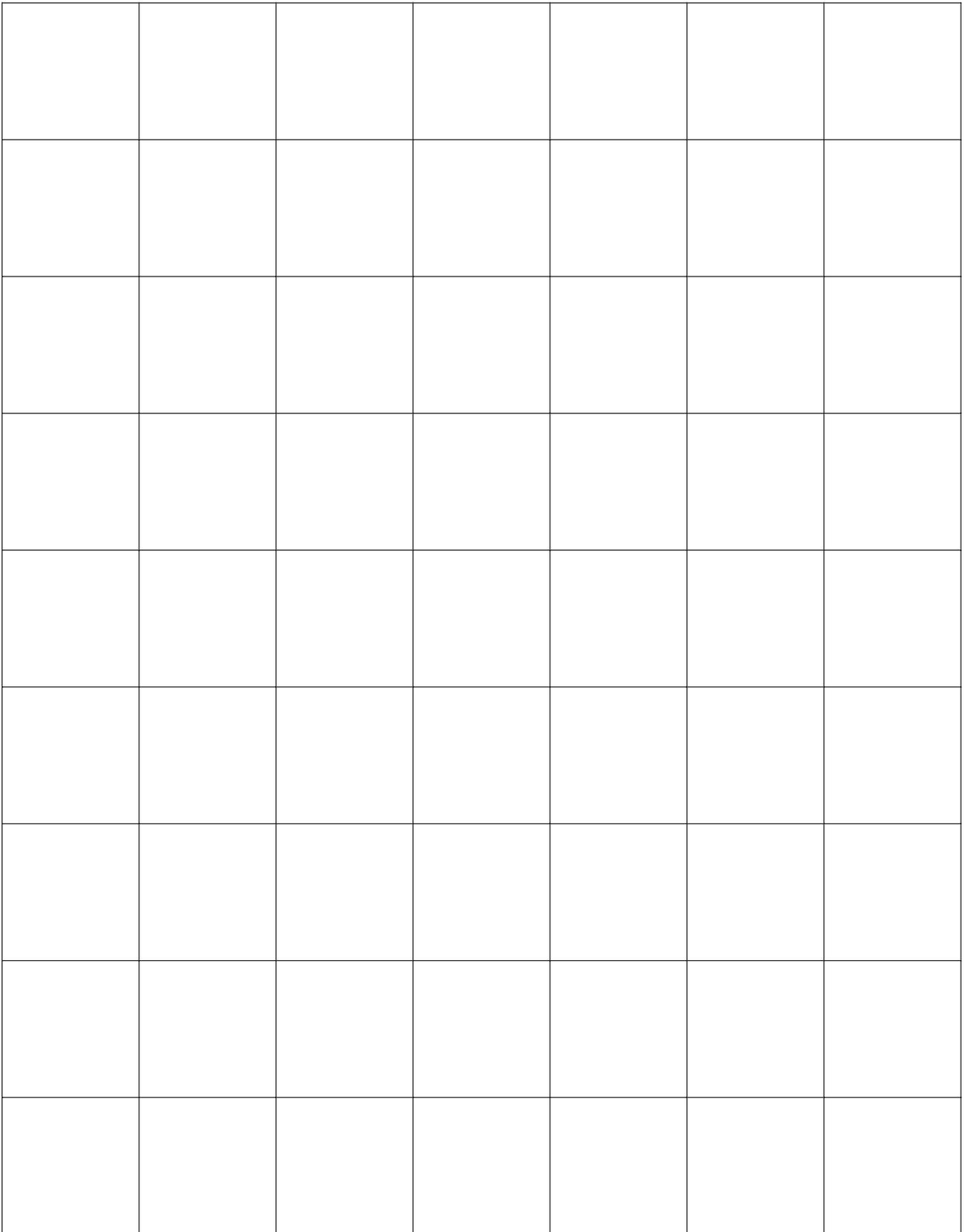
*Millions to Measure*, by D. M. Schwartz; ISBN 0688129161

*Let's Measure It*, by L. Connelly; ISBN 1574710060

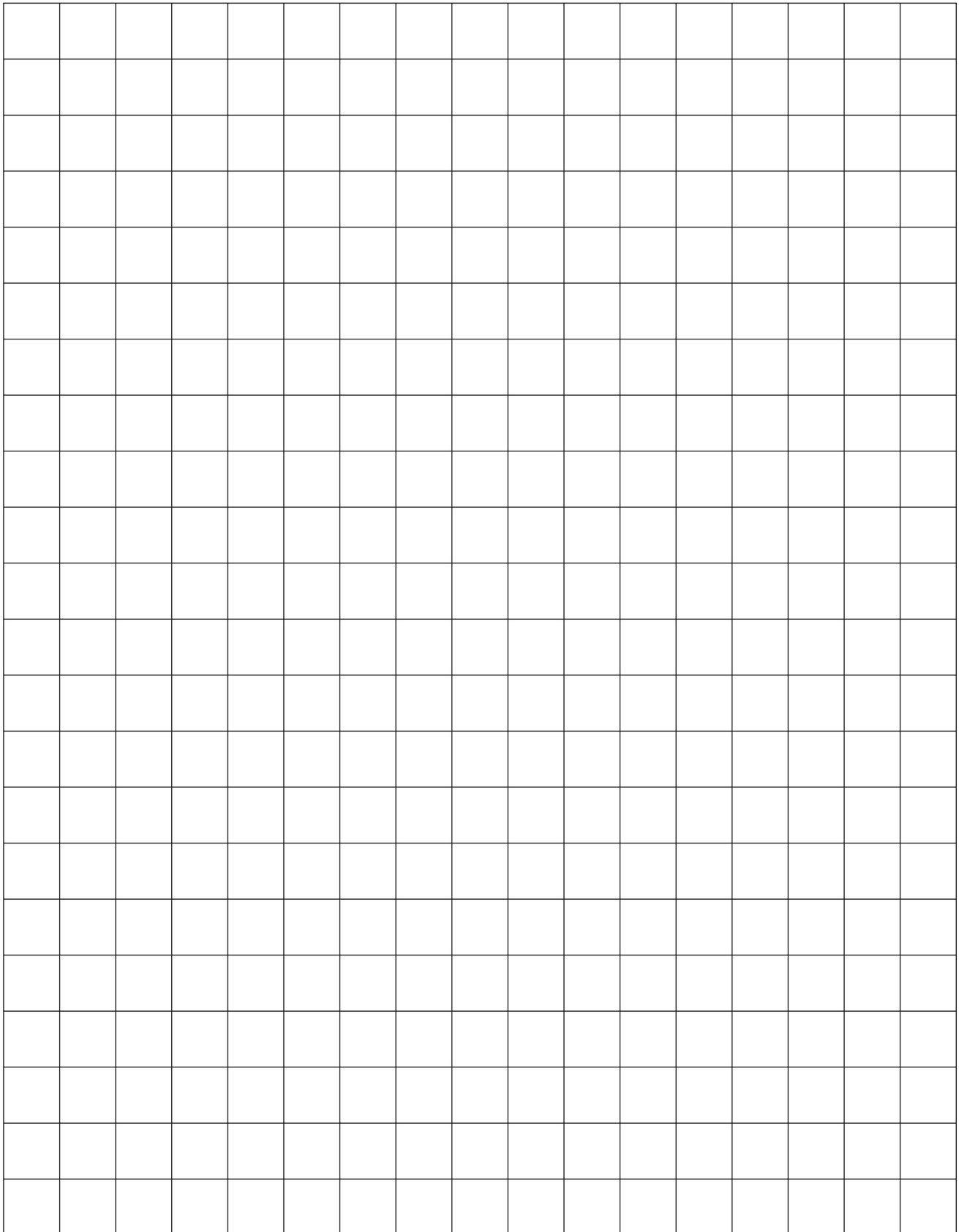
## **Family Connections**

- Send home a grid, measurement record sheet, and paper tiles for students to do this activity with family members.
- Have students discuss the different kinds of perimeters and areas found at home (e.g., the backyard fence or the carpet in the living room). Students then record on another sheet of paper a list of things that could also be measured as perimeter or area.

# 1" Grid



# Centimeter Grid







***Science  
Standard  
III-1 & 2  
Activities***



# Move It, Sir Isaac!

**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.

**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

**Content Connections:**

Math IV-1 & 2

## Science Standard III

### Objective 1

#### Connections

## Background Information

Thanks to Sir Isaac Newton's research of approximately 360 years ago, we have the laws of motion and force. Those laws have led to many wonderful achievements in science, which have profound impact on our everyday lives. His first law states that objects at rest will remain at rest unless acted upon by an outside force that is great enough to overcome the object's inertia, or tendency to stay still; the larger the object is, the more force is required to move it.

The activities in this lesson are designed to lead students to understand this concept and to relate it to their everyday lives.

Some classes may need some time built into the lesson to explore the materials before they are ready to handle them appropriately. Some students are extremely sensory-based in their actions and the manner in which they attempt to make sense of their world. If needed, conduct a short, introductory activity to allow the students to handle the materials, showing them how to appropriately use them.

## Research Basis

Carpenter, T.P., Blanton, M.L., Cobb, P., Franke, M.L., Kaput, J., McClain, K. (2004).  
Scaling Up Innovative Practices in Mathematics and Science. *National Center For Improving Student Learning and Achievement in Mathematics and Science.*

Learning with understanding must build on what students already know and their ways of thinking. Teachers need to gain understanding of ideas that would enable them to adapt an innovation in teaching practices to their own instructional settings. Instead of thinking of adopting resources and using them as they are presented, teachers need to adapt the resources to the needs of their teaching circumstances.

## **Assessment Suggestions**

- Students show an example of and/or articulate Newton’s first law of motion. They will write, articulate, or demonstrate the definition of force.
- The *Move It, Sir Isaac!* and *Move It at Home, Sir Isaac!* worksheets will be included in science journals.

## **Invitation to Learn**

### **Bump on a Log**

Divide students into groups and place a lump of clay in front of them on the floor or on a group of desks. Use the *Bump on a Log* handout to connect with the idiomatic phrase, if desired. Instruct them not to touch the clay or try to move it in any way. Have the students discuss and describe it’s action by answering the following questions:

1. What is the lump of clay doing?
2. What can the lump of clay do?
3. How long will it stay here if we leave it alone?

Have students share their observations with the class.

## **Instructional Procedures**

1. Referring to the background information or other sources, introduce Sir Isaac Newton and his contribution to science.
  - Paraphrase Newton’s first law of motion: An object at rest will remain at rest unless acted on by an outside force.
2. Ask students to explore what force is and discuss with their group how they are going to move their lump of clay.
3. Explain that they may move the clay by any means that they can think of, without picking it up, changing its shape, or moving it into another group’s workspace. Allow about one minute to explore.
4. Ask: “What actions did you use to move the lump of clay?” If they say “with my finger,” dig deeper: “What did you do with your finger? How did your finger move the clay?” The discussion should culminate with a definition of force: Force is a push or a pull.
5. What are the results of pushes? Pushes may be hard or soft. What will happen if we move the clay by a soft push? (It will

move a little.) What will happen if we move the clay by a hard push? (It will move a lot.) Experiment to see how much force is necessary to move an object. What are the results from using different amounts of force?

6. Next, move the class to a taped area on the floor. Do the activity, *Move It, Sir Isaac*.
  - a. We are going to explore the results of soft and hard pushes on objects. This is going to be like a contest. Students take turns pushing, counting, and measuring. Place the lump of clay on the starting line, then move it by soft pushes to the finish line a yard away. Take turns. One person will push, one will record, the others will count. Record how many pushes it took. Measure the first push and record it. Then start over, taking turns pushing the clay harder, recording results. Repeat the activity with the paper clip, and then with the marble.
  - b. Model for the students how to push softly, then hard, showing them how to measure the first push. Demonstrate how to complete the *Move It, Sir Isaac!* worksheet.
  - c. Have one student on each team do each activity. This student will be the designated monitor to help keep group members on task. Check for understanding. Give feedback or reteach if necessary.

### **Materials**

For the class:

- Masking tape

For each group:

- Clipboard
- Paper drawing of a log
- Ruler
- Marble
- Paper clip

For each student:

- Bump on a Log* handout
- Modeling clay
- Journal
- Move It, Sir Isaac!* worksheet
- Move It at Home, Sir Isaac!* worksheet

## ***Curriculum Extensions/Adaptations/Integration***

- To help all students remember the first law of force and motion, guide them to create a mental model (Payne, 2002), e.g., draw a picture or other representation of the law, then explain it in their own words. Include these representations in their science journals.
- Students predict how many pushes each object will need. Based on their prediction, would larger objects need more or fewer pushes? After making their predictions, experiment, then analyze the results. They would create a double bar graph showing the results.
- Integrate with physical education using a scooter activity to explore the effects of pushing and pulling.

## Resources

### Books

*Science Experiments With Forces*, by S. Nankivell-Aston & D. Jackson; ISBN 0-531-14582-4

*Pushing and Pulling*, by G. Gibson; ISBN 0-7613-0461-4

*Forces and Movement*, by P. Riley; ISBN 0-531-15368-1

*The Handy Science Answer Book*, by the Carnegie Library of Pittsburgh; ISBN 0810394510

*Super Science Investigations, Grades 3-5*, (available from <http://www.theeducationcenter.com/>, 1-877-696-0825); Item TEC919

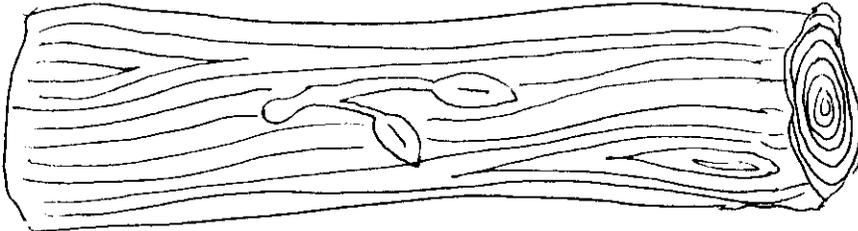
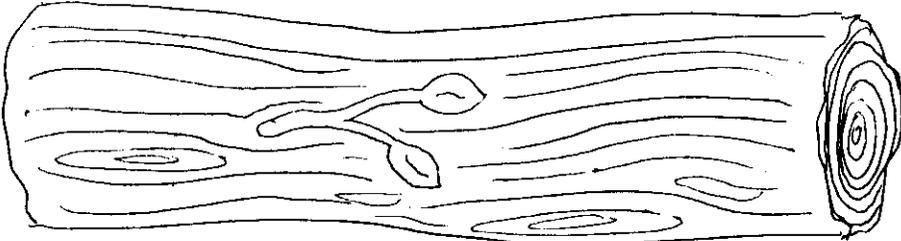
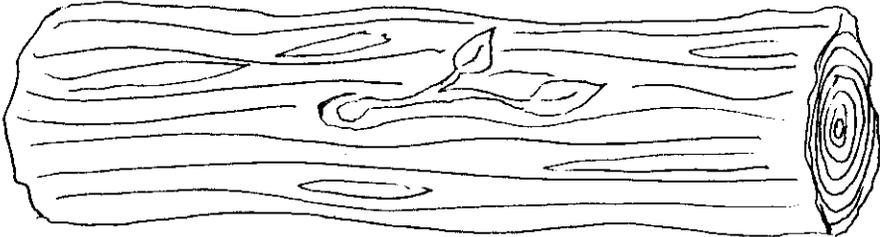
### Web site

*Eric Weisstein's World of Biography*, Retrieved January 23, 2005 from <http://www.scienceworld.wolfram.com>

## Family Connections

- Use the *Move It at Home, Sir Isaac!* worksheet to compare the force needed to move various objects in the home. Record the results and share with the class (e.g., instead of using a finger to push a small object, what did they use to move a box of cereal? What did they use to move a chair? What would they have to use to move their bed?). Be sure to record the number of hard and soft pushes used and the distance the object was moved.

# Bump on a Log



## Move It, Sir Isaac!

Count the number of soft and hard pushes it takes to get the object to the finish line. Measure the first soft push and record it before finishing the soft pushes. Measure the first hard push and record it before finishing the hard pushes.

Object	Number of Soft Pushes	About how long is one push?	Number of Hard Pushes	About how long is one push?
Lump of clay				
Paper clip				
Marble				

1. Does it take more or fewer soft pushes to move an object from the starting line to the finish line? Why do you think so?
2. Does it take more or fewer hard pushes to move an object from the starting line to the finish line? Why do you think so?
3. Does it take more force to move a heavy object than a light object? Why do you think so?
4. Describe how soft and hard pushes are different.
5. Does the shape of an object make a difference?

Name \_\_\_\_\_

## ***Move It At Home, Sir Isaac!***

Explain to a family member what your experiment is and get permission or help to move any very large objects. Make a start and finish line at least three feet apart. Choose objects to move. Count the number of soft and hard pushes it takes to get the object to the finish line.

<b>Object</b>	<b>Number of Soft Pushes</b>	<b>Number of Hard Pushes</b>	<b>About how many feet did you move it?</b>	<b>What did you use? finger, hand, legs, etc.</b>

1. Which objects took less force to push? Why do you think so?

2. Which objects took more force to push? Why do you think so?

# Rock-A-Bye Pendulum

## Science Standard III

### Objective 2

#### Connections

**Standard III:**

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

**Objective 2:**

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

**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

**Content Connections:**

Math V-2; Physical Education II-1 & 2

## Background Information

Newton’s first law of motion describes the tendency of all objects and matter in the universe is to stay still, or if moving, to continue moving in the same direction, unless acted on by some outside force. The teaching of force and motion in third grade sets the foundation for further understanding when its principles are revisited again in sixth and seventh grades, and with a more in-depth focus in eighth grade.

This lesson plan uses a pendulum, as when a pendulum is set in motion it remains in motion, thus allowing time to perform experiments on an object in motion. Many universities exhibit large pendulums that actually show the rotation of the earth, hence they are important instruments having to do with force and motion.

This activity requires students to practice a basic scientific process. A question is given to them and they make predictions before setting up an experiment to prove or disprove their prediction. Students record their results and analyze their findings.

## Research Basis

King, Kenneth. (2005). Making Sense of Motion. *Science Scope*. p. 22-26.

“Making Sense of Motion” begins with a general statement that interest in motion comes at an early age as exhibited by a very young child playing with a car and making the vroomm sounds that suggest speed. All students need to develop an understanding of motion and force. Activities including hands-on investigation involve use of higher-order thinking skills.

## Assessment Suggestions

- Have students record results on the *Rock-A-Bye Pendulum* worksheet and discuss. Include an explanation of the effects of various forces on objects in motion in their science journals. They will articulate, demonstrate, or draw.

## Invitation to Learn

### Pinball

What happens when force is applied to an object in motion? Two similar activities compare the effects of a gentle force and a harder force on an object in motion.

1. Explore effects of a soft or gentle force. Demonstrate by setting up a track between two yardsticks and having students take turns rolling the marble down the track. Blow on it through the straw from the front, side, and behind. Students discuss what they saw and why it happened.
2. Demonstrate the effects of a hard force. Have students take turns rolling the marble down the track. As the marble is rolled down the “lane,” hit it with the “flipper” (popsicle stick) from the front, side, and behind. Students discuss what they saw and why it happened.
3. Discuss as teams what effect forces have on objects in motion.

## Instructional Procedures

Explain that students will be building a machine to help further explore the effects of force on an object in motion. Each group is responsible for building a machine and using it to experiment with applying force to an object in motion.

1. Demonstrate how to build the pendulum by placing the ruler on a desk so that four inches are on the desk and eight inches extend over the side. Tape the ruler to the desk.
2. Wrap one end of the string around the ball once. Wrap a piece of tape around the ball, covering the string. Put two pieces of tape where the string hangs off the ball so it won't tear through the tape.
3. Tie or tape the other end of the string around the ruler, three inches from the end.

### Materials

- Marble
- Popsicle sticks
- Large straw
- Yard or meter stick

### Materials

For each group:

- Ruler
- Tape
- 2 feet of string
- 2" ball
- Rock-A-Bye-Pendulum* worksheet

4. Show how to set the pendulum in motion by pulling it up and letting it go.
5. Help students build the pendulum and begin the activity.
6. Groups predict what will happen when a force acts on the pendulum and write the prediction on the *Rock-A-Bye-Pendulum* worksheet.

### ***Curriculum Extensions/Adaptations/Integration***

- Integrate with Math Standard V (Probability) by predicting what will happen to the pendulum when acted upon by other forces. Extend by trying other forces and record the results. Assessment includes the students stating that their prediction is most likely/least likely to happen in specific circumstances.
- Integrate with Physical Education by teaching coordination of moving with a partner in dancing and tag. Dribbling a basketball also demonstrates the effect of force on a moving object.
- Adapt by using the activity as a demonstration only. Student volunteers may use the pendulum. Responses may vary, including verbal, written, or pictorial.

### ***Resources***

#### **Books**

*The Handy Science Answer Book*, by the Carnegie Library of Pittsburgh; ISBN 0810394510

*Gizmos & Gadgets: Creating Science Contraptions That Work (and Knowing Why)*, by Jill Frankel Hauser; ISBN 1-885593-26-0

*Machines: Mind-Boggling Experiments You Can Turn Into Science Fair Projects*, by Janice Pratt VanCleave; ISBN 0-471-57108-3

*Forces and Motion (Hands on Science)*, by Sarah Angliss and Maggie Hewson; ISBN 0-7534-5348-7

*Eyewitness Force and Motion*, by Peter Lafferty; ISBN 0789448823

#### **Web site**

*Eric Weisstein's World of Biography*. Retrieved January 23, 2005 from <http://www.scienceworld.wolfram.com>

## ***Family Connections***

- Students observe forces in nature. Compare the effects of a strong wind and a light breeze on a shrub or tree. Observe cars going by their house. If they live near an intersection, watch and compare the force necessary for the car to slow down to turn. Do cars traveling at higher speeds have to brake sooner and harder than cars traveling slower? What else did they discover that changed its motion as a result of being acted on by a force? Report findings to the class.

## **Rock-A-Bye Pendulum**

Build a pendulum and explore the effect of different amounts of force on an object in motion. Follow these steps to build a pendulum:

1. Gather a ball, string, ruler, and tape.
2. Place the ruler on a desk so that four inches are on the desk and eight inches extend over the side. Tape it to the desk.
3. Wrap one end of the string around the ball once. Wrap a piece of tape around the ball, covering the string. Put two pieces of tape where the string hangs off the ball.
4. Tie or tape the other end of the string around the ruler, three inches from the end.

Congratulations! You are ready to do the experiment.

Set the pendulum in motion by pulling it up and letting it go. Predict what will happen when each of the listed forces acts upon the pendulum. Write your group’s prediction, then try applying the forces to the moving pendulum. Write what happened and why you think it happened.

<b>Force</b>	<b>Prediction</b>	<b>Results</b>	<b>Why do you think this happened?</b>
<b>Blowing</b>			
<b>Tapping with your hand</b>			
<b>Tapping with a paper</b>			
<b>No force (don't touch it, just watch what it does)</b>			

Name three things that could happen when a force acts on a moving object.

- 1.
- 2.
- 3.

# Lifting the Load

**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.

**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

**Content Connections:**

Math V-2

## Science Standard III

### Objective 1

#### Connections

## Background Information

A simplified definition of work is to make an object move or to change its motion. Simple machines are devices that make work easier. All simple machines transfer force. Some change the direction of force, while others change the strength of the force. Still others change both the direction and the strength. Most simple machines make work easier by allowing you to use less force over a greater distance to move an object. Some machines make work easier by allowing you to move things farther and/or faster. In these machines, a larger force is required, but over a shorter distance.

It would be preferable to include more than one pulley system, but due to the nature of the activity, it would involve a considerable amount of time for the students to attempt to build a more complex pulley system. This activity is adequate as a simple comparison between working with and without a pulley.

The invitation to learn is an example of a wheel and axle.

## Research Basis

Joritz-Nakagawa, J. (1992). Spencer Kagan's Cooperative Learning Structures. *2nd Peace as a Global Language Conference Proceedings & Supplements*, 7-8.

This paper discusses Spencer Kagan's approach to cooperative learning, which is structured peer interaction and collaboration to achieve a purpose. There are countless structural possibilities that can be used in any learning situation. The article gives examples of some structures. It also mentions structuring activities to involve multiple intelligences to make learning meaningful and accessible to students.

## Assessment Suggestions

- Class discussion and responses on the *Lift the Load* worksheet are the primary form of assessment.
- Active participation with the group in building, discussing, and experimenting is another form of assessment.

## Invitation to Learn

### Materials

- Can with a plastic lid
- 1 or more rubber bands, not too strong
- 2 matchsticks or wooden splints
- Weighted mass (e.g., 1/2" galvanized pipe joint or large metal nuts, bolts, washers, etc.)
- Poster board cut to the dimensions of the can (sleeve)
- Opaque tape (optional)

### It's "un-Can-ny!"

Students observe as you place what seems to be an ordinary can on a table. Tell them to watch its movements very carefully. Begin with the can sitting on the table. Focus attention to the fact that it is still and will not move by itself. Next, roll the can gently. It will return to you. Have the students try to figure out why the can returns when it is rolled. You may explain it and show what is happening, or leave it a mystery.

*Explanation:* The can stores energy in the rubber band because the weight remains in position as the rubber band twists. When the can stops rolling forward, the stored energy in the twisted rubber band propels the can in the opposite direction.

To make a returning can:

1. Make two holes in the lid and two in the bottom of the can to attach the rubber bands. Attach the weight to the rubber bands, then run the rubber bands through the holes in the bottom and the lid of the can.
2. Secure rubber bands by running a match stick or splint through the loop in the ends. You may want to cover the ends with tape so the rubber bands cannot be seen.
3. Practice rolling the can. If you roll it too hard, the rubber bands will allow the weight to spin, and it won't work properly.

## Instructional Procedures

Explore how a wheel and axle work to make work easier. Will a wheel and axle make homework easier? Probably not, but it does make some mechanical work easier. Prove this by learning how a wheel and axle work as part of another simple machine called a pulley. Compare how much force is needed to lift objects without a pulley, then how much force is needed with a pulley.

Model for the students and explain how to build the system (see p. 4-19):

1. Assign one student from each group to gather materials.
2. Tape the new pencils to a desk or table top with most of the length extending over the side.
3. In each cup, tape three 4-inch strings around the outside of the cup, then tape them together at the tips to form a three-armed handle for the cup.
4. Take one length of ribbon and attach each end to a cup by running the ribbon through the handle, folding it back to form a small loop, then tape it. Hang this first set of cups over one new pencil.
5. Take the piece of string and thread it through the hole in the spool and tie it to make a loop. Put the loop over the second new pencil.
6. Attach one end of the remaining ribbon to a cup the same as above. Thread the other end over the spool as it hangs from the pencil, then attach it to the last cup.
7. Using the cups without the spool, put items in one cup. Predict how many it will take to lift the cup off the ground and lift the cup to the top. Explain that they will compare this data, using the same items in the cups attached to the pulley.
8. Show the students how to complete the *Lift the Load* worksheet. Model how to predict, record the prediction, how to add items, recognize the actual count, and how record it. Model how to work together and take turns.

Assist groups as necessary in constructing pulley systems and beginning the experiments.

Have students compare the force needed to lift their items with and without the pulley system. Log the results on the *Lift the Load* worksheets and draw conclusions about how pulleys make mechanical work easier using the wheel and axle.

### ***Curriculum Extensions/Adaptations/Integration***

- Students devise their own pulley system and demonstrate for the class. Even if it fails, they will learn in the process and recognize the scientific process involved in an invention process.

#### **Materials**

For each group:

- 2-2 1/2 foot lengths of ribbon
- Thread spool
- 2 new pencils
- 4-8 oz. paper cups
- 12-4" pieces of string
- Tape
- 6" piece of string
- Weights (30 of each): flat or round marbles, pennies, beads, jumbo paperclips, pencil-top erasers, etc.

- Integrate the vocabulary of Math Standard V-2a (Probability) when predicting how many items it will take to lift the cup off the ground and lift it all the way to the top. For example, “It is likely that it will take five marbles to lift the cup of five marbles off the ground. It is not likely that only three marbles can lift the cup.”
- You may choose to use this lesson as a demonstration only and have students respond verbally or by drawing pictures to record predictions and actual results.

## **Resources**

### **Books**

*Simple Machines (Starting with Science Series)*, by Deborah Hodge; ISBN 1550743112

*How Can I Experiment With...? Force and Motion*, by Cindy Devine; ISBN 1-58952-012-2

*Science in Seconds for Kids: Over 100 Experiments You Can Do in Ten Minutes or Less*, by Jean Potter; ISBN 0-471-04456-3

*Science Experiments with Simple Machines (Science Experiments Series)*, by Sally Nankivell-Aston; ISBN 0-531-14579-4

### **Additional Media**

*Mystery Machines*, by Utah State University Junior Engineering, Logan, Utah (This module available for classroom instruction by contacting Junior Engineering, 435-797-8000; lesson plan available at <http://juniorengineering.usu.edu/lessons/machines/machines.php>)

## **Family Connections**

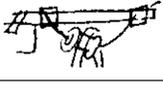
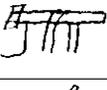
- Students can make and demonstrate their own returning can to family members and teach them how it works. Provide them with a list of necessary materials and assembly instructions.
- Students make their own pulley systems at home and compare the force needed to lift various household items.

Name \_\_\_\_\_

## Lifting the Load

Build the pulley system and compare the force needed to lift items without a pulley to the force used with a pulley.

How to build the pulley system:

	1. Tape the pencils to the desk.
	2. Tape the strings to the cups and tape the ends together.
	3. Tape the ends of the ribbon to the cup handles.
	4. Tape one end of the 6 in. string to a pencil, thread the spool on it, loop a set of cups over it, tape the other end.
	5. Loop the other set over the other pencil.
	6. Experiment and record results.

	Items needed to lift 5 off the ground (no pulley)		Items needed to lift 5 to the top (no pulley)		Items needed to lift 5 off the ground (with pulley)		Items needed to lift 5 to the top (with pulley)	
	Predict	Actual	Predict	Actual	Predict	Actual	Predict	Actual
<b>Marbles</b>								
<b>Paper Clips</b>								

Look at the results of your experiment. Which set of cups required more force or weight to move?

Explain in your own words how a pulley works to make mechanical work easier.



***Science  
Standard  
V-1 & 2  
Activities***



# Make a Refrigerator

**Standard V:**

Students will understand that the sun is the main source of heat and light for things living on Earth. They will also understand that the motion of rubbing objects together may produce heat.

**Objective 1:**

Provide evidence showing that the sun is the source of heat and light for Earth.

**Intended Learning Outcomes:**

1. Use Science Process and Thinking Skills
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning

**Content Connections:**

Math IV-2

Science  
Standard  
V

Objective  
1

Connections

## Background Information

The sun is the main source of heat and light for organisms living on Earth. Plants need sunlight to make food. Animals cannot make their own food. They must eat plants or other animals in order to live.

Without sunlight there would be no living things on Earth. Anything that gives off heat is a heat source. You can measure the difference in temperature with a thermometer. A thermometer uses a scale with each unit called a degree. When you place an ice cube in a glass of water, the ice cube takes heat from the water as it cools.

Many students have the misconception that coats and gloves give off heat. Heat is the flow of energy from hotter to cooler objects. Coats and gloves help stop that flow of energy and trap or hold the heat. Insulators are materials that block the flow of heat so warm things tend to stay warm, or cold items stay cool longer. Good insulators are plastics, air, fabrics that hold air, feathers, etc.

Temperature is a measurement of how much heat an object has. Thermometers can be used to dispel the misconception that clothing gives off heat. Measuring mittens, gloves, and coats before they are worn and while a person is wearing them teaches students that heat from their hands or bodies is trapped by the clothing.

**Science Words to Know**

*Electrical*—uses electricity or batteries

*Lubricate*—to make a surface slippery

*Machines*—tools with fixed or moving parts for doing work

*Mechanical*—does not use electricity (uses burning fuel, human energy, flowing water, or even horse power) to give energy

*Heat source*—makes things warm

*Temperature*—how warm or cold

*Degree*—unit of measure for temperature on a thermometer

*Misconception*—misunderstanding

## **Research Basis**

National Academics Press. (1996). *National Science Education Standards*, pp 123

Full Inquiry involves asking a simple question, completing an investigation, answering a question, and presenting the results to others.

Retrieved January 16, 2005, from <http://nap.edu.openbook/0309053269/123.htm>;

American Association for the Advancement of Science: Project 2061. (1994). *Benchmarks for Science Literacy*. ISBN 0195089863

Tools such as thermometers, magnifiers, rulers, and balances often give more information than can be obtained through observation.

Retrieved January 16, 2005, from [http://www.sciencenetlinks.com/benchmark\\_index.htm](http://www.sciencenetlinks.com/benchmark_index.htm)

Gerber, B.L., Brovey, A.J., & Price, C.B. (2002). Site-Based Professional Development: Learning Cycle and Technology Integration. Research report.

Learning cycles consist of three phases: exploration, concept invention where teachers guide students in interpreting data, and expansion (application of new concept; may include additional lab investigations, textual readings, and/or audio visual aids).

## **Assessment Suggestions**

- Rubric for *Winter Clothing*
  - 4 correct, complete, detailed
  - 3 partially correct, complete, detailed
  - 2 partially correct or complete, lacks some detail
  - 1 incorrect or incomplete, missing data, needs help
  - 0 no attempt

## **Invitation to Learn**

Invite two students come to front of the class and give each of them an ice cube in a sealable bag. Have the students hold the ice cube and ask, “What is happening?”

Clarify that the ice did not bring cold to the hand, but the heat from the hands moved to the ice cube, until they finally became the same temperature.

## ***Instructional Procedures***

### **Design a Refrigerator**

Tell the students that today they are going to design a refrigerator. The goal is to keep their ice cube from melting. They may use one paper towel, one piece of waxed paper, one piece of tin foil, and one plastic container (and any of the optional materials they want). Explain that they will have five minutes to assemble their refrigerator. At the end of the five minutes, they must wait 20 minutes before they may open their refrigerator and discover how well it worked.

1. Gather materials.
2. Weigh and record the weight of each ice cube.
3. Place one ice cube on a paper towel on a desk out of the sun (**do not touch or disturb in any way**). Use the materials any way you choose to try to keep the ice cube from melting as much as possible.
4. Wait 20 minutes. Open your refrigerator and compare the two ice cubes. Is there any difference? Record what happened.
5. Which design seemed to work best? Why do you think that is?

Clarify that the refrigerator insulated the ice cube and stopped the transfer of heat.

### **Does Winter Clothing Create Heat?**

1. Invite students to come to the front of the class and put on a coat, hat, and mittens/gloves. Ask them what is happening to them.
2. Ask the class, “Do you think that outdoor winter clothing makes you warm?” “Is there heat in the coat, the hat, or the mittens?”
3. Show different types of gloves, mittens, coats, and hats. Have students predict if the clothing items will warm up the body and if they think one will warm better than another.

*Journal*—Teachers predict what students will say.

### **Materials**

For the class:

- Platform scale

For each group:

- Small plastic cup
- 2 ice cubes
- 2 paper towels
- 12” wax paper
- 12” tin foil
- Ziploc® bag

Optional:

- Cotton balls
- Newspaper
- Fabric scraps

### **Materials**

- Mittens/gloves
- Hats
- Coats
- Thermometers (6-8)

4. Divide students into groups of three. Give each group an item of clothing. Allow students to select their role in the group:

*Time Keeper*—tells the temperature reader when to read the temperature

*Temperature Reader*—tells the data recorder what the temperature is at the time

*Data Recorder*—writes the temperature in the data chart

5. Check the temperature on the thermometer after sitting on a desk for two minutes. Record the temperature.
6. Put the thermometer inside the article of clothing and check the temperature after two minutes. Record the temperature.
7. Have one student put the clothing on with the thermometer touching the person inside the glove, coat, or hat. Record the temperature after five minutes.
8. Remove the clothing. Set it on a desk out of the sun, put the thermometer inside and wait five minutes. Record the temperature again.
9. What happened? Does a coat give off heat? Do gloves give off heat?

*Journal*—Teachers need to write themselves a reminder to check for student misconceptions.

### ***Curriculum Extensions/Adaptations/Integration***

- Place students of different abilities in each group. Each student should have a meaningful role.
- Have students explain/tell what they discovered.
- Use explicit instruction to teach vocabulary.
- Use pictures and other visual aids to assist comprehension.
- Have students create a graph for the *Winter Clothing* activity.

#### **Extension I**

1. Place water with ice cubes in one bowl, warm water (not above 118° F) in one bowl, and room temperature water (or an equal mixture of the cold and warm water) in the third bowl.
2. Call on one student to place one hand in the cold and the other in the warm water. After minute place both hands in the medium temperature bowl.
3. Ask, “What do you feel?”

#### **Materials**

- 3 two quart bowls
- Ice cubes

(The hand that was in warm water should feel cooler and the hand that was in cold water should feel warmer than the other hand.)

### Extension II

1. Cut a piece of foil larger than your foot.
2. Place the foil and the carpet sample on a tile floor. Allow them to remain undisturbed for ten minutes.
3. Put one bare foot on the foil and the other bare foot on the carpet.
4. Observe any difference between the feel of the temperature of each foot.

(The metal foil feels colder than the carpet because a good conductor [foil] allows heat to move through it, while the carpet [a good insulator] blocks the flow of heat from your foot. Things feel cooler when heat energy is drawn away from your skin.)

### Materials

- Carpet sample
- Aluminum foil

## Resources

### Books

*Experiments with Heat*, by Walter Olesky; ISBN 0-516-01277-0

*Temperature*, by Joy Frisch; ISBN 1-58340-159-8

*Heat*, by Graham Peacock; ISBN 1-56847-075-4

*Forest Fire!*, by Mary Ann Fraser; ISBN 0-8167-4962-0

### Video

*Heat*, by Bill Nye (Disney Educational Productions, 1-800-295-5010, <http://dep.disney.go.com/educational/index>);  
Product ID: VHS 68A71VL00, DVD 77C20VL00

### Web sites

<http://www.kids.msfc.nasa.gov>

<http://www.nasaexplorers.com>

<http://www.sciencelinks.com>

## Family Connections

- Have students bring materials from home to make another refrigerator.
- Have students design a refrigerator at home and bring to share with the class.

# Winter Clothing

*Question:* Do winter clothes create heat?

\_\_\_\_\_

*Hypothesis:* I think \_\_\_\_\_

Predict what will happen when you put on a winter coat.

I predict that \_\_\_\_\_

Record the temperature of a thermometer after sitting on a desk for two minutes.

\_\_\_\_\_

Put the thermometer inside the article of clothing, wait two minutes and record the temperature. \_\_\_\_\_

Have one student put the clothing on with the thermometer touching the person inside the glove, coat, or hat. Record the temperature after five minutes. \_\_\_\_\_

Remove the clothing. Set it on a desk out of the sun, put the thermometer inside, and wait five minutes. Record the temperature again. \_\_\_\_\_

*Conclusion:* What happened?

\_\_\_\_\_  
\_\_\_\_\_

Does a coat give off heat? \_\_\_\_\_

# Things Are Heating Up!

**Standard V:**

Students will understand that the sun is the main source of heat and light for things living on Earth. They will also understand that the motion of rubbing objects together may produce heat.

**Objective 2:**

Demonstrate that mechanical and electrical machines produce heat and sometimes light.

**Intended Learning Outcomes:**

1. Use Science Process and Thinking Skills
3. Understand Science Concepts and Principles
4. Communicate Effectively Using Science Language and Reasoning

**Content Connections:**

Math IV-2

Science  
Standard  
V

Objective  
2

Connections

## Background Information

Students will learn that heat is produced from human activities and mechanical and electrical machines. Heat is produced almost anywhere.

Heat is the random motion of molecules. A hot object is one whose atoms and molecules are excited and show rapid movement. A cooler object's molecules and atoms will be less excited and show less movement. When these molecules are in an excited state, they take up more space because they are moving around so fast. When molecules settle down, or cool down, they take up less space. If hot, high-energy atoms come into contact with cool, low-energy atoms, the excited atoms will lose some of their energy to the cool atoms. The two atoms will settle into an energy level that is between where they each started out. That level is called Thermal Equilibrium.

It is important for students to understand that situations that produce heat involve motion—either observable, such as activity-based (human or mechanical), or electrical. Simple, stationary objects do not produce heat.

## Research Basis

Kesidou, S. & Roseman, J.E., (2002), How Well Do Middle School Science Programs Measure Up? *Findings from Project 2061's Curriculum Review*.

Programs rarely provided students with a sense of purpose for the units of study. This program took account of student's beliefs that interfere with learning. It modeled the use of scientific knowledge so that students could apply what they learned in everyday situations.

American Association for the Advancement of Science. (2001). Science for All Americans online. Chapter 4: The physical Setting

Heat energy is the random motion of molecules. Whenever the amount of energy in one place or form diminishes, the amount in another place or form increases. Heat always tends to diffuse from warmer places to cooler places.

Sillman, K. & Dana, T. (1999). Metaphor: A Tool for Monitoring Prospective Elementary Teachers' Developing Metacognitive Awareness of Learning and Teaching Science, paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Boston Massachusetts.

Providing students with meaningful, hands-on activities is valuable. However, this is not enough; connections have to be made.

### ***Assessment Suggestions***

- 4 correct, complete, detailed
- 3 partially correct, complete, detailed
- 2 partially correct or complete, lacks some detail
- 1 incorrect or incomplete, missing data, needs help
- 0 no attempt

*Adaptation*—Student explains what they did and what they discovered.

### ***Invitation to Learn***

#### ***Materials***

- 9 volt batteries
- Christmas lights cut apart with 1/2 in of insulation stripped

- Ask students to stand up and rub their hands together fast and hard for ten seconds.
  - Ask, “How do your hands feel right now? Why?”
  - When would you most likely do something like this? Why?
  - Why is rubbing your hands together useful or helpful?

To extend, have students either jog in place, stomp their feet, or do jumping jacks. After a period of time, have students stop and discuss their similar heat-based reactions. You need to give them the impression that they are “little heat producers” when they are physically active.

- Give each group one 9 volt battery and one light bulb with wires. Ask, “Can you make the light bulb light up? If so, does it get warm?”

Point out that batteries are an electrical form of energy. Can electricity produce heat or light?

## Instructional Procedures

Set up and label centers where each group can discover the difference in temperature resulting from the following activities. If groups will be reporting their findings, mix the centers with combinations of the four types of activities.

- Human-based activity (erasing the board, rubbing book on desk, rubbing wool and metal buttons, rubbing pennies on paper, etc.).
- Electrical activity (computer, overhead projector, popcorn popper, lamp, flashlight, television, etc.).
- Mechanical activity (sharpening pencil, spinning roller skate, etc.).
- Stationary objects—Objects that do not move (cardboard box, plant, envelope, pencil, etc.).

1. Divide students into four groups. Give each student a *Measuring Heat* worksheet. Tell the students that are going to measure the heat created at each center. Have them answer the question and fill out their hypothesis before they go to their center. Discuss the expectations and procedures and then send to assigned centers.

*Note:* Mechanical heat and human activity will probably not be detectable on a thermometer. Use the sense of touch to determine “yes” or “no” if heat was produced. Use thermometers for electrical and nonexamples.

2. Students follow the directions and record the results.
3. Stop the action, turn off the machines, and discuss within groups what happened.
4. Proceed to the next center or have each group share their results with the class.

## Curriculum Extensions/Adaptations/Integration

- Place students of different abilities in each group. Each student should have a meaningful role. Students could collaborate on the worksheet.
- Have students use the *Sorting Heating Sources* worksheet and accompanying pictures to classify the objects.

### Materials

- Thermometers
- Television
- Popcorn popper
- Eraser
- Mechanical pencil sharpener
- Flashlight
- Book
- Computer
- Metal buttons
- Stapler
- Lamp
- Wool fabric
- Roller skate
- Pennies
- Scissors
- Paper
- Overhead projector
- Nonexamples (e.g., cardboard box, plant, envelope, pencil, etc.)
- Measuring Heat* worksheet
- Sorting Heat Sources* worksheet
- Sorting Heat Sources Pictures*

## **Resources**

### **Books**

*Keepers of the Earth: Native American Stories and Environmental Activities for Children*, by Michael J. Caduto and Joseph Bruchac; ISBN 1-55591-027-0

*The Magic School Bus in the Arctic: A Book about Heat*, by Joanna Cole; ISBN 0-590-18724-4

### **Web sites**

<http://www.sciencenetlinks.com>

[http://www.ajkids.com/search/heat, light, sun](http://www.ajkids.com/search/heat,light,sun)

<http://solar-center.stanford.edu>

## **Family Connections**

- Have students find mechanical and electrical examples at home.
- Students measure the difference in heat of working and nonworking examples they find at home.

Name \_\_\_\_\_

# Measuring Heat

Which activity will produce the most heat?

Hypothesis: I think \_\_\_\_\_.

Activity	Was heat produced?	Was light produced?	Temperature before activity	Temperature after five minutes	Human Mechanical Electrical Nonexample
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					

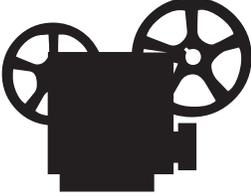
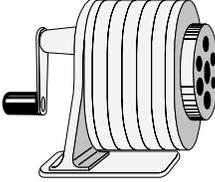
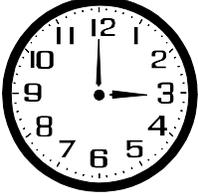
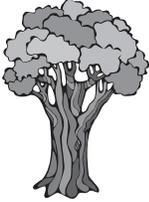
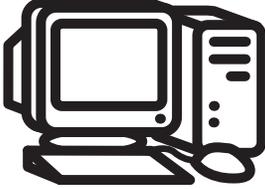
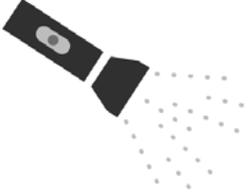
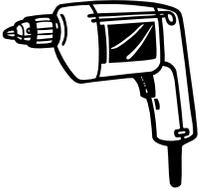
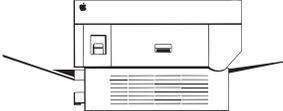
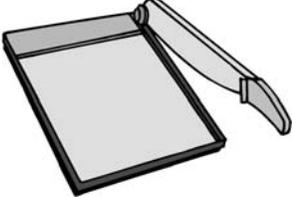
Conclusion \_\_\_\_\_.

# Sorting Heat Sources

Cut out the *Sorting Heat Sources Pictures* and glue them in the correct source of heat. Circle with a yellow crayon if it also produces light.

Electrical Sources of Heat		Mechanical Sources of Heat	
<b>Nonexamples</b>			

# Sorting Heat Pictures



***Math  
Standard  
I-3 & 5  
Activities***



## Get Them All

**Standard I:**

Students will acquire number sense and perform operations with whole numbers and simple fractions.

**Objective 3:**

Model and illustrate meanings of the operations of addition, subtraction, multiplication, and division and describe how they relate.

**Intended Learning Outcomes:**

1. Demonstrate a positive learning attitude toward mathematics.
2. Become mathematical problem solvers.
3. Reason mathematically.

**Content Connections:**

Math I-2

## Math Standard I

## Objective 3

## Connections

### Background Information

Students need to develop number sense through recognition and practice with benchmark numbers. Having a firm understanding of tens and hundreds will help students be more skilled in both addition and subtraction. It will help them see the relationships between the four operations. It will also help them to become mathematical problem solvers, and to understand how and why numbers and math work as they do.

### Research Basis

Walsh, S. (2000). How To Add, Subtract, Multiply, and Divide Natural Numbers  
Online at <http://faculty.ed.u.uc.edu/~swalsh/Math%20Articles/ASMD.html>

This article explains the history of math and how the standard algorithms came into existence. It also explores the reasons why algorithms are important and the concept that before algorithms are taught, students need to have a thorough understanding of the process of the operation and how and why it works.

Raimi, R.A. (2002). On Algorithms of Arithmetic, Department of Mathematics, University of Rochester, Online at: [www.nychold.org/raimi-als0209.html](http://www.nychold.org/raimi-als0209.html)

This article explores why students still need to learn to perform basic mathematical operations rather than relying solely on calculators. Raimi draws an interesting comparison between walking and driving a car. After cars were invented, people did not completely quit walking. People choose whether to walk or drive by doing what makes the most sense for the situation. He suggests that we teach students the same concept in math—use the method that makes the most sense.

## Assessment Suggestions

- Monitor students as you do the activities to assess understanding. Evaluate the *Close to 100 Score Sheets* to see how accurate the problems and solutions are.
- Construct quizzes with column addition and have students show or write which combinations of addends they looked for to make benchmark numbers.

## Invitation to Learn

Read *The Magic School Bus Gets Ants In Its Pants* aloud to the class.

Scatter 100 plastic ants on the floor or desks in the classroom. Instruct students to hurry and get them all! They can't leave one ant on the floor or soon there will be thousands of ants invading the classroom!

Have each student gather some ants, then take them back to their desks and carefully count how many they have. Tell them that you know there were 100 ants originally. Students must figure out how they can tell if they have really gotten them all. Hopefully, they will come up with the idea that they can put together all their groups of ants and find a total.

*Journaling:* Students record the ideas in their journals.

## Instructional Procedures

1. Ask students what math operation is used to put together all the groups and find a total? Review addition vocabulary of addends and sum. Tell students that each group of ants is one of the addends, and that when all addends are put together, they should get a sum of 100.
2. Have students call out the number of ants they each have and write a column addition problem on the board or overhead. Have the class help add them together. Hopefully this will be a little bit difficult for them. Tell students that they will learn strategies for making addition easier today.
3. Read *One Hundred Hungry Ants*. As you read, write each situation as an addition problem on the board.
4. Have students regroup their ants so they get numbers that are easier to add (e.g., they might put them into groups of 5, 10, 20, or 25's).

### Materials

- Magic School Bus Gets Ants In Its Pants*
- 100 plastic ants

### Materials

- One Hundred Hungry Ants*

5. Students repeat step 2 and see how much easier it is to add up the ants.
6. Teach or review the concept of “benchmark” numbers—numbers such as 10s, 25s, 100s, etc. that are easy for us to work with and understand. We often use them to estimate in real life. Do several examples of column addition together to help them practice finding combinations of addends that give benchmark numbers.

Complete the next three activities to reinforce number sense with benchmark numbers.

### What Makes 10

1. Start this activity using base ten blocks and the *What Makes 10? Mat*. Do each problem on the overhead and have students use the manipulatives at their desks.
2. The task is to find out how many more you need to make 10 each time you place a certain number of blocks on the mat.

*Sample problem 1:* Place 5 blocks on the mat, ask “What makes 10?” Have students give answers out loud, and then prove their answers by continuing to place blocks on the mat until all the spaces are filled up. Continue doing this and expand it to make multiples of 10.

*Sample problem 2:* Place 2 base ten sticks and 3 blocks on the mat. Have students predict what multiple of 10 they will have when they complete “What makes 10?”

3. After students understand the concept and have practiced it with manipulatives, it is quick and easy to use fingers to do this activity. Whenever you have a few seconds to fill, hold up some fingers and then ask, “What makes 10?” Extend it to multiples by flashing 10, 20, 30, then hold up three fingers and ask “What makes 10?” “That ten makes what?” (40)
4. You can also play *What Makes 10?* with a deck of playing cards with face cards removed. Shuffle the deck and deal out all the cards between two to four players. Players lay out the first nine cards in a 3” x 3” grid. Each player tries to find combinations that make 10. For each card taken, replace it with the next card from the hand. Play continues for two minutes. The player with the most correct combinations wins.

### Materials

- What Makes 10? Mat*
- Base ten blocks

**Materials**

- ❑ *Close to 100 Game Cards*
- ❑ *Close to 100 Scoresheets*

**Close to 100**

Adapted from *Investigations in Numbers, Data, and Space*, by Dale Seymour Publications.

Students play in pairs so you need one deck of cards for each pair of students. Each deck consists of 44 cards—four of each of the digits 0-9, plus four “wild cards.” Each individual player needs a *Close to 100 Scoresheet*.

The object of the game is to create two digit numbers whose sum is as close to 100 as possible. Each game consists of five rounds.

1. For Round 1, deal six cards to each player. Players choose any four of the cards to make two 2-digit numbers that, when added together, come as close as possible to a total (sum) of 100. Wild cards may be assigned any value. Each player records his/her numbers and the total on his/her *Close to 100 Scoresheet*. The player’s score for the round is the difference between that total and 100. The used cards are discarded, and the two cards remaining in each hand are kept for the next round.
2. For Rounds 2 through 5, deal out four new cards to each player and repeat the steps in Round 1.
3. At the end of five rounds players total their scores. The player with the lowest total wins the game.

**Salute!**

This game can be adapted to play and practice with addition, subtraction, or multiplication.

1. Arrange students into groups of three, one student is designated as the “calculator.” Play three games so each student has a turn to be the calculator.
2. Cards are divided equally between two players.
3. One game consists of five rounds. This can be adjusted to fit shorter or longer time periods.
4. For each round, the calculator says “Salute!” The other two students salute each other by taking the top card off their pile without looking at it and holding it up to their foreheads face out. The calculator then announces the sum of the two numbers. The players look at each other’s cards and race to determine the value of their own card.

*Example:* Johnny holds up a 30 and Susie holds up a 9. The calculator announces 39. Johnny figures out that his card must be 30 since Susie’s is 9 and announces 30. He wins and collects both cards.

**Materials**

- ❑ Salute with 1s, 10s, and 100s

5. The winner is the player with the most cards collected at the end of the designated number of rounds.
6. Switch roles until each student has had an opportunity to be the calculator.
7. This game can be adapted to play and practice with addition, subtraction, or multiplication.

### ***Curriculum Extensions/Adaptations/Integration***

- Use *One Hundred Hungry Ants* as a connection between repeated addition and multiplication. It is an excellent introduction to the meaning of multiplication.
- Use the revised version of the children’s song “The Ants Go Marching One by One” to review addition concepts.

(Complete original words and music are available at: [niehs.nih.gov/kids/lyrics/antsgo](http://niehs.nih.gov/kids/lyrics/antsgo))

To the tune of “The Ants Go Marching One by One”

Oh when we add we get them all, the sum, the sum

Oh when we add we get them all, the sum, the sum

Combine the addends and total them up

It works just fine if you mix them up

So when you add you must make sure you get them all

Add, Add, Add, Add, Add, Add, Add, Add!

Do other sums with the song.

*Example:*

The ants go marching 30 by 30 Hurrah, hurrah

The ants go marching 30 by 30 Hurrah, hurrah

Let’s find which addends we can add up

To get the sum we must hurry up

And the ants go marching 30 by 30 by 30 by 30

add, add , add, add, add, add, add, add, add!

- Bring an ant farm for students to observe in the classroom.
- Do a unit on ants during science. Have students write math problems using ants and ant behaviors (e.g., There were 235 ants in the ant farm. We added 47 new ants. How many ants are now in the ant farm?).

- Create a detailed closeup drawing of an ant as it would look under a magnifying glass. Use a magnifying glass shape as the frame, do the actual artwork in a 6” diameter circle and glue it onto the frame where the glass would be on a magnifying glass.

## **Resources**

### **Books**

*Magic School Bus Gets Ants In Its Pants*, by Joanna Cole;  
ISBN 059040024X

*One Hundred Hungry Ants*, by Elinor Pinczes; ISBN 0395631165

### **Individuals**

Dixie Blackinton, dblackinton@weber.edu

Diane Pugmire, dpugmire@weber.edu

### **Additional Media**

100 plastic ants, available from  
<http://www.realcooltoys.com/index.html>, Item ACC-08919

Base ten blocks, available from [www.educatorsoutlet.com](http://www.educatorsoutlet.com), variety of blocks available

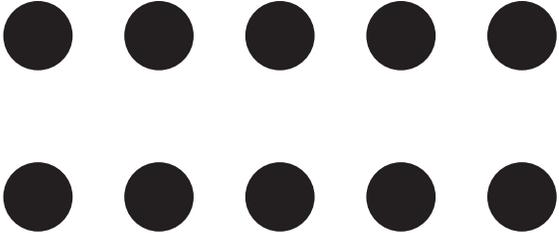
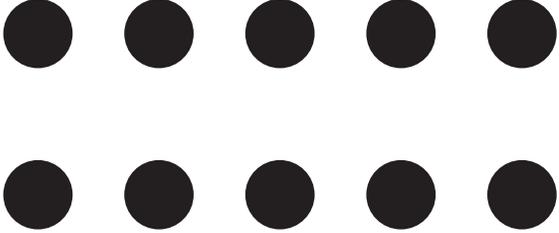
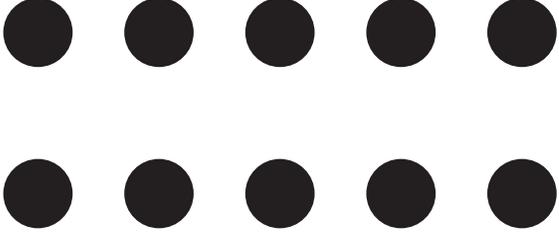
Math Activities with Base 10 Blocks–Addition and Subtraction,  
available from [www.educatorsoutlet.com](http://www.educatorsoutlet.com), Item #10657

Salute with 1’s, 10’s and 100’s, available from [www.enc.org](http://www.enc.org),  
ENC #012273

## **Family Connections**

- Send a letter home to families explaining the concepts you are studying. Encourage families to go outside together and find an ant colony to observe and make up problems about the ants as they watch them.

# What Makes 10? Mat

Tens	Ones
	
	
	

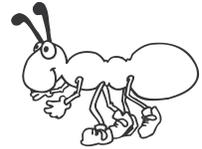
# Close to 100 Score Sheet

Round 1: Deal six cards to each player. Players choose any four of their cards to make two 2-digit numbers that, when added together, come as close as possible to a sum of 100.

Wild cards may have any value. Each player records his/her numbers and the total below. **The player's score for each round is the difference between the total and 100.** The used cards are discarded and the remaining two cards are kept for the next round.

Rounds 2-5: Deal out four new cards to each player and repeat the steps in Round 1.

At the end of five rounds, players total their scores. The player with the lowest total wins the game!



		Score for Round
Round 1	_____ + _____ = _____	
Round 2	_____ + _____ = _____	
Round 3	_____ + _____ = _____	
Round 4	_____ + _____ = _____	
Round 5	_____ + _____ = _____	

**Total** \_\_\_\_\_

## Close to 100 Game Cards

Wild Card	Wild Card	Wild Card	Wild Card
<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>
<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>
<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>
<b>6</b>	<b>6</b>	<b>6</b>	<b>6</b>
<b>7</b>	<b>7</b>	<b>7</b>	<b>7</b>
<b>8</b>	<b>8</b>	<b>8</b>	<b>8</b>
<b>9</b>	<b>9</b>	<b>9</b>	<b>9</b>

# Subtraction—There’s Got to be An Easier Way!

## Math Standard I

## Objectives 3 & 5

## Connections

**Standard I:**

Students will acquire number sense and perform operations with whole numbers and simple fractions.

**Objective 3:**

Model and illustrate meanings of the operations of addition, subtraction, multiplication, and division and describe how they relate.

**Objective 5:**

Solve whole number problems using addition, subtraction, multiplication, and division in vertical and horizontal notation.

**Intended Learning Outcomes:**

1. Demonstrate a positive learning attitude toward mathematics.
2. Become mathematical problem solvers.
3. Reason mathematically.

**Content Connections:**

Math I-2

## Background Information

Third grade students have been taught the subtraction with regrouping algorithm and practiced it intensively in second grade. However, many third graders still struggle with it, and the struggle often continues into the upper grades. Many adults also make computational errors when subtracting with regrouping, especially when zeros are involved.

Students should know several different strategies to solve subtraction problems. Ideally, they will develop enough number sense that they will be able to choose the strategy that best works for individual problems. This lesson uses benchmark numbers to help students improve their ability to compute subtraction problems accurately and efficiently by using mental math strategies as much as possible. This reflects real life situations since very few of us go to the grocery store armed with calculators, math notebooks, and pencils. We need to do a lot of math “in our heads” and these strategies help develop the skills needed to become more proficient at it.

## Research Basis

Raimi, R.A. (2002). On Algorithms of Arithmetic, Department of Mathematics, University of Rochester, Online at: [www.nychold.org/raimi-algs0209.html](http://www.nychold.org/raimi-algs0209.html)

This article explores why students still need to learn to do basic mathematical operations rather than relying solely on calculators. He draws an interesting comparison between walking and driving a car. After cars were invented people did not completely quit walking. People

choose whether to walk or drive by doing what makes the most sense for the situation. He suggests we teach students the same concept in math. Use the method that makes the most sense.

Curry, D., Schmitt, M.J., & Waldron, S. (1996). A Framework for Adult Numeracy Standards: The Mathematical Skills and Abilities Adults Need to Be Equipped for the Future, Online at [http://shell04.theworld.com/std/anpn/framework\\_.html](http://shell04.theworld.com/std/anpn/framework_.html)

This is a research study conducted in 1996 that attempted to identify the critical math skills and concepts adults need to succeed in the workplace and life. It was funded by the National Institute for Literacy and conducted by the Adult Numeracy Practitioners Network. Some of the important concepts they identified are:

- Use an interdisciplinary approach
- Link new math learning to previous knowledge
- Teach concepts before rules

## ***Assessment Suggestions***

- Do a *Problem of the Day* and have students choose which strategy they think would work best and why. Have students come up and explain how they solved the problem with each of the strategies and have the class discuss which one probably was the best choice.
- Write a quiz with subtraction problems. Have students show how they did each problem and indicate which method they used. To save them from writing so much you could assign each method a letter. For example: standard algorithm A, mental math B, expanded form C, and compensation D.

## ***Invitation to Learn***

### **Inventions That Changed the World**

Do a quick background on what inventions are—new items or methods designed to make something easier, faster, better, etc. There are several resources on inventions listed at the end of this activity that you could use for this.

Make eight to ten cards with important inventions on them. Hang them facedown on the board. Have a student come up and choose a card. Tell them to pick carefully because their choice might just change the world! Have the student show the card to the class. Have them imagine what the world would be like if this invention had never been invented. Repeat with the rest of the cards.

### **Materials**

- ☐ Pictures of eight to ten major inventions on cardstock

Ask, “Why are we talking about inventions in math class? Do you think there have been inventions made in math? Today we are going to learn about some of the inventions that people have made in the field of mathematics.”

## ***Instructional Procedures***

### **Part A**

#### **Materials**

For each pair:

- Aquarium gravel or other small rocks—at least 100 rocks

1. Organize students into pairs. Give each group a container of small rocks. Tell them that they will first try math the original way it developed, before anyone invented ways to make it easier, faster, or better.
2. Tell students that they are all shepherders and they need to keep track of how many sheep they have. It is hard to count the sheep because they all keep moving around. Can they think of way that rocks might have been used in counting? How could you use the rocks to show that you have eight sheep?
3. What would you do if a wolf came and ate two of your sheep? What could you do to show how many sheep you have now? (Take two rocks away.)
4. Imagine that you are a really good shepherd and your flock of sheep grows until you have 100 sheep. Would it be difficult to keep track of 100 rocks spread out all over? Could you figure out something to do with your rocks to make it easier to keep track of how many sheep you have? (Give the students a chance to discuss and organize the rocks.)

*Note:* Most groups will probably organize their rocks in groups of 2s, 5s, 10s, or 25s. Ask why they did this. Tell them that we have a Base 10 number system and are used to working with these familiar benchmark (easy to count) numbers. Explain that different cultures developed different number systems, some have a Base 4 or a Base 11 system.

6. Ask students how they would feel about constantly carrying around those 100 rocks. What if they had 1,000 sheep? What if they accidentally dropped or lost some of the rocks—would that mean they had lost the sheep, too? They will probably see that using the rocks would create some problems.
7. People got tired of using the rocks and started inventing ways to make counting and keeping track of things easier. So that was a math invention! Most cultures invented a way to record their counting. Whatever method and symbols they decided to use,

their system had to be based on sound mathematical principles. If you had 6 sheep and 1 had a lamb, then you had 7 sheep. Not any other amount, but 7, so however you wrote the number it had to represent the number of actual sheep, (or anything else) you had left.

8. Explain that thinking of numbers as “nouns” can help them understand this concept and help them think about what is actually happening as we do the math operations.

### Part B

1. Write a subtraction problem on the board. Have a student volunteer to come to board and solve it.

As they do, explain that they are using a “math invention.” The standard algorithms we use today were invented many years ago as ways to make doing math faster and easier.

In order to be able to invent algorithms that work accurately every single time, their inventors had to understand the math principles and how numbers work. The subtraction algorithm that was just shown is one of the most difficult for us to remember how to do and do accurately every single time. Even if we memorize the algorithm, it really doesn’t do us a lot of good unless we understand what is actually happening, and more importantly, why the algorithm works. Today, we are going to look at some different inventions—different algorithms and strategies for doing subtraction.

2. Review the basic meanings of subtraction.

*Take Away*—Give each student a small handful of counters (or candy, if you really want to get their attention). Go to each child and say “You have \_\_\_\_\_, I am going to take away \_\_\_\_\_, how many will you have left?” These types of problems ask *how many you have left* or *how many remain*.

*Compare*—Give each student/pair two number lines and some small stickers. You can make number lines with any numbers you would like to work with. For example, with a number line from 1-100 counting by 5s, you could do problems like this: Put a sticker on 87 on one number line, put a sticker on 100 on the other number line. Now find the difference between these two numbers. Show how number lines can be used to compare. These types of problems ask things like *how many more* or *how many less* does one group have than another.

#### Materials

- Containers with counters or small wrapped candies

#### Materials

- Number lines
- Small stickers

**Materials**

- Card set with subtraction questions and matching missing addend number sentences

**Materials**

- Overhead money sets
- Sets of money for each student
- Overhead bill set
- Overhead coin set

**Materials**

- Base ten blocks

*Missing Addend*—This allows us to use addition to solve subtraction problems. This answers problems like, “Paul needs \$6 to go to the movie, he has \$4 already. How much does he need to earn?” Switch it to addition by writing  $\$4 + \underline{\quad} = \$6$ . Put the cards on the board—three subtraction questions and three missing addend number sentences. Have the class match them up.

*Mental Math*—Benchmark numbers; demonstrate with money

Use overhead money or play money for each student to demonstrate the concept of subtraction with benchmark numbers. Give them several scenarios similar to this:

You had \$5.00. You spent \$3.50 on a comic book. How much do you have left?

Start counting it back in pennies and see how they react. What’s wrong? That will take forever! What’s a better strategy? Two quarters and one dollar. How did you know and count that? You are used to counting with coin values of nickels, dimes, and quarters. Those are familiar numbers. We can use those same benchmark numbers to help us with subtraction.

*Mental math subtraction problems*—Do several problems like this together. You can also construct worksheets for them to practice this skill—make sure you have students write how they figured the problem out. This also builds on the mental math addition they did recognizing how many more makes 10, 100, etc. Remind them they have practiced this so they don’t think it is a new skill. It helps to have students record the problem while you work it out so they have a visual record of the problem. Use base ten blocks to show each step.

- You had 80 sheep. You sold 57 of them. How many do you have left?

*Think:* 3 sheep would get me to 60 (just like pennies—put out 3 cubes). And 20 more sheep (like dimes—put out two ten sticks) would get me to 80. So I have  $3 + 20$ , or 23 sheep left.

- You have 900 cows. Your neighbor has 564 cows. How many more cows do you have?

*Think:* 6 more would give me 70—put out 6 cubes, 30 more would give me 600—put out 3 ten sticks. 300 more would give me 900—put out three hundreds squares. Add up (teach them to start with the hundreds place in mental addition because then they end up with expanded form).

$300 + 30 + 6$  and you get 336, so you have 336 more cows than your neighbor.

Actually writing the problems in expanded form might be helpful for some students.

Go back to the sheep problem. How would you write it in expanded form?

$$\begin{array}{r} 80 + 0 \\ - 50 + 7 \\ \hline \end{array}$$

If you subtract  $0 - 7$  you will get a negative 7, which doesn't work very well in counting sheep, even though it will be very useful later in math. Put out eight ten sticks and then exchange one ten stick for ten one cubes. Can we rename 80 as  $70 + 10$ ?

Does  $70 + 10$  have the same value as 80? Then we are okay. Take away the blocks as you do each subtraction.

$$\begin{array}{r} 70 + 10 \\ - 50 + 7 \\ \hline 20 + 3 \end{array}$$

Larger numbers can get a little tricky. Talk about whether they should use this strategy or the mental math strategy, which would be a better choice?

$$\begin{array}{r} 900 + 0 + 0 \\ - 500 + 60 + 4 \\ \hline \end{array}$$

You have to regroup so you have enough in the tens and ones columns. Model with base ten blocks again. Tell students to take one of the hundreds—that leaves 800 and split that hundred into tens and ones so you could do the problem. The easiest way is  $90 + 10$ —nine ten sticks and ten ones cubes. Take away the blocks for each place as you do the subtraction. This leaves a problem like this:

$$\begin{array}{r} 800 + 90 + 10 \\ - 500 + 60 + 4 \\ \hline 300 + 30 + 6 \text{ or } 336 \end{array}$$

Do several problems having them choose which strategy is best. Show overhead of sample problems that work with each strategy.

*Compensation Strategy*—Use the following demonstration to introduce this strategy:

Invite two students with a noticeable height difference to come to the front of the classroom. Measure the difference in their height. Have them both stand on equal size chairs. Explain that while both of their heights were changed to make them taller, because the exact same thing was done to both, there was no change in the difference between their heights.

The same concept applies to numbers. I can make a math problem easier by changing both numbers to make them easier to subtract.

$$\begin{array}{r} 593 \\ - 256 \\ \hline \end{array}$$

*Think:* I can make 593 an even 600 by adding 7. If I do that, I must add 7 to 256, which would give me 263. Write your new problem

$$\begin{array}{r} 600 \\ - 263 \\ \hline \end{array}$$

*Think:* 7 more would give me 70, 30 more would give me 300, and 300 more would give me 600. So  $300 + 30 + 7$ , or 337, is my answer.

Do the standard algorithm to prove that you get the same answer.

Compensation also works if your students are struggling with subtracting with zeros and cannot yet do it mentally.

$\begin{array}{r} 400 \\ - 287 \\ \hline \end{array}$	You would take one from both 400 and 287, leaving you with this:	$\begin{array}{r} 399 \\ - 286 \\ \hline \end{array}$
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This eliminates the need to regroup.

Explain that different strategies work best for different problems. Encourage students to look at each problem and see if they can choose the best strategy. Point out that when you have problems with two zeros that you must regroup twice, it is difficult to do the standard algorithm, but much easier to use one of the mental math strategies. Some students will stick almost exclusively to the standard algorithm because that is familiar, and people do what they are most familiar with. Point out which problems they might have been able to solve more quickly and easily using one of the other strategies. It is helpful to have students practice with problems that are best suited to each strategy. This will help them become more adept at choosing the most appropriate strategy.

## Curriculum Extensions/Adaptations/Integration

- The Incan people used an elaborate system of colored strings and knots called a “quipu.”

For more information and drawings look up  
[www.Spanish.sbc.edu/MMLatAm/Quipus.html](http://www.Spanish.sbc.edu/MMLatAm/Quipus.html)

Scientists and mathematicians do not agree on exactly how they used the quipu, but they do agree that it was used to count and record things.

Making their own quipus from colored string would be an interesting art project for students.

- Play Salute with 10s, 100s, and 1000s, but change to subtraction.
- Have sports enthusiasts bring in newspaper articles with sports scores. Hang the scores in the classroom and have students arrange them from the least to the greatest differences.
- Subtraction Top It*, adapted from *Everyday Mathematics Parent Handbook*. This is based on the familiar card game, War, and can be played with two to four players.

1. Make number cards with four of each number from 1-10 or use decks of cards and take out the face cards. You can also make decks with 2-digit numbers.
2. Shuffle the cards and place them face down on the desk. Each player takes two cards and turns them face up. The player with the greatest (or least) difference is the winner and takes all the cards. Play ends when there are not enough cards for all the players to draw two cards. The winner is the player with the most cards.

You can do variations of this by deciding that the winner is the one with either the greatest or least difference between their cards

You can also have them draw four cards to make two 2-digit numbers. This involves them using strategies to make the numbers with the difference they are looking for.

- Use familiar fairy tales or other stories and have students rewrite them using numbers. Make up subtraction problems with the story. For example:

Once upon a time, 430 years ago, there were three little pigs. The little pigs decided to go out in the world and build houses for themselves. The first little pig built his house from 743 pieces of straw. The second little pig built his house from 436 sticks of wood, and the third little pig built his house from 245 bricks. The

### Materials

- Colored string

big bad wolf came and tried to get the pigs. He huffed and puffed 176 times and blew down the straw house, but the first little pig escaped. He huffed and puffed 289 times and blew down the house of sticks, but the second little pig escaped, also. He went to the brick house and blew 643 times until he was so tired he passed out. Then he climbed on the roof and went down the chimney, but he landed in boiling water that was 212° and got boiled. The three little pigs lived happily for 50 more years.

- *Journaling*—Write possible subtraction problems from this story.

## **Resources**

### **Book**

*The Kid Who Invented the Popsicle*, by Don C. Wulffson;  
ISBN 0141302046

### **Web sites**

*Everyday Mathematics Parent Handbook*, available from Ann Arbor Public Schools at  
[http://instruction.aaps.k12.mi.us/links\\_results.php](http://instruction.aaps.k12.mi.us/links_results.php)

For more information and drawings look up  
[www.Spanish.sbc.edu/MMLatAm/Quipus.html](http://www.Spanish.sbc.edu/MMLatAm/Quipus.html)

### **Additional Media**

Overhead money sets and/or sets of money for each student, available from [www.enasco.com](http://www.enasco.com)

***Math  
Standard  
V-1  
Activities***



# Bloomin' Bud Glyph

**Standard V:**

Students will collect and organize data to make predictions and identify basic concepts of probability.

**Objective 1:**

Collect, organize, and display data to make predictions.

**Intended Learning Outcomes:**

3. Reason mathematically.
4. Communicate mathematically.
6. Represent mathematical situations.

**Content Connections:**

**Math  
Standard  
V**

**Objective  
1**

Connections

## Background Information

Interpreting data is an important aspect of mathematics. Students should find ways to read charts and graphs. Glyphs are a fun way to figure out information about a person. They help to interpret and describe data of many types.

## Research Basis

Baker, S., Gersten, R., & Kae-Sik, L. (2002). A synthesis of empirical research on teaching mathematics to low-achieving students. *Elementary School Journal*, 103(1), 51-73. Retrieved March 11, 2004, from Ebscohost database.

This article discusses factors contributing to the improvement of mathematics achievement of students, including active instruction, which is critical for engaging students in learning.

Bernier, R. (2004). Making yourself indispensable by helping teachers create rubrics. *CSLA Journal*, 27(2), 24-25. Retrieved March 2, 2005, from Ebscohost database.

Helping teachers create rubrics helps students meet those content standards. Various ways to use rubrics to document student achievement are discussed in this article.

## Assessment Suggestions

- Put the students into pairs. Give each student a small checklist and have them interpret a different glyph. Check to see if interpretations are correct.

## Invitation to Learn

### Materials

- Teacher glyph

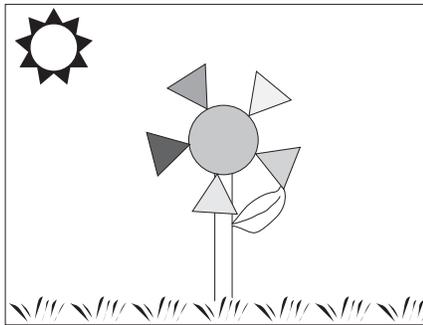
How would you like to create a picture about you and see if your partner can figure out information about you? First, let's see if you can determine information about your teacher. Show a completed teacher glyph. Have the students use the *Glyph Interpretation Sheet* to explain what they learned about the teacher.

## Instructional Procedures

### Materials

- Glyph Interpretation Sheet*
- 9" x 12" white or manila construction paper
- Glue
- Die cut shapes (1" yellow and orange circles, green stems [straight and curved], 1" red, orange, yellow, green, blue, purple triangles, green leaf, green grass [2" x 6" and 4" x 6"], and yellow sun)

1. Students create their own glyphs and have a partner interpret it.
2. Provide chart for students to read and make their own glyphs.
3. Pass out materials for students to make their own glyphs.
4. When they are finished, place students in small groups and have them interpret and compare glyphs to discover things that are the same and/or different.



## Curriculum Extensions/Adaptations/Integration

### Materials

- Graph paper for student bar graph
- Rubric for graphs*

- In students' journals, using the *Rubric for Graphs*, have students create their own bar graph, line graph, or picture or pictograph.
  1. Pass out large graph paper or have students graph one of the areas in their journals.
  2. Tally, then graph, students' gender, favorite school subjects, and handwriting.
    - Students gather the data with the teacher and tally the different categories.
    - Students graph the information for handwriting and favorite school subjects with crayons.
      - How many students like math?
      - How many students like reading?

- How many student like spelling?
  - Science? Writing? Art? Music?
  - Determine the “scale” to use for the bar graph.
  - Give the graph a title. Label the horizontal and vertical axes.
  - Looking at the graph, have students determine the class’ favorite subject.
- Students write a paragraph to interpret their partner’s or class’ glyph or graph in their journal.
  - Students create their own glyphs for different holidays/seasons, hobbies, likes/dislikes, or about their family.
  - Picture graphs are fun for students. A picture graph of how students get to school is included on pages 7-8 to 7-12.

Types of glyphs that can be made are:

- Parent/child
  - Baby block
  - All about me
  - Birthday
  - Pumpkin patch
  - Thanksgiving placement
  - Gingerbread man
  - Snowman
  - Bookworm
  - Valentine postcard
  - Silly shamrock
  - Eggs-citing egg
  - Rainy day
  - Home sweet home
  - Fast food
  - Ladybug
  - Summer sunshine
  - Design your own school year memories kite
- A list of weekly clothespin questions is found on page 7-13. Each student has a clothespin with his/her name on it to indicate his/her choice on the chart for the week.

# Glyph Interpretation Sheet

**Stem**

Straight  Boy

Crooked  Girl

**Leaf**

Which kind of writing do you prefer?

Cursive → leaf on the left side of the stem

Manuscript → leaf on the right side of the stem

**Center**

Are you excited for your summer break?

Yellow  YES

Orange  NO

**Grass**

Which type of lunch do you prefer?

Home lunch → Grass 4" tall 

School lunch → Grass 2" tall 

**Petals**

What school subjects do you like?

Math ..... red

Spelling..... orange

Reading..... yellow

Art/Music..... green

Science ..... blue

Writing..... purple

One  (petal) per subject.

**Sunshine**

Are you excited for 4th grade?

Yes, I'm excited → 

No, I'm not excited → No sun

**Scoring Rubric/Key**

1. Student unable to complete glyph, even with help
2. Student attempts, but has major errors
3. At least 4 items interpreted correctly
4. Fully interpreted correctly

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3. At least 4 items interpreted correctly
4. Fully interpreted correctly

Name \_\_\_\_\_

# Rubric for Graphs

<b>Picture Graphs</b>	
<ol style="list-style-type: none"> <li>Title</li> <li>Legend or Key</li> <li>Information is accurate</li> <li>Different picture for each category</li> <li>Each axis labeled</li> </ol>	<p><b>Rubric</b></p> <p>4—Applies to all 5 items                      3—Applies to 4 items                      2—Applies to 3 items                      1—Applies to 2 items or less</p>

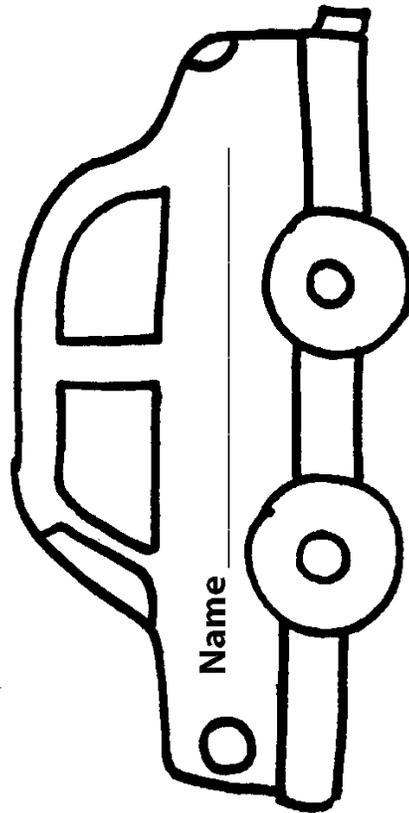
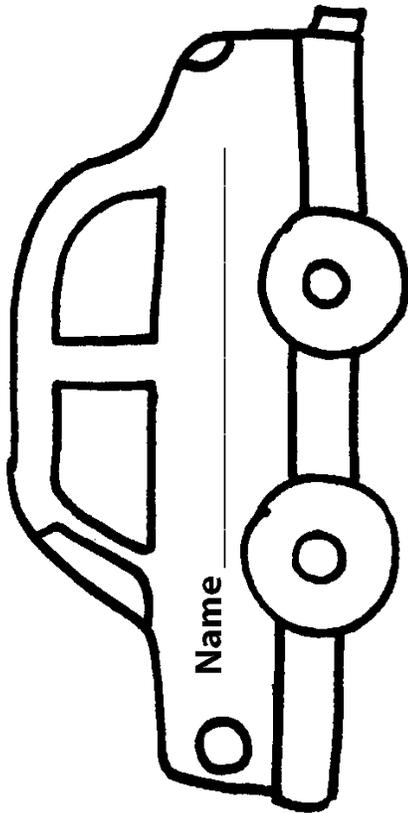
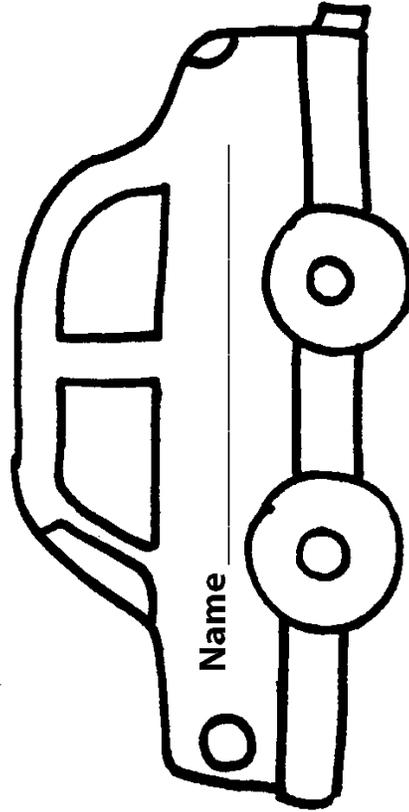
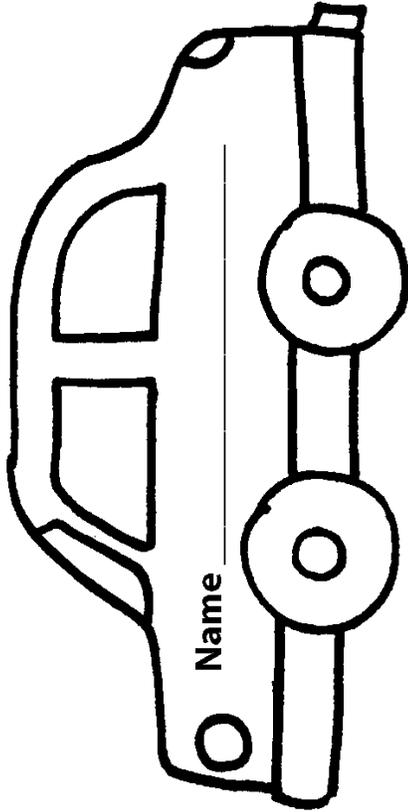
<b>Pictograph</b>	
<ol style="list-style-type: none"> <li>Title</li> <li>Legend or Key</li> <li>Information is accurate</li> <li>Same picture throughout</li> <li>Each axis labeled</li> </ol>	<p><b>Rubric</b></p> <p>4—Applies to all 5 items                      3—Applies to 4 items                      2—Applies to 3 items                      1—Applies to 2 items or less</p>

<b>Pie Graphs</b>	
<ol style="list-style-type: none"> <li>Title</li> <li>Legend or Key</li> <li>Information is accurate</li> <li>Equals one WHOLE</li> <li>Number pattern to make graph</li> </ol>	<p><b>Rubric</b></p> <p>4—Applies to all 5 items                      3—Applies to 4 items                      2—Applies to 3 items                      1—Applies to 2 items or less</p>

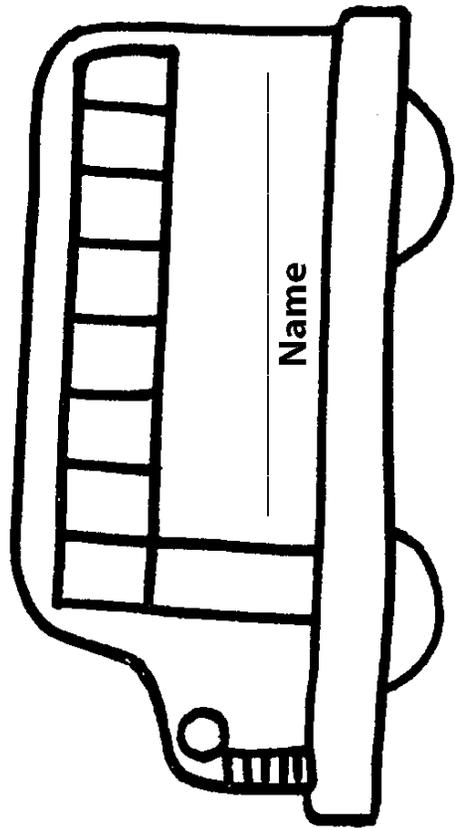
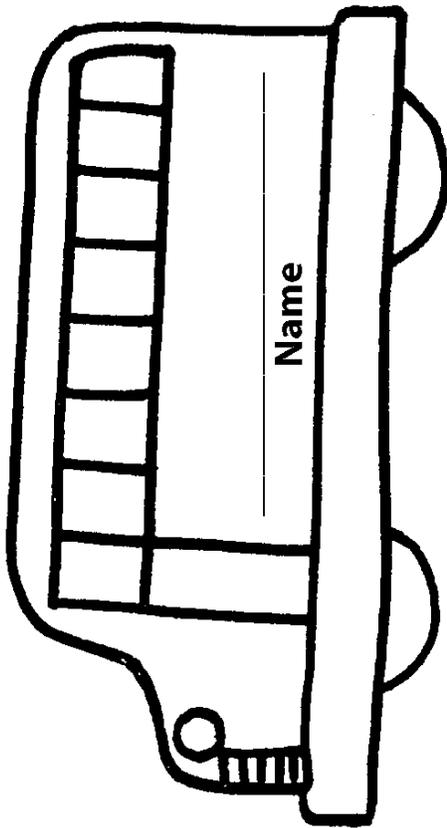
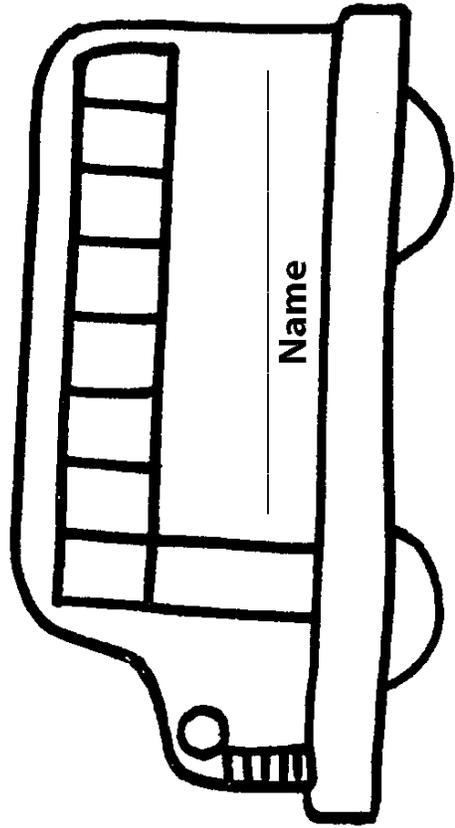
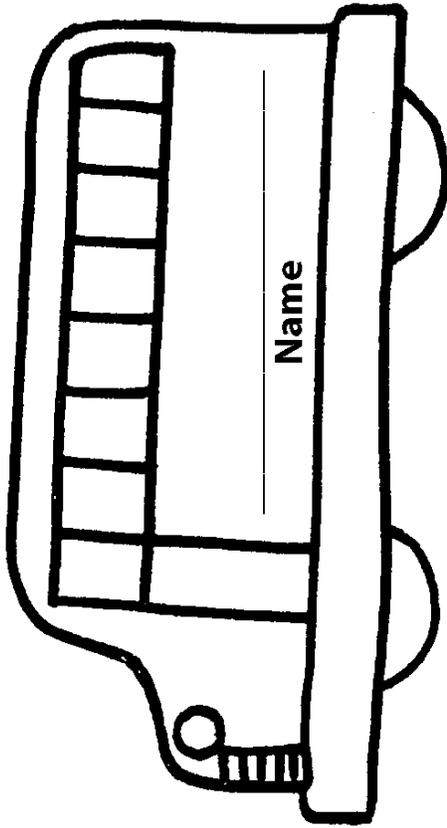
<b>Line Graphs (shows change over time)</b>	
<ol style="list-style-type: none"> <li>Title</li> <li>Label horizontal axis</li> <li>Label vertical axis</li> <li>Numbers in a pattern (increments)</li> <li>Numbers labeled on lines</li> <li>Each individual label on the horizontal axis</li> <li>Plotting the points correctly</li> </ol>	<p><b>Rubric</b></p> <p>4—Includes all 7 items                      3—Includes 5 or 6 items                      2—Includes 3 or 4 items                      1—Includes 2 items or less</p>

<b>Bar Graphs</b>	
<ol style="list-style-type: none"> <li>Title</li> <li>Label horizontal axis</li> <li>Label vertical axis</li> <li>Numbers in a pattern (increments)</li> <li>Numbers must be labeled on the line, not on the space</li> <li>Information is accurate on the bars</li> <li>Bars cannot touch (spaces between each one)</li> </ol>	<p><b>Rubric</b></p> <p>4—Includes all 7 items                      3—Includes 5 or 6 items                      2—Includes 3 or 4 items                      1—Includes 2 items or less</p>

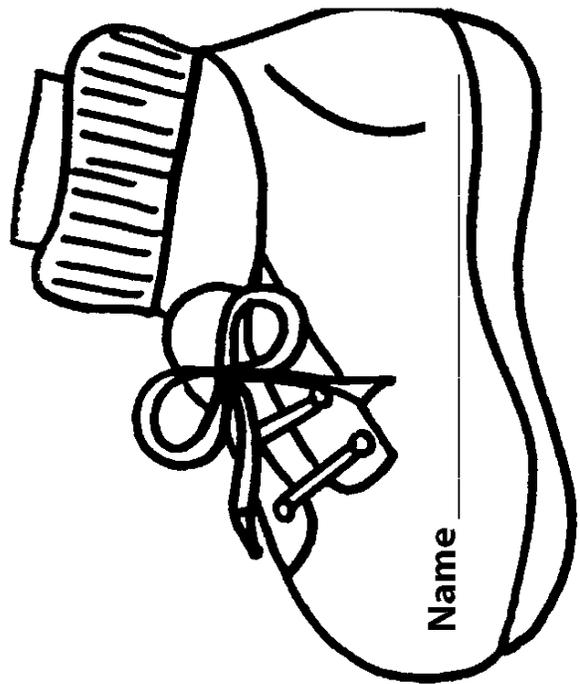
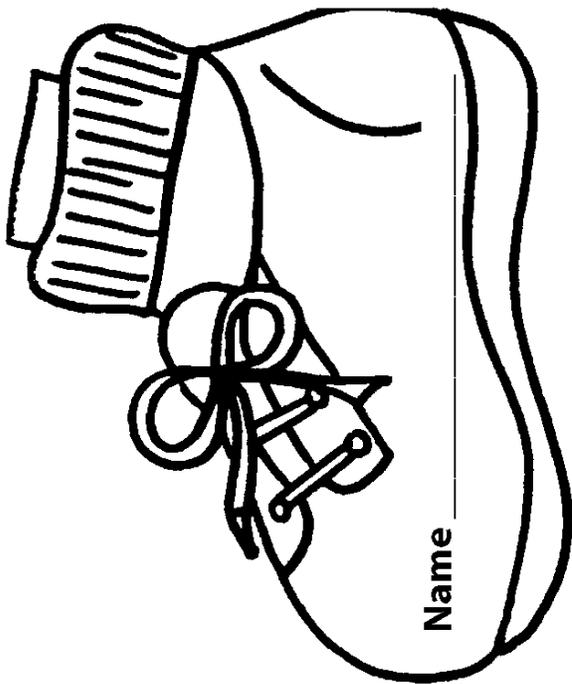
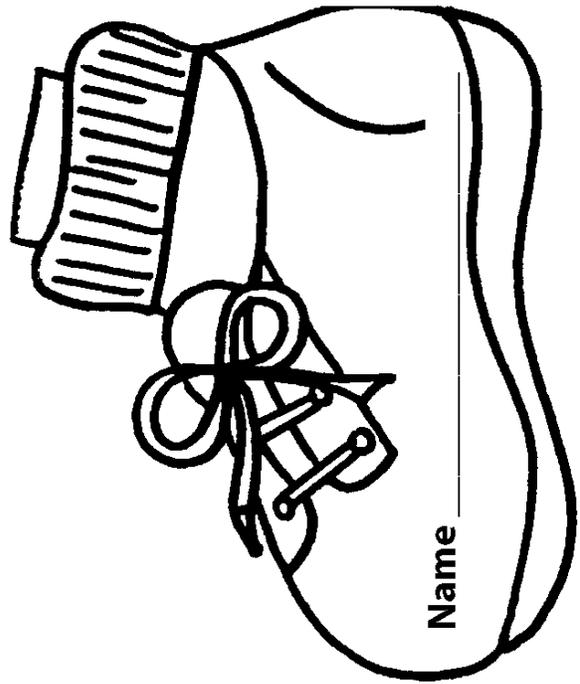
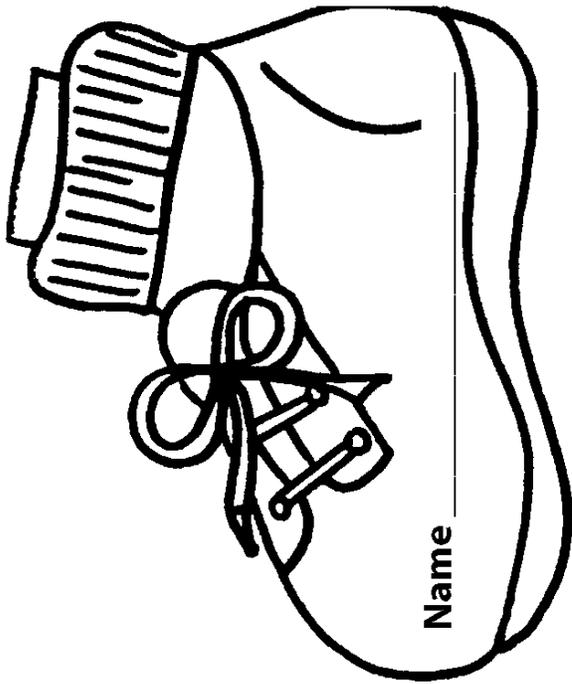
*Cars*



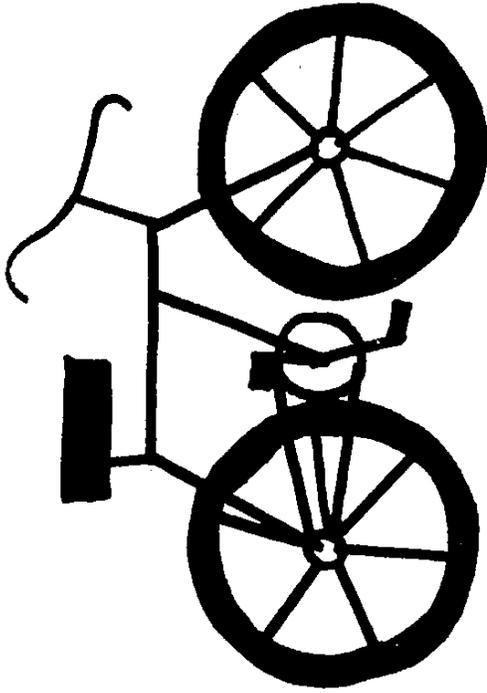
*Buses*



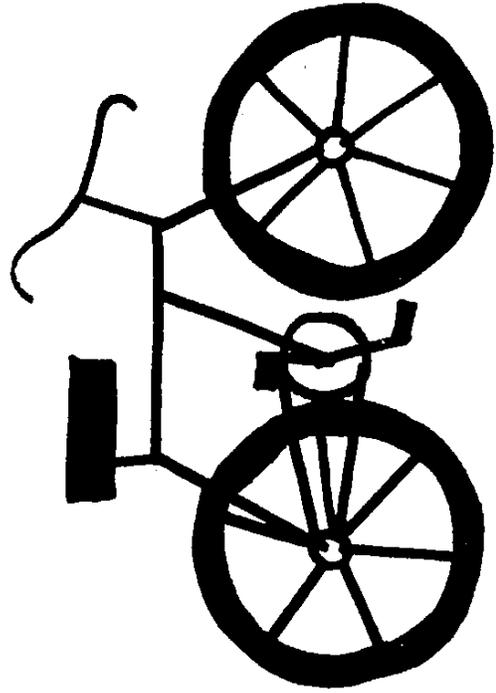
Feet



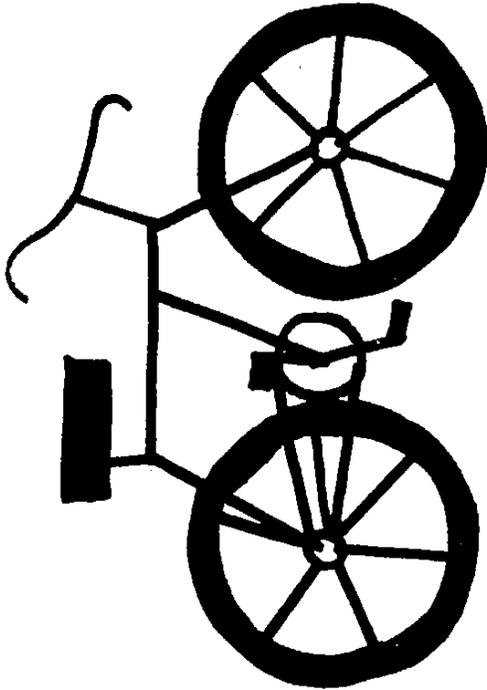
# Bikes



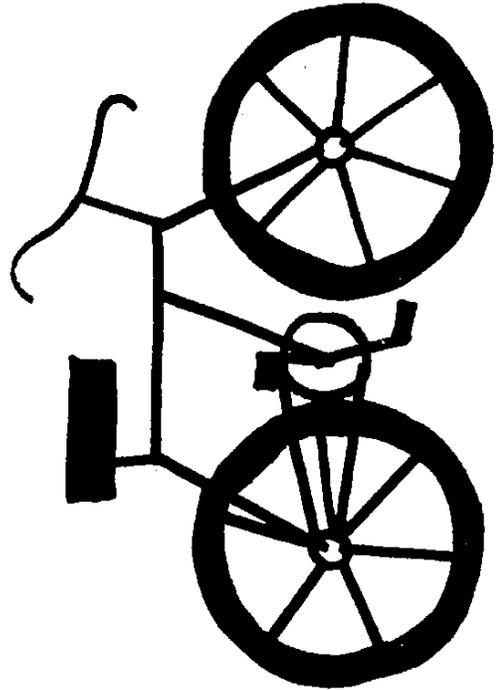
Name \_\_\_\_\_



Name \_\_\_\_\_



Name \_\_\_\_\_



Name \_\_\_\_\_



## Weekly Clothespin Questions

- Which do you like better, hamburgers or hotdogs
- Would you like to ride a bike or roller blade?
- Which would you rather grow in a garden, fruits or vegetables?
- Did you come to this school last year?
- Where do you like to play, inside or outside?
- Have you ever sailed on a boat like Christopher Columbus?
- Which do you prefer, bath or shower?
- Have you ever been to a haunted house?
- Would you rather have five dimes or two quarters?
- Do you like cookies or brownies?
- Would you rather wear mittens or gloves?
- Do you like big or small marshmallows in hot chocolate?
- Would you rather set the table or clear the table?
- Do you like big or little presents ?
- Who is your favorite president, Washington or Lincoln?
- Would you rather have a pet lamb or a pet lion?
- Do you have more than three smoke alarms or less than three in your house?
- Would you rather have a friend come to your house or you go to your friend's house?
- Would you rather go snowmobiling or skiing?
- Would you like to see President Lincoln with a beard or without a beard?
- Would you rather give Valentines or receive them?
- Would you rather read books or be read to?
- Have you lived in more than three houses or less than three houses?
- Do you like blinking or nonblinking lights?
- Does the oldest person in your family dress up for Halloween?
- Would you rather wear a hat or a hood?
- Do you like white or dark turkey meat?
- Would you rather sing *Jingle Bells* or *Rudolph*?
- Would you rather go caroling or sleigh riding?
- Do you have an even or odd number of letters in your first name?
- Do you like to jump holding your rope or having friends hold the rope?
- Do you prefer ketchup or mustard?
- Would you rather fly a regular kite or a box kite?
- Would you like to buy a new truck or a new car?

# Lemonade for Sale

## Math Standard V

### Objective 1

#### Connections

<b>Standard V:</b> Students will collect and organize data to make predictions and identify basic concepts of probability.
<b>Objective 1:</b> Collect, organize, and display data to make predictions.
<b>Intended Learning Outcomes:</b> 3. Reason mathematically. 4. Communicate mathematically. 6. Represent mathematical situations.
<b>Content Connections:</b>

## Background Information

Students should be involved in collecting and describing data. Students will construct their own graphs based on data they collect from reading *Lemonade For Sale*.

Rubrics for graphs help students understand the requirements needed to complete a graph.

## Research Basis

Goldsmith, L. T., & Mark, J. (1999). What is a standards-based mathematics curriculum? *Educational Leadership*, 5(57), 40-44. Retrieved July 2, 2004 from Ebscohost database.

This article discusses factors that influence student learning and promote a deeper and more substantial mathematical understanding, with an emphasis on conceptual understanding—students learn by doing.

Fogarty, R. (1999). Architects of the Intellect. *Educational Leadership*, 57(3), 76-78. Retrieved June 14, 2004, from Ebscohost database.

This article presents information on the proponents of constructivist theory of learning—John Dewey, Jean Piaget, and Reuven Feuerstein. Teachers can become architects of intellect as they design exquisite learning experiences for their students.

Levine, E. (2002). One kid at a time. *Educational Leadership*, 59(7), 29-32. Retrieved April 6, 2004, from Ebscohost database.

This article focuses on the strategic curriculum approach and factors that provide context for learning—students learn best when they are engaged.

Hartshorn, R., & Boren, S. (1990). *Experiential learning of mathematics: Using manipulatives*. Washington, DC: ERIC Clearinghouse on Rural Education and Small Schools, ERIC Digest. (ERIC Document Reproduction Service No. ED321967)

Experiential education is based on the idea that active involvement enhances students' learning. This is difficult with abstract ideas, but the use of the manipulatives can bring experience to students' mathematical understanding.

## Assessment Suggestions

- Observe students graphing different kinds of information.
- Have students complete the *Lemonade Graph*, including key, scale, titles, and markings.
- Have students gather data or information about something in the classroom or home environment, or the class' favorite candy. Students complete a tally chart, bar graph, and write about their findings.

## Invitation to Learn

How many students have ever had a “lemonade stand” or sold Kool-Aid in their front yards?

Today we are going to read a book about children who want to earn money. We will keep track of how much lemonade they sell in our journals. Let's find out what happens.

## Instructional Procedures

Have students glue the *Rubric for Graphs* (p. 7-7) onto inside cover of journals.

1. How much lemonade do you think the children will sell?
2. Will they sell the same amount every day of the week?
3. Is there a day that might be better than another day of the week? Why do you think?
4. Make any other predictions the students may have ideas for.
5. Pass out the *Lemonade Graph*.
6. Have students follow along and create the graph in student journals as the teacher reads the *Lemonade for Sale Summary*.
7. Use the *Rubrics for Graphs* to complete the graph.

### Materials

- Lemonade for Sale*
- Rubric for Graphs* (p. 7-7)
- Lemonade for Sale Summary*
- Crayons
- Pocket chart
- Lemonade Graph*

## ***Curriculum Extensions/Adaptations/Integration***

- Have students write what they learned about bar graphs in their journals.
- Have students gather information, tally the totals, and create their own graphs following the rubrics glued to the covers of their math journals.
- Extend learning to include other types of graphs:
  - Use a graph to take attendance in the morning.
  - Have the students mark the lunch chart graph.
  - Use graphs to enhance other curriculum areas, such as science, social studies, reading, etc.
  - Use different types of objects to make graphs. Some ideas might be clothespins, paper clips, magnets, name strips, Post-it® notes, tally marks, pictures of objects, etc.
  - Use different mediums to help maintain interest levels. Examples might include water in 2 liter bottles (each student pours in 1/2 cup of water for the bottle of their choice: favorite place to swim: ocean, lake, swimming pool, etc.).
  - Remember to ask probing questions about the graph after it has been made:
    - Which category had the most, greatest, fewest, or least?
    - How many more or less did one choice have over another?
    - Which was the class favorite?
  - Graph the syllables of the spelling words or syllables of students' names.
  - Graph favorite candy or treats such as Skittles, M&M's, candy bars, etc.
  - Use a variety of questioning when graphing:
    - Which do you prefer?
    - My favorite \_\_\_\_\_ is:
    - My choice for \_\_\_\_\_ is:
    - What is your estimate (for counting, measuring, timing, etc.)?

- Other Graphing Questions (which are limitless):
  - Which graph do you like best, bar graph, tally marks, or pictographs?
  - Do you prefer primary or secondary colors?
  - What is your favorite three dimensional shape?
  - How do you feel today, happy, frustrated, tired?
  - Which is your favorite, fishing, hiking, or camping?
  - What is your favorite sport, football, soccer, basketball, or baseball?
  - Do you like antonyms or synonyms?
  - Do you like subjects or predicates? Nouns or Verbs? Adjectives or Nouns?
  - What weather do you like best, rain, snow, or sunny?
  - Would you rather travel in a car, plane, or train?
  - What is your favorite subject, art, music, or science?
  - What drink do you like best, hot chocolate, orange juice, or punch?
  - Do you prefer hamburger, pizza, or fries?
  - Which movie do you like best, *Finding Nemo* or *Monster's Inc.*?
  - What do you prefer, cooking, drawing, or reading?
  - What is your favorite kind of potatoes, baked, mashed, or french fries?
  - Do you prefer addition, subtraction, or fractions?
  - Which holiday is your favorite, Halloween or Valentine's Day?
  - Which farm animals are the most important, cows, chickens, pigs, or horses?
  - My home is heated by fireplace, gas heat, electricity, or wood-burning stove?
  - Where do you prefer to live, city, suburb, rural community, or forest?
  - Which month do you predict will be the coldest, December, January, or February?
  - What will today's temperature be at 12:00 noon today?

- How many hours of sleep do you usually get a night, seven, eight, nine, or ten?
- Which coin do you like the best, quarter, nickel, dime, or penny?
- Is your house number even or odd?
- What season were you born?
- What month were you born?
- What time do you usually get out of bed? Or go to bed? (e.g., before 7:00, between 7-8:00, or after 8:00, etc.)
- Which community worker has the most dangerous job, police officer, firefighter, or construction worker?
- Which pet would you prefer to have, gerbil, puppy, kitten, or bird?
- What is your favorite type of fruit, orange, peach, apple, or pear?
- If you were an animal, where would you prefer to hibernate?
- Where do you think a plant will live the longest, under the sink, on the porch, or by a window?
- Do you prefer vertebrates or invertebrates?
- Ideas for picture-graphs:
  - What is your favorite national park?
  - What is your favorite fruit?
  - Which animal would you like to be?
  - Which continent would you like to visit?
- Ideas for 2-ring Venn Diagrams:
  - I like eating pretzels. I like eating potato chips
  - I like milk. I like orange juice.
  - I like pepperoni pizza. I like Canadian bacon pizza.
  - I like mashed potatoes. I like baked potatoes.
  - I am wearing pants with pockets. I am wearing a shirt with a pocket.
  - My clothes have a button. My clothes have a zipper.
  - I like to play soccer. I like to play basketball.
  - I am the oldest child. I am the youngest child.
  - I like it when it snows. I like to hear thunder.

- My birthday is an even number. The sum of my birthday digits is less than 6.
- There are more than four people living in my house. I have a pet.
- I like to read chapter books. I like to read picture books.
- Ideas for 3-ring Venn Diagrams:
  - I like to eat cake. I like to drink milk. I like to eat broccoli.
  - I am wearing a sweatshirt. I am wearing blue pants. I am wearing shoes with laces.
  - I am nervous when it thunders. I have seen a rainbow. I like to watch the lightning.
  - I wear green on St. Patrick’s Day. I wear red on Valentine’s Day. Christmas is my favorite holiday.
  - I can name the days of the week in order. I can name the months of the year in order. I can tell you how many days there are in a year.
  - I can count to ten in another language. My parents speak another language. I speak another language.
- So many different ways to incorporate graphs! Have fun!

## Resources

### Books

*Lemonade for Sale*, by Stuart J. Murphy; ISBN 0-06-446715-5

*Tiger Math: Learning to Graph from a Baby Tiger*, by Ann Whitehead Nagda; ISBN 080507161X

*Graph It!*, by Lisa Trumbauer; ISBN 0736812822

*Graphs*, by Sara Pistoia; ISBN 1567661203

*Graphing Activities*, by Joy Evans; ISBN 1557991243

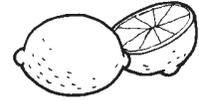
*Graphs*, by Bonnie Bader; ISBN 0448432374

## Family Connections

- Have students find graphs from newspapers or magazines at home. Have family members discuss the information found on the graph and then bring them to class to share.



## Lemonade for Sale Summary



The Elm Street Kids' clubhouse is falling down. If they sell lemonade they can earn money to fix up the clubhouse. The kids work together to keep track of the lemonade they sell each day.

They sold 30 cups of lemonade on Monday. Tuesday they sold 40 cups of lemonade. They sold 56 cups of lemonade on Wednesday. Thursday was not a good day—they only sold 24 cups of lemonade. The children were worried that something was terribly wrong because no matter how hard they hollered, "Lemonade for sale!" no one was buying. Come to find out, someone new in the neighborhood, Jed, was juggling down the street.

On Friday, Jed juggled next to the lemonade stand while the rest of the children sold lemonade. They sold so much lemonade it was hard to keep track. They sold over 100 cups of lemonade on Friday!

1. Make a graph showing the amount of lemonade sold each day. Remember to include a title, scale, and label the axes. Use the bar graph rubric to check your work.
2. In your journal, make and complete a bar graph to show the lemonade sold during the week. What kind of questions can you ask from looking at the graph?

Name \_\_\_\_\_

# ***Lemonade Graph***



# Take a Chance with Probability

## Math Standard V

### Objective 1

#### Connections

**Standard V:**

Students will collect and organize data to make predictions and identify basic concepts of probability.

**Objective 1:**

Collect, organize, and display data to make predictions.

**Intended Learning Outcomes:**

3. Reason mathematically.
4. Communicate mathematically.
6. Represent mathematical situations.

**Content Connections:**

Math V-2

## Background Information

Students should be involved in collecting and describing data from probability experiments. They should also be able to make predictions and construct and interpret charts and graphs to make inferences based on the analysis of their data.

The definition of “probability” is the chance of something happening.

Students may be more familiar with words such as “certain,” “impossible,” and “possible.” Ask questions and have students determine whether or not they think these things might occur using “certain, impossible, and possible.”

Introduce three more phrases used in probability to help make the chance of something happening more clear—“more likely, equally likely, and less likely.” Students may come up with their own examples for these three phrases.

“Outcomes” are the different possibilities that may occur for a situation. Students need to determine the outcomes for each activity.

## Research Basis

Baker, J.D., & Beisel, R. W. (2001). An experiment in three approaches to teaching average to elementary school children. *School Science & Mathematics, 101*(1), 23-31. Retrieved February 18, 2004, from Ebscohost Database.

This study implicates that learning supported with visual imagery, concrete hands-on experiences, and problem solving helps students gain a greater conceptual understanding.

Brewer, J., & Daane, C. J. (2002). Translating constructivist theory into practice in primary-grade mathematics [Electronic version]. *Education*, 123(2), 416-422. Retrieved February 20, 2004, from Ebscohost database.

This is a study of eight primary-grade math teachers using constructivist practices that encourages problem solving, reasoning, communication, and social interaction to build a concrete understanding of mathematics.

Cain-Caston, M. (1996). Manipulative queen [Electronic version]. *Journal of Instructional Psychology*, 23(4), 270-274. Retrieved March 7, 2004, from Ebscohost database.

This is a study that aims to determine the differences in mathematics achievement of third grade students who were taught mathematics using manipulatives vs. those who were taught using worksheets. Children learn best by doing. This article gives four main reasons for using manipulatives.

Chinnappan, M., & Lawson, M. (1996). Student difficulties with accessing and using mathematical knowledge [Electronic version]. *School Science & Mathematics*, 96(3), 140-145. Retrieved July 5, 2004, from Ebscohost database.

This article examines reasons for student difficulties in accessing and using mathematical knowledge during problems solving exercises. Making connections and constructing knowledge enable students to solve new problems.

## ***Assessment Suggestions***

- Students create their own game for probability.
- Students write a story about probability.

## ***Invitation to Learn***

Ask students to determine the probability of the following occurring today using the words impossible, unlikely, likely, certain:

- The sun will shine today.
- Everyone in the room is alive.
- The price of a loaf of bread is \$10.00.
- The price of a loaf of bread will go up next year.
- A girl in our class is 2 meters tall.
- The cafeteria will serve chocolate milk
- There are more left-handed students in our room than right-handed students.
- The sun will set in the west.

- Your mother will join a professional dance company and be gone for a week so she won't be able to come home and fix dinner tonight.

The chance of these things happening may or may not be likely. However, we are going to determine the outcomes for the following games today.

### Guess My Color

#### Materials

- 4 red marbles
- 3 blue marbles
- 2 green marbles
- 1 yellow marble

1. To begin, I have a bag of 10 marbles. What are the outcomes (colors or types of marbles)? We don't know what color they are. Is it possible to predict what color the marbles are without taking them all out of the bag and looking at them? (no)
2. Gather students' ideas.
3. Let's pick out one marble at a time and put it back into the bag and do that 30 times. Let's see if we can guess how many marbles of each color we have in our bag. Have different students come up and pick out one marble from the bag.
4. Tally the information on the board. (This information can be graphed later.)
5. Have the students try to determine how many of each color they think are in the bag.
6. Take the marbles out of the bag and see how close they were.
7. It is difficult to determine something if we don't know the "outcomes."
8. The outcomes are the different possibilities that may occur. For our game the outcomes are red, blue, yellow, and green marbles.

### Instructional Procedures

Today we will be playing games to discover different kinds of probability. At each station, students need to write their *predictions* of their outcomes in their math journals before they begin the game.

1. Divide students into eight small groups of two to three students. There are eight bags of games. Students go around the room and have three to five minutes at each station. Directions are included with each bag. Students read and follow the instructions on each game card, reaching into the bags without looking and pulling out one item. Write down the outcomes.
2. Gather the students together and talk about each center. Have the students use the probability vocabulary words and describe what occurred at each station.

#### Materials

- 8 activity bags with materials and instruction cards

## ***Curriculum Extensions/Adaptations/Integration***

- Have students create their own probability games.
- Graph some of the possibilities or data students received from playing the games. Use the graphing rubrics to make sure graphs are accurate.
- Integrate fractions into the probability lessons.

## ***Resources***

### **Book**

*Navigating through Data Analysis and Probability in Grades 3–5*  
(with CD-ROM), (available from <http://my.nctm.org/store/Ecat/>);  
ISBN 0-87353-521-9, Stock #12324

## ***Family Connections***

- Have students come up with predictions and probability for family activities (e.g., going out to eat, vacations, going to the movies, camping, etc.) and share them with family members.

# Activity Cards

## Marble Draw

1. Without looking into the bag, PREDICT which color has the highest probability of being picked and which has the lowest.
2. Predict how many times each color will be drawn.
3. Draw out a marble 20 times. Record each draw.
4. Compare the results with your predictions.

Color 1 \_\_\_\_\_

Color 2 \_\_\_\_\_

Color 3 \_\_\_\_\_

### Materials

- 1 marble of color 1
- 3 marbles of color 2
- 5 marbles of color 3

## Colored Disks

1. Drop the 2-colored disk 20 times, holding it approximately 8" above the table each time.
2. PREDICT how many times it will land with the red side up, and how many times with the gold side up
3. Record the results and compare the results with your prediction.

Red \_\_\_\_\_

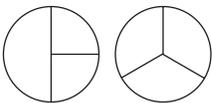
Gold \_\_\_\_\_

### Materials

- 2-colored disk

## Spinner Fun

1. Select one of the two 3-colored spinners.
2. PREDICT how many times you will spin each color on the spinner in 20 spins.
3. Spin and record your results.
4. Compare your results with your predictions.



Color 1 \_\_\_\_\_

Color 2 \_\_\_\_\_

Color 3 \_\_\_\_\_

### Materials

- Two 3-colored spinners

## Tiles 3 or 5

1. Without looking into the bag, PREDICT which number has the highest probability of being picked.
2. PREDICT how many times each tile will be drawn in 20 draws.
3. Draw out a tile 20 times and record your results.
4. Compare your predictions to the results.

Tile 3 \_\_\_\_\_

Tile 5 \_\_\_\_\_

### Materials

- 2 tiles—one with a 3 on it, one with a 5 on it

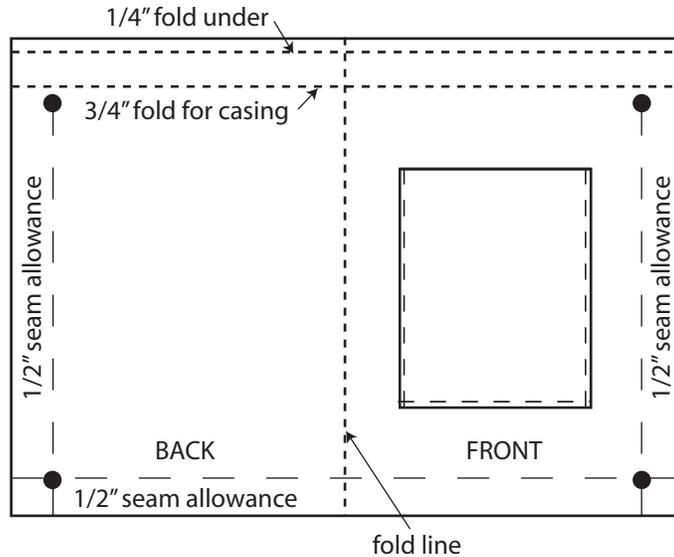
<p style="text-align: center;"><b>Coin Toss</b></p> <ol style="list-style-type: none"> <li>1. PREDICT how many times the coin will land heads up, and how many times it will land tails up.</li> <li>2. Flip the coin 20 times.</li> <li>3. Record the results.</li> <li>4. Compare your predictions to the results.</li> </ol> <p>Heads _____</p> <p>Tails _____</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>Materials</b></p> <p><input type="checkbox"/> Penny</p> </div>	<p style="text-align: center;"><b>WILLOW Tiles</b> <b>W I L L O W</b></p> <ol style="list-style-type: none"> <li>1. Without looking into the bag, PREDICT whether you will draw more W's or L's.</li> <li>2. What factors affect the outcome?</li> <li>3. Draw from the bag 20 times.</li> <li>4. Record your results.</li> <li>5. Compare your results with your prediction.</li> </ol> <p>W _____</p> <p>L _____</p> <p>Other _____</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>Materials</b></p> <p><input type="checkbox"/> 6 same-colored tiles with a letter on each one (W, I, L, L, O, W)</p> </div>
<p style="text-align: center;"><b>EVEN or ODD Tiles</b> <b>1 2 3 4 5 6 7</b></p> <ol style="list-style-type: none"> <li>1. PREDICT whether you will draw more odd or even numbers.</li> <li>2. Draw a number tile 20 times.</li> <li>3. Record your results.</li> <li>4. Compare your predictions with the results.</li> </ol> <p>Even _____</p> <p>Odd _____</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>Materials</b></p> <p><input type="checkbox"/> 7 tiles numbered 1-7</p> </div>	<p style="text-align: center;"><b>BOBBY Tiles</b> <b>B O B B Y</b></p> <ol style="list-style-type: none"> <li>1. PREDICT how many B's you will draw out in 20 turns.</li> <li>2. Draw a tile 20 times.</li> <li>3. Record your results.</li> <li>4. Compare your predictions with the results.</li> </ol> <p>B _____</p> <p>Other _____</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>Materials</b></p> <p><input type="checkbox"/> 5 tiles with a letter on each one (B, O, B, B, Y)</p> </div>

# Probability Bags

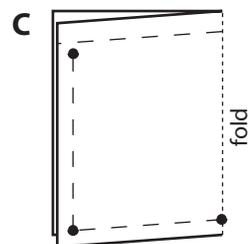
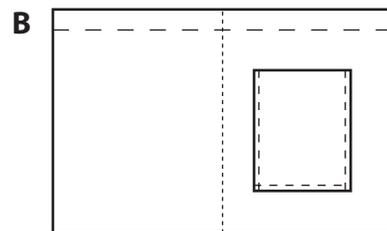
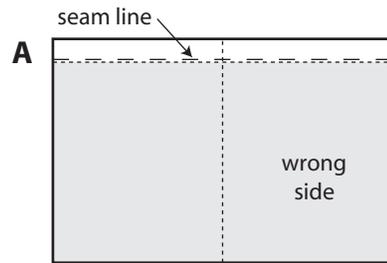
## Materials

For each bag:

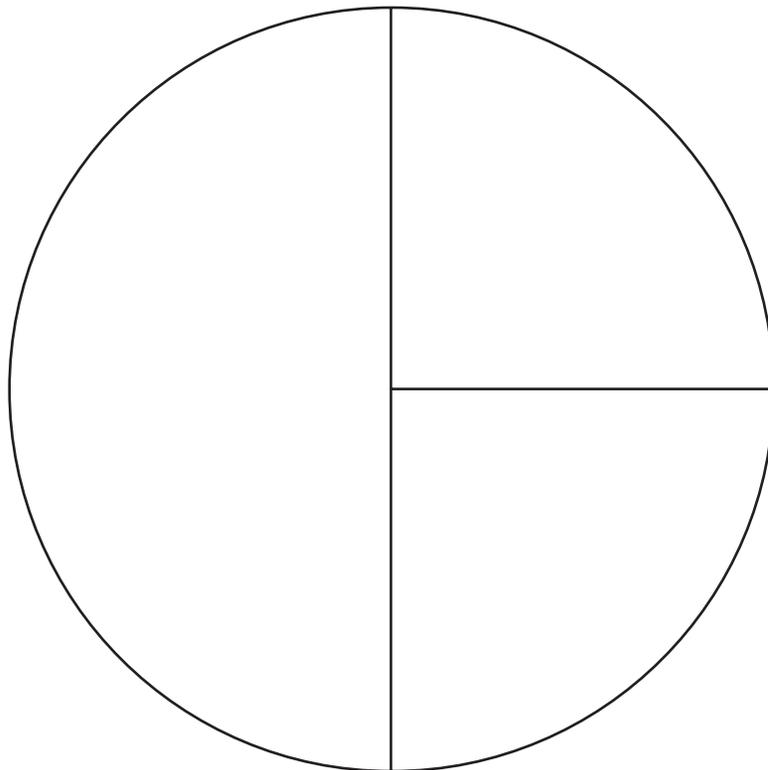
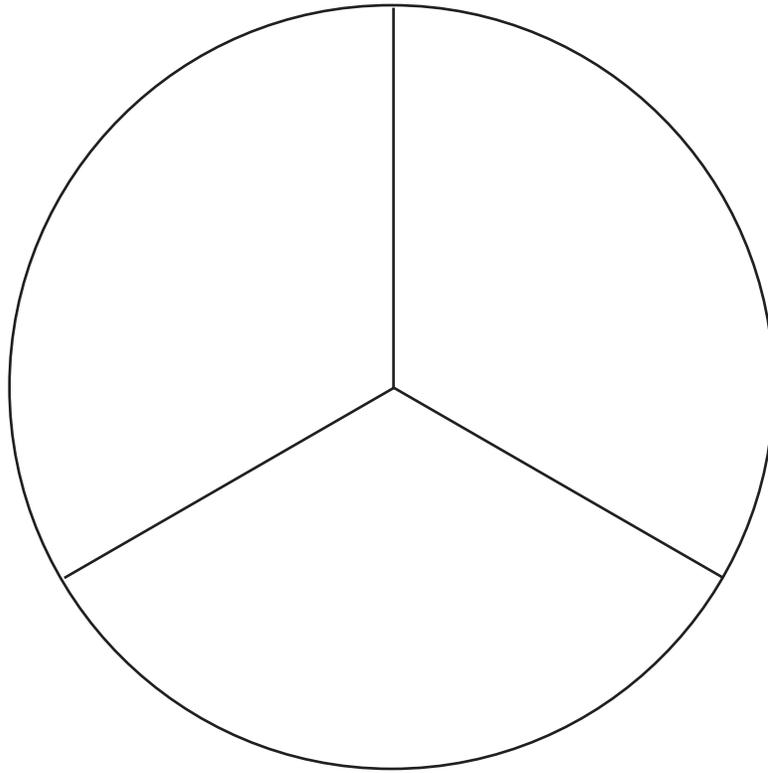
- ☐ 14" x 10" piece of fabric
- ☐ 16" of 1/4" satin ribbon
- ☐ 4" x 5" piece of clear plastic for pocket



1. Lay fabric flat (not folded).
2. Fold top over, **wrong** sides together, 1/4" to hide raw edges.
3. Fold over **again** 1/2" and sew near first folded edge to form a casing 1/2" from the top (A).
4. With fabric still flat, stitch the clear plastic piece onto the front of the bag along the sides and bottom, leaving the top open in order to insert the center directions (B).
5. Fold the fabric along the center fold line, **right** sides together (C).
6. Stitch along the side and bottom, between the dots shown, making sure **not** to stitch over the casing.
7. Turn bag right-side out.
8. Use a safety pin to guide the ribbon through the casing.
9. Tie the ribbon ends together with a knot.



# Spinners





***Science  
Standard  
IV-1  
Activities***



# Gravity—May the Force Be With 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 Science Process and Thinking Skills
4. Communicate Effectively Using Science Language and Reasoning

**Content Connections:**

Math IV-1 & 2, V-1

## Science Standard IV

### Objective 1

#### Connections

## Background Information

Gravity is the force that keeps us on Earth. It is what makes things fall to the ground and rivers flow downhill. It is what keeps the moon circling our planet and all of the planets circling the sun. Gravity, or “gravitation,” is the universal force of attraction that tries to pull every piece of matter together. Every object in the Universe, no matter how small, has its own gravitational pull. The strength of this pull depends on the objects’ mass or amount of matter it has. Earth has a stronger pull than the moon because it is larger and has more mass.

Properties of gravity that third graders will learn in this unit:

- Gravity pulls all objects in the same direction—toward Earth.
- The amount of incline of a hill (how steep it is) changes the speed of a moving object.
- Heavier objects require more force to overcome gravity (and be lifted up) than lighter ones. Weight is the measure of that force.

## Research Basis

Barton, M.L. & Jordan, D.L., (2001) *Teaching Reading in Science*. Association for Supervision and Curriculum Development.

This is a companion to *Teaching Reading in the Content Areas*. The authors review what the research says about reading and science. They review strategies of effective readers. The book includes a variety of graphic organizers to help students make sense of what they are reading and learning.

Kopniecek, B & Kopniecek, R. (1990). Teaching for Conceptual Change: Confronting Children's Experience. *Watson, Phi Delta Kappan*, 680-684.  
<http://www.exploratorium.edu/IFI/resources/teachingforconcept.html>

This is an article on the barriers to changing childrens' misconceptions. The authors follow an elementary school teacher as she tries to help her students discover that sweaters and mittens do not generate heat. They review the research on reasons for students' difficulty in changing misconceptions and present some strategies to assist with facilitating the change in mindset.

Snow, M.S., & Brinton, D.M. (1997). *The Content-Based Classroom: Perspectives on Integrating Language and Content*. White Plains, N.Y. Addison Wesley Longman.

This anthology features a variety of authors who have expertise in a wide range of settings and student populations. The text presents alternative models, research and assessment, and looks at the relationship between content-based instruction and other instructional approaches. It is filled with practical strategies and ideas.

Suping, S.M. (2003). *Conceptual Change Among Students in Science*. Retrieved January 5, 2005 from <http://www.stemworks.org/digests/EDO-SE-03-03.pdf>

The author identifies two types of naïve knowledge or prior conceptions that students bring with them. One of them, misconceptions, is highly resistant to change. The remainder of the article looks at the theoretical framework for conceptual change and presents four views of how it occurs. Four conditions to foster this change are described. Some suggestions for classroom instructional methods that promote conceptual change are briefly described. An extensive reference list aids those wanting more information.

Volkman, M. & Abell, (2003) Seamless Assessment, *Science & Children*. 40(8), 41-45.

Elaborate, and evaluate. The authors show how they used a variety of strategies to assess their students during a unit on the moon. Strategies include: questionnaires, journals (which includes drawings and writings), puzzlers, building models, thought experiments, explanations essays, and poster presentations.

“The mark of a good assessment is that it not only provides information about what students know, but challenges students to develop deeper understanding.”

## ***Assessment Suggestions***

Assessment is most valuable if it is embedded within teaching. If we wait until the end of the instructional unit to assess understanding, valuable instructional opportunities are lost. “The 5E model of science instruction defines a sequence of inquiry-based science instruction that

helps students focus on evidence and explanation. Each stage implies a unique purpose for assessment: diagnosing students' incoming ideas, collecting information about students' formative understanding, determining if students can apply their understanding to a new problem, and providing data for summative evaluation.” (Volkman, 2003)

- *Assessment Matrix*
- Journals
- Individual dry erase boards—great for quick comprehension checks.
- Silent True/False
 

Students write TRUE and FALSE on 2 cards. They listen for statements that are true or false and hold up the appropriate card.
- Group discussions—Pose a question. Small groups work out the answer. When all are satisfied, a spokesperson gives the group's response.
- Concentric circle talk
  - Divide the class in half, giving all students a one or two.
  - Have all the “ones” stand in a circle facing outward.
  - Have all the “twos” stand in circle outside the first, facing inward.
  - Students will be facing a partner.
  - Tell the inner circle students (ones) that their job is to listen.
  - Tell the outside circle (twos) that their job is to speak for 30 seconds about \_\_\_\_\_ (e.g., describe an experiment that demonstrates objects roll down steep inclines faster than a gentle or more level incline).
  - After 30 seconds, tell the speakers to move one (or two or three) places to the left. This time they have to talk for one minute.
  - Move to the left again and speak.
  - Speakers and listeners change places. Repeat the above steps.
- *Frayer Model Map* (p. 8-13)
 

This could be done as class or small group for practice on the subject of gravity. Have each student complete one at a later date as an individual assessment tool.
- Draw a three to four frame cartoon showing two objects dropping and water levels staying the same.

- Design other demonstrations to prove that the motion of objects change with the incline of a hill.
- Mini plays: Working in small groups, have students play the parts of different scientists explaining a scientific concept (e.g., inclines affect the speed of objects) and explaining how they can prove or demonstrate that concept.

## ***Invitation to Learn***

Drop a large book or other object on the floor (the larger it is the more dramatic it will be). Ask why it landed on the floor? Once you let go of the book, why did it not stay in the air? Why did it move by itself without being touched? Lead the class to the idea that gravity made it fall. Say that gravity is a force. Review the definition of force from Standard III (a push or a pull). Ask whether gravity is a push or a pull. (pull)

Complete a K-W-L chart. Ask the students what they know about gravity. Write their statements under the **Know** column. Accept all comments—even incorrect ones. Later they will have an opportunity to correct any misconceptions and errors. Before each experiment, write the questions to be answered in the what I **Want** to know column. Add any questions the students have and questions you might elicit during discussions. As you work through the unit, refer back to this chart asking the students if there are any statements in the **Know** column that they want to change. These new statements will be written in the what I **Learned** column.

## ***Instructional Procedures***

### **Hang in There—Does gravity always pull objects toward Earth?**

1. Have the students cut a 12-inch piece of string. Tie one end to a paper clip or washer. Tie the other end to a ruler. Tape the string on the ruler so it does not slide.
2. Hold the ruler parallel to the floor. Tilt one end of the ruler. Notice the direction of the clip. Hold the ruler perpendicular to the ground. Notice the direction the clip is hanging. The clip always hangs straight down. Earth's gravity is a force that always pulls an object downward toward Earth.

*Math extension:* Instruct students to place their ruler on their desk so it forms an acute, obtuse, and right angle. The angles change—what about the direction of the string?

### ***Materials***

- String
- Paper clips or washers
- Rulers

*Discussion:* Look around the school, playground, and your home. What objects do you see hanging down (swings, tetherball, mobiles, clothes on hangers, etc.)? What could be some problems or how could your life be different if gravity did not pull all of these objects straight down?

### **Tilt-a-Box: How does gravity affect water?**

1. Think about rain drops. If there is no wind, what direction do rain drops always fall? (Students could make rain drops with pipettes and/or spray bottles and observe that the drops always fall straight down.)
2. Ask: Do water levels always stay parallel to the ground? Can it stand at an angle? Fill a shoebox-size plastic storage box half full of water. Have students measure the distance from the water level at both ends of the box to the table. Then tip the box by placing in on a block, pencil box, etc. Measure the level at both ends again. Students will see that the water level stays parallel to the table. (Tip: Have a student hold one ruler on the side of the box along the water line. It will make it easier for them to observe that the water level is still parallel to the table.)

*Discussion:* Ask students to explain how this demonstrates that gravity pulls all objects toward Earth. What other experiments could you design to show that gravity pulls on liquids. (Could make Jell-o or pudding. Pour into clear glasses or bowls. Prop the bowl at an angle in the refrigerator.)

#### **Materials**

- Water
- Variety of water containers

### **How do we help children change their misconceptions?**

Students come to our classes with misconceptions about phenomena and they can develop or have misconceptions reinforced during science lab. For example, in the Tilt-a-Box experiment, students may not see that the water level is parallel to the table because they observe that the water level is at an angle in the box. Therefore they may believe that the water is not parallel to the table. Classroom discussions and a variety of ongoing assessments are important strategies to identify and correct this type of misconception.

“If one concept is to replace another, then certain conditions must prevail. First, the old way of thinking must be challenged by direct observation, by a discrepant event. Next, a new explanation for the phenomenon in question must arise, an explanation that is understandable (take care with vocabulary) and plausible. Finally, the new explanation must lead to further testing. If these conditions can be created in the classroom, conceptual change can occur.”

(Suping, 2003) (Kopnicek, 1990)

Gravity causes objects to roll down inclined surfaces. The steeper the incline is, the faster the object will roll.

The activity, Galileo's Marble Chute, is based on a chute Galileo created to test his theory that gravity causes falling objects to move faster. Since he did not have a stopwatch, he designed a water clock to measure the time it took the ball to travel through each chute.

**Galileo's Marble Chute: How does the incline of a hill affect the speed of an object?**

**Materials**

- Cardboard tube
- Thin cardboard
- Tape
- Large marble

1. Ask the students if they like to go sledding or tobogganing. Ask them to describe where the best places are to go sledding. Where is the nearest place you can get a good ride? What kind of hill makes you go faster?
2. Ask: Does the incline, or how steep a hill is, affect the motion of an object or how fast you can go?
3. Cut the tube in half lengthwise. Tape the two ends of the halves together to form a long chute.
4. Make marks every 6 inches. Cut a short slot on both sides of the chute at each mark.
5. Cut flaps from the thin cardboard. The curved section should match the inside of the tube.
6. Slide the flaps into the slots to make a series of gates. Slightly angle the flaps the same way.

**Classroom Discussion Is Critical**

It is important to ask questions that challenge students' beliefs. "Unless learners are forced to confront their misconceptions, they ignore information that conflicts with their personal theories." (Barton, 2001)

When students are not often asked their opinions, they become reluctant to admit errors in their thinking. They find ways to adjust old ideas before assimilating new ones.

These three strategies are useful in the effort to overcome resistance to conceptual change:

*Stress the relevance*—Connect the new concepts to the child's everyday life.

*Make predictions*—Children who are asked to predict the results of their experiments are more willing to change their thinking

*Stress consistency*—Children facing new patterns of thought should be encouraged to be consistent in their thinking.

- Prop one end of the chute up on a pile of books. Test the marble to make sure none of the gates stick. When the marble rolls smoothly down the chute, you are ready to start the test. As the marble rolls down the chute, you should hear the gates clicking at shorter intervals. If you are having trouble hearing a difference, try experimenting with a lower slope. Also, the longer the chute is, the easier it is to hear the acceleration of the marble.

Explanations of new concepts should be presented in different ways. Also, students should be provided with several opportunities to apply what they have learned to new situations. This reinforces students' new understanding (Barton, 2001).

The following activities reinforce the *Hang in There* activity. They also provide students with opportunities to explore the results of the idea that objects roll faster down steeper inclines as gravity pulls them toward Earth.

### Can Drop

- Place one end of the board up on a brick, 2" x 4", or book.
- Place a small can (such as a tomato paste can) on the board and let it roll down the inclined plane.
- Measure how far it traveled past the end of the board.
- Add another brick or book. Roll the can down the incline plane. Repeat several times—adding another brick or book each time to increase the steepness of the incline.
- Have the students draw a chart in their journals to show the results.
- Discuss with the students how they know that the can is picking up speed. What is the evidence? Make comparisons with other events that show that faster objects travel further (e.g., punting vs. trying to hit a home run in baseball) compare the difference in the amount of force applied.

### Marble Drop

- Shape the modeling clay into a thick, flat circle or rectangle shape (or choose another geometric shape the students are learning in math). Place on the tray next to the table.
- Place the tube perpendicular to the edge of the table. Lift one end of the tube 1" up to form an incline. Roll a marble through the tube so it drops into the clay. Lift the tube up another inch, move the clay slightly to one side and roll the marble through the tube again. Lift the tube 3", move the clay and roll the marble again.

#### Materials

- 3-4 foot board
- Small cans (with contents still inside for weight)
- Several bricks, 2 x 4s or textbooks (the same size)
- Tape measures

#### Materials

- Cardboard paper towel tube
- Soft modeling clay
- Steel balls or marbles

3. Compare the depth of the three holes.

*Problem solving opportunity:* The ruler is probably too small to fit in the dent. Ask the students how they could measure accurately? (Put a pencil in the dent, mark the depth with another pencil, then measure with the ruler.)

*Discussion:* Ask the students to explain how this experiment demonstrates the concept the steeper the incline of the hill, the faster an object travels. Have them think of other objects that might land differently if the incline hill is steeper (e.g., what would be the condition of an egg rolling down a shallow incline vs. a steep incline?).

Help the students come up with other questions and add them to the K-W-L chart.

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Heavier objects require more force than lighter ones to overcome gravity. That force is expressed as weight and can be measured using scales.

### **Weighing in On Gravity: Does it take more force to lift heavier objects?**

1. Hold up a large book and a pencil. Ask which one would require more force to lift up. We can find out how much force it takes for each of these objects to overcome gravity by measuring their weight.
2. Scales tell us how much something weighs or how much force gravity is pulling on it. You are going to make your own scale to see how much force it takes to lift objects and overcome gravity.
3. Make three holes just below the rim of the yogurt container. Thread strings through each hole and tie knots. Tie the other ends together and tie them onto the end of the rubber band.
4. Hook the other end of the rubber band through a paper clip. Tape the paper clip to the zero end of the yard stick.
5. One student stands the yardstick on the floor and holds it in a vertical position.
6. Using the *Experiment Log*, record the point on the yardstick where the rubber band meets the string handle. This is the measuring point.
7. Place an object in the container and note how far down the yardstick the point stretches.

#### **Materials**

- Large book
- Pencil
- Yogurt cups
- String
- Paper clips
- Rubber band
- Yardstick
- Washers
- Variety of small objects that will fit in the yogurt cup (e.g., erasers, pencils, marbles, coins, pebbles, etc.)
- Spring scales
- Experiment Log*

*Note:* an alternative to a rubber band would be a small spring such as found inside a pen.

8. Compare the weight of a variety of objects.
9. Have students observe a spring scale. Compare the results of their homemade scale to the spring scale.
10. Have students weigh their objects using the spring scale and record their results in the third column of their chart.

Discuss how their scales demonstrate or prove that gravity is pulling objects toward Earth.

### ***Curriculum Extensions/Adaptations/Integration***

- Teach techniques for making charts (using the ruler to measure and make the rows and columns even). Make a class chart showing the results of each experiment. Students can make their own in their journals.
- Learn how to draw cartoons. Have students draw a three to four frame cartoon showing what happens when objects roll down hills with increasingly steeper inclines.
- Give each group or student a large piece of butcher paper. Have them draw pictures of familiar objects that hang straight down because of gravity. Make a collage bulletin board.
- Have the students brainstorm all the ways gravity affects their lives. Record their ideas on chart paper.
- Working in small groups, have students brainstorm a list of the effects on astronauts living and working in near-zero gravity. (Give each student a colored pencil. Have them take turns being the scribe and writing their ideas on a large sheet of construction or butcher paper.)

Ask the students to identify and circle those effects that might be a problem. Then ask them to choose one of those problems and brainstorm solutions.

Instruct each group to choose their best solution. They are to prepare a short presentation for the rest of the class describing the problem and their solution.

Tell them that all group members must have an equal part in their presentation. This lesson is adapted from *Creating Creative Curriculum: Focus: Science*.

- Read *Max Goes to the Moon*. Extend the story. Max had a problem playing frisbee on the moon. What other games might have to be adapted to playing on a surface with little or no gravity?

- Work in small groups to assist English Language Learners.
- Draw pictures/diagrams. Assign partners who will help with labeling.
- Place new words on wall charts. (Snow, 1997)
- Concentric Circle Talk.
- Investigate Aristotle, DaVinci, and/or Newton and the important contributions they made to our understanding of gravity. There are engaging, readable books, as well as excellent Web sites, for student exploration. Prepare a presentation for the class (e.g., posters, brochures, power points, play, etc.).
- Have students prepare other experiments to demonstrate to the class. (Or they could be in charge of a learning center and work with individuals and small groups.)

## **Resources**

### **Book**

*The Science Book of Gravity*, by Neil Ardley; ISBN 0-15-200621-4

*Max Goes to the Moon*, by Jeffrey Bennett; ISBN 0-97-218190-3

*I Fall Down*, by Vicki Cobb; ISBN 0-688-17843-X

*How Can I Experiment with Gravity?*, by Cindy Dalton, & Teresa Sikora; ISBN 1-58952-013-0

*Gravity*, by John Farndon; ISBN 0-7614-1340-5

*Investigate and Discover Forces and Machines*, by Robert Gardner; ISBN 0-671-69046-9

*Waking Upside Down*, by Philip Heckman; ISBN 0-689-31930-4

*Gravity: The Universal Force*, by Don Nardo; ISBN 1-56-006204-5

*Toy Lab*, by Michael Ross; ISBN 0-87-614456-3

*The Science of Gravity*, by John Stinger; ISBN 0-7398-1323-4

*Zero Gravity*, by Gloria Skurznski; ISBN 0-02-782925-1

*Experiments with Gravity*, by Salvatore Tocci; ISBN 0-516-22513-8

*Gravity*, by Janice VanCleave; ISBN 0-471-55050-7

*Physics for Every Kid*, by Janice VanCleave; ISBN 0-471-52505-7

*Zero Prep for Beginners: Ready-to-Go Activities for the Language Classroom*, by Laurel Pollard, Natalie Hess, & Jan Herron; ISBN 1-882483-82-0

*Creating Creative Curriculum: Focus: Science*, by Anne Crabbe; ISBN B0006OWQVQ

### **Videos**

*Gravity*, by Bill Nye (Disney Educational Productions,  
1-800-295-5010, <http://dep.disney.go.com/educational/index>);  
Product ID: VHS P#68A76VL00, DVD P#77C17VL00

### **Web sites**

[www.dragonflytv.org](http://www.dragonflytv.org)

[www.nsta.org](http://www.nsta.org)

[www.sciencenetlinks.com](http://www.sciencenetlinks.com)

<http://wings.avkids.com/index.html>

[http://teach-nology.com/web\\_tools/work\\_sheets/](http://teach-nology.com/web_tools/work_sheets/)

### ***Family Connections***

- Have students write a letter to family members explaining the concept they just learned. Include plans for an experiment they want to do at home (e.g., roll a tomato or egg down inclines of different heights). Have them draw a data chart that can be filled out at home.

## Assessment Matrix

Model Phase / Description	Assessment Purpose	Gravity Unit Assessment Example
<p><b>Engage:</b></p> <ul style="list-style-type: none"> <li>• Initiate learning task,</li> <li>• Introduce major ideas</li> <li>• Make connections between past and present learning experiences</li> <li>• Focus student thinking on learning outcomes of the upcoming activities</li> <li>• Mentally engage students in concept to be explored</li> </ul>	<p>To identify students' existing science ideas</p>	<p>K-W-L Chart</p>
<p><b>Explore:</b></p> <ul style="list-style-type: none"> <li>• Provide opportunities for students to test their ideas against new experiences + compare with ideas of their peers and teacher</li> <li>• Provide a common base of experiences in which students actively explore their environment or manipulate materials</li> </ul>	<p>To determine how students are building conceptual understandings</p>	<ul style="list-style-type: none"> <li>• Gravity Learning Logs</li> <li>• Discuss K-W-L chart—any changes to old ideas? New questions?</li> <li>• Design own experiments to find answers to questions</li> <li>• Silent True/False</li> </ul>
<p><b>Explain:</b></p> <ul style="list-style-type: none"> <li>• Provides opportunities for students to develop explanations</li> <li>• Introduces formal language, scientific terms, and content information</li> </ul>	<p>For students to demonstrate their current understanding</p>	<ul style="list-style-type: none"> <li>• Mini-plays</li> <li>• Cartoons</li> <li>• Concentric Circle Talk</li> <li>• Frayer Model Chart</li> </ul>
<p><b>Elaborate:</b></p> <ul style="list-style-type: none"> <li>• Applies or extends students' developing concepts in new concepts</li> <li>• Students develop deeper and broader understanding</li> </ul>	<p>For students to demonstrate their ability to apply/transfer their understanding to new contexts</p>	<ul style="list-style-type: none"> <li>• Design another Demonstration</li> <li>• Group/class discussions</li> </ul>
<p><b>Evaluate:</b></p> <ul style="list-style-type: none"> <li>• Encourages students to assess their understanding as they apply it to solve problems</li> </ul>	<p>To determine what students learned from the lessons</p> <p>For students to be metacognitive about their learning</p>	<ul style="list-style-type: none"> <li>• K-W-L chart + groups + class discussion</li> <li>• Journals – short essays, diagrams, pictures</li> </ul>

Name \_\_\_\_\_

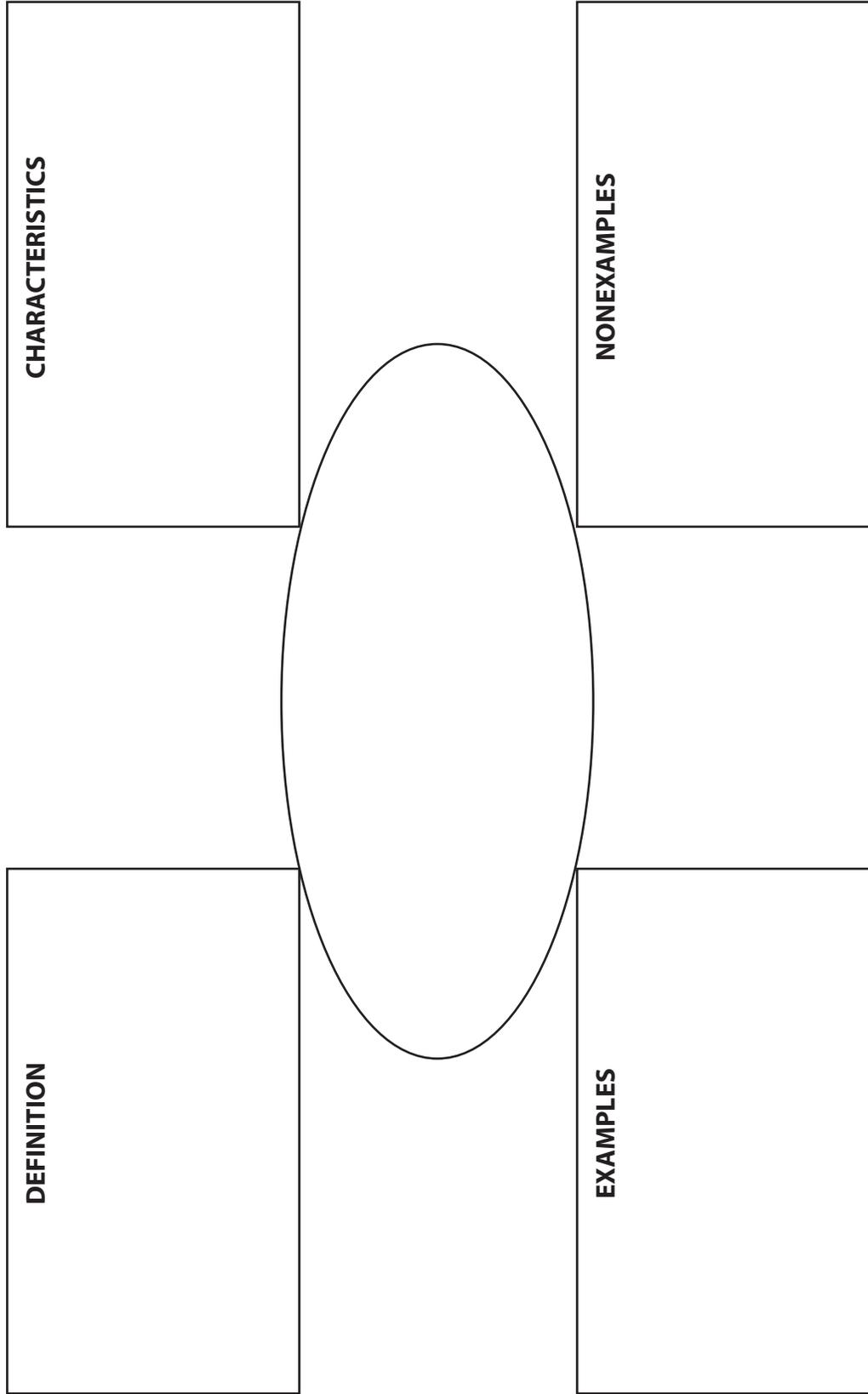
## ***Experiment Log***

<b>Object to be Weighed</b>	<b>How Far the Rubber Band Stretched on my Homemade Scale</b>	<b>Weight Using Spring Scale</b>

Name \_\_\_\_\_

# *The Frayer Model Map on*

\_\_\_\_\_



# *Appendix*



Name \_\_\_\_\_

# Getting to Know You Glyph

**Body**  
Age  
Odd  Even

**Face**  
Girl  Boy

**Mouth**  
Favorite Food  
Pizza  Spaghetti

**Eyes**  
Favorite Season  
Spring or Summer  green   
Fall or Winter  brown

**Shoes**  
Walk to School  Ride to School

**Face**  
Favorite Subject  
Hooked on Reading  Math

**Scoring Rubric/Key**

4. Fully interpreted correctly
3. Student interprets 5 or 6 items correctly
2. Student interprets 3 or 4 items correctly
1. Student interprets 2 or fewer correctly

Name \_\_\_\_\_

# Getting to Know You Glyph

**Body**  
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1. Student interprets 2 or fewer correctly

**Hair**

Number of people in your family

1 ★ for each person

**Hair**

Number of people in your family

1 ★ for each person

Name \_\_\_\_\_

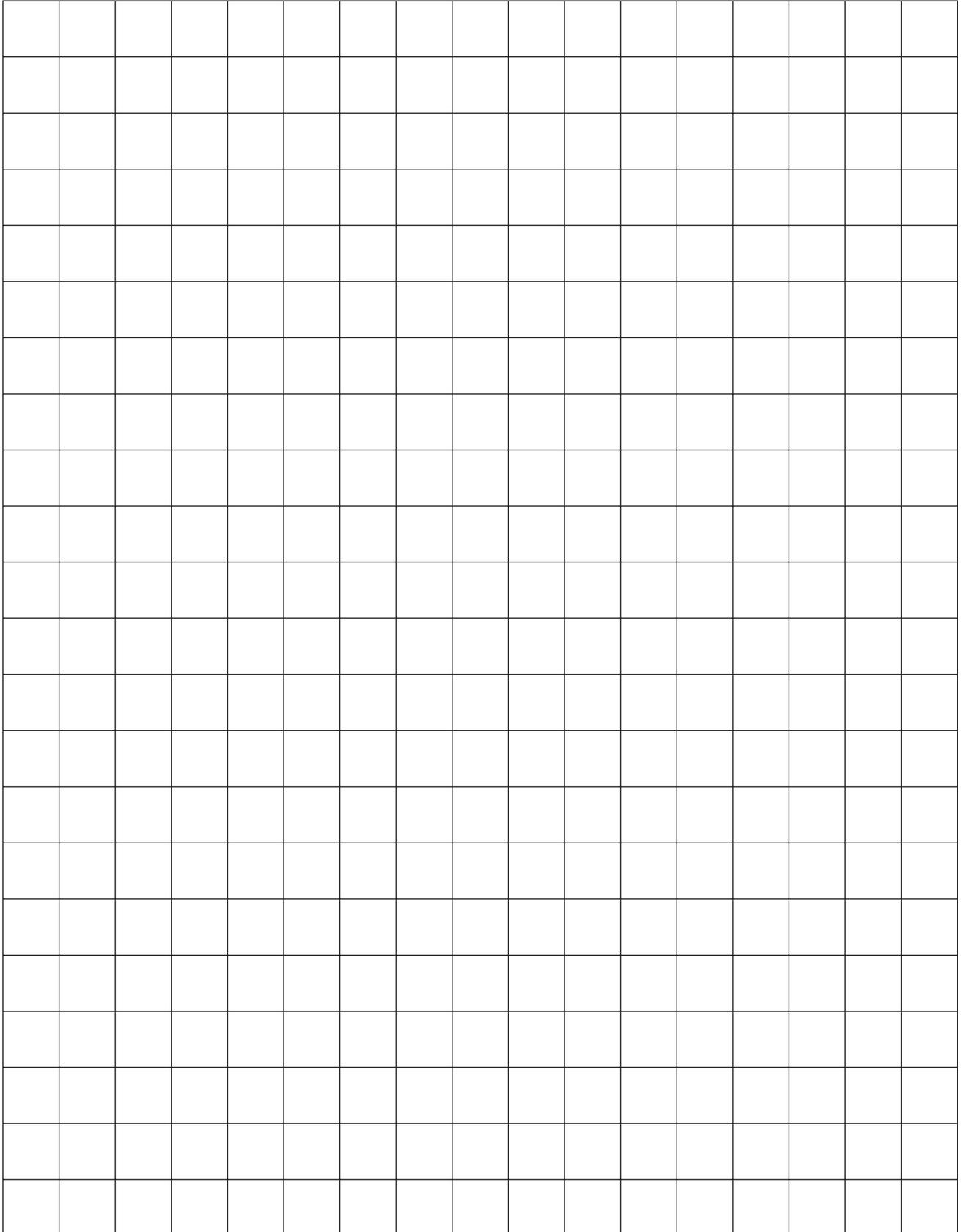
# *Sliding Synthesis Journal*

<b>What I Did</b>	<b>What I Learned</b>	<b>How I Can Use It</b>

# 1" Grid



# Centimeter Grid



Name \_\_\_\_\_

## *Move It, Sir Isaac!*

Count the number of soft and hard pushes it takes to get the object to the finish line. Measure the first soft push and record it before finishing the soft pushes. Measure the first hard push and record it before finishing the hard pushes.

<b>Object</b>	<b>Number of Soft Pushes</b>	<b>About how long is one push?</b>	<b>Number of Hard Pushes</b>	<b>About how long is one push?</b>
Lump of clay				
Paper clip				
Marble				

1. Does it take more or fewer soft pushes to move an object from the starting line to the finish line? Why do you think so?
  
2. Does it take more or fewer hard pushes to move an object from the starting line to the finish line? Why do you think so?
  
3. Does it take more force to move a heavy object than a light object? Why do you think so?
  
4. Describe how soft and hard pushes are different.
  
5. Does the shape of an object make a difference?

## **Rock-A-Bye Pendulum**

Build a pendulum and explore the effect of different amounts of force on an object in motion. Follow these steps to build a pendulum:

1. Gather a ball, string, ruler, and tape.
2. Place the ruler on a desk so that four inches are on the desk and eight inches extend over the side. Tape it to the desk.
3. Wrap one end of the string around the ball once. Wrap a piece of tape around the ball, covering the string. Put two pieces of tape where the string hangs off the ball.
4. Tie or tape the other end of the string around the ruler, three inches from the end.

Congratulations! You are ready to do the experiment.

Set the pendulum in motion by pulling it up and letting it go. Predict what will happen when each of the listed forces acts upon the pendulum. Write your group’s prediction, then try applying the forces to the moving pendulum. Write what happened and why you think it happened.

<b>Force</b>	<b>Prediction</b>	<b>Results</b>	<b>Why do you think this happened?</b>
<b>Blowing</b>			
<b>Tapping with your hand</b>			
<b>Tapping with a paper</b>			
<b>No force (don't touch it, just watch what it does)</b>			

Name three things that could happen when a force acts on a moving object.

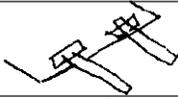
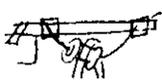
- 1.
- 2.
- 3.

Name \_\_\_\_\_

## Lifting the Load

Build the pulley system and compare the force needed to lift items without a pulley to the force used with a pulley.

How to build the pulley system:

	1. Tape the pencils to the desk.
	2. Tape the strings to the cups and tape the ends together.
	3. Tape the ends of the ribbon to the cup handles.
	4. Tape one end of the 6 in. string to a pencil, thread the spool on it, loop a set of cups over it, tape the other end.
	5. Loop the other set over the other pencil.
	6. Experiment and record results.

	Items needed to lift 5 off the ground (no pulley)		Items needed to lift 5 to the top (no pulley)		Items needed to lift 5 off the ground (with pulley)		Items needed to lift 5 to the top (with pulley)	
	Predict	Actual	Predict	Actual	Predict	Actual	Predict	Actual
<b>Marbles</b>								
<b>Paper Clips</b>								

Look at the results of your experiment. Which set of cups required more force or weight to move?

Explain in your own words how a pulley works to make mechanical work easier.

# Winter Clothing

*Question:* Do winter clothes create heat?

\_\_\_\_\_

*Hypothesis:* I think \_\_\_\_\_

Predict what will happen when you put on a winter coat.

I predict that \_\_\_\_\_

Record the temperature of a thermometer after sitting on a desk for two minutes.

\_\_\_\_\_

Put the thermometer inside the article of clothing, wait two minutes and record the temperature. \_\_\_\_\_

Have one student put the clothing on with the thermometer touching the person inside the glove, coat, or hat. Record the temperature after five minutes. \_\_\_\_\_

Remove the clothing. Set it on a desk out of the sun, put the thermometer inside, and wait five minutes. Record the temperature again. \_\_\_\_\_

*Conclusion:* What happened?

\_\_\_\_\_  
\_\_\_\_\_

Does a coat give off heat? \_\_\_\_\_

Name \_\_\_\_\_

## *Measuring Heat*

Which activity will produce the most heat?

Hypothesis: I think \_\_\_\_\_.

<b>Activity</b>	<b>Was heat produced?</b>	<b>Was light produced?</b>	<b>Temperature before activity</b>	<b>Temperature after 5 minutes</b>	<b>Human Mechanical Electrical Nonexample</b>
<b>1</b>					
<b>2</b>					
<b>3</b>					
<b>4</b>					
<b>5</b>					
<b>6</b>					
<b>7</b>					
<b>8</b>					
<b>9</b>					
<b>10</b>					
<b>11</b>					
<b>12</b>					
<b>13</b>					
<b>14</b>					
<b>15</b>					
<b>16</b>					
<b>17</b>					
<b>18</b>					
<b>19</b>					

Conclusion \_\_\_\_\_.

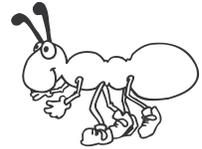
# Close to 100 Score Sheet

Round 1: Deal six cards to each player. Players choose any four of their cards to make two 2-digit numbers that, when added together, come as close as possible to a sum of 100.

Wild cards may have any value. Each player records his/her numbers and the total below. **The player's score for each round is the difference between the total and 100.** The used cards are discarded and the remaining two cards are kept for the next round.

Rounds 2-5: Deal out four new cards to each player and repeat the steps in Round 1.

At the end of five rounds, players total their scores. The player with the lowest total wins the game!



		Score for Round
<b>Round 1</b>	_____ + _____ = _____	
<b>Round 2</b>	_____ + _____ = _____	
<b>Round 3</b>	_____ + _____ = _____	
<b>Round 4</b>	_____ + _____ = _____	
<b>Round 5</b>	_____ + _____ = _____	

**Total** \_\_\_\_\_

# Glyph Interpretation Sheet

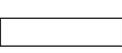
**Leaf**

Which kind of writing do you prefer?

Cursive → leaf on the left side of the stem

Manuscript → leaf on the right side of the stem

**Stem**

Straight  Boy

Crooked  Girl

**Grass**

Which type of lunch do you prefer?

Home lunch →  Grass 4" tall

School lunch →  Grass 2" tall

**Center**

Are you excited for your summer break?

Yellow  YES

Orange  NO

**Sunshine**

Are you excited for 4th grade?

Yes, I'm excited → 

No, I'm not excited → No sun

**Petals**

What school subjects do you like?

Math ..... red

Spelling..... orange

Reading..... yellow

Art/Music..... green

Science ..... blue

Writing..... purple

One  (petal) per subject.

**Scoring Rubric/Key**

1. Student attempts, but has major errors
2. Student unable to complete glyph, even with help
3. At least 4 items interpreted correctly
4. Fully interpreted correctly

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Name \_\_\_\_\_

# Rubric for Graphs

<p><b>Picture Graphs</b></p> <ol style="list-style-type: none"> <li>Title</li> <li>Legend or Key</li> <li>Information is accurate</li> <li>Different picture for each category</li> <li>Each axis labeled</li> </ol> <p><b>Rubric</b></p> <ol style="list-style-type: none"> <li>4—Applies to all 5 items</li> <li>3—Applies to 4 items</li> <li>2—Applies to 3 items</li> <li>1—Applies to 2 items or less</li> </ol>
--

<p><b>Pictograph</b></p> <ol style="list-style-type: none"> <li>Title</li> <li>Legend or Key</li> <li>Information is accurate</li> <li>Same picture throughout</li> <li>Each axis labeled</li> </ol> <p><b>Rubric</b></p> <ol style="list-style-type: none"> <li>4—Applies to all 5 items</li> <li>3—Applies to 4 items</li> <li>2—Applies to 3 items</li> <li>1—Applies to 2 items or less</li> </ol>
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<p><b>Pie Graphs</b></p> <ol style="list-style-type: none"> <li>Title</li> <li>Legend or Key</li> <li>Information is accurate</li> <li>Equals one WHOLE</li> <li>Number pattern to make graph</li> </ol> <p><b>Rubric</b></p> <ol style="list-style-type: none"> <li>4—Applies to all 5 items</li> <li>3—Applies to 4 items</li> <li>2—Applies to 3 items</li> <li>1—Applies to 2 items or less</li> </ol>
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<p><b>Line Graphs (shows change over time)</b></p> <ol style="list-style-type: none"> <li>Title</li> <li>Label horizontal axis</li> <li>Label vertical axis</li> <li>Numbers in a pattern (increments)</li> <li>Numbers labeled on lines</li> <li>Each individual label on the horizontal axis</li> <li>Plotting the points correctly</li> </ol> <p><b>Rubric</b></p> <ol style="list-style-type: none"> <li>4—Includes all 7 items</li> <li>3—Includes 5 or 6 items</li> <li>2—Includes 3 or 4 items</li> <li>1—Includes 2 items or less</li> </ol>
--

<p><b>Bar Graphs</b></p> <ol style="list-style-type: none"> <li>Title</li> <li>Label horizontal axis</li> <li>Label vertical axis</li> <li>Numbers in a pattern (increments)</li> <li>Numbers must be labeled on the line, not on the space</li> <li>Information is accurate on the bars</li> <li>Bars cannot touch (spaces between each one)</li> </ol> <p><b>Rubric</b></p> <ol style="list-style-type: none"> <li>4—Includes all 7 items</li> <li>3—Includes 5 or 6 items</li> <li>2—Includes 3 or 4 items</li> <li>1—Includes 2 items or less</li> </ol>
--



Name \_\_\_\_\_

## *Experiment Log*

<b>Object to be Weighed</b>	<b>How Far the Rubber Band Stretched on my Homemade Scale</b>	<b>Weight Using Spring Scale</b>

Name \_\_\_\_\_

# *The Frayer Model Map on*

