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

ELEMENTARY CORE ACADEMY • ELEMENTARY CORE ACADEMY • ELEMENTARY

6TH GRADE

2008 Participant Handbook

UTAH STATE OFFICE OF EDUCATION

UtahState UNIVERSITY

ELEMENTARY CORE ACADEMY
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Organizations:

Utah State Office of Education (USOE)
Utah State University (USU)
State Science Education Coordination Committee (SSECC)
State Mathematics Education Coordination Committee (SMECC)
Special Education Services Unit (USOE)

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UTAH STATE OFFICE OF EDUCATION

Leadership…Service…Accountability

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

Funding Sources

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

District Funds:

Various sources including Quality Teacher Block, Federal ESEA Title II, and District Professional Development Funds

School Funds:

Trust land, ESEA Title II, and other school funds
Utah State Office of Education Special Education Services

The state and district funds are allocations from the state legislature. ESEA is part of the "No Child Left Behind" funding that comes to Utah.

Additionally, numerous school districts, individual schools, and principals in Utah have sponsored teachers to attend the Academy. Other educational groups 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

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 the 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 no longer 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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Utah Elementary Math Core Curriculum

Introduction

Most children 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 building beliefs about what mathematics is, about what it means to know and do mathematics, and about themselves as mathematical learners. Students use mathematical tools, such as manipulative materials and technology, to develop conceptual understanding and solve problems as they do mathematics. Students, as mathematicians, learn best through participatory 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 (logically explaining and justifying a solution to a problem), and engaging (seeing mathematics as sensible, useful, and doable, and being able to do the work) (NRC, 2001).

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 school mathematics. Instruction should not be based on the 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 and revised by a community of Utah mathematics teachers, mathematicians, university mathematics educators, and

State Office of Education specialists. It was critiqued by an advisory committee representing a wide variety of people from the community, as well as an external review committee. The Core reflects the current philosophy of mathematics education that is expressed in national documents developed by the National Council of 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. 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.

- Each grade level begins with a brief description of areas of instructional emphasis which can serve as organizing structures for curriculum design and instruction.
- The INTENDED LEARNING OUTCOMES (ILOs) describe the skills and attitudes students should acquire as a result of successful mathematics instruction. They are found at the beginning of each grade level and are an integral part of the Core.
- 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.
- INDICATORS are observable or measurable student actions that enable students to master an Objective. Indicators can help guide classroom instruction.
- MATHEMATICAL LANGUAGE AND SYMBOLS STUDENTS SHOULD USE includes language and symbols students should use in oral and written language.
- EXPLORATORY CONCEPTS AND SKILLS are included to establish connections with learning in subsequent grade levels. They are not intended to be assessed at the grade level indicated.

Guidelines Used in Developing the Elementary Mathematics Core

The Core is:

Consistent With the Nature of Learning

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. 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 and skills. 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 Core is designed to encourage a variety of interactive learning opportunities. Instruction should include recognition of the role of mathematics in the classroom, school, and community.

Comprehensive

By emphasizing <u>depth</u> rather than <u>breadth</u>, the Elementary Mathematics Core seeks to empower students by providing a comprehensive background in mathematics. Teachers are expected to teach all the standards and objectives specified in the Core for their grade level, but may add related concepts and skills.

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 handbook is also available for teachers and has sample lessons on each topic for each grade level. The 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. The 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.

Based Upon the National Council of Teachers of Mathematics Curriculum Focal Points

In 2006, the National Council of Teachers of Mathematics (NCTM) published *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics* (NCTM, 2006). This document is available online at http://www.nctm.org/focalpoints. This document describes three focal points for each grade level. NCTM's focal points are areas of emphasis recommended for the curriculum of each grade level. The focal points within a grade are ***not the entire curriculum*** for that particular grade; however, Utah's Core Curriculum was designed to include these areas of focus.

Intended Learning Outcomes for Third through Sixth 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 acquire as a result of successful mathematics instruction. They are an essential part of the Mathematics Core Curriculum and provide teachers with a standard for student learning in mathematics.

ILOs for mathematics:

1. **Develop a positive learning attitude toward mathematics.**
2. **Become effective problem solvers by selecting appropriate methods, employing a variety of strategies, and exploring alternative approaches to solve problems.**
3. **Reason logically, using inductive and deductive strategies and justify conclusions.**
4. **Communicate mathematical ideas and arguments coherently to peers, teachers, and others using the precise language and notation of mathematics.**
5. **Connect mathematical ideas within mathematics, to other disciplines, and to everyday experiences.**
6. **Represent mathematical ideas in a variety of ways.**

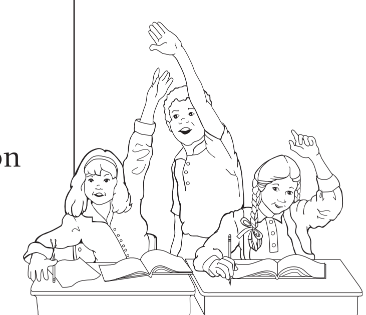
Significant mathematics understanding occurs when teachers incorporate ILOs in planning mathematics instruction. The following are ideas to consider when planning instruction for students to acquire the ILOs:

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

   When students are confident in their mathematical abilities, they demonstrate persistence in completing tasks. They pose mathematical questions about objects, events, and processes while displaying a sense of curiosity about numbers and patterns. It is important to build on students' innate problem-solving inclinations and to preserve and encourage a disposition that values mathematics.

2. **Become effective problem solvers by selecting appropriate methods, employing a variety of strategies, and exploring alternative approaches to solve problems.**

   Problem solving is the cornerstone of mathematics. Mathematical knowledge is generated through problem solving



as students explore mathematics. To become effective problem solvers, students need many opportunities to formulate questions and model problem situations in a variety of ways. They should generalize mathematical relationships and solve problems in both mathematical and everyday contexts.

3. **Reason logically, using inductive and deductive strategies and justify conclusions.**

   Mathematical reasoning develops in classrooms where students are encouraged to put forth their own ideas for examination. Students develop their reasoning skills by making and testing mathematical conjectures, drawing logical conclusions, and justifying their thinking in developmentally appropriate ways. Students use models, known facts, and relationships to explain reasoning. As they advance through the grades, students' arguments become more sophisticated.

4. **Communicate mathematical ideas and arguments coherently to peers, teachers, and others using the precise language and notation of mathematics.**

   The ability to express mathematical ideas coherently to peers, teachers, and others through oral and written language is an important skill in mathematics. Students develop this skill and deepen their understanding of mathematics when they use accurate mathematical language to talk and write about what they are doing. When students talk and write about mathematics, they clarify their ideas and learn how to make convincing arguments and represent mathematical ideas verbally, pictorially, and symbolically.

5. **Connect mathematical ideas within mathematics, to other disciplines, and to everyday experiences.**

   Students develop a perspective of the mathematics field as an integrated whole by understanding connections within mathematics. Students should be encouraged to explore the connections that exist with other disciplines and between mathematics and their own experiences.

6. **Represent mathematical ideas in a variety of ways.**

   Mathematics involves using various types of representations including concrete, pictorial, and symbolic models. In particular, identifying and locating numbers on the number line has a central role in uniting all numbers to promote understanding of equivalent representations and ordering. Students also use a variety of mathematical representations to expand their capacity to think logically about mathematics.

Sixth Grade Mathematics Standards

By the end of grade six, students have mastered the four arithmetic operations with whole numbers, positive rational numbers, positive decimals, and positive and negative integers; they accurately compute and solve problems. They find prime factorizations, least common multiples, and greatest common factors. They create, evaluate, and simplify expressions, and solve equations involving two operations and a single variable. They solve problems involving an unknown angle in a triangle or quadrilateral, and use properties of complementary and supplementary angles. Students know about π as the ratio between the circumference and the diameter of a circle and solve problems using the formulas for the circumference and area of a circle. Students analyze, draw conclusions, and make predictions based upon data and apply basic concepts of probability.

Standard I: **Students will expand number sense to include operations with rational numbers.**

Objective 1: Represent rational numbers in a variety of ways.

a. Recognize a rational number as a ratio of two integers, a to b, where b is not equal to zero.

b. Change whole numbers with exponents to standard form (e.g., $2^4 = 16$) and recognize that any non-zero whole number to the zero power equals 1 (e.g., $9^0 = 1$).

c. Write a whole number in expanded form using exponents (e.g., $876{,}539 = 8 \times 10^5 + 7 \times 10^4 + 6 \times 10^3 + 5 \times 10^2 + 3 \times 10^1 + 9 \times 10^0$).

d. Express numbers in scientific notation using positive powers of ten.

Objective 2: Explain relationships and equivalencies among rational numbers.

a. Place rational numbers on the number line.

b. Compare and order rational numbers, including positive and negative mixed fractions and decimals, using a variety of methods and symbols, including the number line and finding common denominators.

c. Find equivalent forms for common fractions, decimals, percents, and ratios, including repeating or terminating decimals.

Standard I:
Students will expand number sense to include operations with rational numbers.

d. Relate percents less than 1% or greater than 100% to equivalent fractions, decimals, whole numbers, and mixed numbers.

e. Recognize that the sum of an integer and its additive inverse is zero.

Objective 3: Use number theory concepts to find prime factorizations, least common multiples, and greatest common factors.

a. Determine whether whole numbers to 100 are prime, composite, or neither.

b. Find the prime factorization of composite numbers to 100.

c. Find the greatest common factor and least common multiple for two numbers using a variety of methods (e.g., list of multiples, prime factorization).

Objective 4: Model and illustrate meanings of operations and describe how they relate.

a. Relate fractions to multiplication and division and use this relationship to explain procedures for multiplying and dividing fractions.

b. Recognize that ratios derive from pairs of rows in the multiplication table and connect with equivalent fractions.

c. Give mixed number and decimal solutions to division problems with whole numbers.

Objective 5: Solve problems involving multiple steps.

a. Select appropriate methods to solve a multi-step problem involving multiplication and division of fractions and decimals.

b. Use estimation to determine whether results obtained using a calculator are reasonable.

c. Use estimation or calculation to compute results, depending on the context and numbers involved in the problem.

d. Solve problems involving ratios and proportions.

Objective 6: Demonstrate proficiency with the four operations, with positive rational numbers, and with addition and subtraction of integers.

a. Multiply and divide a multi-digit number by a two-digit number, including decimals.

b. Add, subtract, multiply, and divide fractions and mixed numbers.

c. Add and subtract integers.

Mathematical language and symbols students should use:

prime, composite, exponent, least common multiple, least common denominator, greatest common factor, decimals, percents, divisible, divisibility, equivalent fractions, integer, dividend, quotient, divisor, factor, simplest terms, mixed numeral, improper fraction

Exploratory Concepts and Skills

- Explore the addition and subtraction of positive and negative fractions.
- Investigate the concepts of ratio and proportion.
- Investigate the distributive property of multiplication over addition of double-digit multipliers.

Standard II: Students will use patterns, relations, and algebraic expressions to represent and analyze mathematical problems and number relationships.

Standard II: Students will use patterns, relations, and algebraic expressions to represent and analyze mathematical problems and number relationships.

Objective 1: Analyze algebraic expressions, tables, and graphs to determine patterns, relations, and rules.

a. Describe simple relationships by creating and analyzing tables, equations, and expressions.

b. Draw a graph and write an equation from a table of values.

c. Draw a graph and create a table of values from an equation.

Objective 2: Write, interpret, and use mathematical expressions, equations, and formulas to represent and solve problems that correspond to given situations.

a. Solve single variable linear equations using a variety of strategies.

b. Recognize that expressions in different forms can be equivalent and rewrite an expression to represent a quantity in a different way.

c. Evaluate and simplify expressions and formulas, substituting given values for the variables (e.g., 2x + 4; x = 2; therefore, 2 (2) + 4 = 8).

Mathematical language and symbols students should use:

order of operations, sequence, function, pattern, algebraic expression, approximately equal, ≈, notation for exponents: 4^3 or 4^3, a number in front of a variable indicates multiplication (e.g., 3y means 3 times the quantity y), formula, generalization

Exploratory Concepts and Skills

- Use physical models to investigate and describe how a change in one variable affects a second variable.
- Use models to develop understanding of slope as constant rate of change.
- Model situations with proportional relationships and solve problems.

Standard III: Students will use spatial and logical reasoning to recognize, describe, and analyze geometric shapes and principles.

Objective 1: Identify and analyze attributes and properties of geometric shapes to solve problems.

a. Identify the midpoint of a line segment and the center and circumference of a circle.

b. Identify angles as vertical, adjacent, complementary, or supplementary and provide descriptions of these terms.

c. Develop and use the properties of complementary and supplementary angles and the sum of the angles of a triangle to solve problems involving an unknown angle in a triangle or quadrilateral.

Objective 2: Visualize and identify geometric shapes after applying transformations on a coordinate plane.

a. Rotate a polygon about the origin by a multiple of 90° and identify the location of the new vertices.

b. Translate a polygon either horizontally or vertically on a coordinate grid and identify the location of the new vertices.

c. Reflect a polygon across either the x- or y-axis and identify the location of the new vertices.

Mathematical language and symbols students should use:
midpoint, circumference, complementary and supplementary angles, rotate, translate, reflect, transformation

Exploratory Concepts and Skills

- Use manipulatives and technology to model geometric shapes.
- Investigate tessellations.
- Explore the angles formed by intersecting lines.
- Identify and draw shapes and figures from different views/perspectives.

Standard III:
Students will use spatial and logical reasoning to recognize, describe, and analyze geometric shapes and principles.

Standard IV: **Students will understand and apply measurement tools and techniques and find the circumference and area of a circle.**

Objective 1: Describe and find the circumference and area of a circle.

a. Explore the relationship between the radius and diameter of a circle to the circle's circumference to develop the formula for circumference.

b. Find the circumference of a circle using a formula.

c. Describe pi as the ratio of the circumference to the diameter of a circle.

d. Decompose a circle into a number of wedges and rearrange the wedges into a shape that approximates a parallelogram to develop the formula for the area of a circle.

e. Find the area of a circle using a formula.

Objective 2: Identify and describe measurable attributes of objects and units of measurement, and solve problems involving measurement.

a. Recognize that measurements are approximations and describe how the size of the unit used in measuring affects the precision.

b. Convert units of measurement within the metric system and convert units of measurement within the customary system.

c. Compare a meter to a yard, a liter to a quart, and a kilometer to a mile.

d. Determine when it is appropriate to estimate or use precise measurement when solving problems.

e. Derive and use the formula to determine the surface area and volume of a cylinder.

Standard IV:
Students will understand and apply measurement tools and techniques and find the circumference and area of a circle.

Mathematical language and symbols students should use:
cylinder, radius, diameter, circumference, area, surface area, volume, π

Exploratory Concepts and Skills
- Investigate volumes and surface areas of a variety of three-dimensional objects.

Standard V: Students will analyze, draw conclusions, and make predictions based upon data and apply basic concepts of probability.

Objective 1: Design investigations to reach conclusions using statistical methods to make inferences based on data.

a. Design investigations to answer questions.

b. Extend data display and comparisons to include scatter plots and circle graphs.

c. Compare two similar sets of data on the same graph and compare two graphs representing the same set of data.

d. Recognize that changing the scale influences the appearance of a display of data.

e. Propose and justify inferences and predictions based on data.

Objective 2: Apply basic concepts of probability and justify outcomes.

a. Write the results of a probability experiment as a fraction between zero and one, or an equivalent percent.

b. Compare experimental results with theoretical results (e.g., experimental: 7 out of 10 tails; whereas, theoretical 5 out of 10 tails).

c. Compare individual, small group, and large group results of a probability experiment in order to more accurately estimate the actual probabilities.

Mathematical language and symbols students should use:
data display, scatter plot, circle graph, scale, predict, justify, probability, experimental results, theoretical results

Exploratory Concepts and Skills
- Investigate the notion of fairness in games.

Standard V:
Students will analyze, draw conclusions, and make predictions based upon data and apply basic concepts of probability.

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.

- 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.

Guidelines 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.

The Core is:

- Coherent
- Developmentally Appropriate
- Encourages Good Teaching Practices
- Comprehensive
- Feasible
- Useful and Relevant
- Encourages Good Assessment Practice

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 handbook is also available for teachers and has sample lessons on each topic for each grade level. The 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. 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.

Sixth Grade Science Core Curriculum

- Design and perform experiments
- Value inquiry
- Maintain an open questioning mind
- Pose questions about objects, events, processes, and results
- Plan and conduct experiments
- Read, observe, compare, describe, infer, and draw conclusions
- Formalize the process of science
- Identify variables in a formal experiment

The theme for Sixth Grade Science is Scale, with Relative Position as an underlying concept. Sixth graders should begin to relate to the incredible size and distance of objects in the solar system, galaxy, and universe, as well as compare their world to the miniscule scale of microorganisms. Students will also understand how relative position affects such events as the appearance of the moon and the changing of the seasons. Students will experiment with heat, light, and sound, and begin to understand concepts of energy.

Students should begin to design and perform experiments and value inquiry as the fundamental scientific process. They should be encouraged to maintain an open and questioning mind as they plan and conduct experiments. They should be helped and encouraged to pose their own questions about objects, events, processes, and results. They should have the opportunity to plan and conduct their own experiments, and come to their own conclusions as they read, observe, compare, describe, infer, and draw conclusions. The results of their experiments need to be compared for reasonableness to multiple sources of information. It is important for students at this age to begin to formalize the processes of science and be able to identify the variables in a formal experiment.

Good science instruction requires hands–on science investigations in which student inquiry is an important goal. Teachers should provide opportunities for all students to experience many things. Sixth graders should experience the excitement of locating the North Star and Little Dipper, and the wonders of gazing into the night sky. They should find the fascination of peering into the world of microorganisms, experimenting and watching them as they move and feed and reproduce. Students should come to enjoy science as a process of discovering the natural world.

Science 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. Technology issues and the nature of science are significant components of this Core. 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 sixth 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 sixth grade; Sci-ber Text –an electronic science textbook 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 sixth grade Science Core. These resources are all available on the Utah Science Home Page at http://www.usoe.k12.ut.us/curr/science.

SAFETY PRECAUTIONS

The hands–on nature of this science curriculum increases the need for teachers to use appropriate precautions in the classroom and field. Proper handling and disposal of microorganisms is crucial for a safe classroom. 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 Sixth Grade Science

- Use Science Process and Thinking Skills
- Manifest Scientific Attitudes and Interests
- Understand Science Concepts and Principles
- Communicate Effectively Using Science Language and Reasoning
- Demonstrate Awareness of Social and Historical Aspects of Science
- Understand the Nature of 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 sixth grade students will be able to:

1. Use Science Process and Thinking Skills
   a. Observe simple objects, patterns, and events, and report their observations.
   b. Sort and sequence data according to criteria given.
   c. Given the appropriate instrument, measure length, temperature, volume, and mass in metric units as specified.
   d. Compare things, processes, and events.
   e. Use classification systems.
   f. Plan and conduct simple experiments.
   g. Formulate simple research questions.
   h. Predict results of investigations based on prior data.
   i. Use data to construct a reasonable conclusion.
2. Manifest Scientific Attitudes and Interests
   a. Demonstrate a sense of curiosity about nature.
   b. Voluntarily read and look at books and other materials about science.
   c. Pose science questions about objects, events, and processes.
   d. Maintain an open and questioning mind toward new ideas and alternative points of view.
   e. Seek and weigh evidence before drawing conclusions.
   f. Accept and use scientific evidence to help resolve ecological problems.
3. Understand Science Concepts and Principles

   a. Know and explain science information specified for the grade level.
   b. Distinguish between examples and non-examples of concepts that have been taught.
   c. Solve problems appropriate to grade level by applying science principles and procedures.

4. Communicate Effectively Using Science Language and Reasoning
   a. Record data accurately when given the appropriate form (e.g., table, graph, chart).
   b. Describe or explain observations carefully and report with pictures, sentences, and models.
   c. Use scientific language in oral and written communication.
   d. Use reference sources to obtain information and cite the source.
   e. Use mathematical reasoning to communicate information.
5. Demonstrate Awareness of Social and Historical Aspects of Science
   a. Cite examples of how science affects life.
   b. Understand the cumulative nature of science knowledge.
6. Understand the Nature of Science
   a. Science is a way of knowing that is used by many people not just scientists.
   b. Understand that science investigations use a variety of methods and do not always use the same set of procedures; understand that there is not just one "scientific method."
   c. Science findings are based upon evidence.

Sixth Grade Science Standards

Standard I:
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Science Benchmark
The appearance of the lighted portion of the moon changes in a predictable cycle as a result of the relative positions of Earth, the moon, and the Sun. Earth turns on an axis that is tilted relative to the plane of Earth's yearly orbit. The tilt causes Sunlight to fall more intensely on different parts of the Earth during various parts of the year. The differences in heating of Earth's surface and length of daylight hours produce the seasons.

Standard I: Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Objective 1: Explain patterns of changes in the appearance of the moon as it orbits Earth.

a. Describe changes in the appearance of the moon during a month.
b. Identify the pattern of change in the moon's appearance.
c. Use observable evidence to explain the movement of the moon around Earth in relationship to Earth turning on its axis and the position of the moon changing in the sky.
d. Design an investigation, construct a chart, and collect data depicting the phases of the moon.

Objective 2: Demonstrate how the relative positions of Earth, the moon, and the Sun create the appearance of the moon's phases.

a. Identify the difference between the motion of an object rotating on its axis and an object revolving in orbit.
b. Compare how objects in the sky (the moon, planets, stars) change in relative position over the course of the day or night.
c. Model the movement and relative positions of Earth, the moon, and the Sun.

Standard II: Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 1: Describe the relationship between the tilt of Earth's axis and its yearly orbit around the Sun.

a. Describe the yearly revolution (orbit) of Earth around the Sun.

b. Explain that Earth's axis is tilted relative to its yearly orbit around the Sun.

c. Investigate the relationship between the amount of heat absorbed and the angle to the light source.

Objective 2: Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the Sun produces the seasons.

a. Compare Earth's position in relationship to the Sun during each season.

b. Compare the hours of daylight and illustrate the angle that the Sun's rays strikes the surface of Earth during summer, fall, winter, and spring in the Northern Hemisphere.

c. Use collected data to compare patterns relating to seasonal daylight changes.

d. Use a drawing and/or model to explain that changes in the angle at which light from the Sun strikes Earth, and the length of daylight, determine seasonal differences in the amount of energy received.

e. Use a model to explain why the seasons are reversed in the Northern and Southern Hemispheres.

Science language students should use:

Earth's tilt, seasons, axis of rotation, orbits, phases of the moon, revolution, reflection

Standard II:
Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Standard III:
Students will understand the relationship and attributes of objects in the solar system.

Science Benchmark

The solar system consists of planets, moons, and other smaller objects including asteroids and comets that orbit the Sun. Planets in the solar system differ in terms of their distance from the Sun, number of moons, size, composition, and ability to sustain life. Every object exerts gravitational force on every other object depending on the mass of the objects and the distance between them. The Sun's gravitational pull holds Earth and other planets in orbit. Earth's gravitational force holds the moon in orbit. The Sun is one of billions of stars in the Milky Way galaxy, that is one of billions of galaxies in the universe. Scientists use a variety of tools to investigate the nature of stars, galaxies, and the universe. Historically, cultures have observed objects in the sky and understood and used them in various ways.

Standard III: Students will understand the relationship and attributes of objects in the solar system.

Objective 1: Describe and compare the components of the solar system.

a. Identify the planets in the solar system by name and relative location from the Sun.
b. Using references, compare the physical properties of the planets (e.g., size, solid or gaseous).
c. Use models and graphs that accurately depict scale to compare the size and distance between objects in the solar system.
d. Describe the characteristics of comets, asteroids, and meteors.
e. Research and report on the use of manmade satellites orbiting Earth and various planets.

Objective 2: Describe the use of technology to observe objects in the solar system and relate this to science's understanding of the solar system.

a. Describe the use of instruments to observe and explore the moon and planets.
b. Describe the role of computers in understanding the solar system (e.g., collecting and interpreting data from observations, predicting motion of objects, operating space probes).

c. Relate science's understanding of the solar system to the technology used to investigate it.

Objective 3: Describe the forces that keep objects in orbit in the solar system.

a. Describe the forces holding Earth in orbit around the Sun, and the moon in orbit around Earth.

b. Relate a celestial object's mass to its gravitational force on other objects.

c. Identify the role gravity plays in the structure of the solar system.

Standard IV: Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Objective 1: Compare the size and distance of objects within systems in the universe.

a. Use the speed of light as a measuring standard to describe the relative distances to objects in the universe (e.g., 4.4 light years to star Alpha Centauri; 0.00002 light years to the Sun).

b. Compare distances between objects in the solar system.

c. Compare the size of the Solar System to the size of the Milky Way galaxy.

d. Compare the size of the Milky Way galaxy to the size of the known universe.

Objective 2: Describe the appearance and apparent motion of groups of stars in the night sky relative to Earth and how various cultures have understood and used them.

a. Locate and identify stars that are grouped in patterns in the night sky.

b. Identify ways people have historically grouped stars in the night sky.

c. Recognize that stars in a constellation are not all the same distance from Earth.

Standard IV:
Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

d. Relate the seasonal change in the appearance of the night sky to Earth's position.

e. Describe ways that familiar groups of stars may be used for navigation and calendars.

Science language students should use:
asteroids, celestial object, comets, galaxy, planets, satellites, star, distance, force, gravity, gravitational force, mass, scale, solar system, constellation, Milky Way galaxy, speed of light, telescope, universe, Sun, light years

Science Benchmark

Microorganisms are those living things that are visible as individual organisms only with the aid of magnification. Microorganisms are components of every ecosystem on Earth. Microorganisms range in complexity from single to multicellular organisms. Most microorganisms do not cause disease and many are beneficial. Microorganisms require food, water, air, ways to dispose of waste, and an environment in which they can live. Investigation of microorganisms is accomplished by observing organisms using direct observation with the aid of magnification, observation of colonies of these organisms and their waste, and observation of microorganisms' effects on an environment and other organisms.

Standard V: Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Objective 1: Observe and summarize information about microorganisms.

a. Examine and illustrate size, shape, and structure of organisms found in an environment such as pond water.

b. Compare characteristics common in observed organisms (e.g., color, movement, appendages, shape) and infer their function (e.g., green color found in organisms that are producers, appendages help movement).

c. Research and report on a microorganism's requirements (i.e., food, water, air, waste disposal, temperature of environment, reproduction).

Objective 2: Demonstrate the skills needed to plan and conduct an experiment to determine a microorganism's requirements in a specific environment.

a. Formulate a question about microorganisms that can be answered with a student experiment.

b. Develop a hypothesis for a question about microorganisms based on observations and prior knowledge.

c. Plan and carry out an investigation on microorganisms. {Note: Teacher must examine plans and procedures to assure the safety of students; for additional information,

Standard V: Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

you may wish to read microbe safety information on Utah Science Home Page.}

d. Display results in an appropriate format (e.g., graphs, tables, diagrams).

e. Prepare a written summary or conclusion to describe the results in terms of the hypothesis for the investigation on microorganisms.

Objective 3: Identify positive and negative effects of microorganisms and how science has developed positive uses for some microorganisms and overcome the negative effects of others.

a. Describe in writing how microorganisms serve as decomposers in the environment.

b. Identify how microorganisms are used as food or in the production of food (e.g., yeast helps bread rise, fungi flavor cheese, algae are used in ice cream, bacteria are used to make cheese and yogurt).

c. Identify helpful uses of microorganisms (e.g., clean up oil spills, purify water, digest food in digestive tract, antibiotics) and the role of science in the development of understanding that led to positive uses (i.e., Pasteur established the existence, growth, and control of bacteria; Fleming isolated and developed penicillin).

d. Relate several diseases caused by microorganisms to the organism causing the disease (e.g., athlete's foot -fungi, streptococcus throat -bacteria, giardia -protozoa).

e. Observe and report on microorganisms' harmful effects on food (e.g., causes fruits and vegetables to rot, destroys food bearing plants, makes milk sour).

Science language students should use:
algae, fungi, microorganism, decomposer, single–celled, organism, bacteria, protozoan, producer, hypothesis, experiment, investigation, variable, control, culture

Science Benchmark

Heat, light, and sound are all forms of energy. Heat can be transferred by radiation, conduction and convection. Visible light can be produced, reflected, refracted, and separated into light of various colors. Sound is created by vibration and cannot travel through a vacuum. Pitch is determined by the vibration rate of the sound source.

Standard VI: Students will understand properties and behavior of heat, light, and sound.

Objective 1: Investigate the movement of heat between objects by conduction, convection, and radiation.

a. Compare materials that conduct heat to materials that insulate the transfer of heat energy.
b. Describe the movement of heat from warmer objects to cooler objects by conduction and convection.
c. Describe the movement of heat across space from the Sun to Earth by radiation.
d. Observe and describe, with the use of models, heat energy being transferred through a fluid medium (liquid and/or gas) by convection currents.
e. Design and conduct an investigation on the movement of heat energy.

Objective 2: Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

a. Compare light from various sources (e.g., intensity, direction, color).
b. Compare the reflection of light from various surfaces (e.g., loss of light, angle of reflection, reflected color).
c. Investigate and describe the refraction of light passing through various materials (e.g., prisms, water).
d. Predict and test the behavior of light interacting with various fluids (e.g., light transmission through fluids, refraction of light).
e. Predict and test the appearance of various materials when light of different colors is shone on the material.

Standard VI:
Students will understand properties and behavior of heat, light, and sound.

Objective 3: Describe the production of sound in terms of vibration of objects that create vibrations in other materials.

a. Describe how sound is made from vibration and moves in all directions from the source in waves.

b. Explain the relationship of the size and shape of a vibrating object to the pitch of the sound produced.

c. Relate the volume of a sound to the amount of energy used to create the vibration of the object producing the sound.

d. Make a musical instrument and report on how it produces sound.

Science language students should use:
angle of incidence, angle of reflection, absorption, conduction, conductor, convection, medium, pitch, prism, radiation, reflection, refraction, spectrum, vibration

Facilitated

Activities

What MI am I? Questions

Verbal Linguistic
- I like to read a lot.
- I enjoy crosswords and other word games.
- I am good at written tests and essays.
- I can remember things exactly as they are told to me.
- I frequently quote things from books I've read or movies I've seen.
- I am a good story teller and/or writer.
- I like to talk through problems and explain solutions.

Bodily Kinesthetic
- I like thrilling rides.
- I use my hands and body language when I talk.
- I like to learn something by doing it rather than reading about it or watching a video.
- I like crafts and hobbies where I get to use my hands.
- I don't like to sit too long and/or I move, tap or fidget while sitting.
- I always touch things and examine the tex-

Logical Mathematical
- I enjoy math and/or science.
- I like working with numbers and can do mental calculations.
- I like logical thinking puzzles, brainteasers, and strategy games.
- I like to categorize and group things.
- I am interested in new scientific advances.
- I create lists (to do lists, itineraries, etc.).
- I easily grasp cause and effect relationships.

Naturalist
- I am involved in protecting the environment.
- I prefer to be outdoors.
- I like gardening.
- I enjoy fishing and/or tracking.
- I have or like pets.
- I can recognize and name many different trees, flowers, and plants.
- I notice tracks, nests, and wildlife while walking or hiking and/or read weather signs.

Visual Spatial
- I like to record events by taking pictures or video recordings.
- I doodle when I am listening to people, taking notes, or thinking.
- I can visualize how things look from different perspectives
- I prefer reading material with illustrations.
- I enjoy visual games and/or puzzles, mazes, etc.
- I can easily ready charts and maps.
- I remember things best by seeing them.

Interpersonal
- I have many close personal friends.
- I communicate well with people and people enjoy talking with me.
- I prefer team sports.
- I can tell what others are feeling.
- I like to share my ideas and feelings with others.
- I work best in cooperative groups.
- I like to get the advice of others to help me solve a problem or make a decision.

Musical Rhythmic
- It is easy for me to follow the beat of music and keep time.
- I enjoy engaging in musical activities.
- I can play an instrument and/or sing on key.
- I can usually remember a tune after hearing it a couple of times.
- I like to listen to music at home or riding in the car.
- Theme music and commercial jingles often pop into my head.
- I like to listen to music while I work.

Intrapersonal
- I have a few close friends.
- I am not easily influenced by other people (peer pressure).
- I know about my own feelings, strengths, and weaknesses.
- I enjoy being alone sometimes and am happy with my own company.
- I prefer to work alone.
- I like to make up my own mind and am an independent thinker.
- I keep a personal diary or log.

What MI am I? Graph

verbal/ linguistic	logical/ mathematical	visual spatial	musical/ rhythmic	bodily kinesthetic	naturalist	inter personal	intrapersonal

Café Chez Journal

Math Menu

Desserts

Wonderings

Lesson feedback

Lateral thinking prompts
(e.g., If math was an animal, what animal would it be and why?)

Reflections on tests

Mathematics on tests

Book reports

Hors d' Oeuvres

About the author

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Copy of the COREs

CRT reference sheets

Affective interest inventory

Multiple intelligence graph

Goal setting

Main Entrees

Math Entrees

Explaining a process

Defining terms

Prove and disprove statements

Creating their own problems

Graphic organizers
(Venn diagrams, mind maps, graphs, tables, foldables, etc.)

Café Chez Journal

Science Menu

Desserts

Wonderings

Unanswered questions

Student explorations

Discovery days

Science process skills

Hors d' Oeuvres

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Bell ringers

Self starters

Sticky notes or tabs

Main Entrees

Science Entrees

Experiments: Question, Prediction, Planning, Observations, Claims, Wonderings

Quick writes: What have I learned today?

Reflections

Graphic organizers

Observations

Lecture notes

Oh No! 9.9 Directions

- This is a game that you play with a partner.
- Each team gets one set of cards. Show them the overhead of the cards in the deck. Inform them that there is two of each card in the deck.
- Each player gets 4 cards to start and will always have 4 cards in his/her hand.
- The rest of the cards are placed face down in a "draw pile".
- The player with the birthday closest to January 1st starts.
- He/she lays down one card to start the game then draws another from the draw pile.
- Player 2 places a card from his/her hand on top and finds the sum of the two cards then draws from the draw pile.
- Play continues back and forth keeping a running a total.
- The object of the game is to force your opponent to lay down a card that puts the total over 9.9. (9.9 is fine 9.91 is not).
- The player who goes over 9.9 looses the game.

Oh No! 9.9 Possible Journal Prompts

"What are all the mathematical expressions you can think of that give you the answer 9.9?"

"What is your strategy for winning this game?"

"What cards are more helpful at the beginning of the game and why?"

"What cards are more helpful at the end of the game and why?"

"What do you think is the best card in the deck?"

"What would be the 4 best cards to have in your hand at the end of the game?"

Oh No! 9.9 Game Cards

add .1	add .1	add .2	add .2
add .25	add .25	add .3	add .3
add .4	add .4	add .5	add .5
add .6	add .6	add .7	add .7

add .8	**add .8**	**add .9**	**add .9**
add 1	**add 1**	**add 1/2**	**add 1/2**
add 1/4	**add 1/4**	**add 3/4**	**add 3/4**
add 1/5	**add 1/5**	**add 2/5**	**add 2/5**

add 3/5	add 3/5	add 4/5	add 4/5
add 1/10	add 1/10	add 3/10	add 3/10
add 7/10	add 7/10	add 9/10	add 9/10
add 1 1/2	add 1 1/2	add 1.5	add 1.5

subtract .5	**subtract .5**	**subtract 1/2**	**subtract 1/2**
subtract .1	**subtract .1**	**subtract 1/10**	**subtract 1/10**
subtract .75	**subtract .75**	**subtract 3/4**	**subtract 3/4**
subtract 1	**subtract 1**	**subtract 1**	**subtract 1**

Ordering Objects in the Universe Cards

Width of a DNA Helix	Length of an Average Virus	Length of an average bacteria
Width of a human hair	Radius of the head of a pin	One inch
One foot	Height of an "average" human	Basketball court
Football field	Distance sound travels in 1 second	One mile
Mount Everest	Altitude of the Hubble Space Telescope	Radius of the Moon
Radius of Earth	Radius of Jupiter	Radius of the Moon's orbit
Radius of the Sun	Earth's orbital radius	Pluto's orbital radius
Milky Way Galaxy - from center to edge	Distance to Alpha Centuri	Radius of Observable Universe

Spacing Out in Space Directions

Directions:

1. Provide sentence strips.
2. Fold the strip in half and open up.
3. Label the sun, Pluto, Uranus, and Neptune.
4. Fold sun to Uranus. Write Saturn on the crease.
5. Fold sun to Saturn. Write Jupiter on the crease.
6. Fold sun to Jupiter. Write asteroid belt on the crease.
7. Fold sun to asteroid belt. Write Mars on the crease.
8. Fold sun to Mars. Write Venus on the crease.
9. Discuss what would be found in between the sun and Venus. Write in Mercury.
10. Discuss which planet is missing. Write in "Earth" in between "Venus" and "Mars".

AGE

Object	Age
1. Hubble Telescope	a few years (1990)
2. Moon	approx. 4.5 billion years
3. Jupiter	approx. 4.5 billion years
4. Sun	approx. 4.5 billion years
5. Alpha Centauri	approx 10 billion years
6. Galaxy	approx 10 billion years

SIZE

Object	Size in Miles	Kilometers
1. Hubble Telescope	40 feet long	12 meters
2. Moon	2,000 miles diameter	3,200 kilometers
3. Jupiter	88,736 miles diameter	142,984 kilometers
4. Sun	875,000 miles diameter	1,408,000 km
5. Alpha Centauri	20,000,000 miles diameter	32,000,000 km
6. Galaxy	600 thousand trillion miles	1 X 1018 km

DISTANCE

Object	Miles	Kilometers
1. Telescope surface of the Earth	350 miles above the	560 km
2. Moon	250,000 miles	402,000 km
3. Sun	93,000,000 miles	1.5 X 108 km
4. Jupiter	790 million mile (closest)	1.3 X 109 km
5. Alpha Centauri	4.37 light-years distant 25.8 trillion miles	41.5 trillion km
6. Galaxy	200 million trillion miles	3 X 1020 km

Order Me by AGE, SIZE, and DISTANCE

1. Order the objects in space by their age from youngest to oldest.

2. Order the objects in space by their size from smallest through largest.

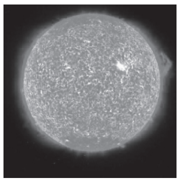
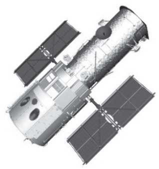
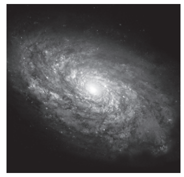
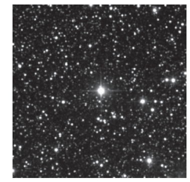
3. Order the objects in space by how close they are to the Planet Earth (nearest to farthest.)

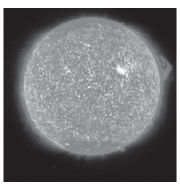
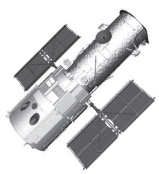
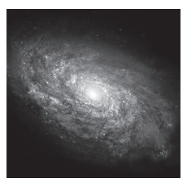
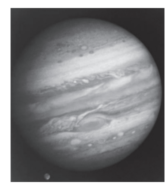
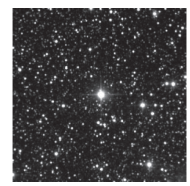
Record three interesting findings:

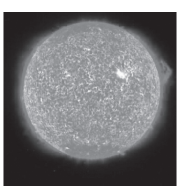
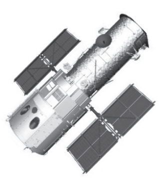
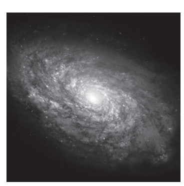
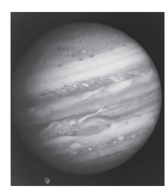
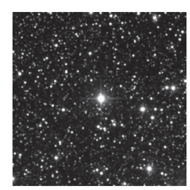
1.

2.

3.

 Sun	 Hubble Space Telescope	 Galaxy	 Moon	 Jupiter	 Alpha Centarui

 Sun	 Hubble Space Telescope	 Galaxy	 Moon	 Jupiter	 Alpha Centarui

 Sun	 Hubble Space Telescope	 Galaxy	 Moon	 Jupiter	 Alpha Centarui

Name ______________________________

Interest Grouping

Please rate these on a scale of 1 - 6, with 1 being your most favorite and 6 being your least favorite.

[ ] Write

[ ] Draw

[ ] Act (Drama)

[ ] Build

[ ] Research

[ ] Music/Singing

Name ______________________________

Interest Grouping

Please rate these on a scale of 1 - 6, with 1 being your most favorite and 6 being your least favorite.

[ ] Write

[ ] Draw

[ ] Act (Drama)

[ ] Build

[ ] Research

[ ] Music/Singing

Name ______________________________

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Name ______________________________

Interest Grouping

Please rate these on a scale of 1 - 6, with 1 being your most favorite and 6 being your least favorite.

[ ] Write

[ ] Draw

[ ] Act (Drama)

[ ] Build

[ ] Research

[ ] Music/Singing

Tic-Tac-Toe Menu Astronomy

You should select any three of the following activities to complete your Astronomy Project.

Due Dates: 1st activity:
2nd activity:
3rd activity:

Venn Diagram Create a Venn Diagram in a creative shape comparing one object in space to another. Choose from: planets, comets, asteroids, meteoroids, constellations, or satellites.	**News Article** Write a newspaper article detailing a significant event in astronomy. Be sure to include the 5 W's: who, what, where, when, and why. You may also write a news brief about an upcoming event.	**Acrostic poem** Create an acrostic poem or phrases and sentences about one of the planets. Your phrases should apply specifically to your planet, not just planets in general.
Letter Write a one-page letter to the President explaining the benefits of continuing the funding for space exploration. Include at least five "Space Spinoffs" used today from the space program (for example: velcro).	**Free Space** You create a fun activity about your subject. Remember to have it approved by your teacher before you begin.	**Space Glossary** Create a glossary of at least 10 astronomical terms. Define each term and provide an example of how that object is used/found in space.
Diary Entries Write seven diary entries that might have been written by an astronaut or someone working in the space program.	**Conflict Paper** Should Pluto have been demoted to the status of a Dwarf Planet, or remained classified as a planet? Write a 5-paragraph essay stating your opinion of this.	**Scrapbook Pages** Create two scrapbook pages of a space launch. Include the purpose of the launch, people involved, and time line of the launch. (jpl website)

Tic-Tac-Toe Rubric

Type of Activity	A Grade	B Grade	C Grade
Venn Diagram			Venn Diagram Drawn 3 similarities, 3 differences, and 3 things in common
News Article			News article, at least 2 paragraphs, and includes 5 Ws
Acrostic Poem			One word per letter of a planet
Letter			Written in letter format, includes 2 ways we use Space Spinoffs
Space Glossary			Includes at least 7 technology terms and definitions
Diary Entries			Includes 5 diary entries of at least 3 sentences each.
Conflict			Includes a thesis statement and 2 - 3 paragraphs why Pluto should be a planet.
Scrapbook Pages			Two scrapbook pages that include 1 of the 3 requirements

NIM Instructions

Learning Objectives:
We will:

- Identify, extend and use patterns to play the game.
- Learn skills and strategies to win the game
- Identify math found in the game

Language Objective:
Explain to your partner the methods you use to find winning strategy.
Using NIM as Differentiated
Problem Solving Approach Problem

NIM

- **Take 10-15 counters from your bag.**
- **Lay them out in a line**
- **With a partner, take turns picking 1, 2, or 3 pieces**
- **No skipping turns!**
- **The winner takes the last 1, 2, or 3 pieces.**
- **Test for winning strategies**

Thoughtful Questions

- **Is it better to go first or second?**
- **When do you know that you are going to win for sure? What does the board look like?**
- **Think about your move, and try to figure out what your opponent is going to do?**
- **Which moves are poor moves?**
- **Would your strategy change if there were a different amount of counters?**
- **Would your strategy change if the maximum number of counters taken per move were changed?**
- **Have you tried testing some of your theories?**
- **Would it be easier if you worked backward or made the game smaller?**

拳術 NIM 秋天

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Instructions for Play:

____

____

____

You cannot

____

Winning Strategies:

____

____

____

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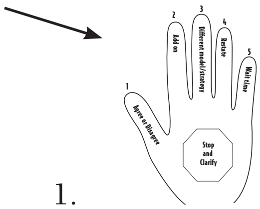
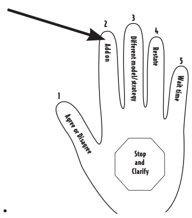
Examining The Five Fingered Math Talk Strategies



1. Asking students to apply their own reasoning to someone else's reasoning:

Examples:

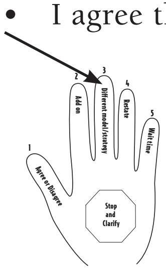
- Do you agree or disagree and why?
- Can you tell us why you agree with what __________________just said?
- Would you all discuss what ____________________ just said? (Wait)



2. Prompting students for further participation:

Examples:

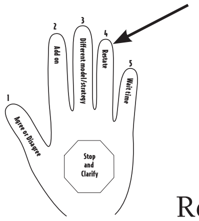
- Would anyone like to add to the discussion?
- Turn and talk to your partner about ______________________.
- I agree that ________________, but why is that important?



3. Promoting the sharing of different strategies and methods:

Examples:

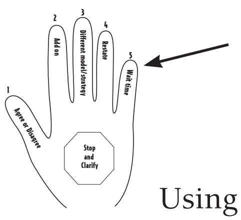
- Who thinks they can explain why _____________ did ________________? Talk to the person next to you for a moment about this.
- Let's try ____________'s method/procedure for ________________. Work with the person next to you. (Wait) Okay, now that you've had a chance to try _________'s procedure, who would like to explain to us what you did?
- How is your strategy (method) different from_______________'s ? What is similar about ______________'s and ______________'s strategies?
- So ______________solved it by___________________. Who solved it a different way?"

4. 

Restating: Asking students to restate what another student has said.

Examples:

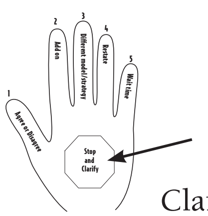
- Can anyone repeat what _______________just said in his or her own words?
- That is an important question. Can anyone repeat what _________________just said?
- Can someone repeat what ____________________ did for his solution so far?"

5. 

Using wait time:

Examples:

- Take your time, we'll wait.
- Okay, let's pause for a minute.
- Okay, let's back up and go over what we've talked about so far.

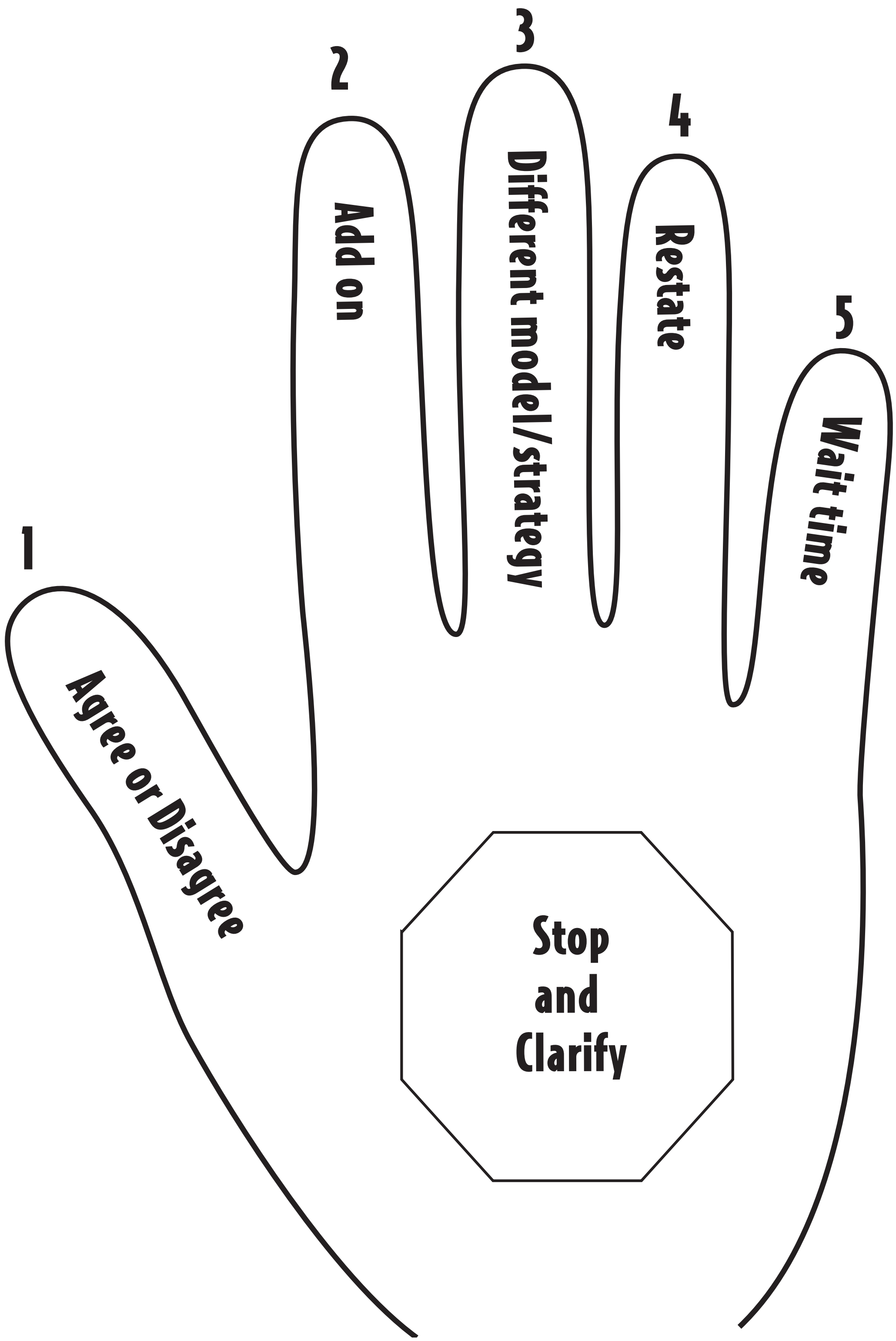
6. 

Clarifying and checking for Understanding

Examples:

- ____________, can you tell more about ______________________?"
- I agree that _________________, but why is that important?
- _______________, could you be a little more specific?"

Examining The Five Fingered Math Talk Strategies



Guide For Mathematical Discussions

THREE FORMATS: Each has value and should be a part of EVERY lesson EVERYDAY.		
Many Heads	**3 to 4 Heads**	**2 Heads**
GRAPHIC to match heading	GRAPHIC to match heading	GRAPHIC to match heading
1. Whole Class Discussion: Provides an opportunity for students to share their thinking, explain their steps and their reasoning, and build on one another's contributions. Teachers **focus on student thinking**, not providing answers.	**2. Small Group Discussion:** Students are given a task to discuss among themselves in groups of three or four. Teacher circulates as groups discuss without controlling the discussion but interjecting questions to keep students ideas moving forward.	**3. Partner Talk:** Teacher asks the question and gives students a minute or two at the most to put their thoughts into words with their partner. Students who understand but are hesitant about voicing their thoughts will have a chance to practice in a small safe environment. Students who have not understood can bring up questions with the partner. **For many students, particularly those who are learning English as a second language, this one- or two-minute aside is invaluable.**

Multiple Intelligences/Learning Styles

Children think, learn and create in a myriad of different ways. Howard Gardner's model of multiple intelligences recognizes the broad range of talents and learning styles we find in our students. Within his model, Gardner identified and categorized eight different intelligences: verbal/linguistic, logical/mathematical, bodily/kinesthetic, intrapersonal, interpersonal, musical/rhythmic, visual/spatial, and naturalistic. According to Gardner, every child possesses each of these intelligences, but some are developed more than others, depending on the individual. Teachers can take these categories and differentiate curriculum through the preparation of activities that nurture these intelligences in students. Indeed, the development of each child's potential is directly influenced by how effectively teachers match what students learn with how they learn (their own particular intelligences).

It is recommended that teachers use the eight multiple intelligences as a springboard to create activities that challenge students to take control of their own learning. Making students aware of the different intelligences will help them identify how they learn best and also which methods challenge them. Teachers can target activities that lead students to enhance both their strengths and weaknesses.

Indeed, educators can think of multiple intelligences as a philosophy of how children learn. University of California—Riverside's Sue Teele describes the goal of Gardner's model in this way: "Multiple intelligences provide for different windows into the same room. We need to unleash the creative potential in all our schools in order to open as many windows as possible for every student in every classroom to succeed . . .the future mandates that we all move forward together in a way that builds on both our mutual strengths and respects our unique differences."

Teele's research suggests that certain intelligences are stronger in students, depending on their stages of development. Using a survey she developed, (the "*Teele Inventory for Multiple Intelligences*"), Sue studied the learning preferences of more than 6,000 students. Her findings revealed that the verbal/linguistic intelligence is strongest in students in kindergarten through third grade. First through fourth grade students show a definite preference for the logical/mathematical intelligence. The visual/spatial and bodily/kinesthetic intelligences are dominant throughout both elementary and middle school. Middle school students also show a preference for the musical/rhythmic and interpersonal intelligences. Based on Teele's findings, elementary school teachers would be well advised to plan lessons that incorporate the use of verbal/linguistic, logical/mathematical, visual/spatial and bodily/kinesthetic activities.

Here are a few considerations for educators, as they strive to create activities based on the different learning styles of their students:

- *Change it up.* Educators should choose activities that target varied intelligences. Since teachers tend to plan lessons and activities that fit their own learning preferences, it's important for them to self-assess and to be sure that all of the intelligences are being represented.

- *Be clear.* When differentiating the "product," teachers need to be sure that students have clear directions (task cards, or posted instructions). Also, routines/procedures should be established for students so they know how/where to find materials and who/when to ask for help.
- *Be realistic.* It's not necessary or appropriate for teachers to use all eight intelligences in every lesson. During the planning phase, the Core Curriculum and unique needs of the students should be considered to determine which two or three to incorporate.
- *Remember to reflect.* Best practice suggests that after trying something new, professionals take time to reflect, including notes of what to retain and what to refine.
- *All in good time.* It can be overwhelming for teachers to create activities that incorporate the multiple intelligences in every single lesson for every content area. Common sense suggests to start with "baby steps" and consult with colleagues for ideas throughout the process.
- *Communicate with parents.* Both students and their parents will appreciate the insights that come from recognizing and putting a name to their unique learning styles. In fact, teachers can invite parents to help students identify their preferences by sending home a *Learning Preferences Survey* to be completed by students and parents together (each horizontal row represents a learning style/intelligence).

References

Tomlinson, C.A. (1999). *The Differentiated Classroom.* (p. 83). Alexandria, VA: ASCD.

Conklin, W. (2007). *Applying Differentiation Strategies*. (pp. 149-202). Huntington Beach, CA: Shell Education.

Teele, S. (1994). Redesigning the educational system to enable all students to succeed. Doctoral dissertation, University of California—Riverside.

Resources

http://www.thomasarmstrong.com/multiple_intelligences.htm

http://en.wikipedia.org/wiki/Multiple_Intelligences

Gardner's Eight Multiple Intelligences

Intelligence	Student Likes	Student Needs
Verbal/Linguistic "word smart" The student thinks in words.	Words: writing, reading, playing word games, telling interesting stories	journals, books, writing materials
Logical/Mathematical "number/reasoning smart" The student thinks by reasoning.	Numbers or logic: figuring out problems, puzzles, experimenting, calculating	Science supplies, trips to museums, math manipulatives
Visual/Spatial "picture smart" The student thinks in pictures.	Pictures: draw, design, doodle	art supplies, building materials, video equipment, puzzles
Bodily/Kinesthetic "body smart" The student thinks by using his/her body.	A physical experience: dancing, moving, jumping, running, touching	movement, sports, theater, physical games, hands-on activities
Rhythmic/Musical "music smart" The student thinks in melodies and rhythms.	Music: listening to music, making own music, tapping to the rhythm, singing	play musical instruments, see concerts, use a karaoke machine
Interpersonal "people smart" The student thinks by talking about his/her ideas to others.	A social experience: organizing events, being the leader, partying, mediating between friends	time with friends, group projects, social events
Intrapersonal "self-smart" The student keeps his/her thoughts to him/herself.	Self-reflection: setting goals, mediating, daydreaming, quiet places	time alone, individualized projects
Naturalist "nature smart" The student thinks by classifying.	An experience in the natural world: studying anything in nature including rocks, animals, plants, and the weather	time outside, nature hikes, telescopes, binoculars, notebooks for classification

Tiered Activities

Using tiered lessons is a way for teachers to ensure that all students, regardless of ability level or learning style, progress towards mastery of learning goals and objectives. Tiered assignments, also known as scaffolding, allow for differing levels of readiness and performance levels. The entire class works toward the same essential understanding (parallel tasks) but their paths to that goal depend upon their abilities and learning styles (varied levels of depth and varied degrees of support).

The following are guidelines for planning tiered lessons/assessments. Teachers should:

1. Using the Core Curriculum, pick a concept or skill that needs to be learned (e.g. "What's the ultimate measurable objective?").
2. Think of an activity that matches the objective.
3. Use pre-assessment data to determine the individual needs of the students. Consider students performing above grade level, students below grade level, English Language Learners, and students with varying learning style preferences (multiple intelligences).
4. Take another look at the selected activity. Target its complexity to be appropriate for on-grade-level learners.
5. Modify the activity or assessment to meet the needs of the other learners in the class. Within one activity, there will be several tiers to meet the wide range of student needs.
6. Seek consultation from the specialists in the school, as well as fellow colleagues.
7. Teach the activity, including the various tiers.
8. Reflect and refine.

Remember, tiered lessons provide differentiation because of varied levels of complexity, not necessarily because of varied quantities of work. Here are a few considerations for educators, as they implement use of tiered activities to scaffold for student learning:

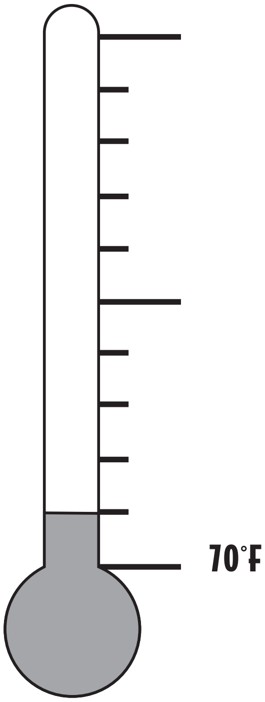
- Just because students are above grade level, that does not mean they should be given more work.
- Just because students are below grade level, that does not mean they should be given less work.
- All tiered activities should be interesting and appealing.
- All tasks should provide a challenge.

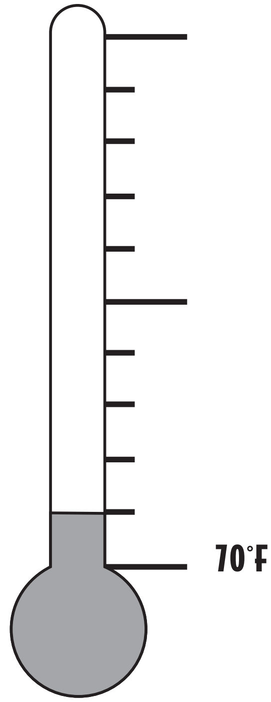
Tomlinson, C.A. (1999). *The Differentiated Classroom*. (p. 83). Alexandria, VA: ASCD.

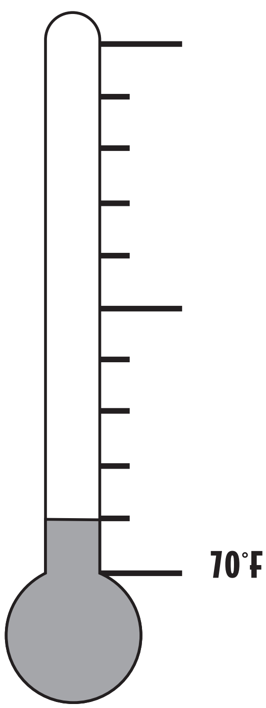
Conklin, W. (2007). *Applying Differentiation Strategies*. (pp. 149-202). Huntington Beach, CA: Shell Education.

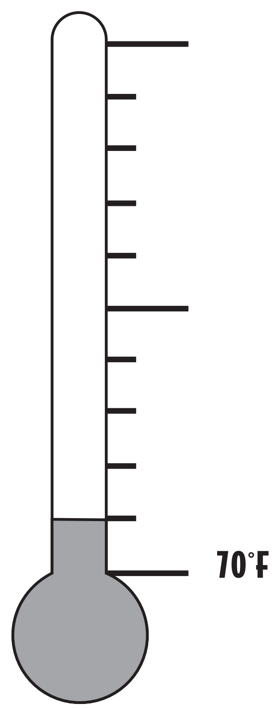
McCombs, B.L. (1995). Understanding the keys to motivation to learn. *Noteworthy Perspectives: What's Noteworthy on Learners, Learning, and Schooling.*

Thermometer









Science II-2

Activities

Earth's Tilt

Catching Some Rays

Standard II:
Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 2:
Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the sun produces the seasons.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts VII: Understand, interpret, and analyze narrative and informational
Math III: Geometric shapes and principles
Math V: Basic concepts of probability

Science Standard II

Objective 2

Connections

Background Information

There are many misconceptions about what causes seasons. When people think about Earth's revolution around the sun, many picture a very oval, elliptical shape. Earth's orbit is a slightly elliptical circle. However, the distance between the sun and Earth does not change significantly throughout the year.

Because of Earth's tilt and revolution around the sun, each of Earth's poles tilt toward the sun for part of the year. Consequently, each pole is tilted away from the sun for part of the year. When the Northern Hemisphere is tilted towards the sun, the result is more hours of daylight and more direct, intensified sunlight for our hemisphere. Direct light causes higher temperatures than indirect light. When our hemisphere is tilted away from the sun during winter, the angled sunlight is spread over a greater area, resulting in less intense heat.

Research Basis

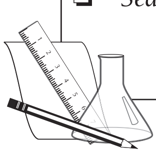
McCoy, J. D., & Ketterlin-Geller, R., (2004). Rethinking instructional delivery for diverse student populations: Serving all learners with concept-based instruction. Intervention in School & Clinic, 40.2, pp. 88-95.

Science issues are a part of our everyday world, but what commonly happens with the teaching of science is students are smothered in abstract and highly theoretical science content. Teachers need to focus on teaching the big essential ideas and concepts, rather than teaching minute details and memorizing facts to regurgitate on a test.

One method of doing this is by using hands-on activities that are modeled after real life situations. This helps students focus on concrete applicable science that is interesting and relevant. Another method is simple, inexpensive labs and activities that require little specialized equipment, but focus on key models or experiments that illuminate specific scientific content. This gives students access to the curriculum in a meaningful way.

Materials

- ❑ *Reader's Theater of Demeter and Persephone*
- ❑ Index cards
- ❑ *Seasons Brainstorming Chart*
- ❑ Styrofoam board
- ❑ Skewers
- ❑ Art paper
- ❑ Scissors
- ❑ Glue
- ❑ Tape
- ❑ Thermometers
- ❑ Protractor
- ❑ Timer
- ❑ *Sunray Data Collection Sheet*
- ❑ Colored pencils
- ❑ *Sunray Line Graph*
- ❑ *Sunray Bar Graph*
- ❑ *Centimeter Grid Paper*
- ❑ Flashlight
- ❑ Science journal
- ❑ *Seasons: The Reasons*



Invitation to Learn

1. The ancient civilization of Greece explained the seasons in a very different way than modern scientists do today. First students will participate in a reader's theater in which the Greek gods tell the story of Demeter and her beautiful daughter, Persephone. The myth tells of the dark god, Hades, kidnapping Persephone and taking her to the underworld to live as his wife. When Demeter hears of her daughter's fate, she mourns so violently that Earth begins to whither and die. It is only upon Persephone's return that Earth blooms to life again. Tell students to pay close attention to how the Ancient Greeks explained the reasons for seasons while reading the myth.
2. Tell students that scientists today explain the reason for Earth's seasons in a very different way than the Ancient Greeks did. Provide each student with an index card. Ask students to write what they know (or think they know) about the scientific explanation for seasons on their card. Collect cards and post them on a board that compares accurate scientific information with misconceptions. Students should compare and contrast the Ancient Greek ideas, common modern-day misconceptions, and the real reasons for seasons throughout the unit. Concepts should be reviewed and updated as knowledge grows, changes, and clarifies.

Instructional Procedures

Activity One: Activating Background Knowledge

1. As a quick, cooperative learning activity, activate students' prior knowledge on the concept of seasons, temperature, and seasonal connections to the students' world. Students should work in small groups to complete the following Seasons Brainstorming Chart: (Charts should be cut out and placed into science journals.)

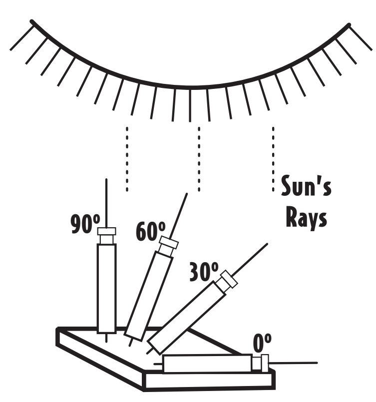
Seasons	Average Temperature	Signs in Nature	People's Activities
Winter			
Spring			
Fall			
Summer			

Activity Two: Sunray Catchers

1. Explain to students that they will be gathering information to explain the real reasons for seasons by collecting detailed temperature data. (This activity should be done outside on a day with little cloud cover to see the most dramatic results.)
2. Allow a short amount of time for students to practice reading the thermometers, holding steadily at eye level and not obstructing the bulb with their fingers. Have students examine the scale used on the thermometers. Ask each group of students to stand in a different area of your classroom and report the accurate temperature. Just as the temperatures within your classroom will differ slightly because of exposure to heat sources and movement, so does the temperature on Earth. In order for students to see accurate results, first calibrate all the thermometers by placing them in ice water for 5 minutes. Students will be able to see the thermometer rise significantly when they move the thermometer to their specified location.

Construction of Sunray Tool

1. Explain to the students that they are going to construct a sunray-gathering tool to help model one reason for the seasons. Construct the sunray-gathering tool with students in groups of three or four.
2. Begin by cutting a piece of Styrofoam about 12 inches square for each group. (This board will be reused in a subsequent lesson.)
3. Now, groups are going to construct holders for the 4 thermometers. Each group will be



given a 12" x 18" piece of art paper that has previously been cut in half lengthwise so that it measures 6" x 18". Have students fold their paper in half, and in half again, creating four equal sections that are 4½" x 6". Cut pieces apart. Then, students should fold each piece in half and glue the outer edges, creating a pocket to hold a thermometer. Finally, have the students label the pockets: 0 degrees, 30 degrees, 60 degrees, and 90 degrees.

4. Tape a skewer to the back of each pocket. The top of the skewer should line up with the top of the pocket.
5. Place a protractor on the horizontal edge of the Styrofoam. Measure with the protractor and push the 30, 60, and 90-degree skewers into the tag board at the correct angle. Slip a thermometer into each pocket, making sure each thermometer bulb is covered. Rest the fourth skewer (0 degrees) on the Styrofoam and use a small piece of tape to hold in place.

Experimenting with the Sunray Catchers

1. Have the students take their ray-catcher, science journal, *Sunray Data Collection Sheet*, four different colored pencils, and the *line graphing paper* outside and choose a location exposed to the sun. Each student group should choose a different location.
2. Students will wait 10 minutes. While students are waiting have them record the procedure for construction of the sunray catcher and their hypothesis for this ray-catching experiment in their science journal.
3. After 10 minutes, making sure to keep the bulb covered, students will slide the thermometer out of the holder enough to read it at eye level. Record the temperatures on the data collection chart. Wait and record the temperatures two more times. As students are waiting to read the thermometers at the stated intervals, they should create a four-line graph on the sunray line graphing paper demonstrating the data they are collecting. Use a separate color for each angle. Label the graph key. Students should record any trends or conclusions they observe in their science journals.
4. When students return to the classroom, have students use calculators to determine the average temperature for each thermometer. Have the students discuss their findings and observations in small groups and then with the whole group. Discuss the trend shown in the data collected. (The temperature increases as the directness of sunlight increases.)

5. Students will finalize findings by creating a bar graph of the averaged data on the sunray bar graphing paper.
6. Instruct students to journal in their science notebooks about today's experiment. What was the experiment? (How does the angle of the sun's rays affect temperature?) What was the variable in our experiment? (The angles of the thermometers.) Sketch a model of the experiment. Write a conclusion based on direct and indirect sunrays based upon today's experiment. (More direct light equals more heat; less direct light equals less heat.) What are the limitations of the model we used? (It is not done to scale; we only used four sun angles, etc.)

Activity Three: Putting a Spotlight on Seasons

1. Do a quick demonstration on the concept of direct and indirect rays by shining a flashlight with a bright, concentrated beam at your classroom globe. Hold the flashlight at a 90-degree angle and have students describe the shape of the light they see shining on the globe. How would students describe these light rays? (Direct light) Hold the flashlight at approximate 60 and 30-degree angles and have students notice how the shape of the light changes. How would students describe these light rays? (Indirect light) Ask students to infer: What would happen to the heat of the sun's rays if they were spread over a larger area? (The heat would be less intense as it spread out.)
2. Have students work in pairs or small groups to compare the area of direct and indirect light. First, students shine light from a flashlight directly onto the centimeter graph paper from 10 centimeters above the paper. One student holds the flashlight as the other student traces around the beam of light shining onto the paper. Students count the squares on the grid paper and estimate the area of the light ray. Then, using a protractor, tilt the flashlight to a 60-degree angle. Make sure the flashlight remains at a constant height above the paper (10 centimeters). Students should trace the light on the paper, and estimate the area. Repeat procedure with a 30-degree angle.
3. Last, students should discuss the findings of the spotlight activity with their partner. Ask students to connect this activity with our previous sunray experiment. What do both models show? (Direct and indirect light) Students should write their findings and connections into their science journals.

Assessment Suggestions

- Instruct students to write on an index card how direct and indirect rays correspond to temperature. These cards should be posted on the compare/contrast board to add to students' understanding of the reasons for seasons.
- Sketch a picture of Earth. Draw the rays hitting the equator directly, and continue drawing sunrays showing the curving of sunlight around the North and South Poles. Notice how short and direct the rays are those strikes at Earth's equator compared to the rays that are longer and must curve when they strike Earth near its poles.

Curriculum Extensions/Adaptations/ Integration

a. For advanced learners, allow them to design their own experiment to show the direct and indirect angle of the sun's rays. How would they change or improve the experiment we did in class? Pose this question: How would the seasons change if Earth were NOT tilted on an axis? What would the results of our experiment be if we collected data in the morning, at noon, and near the end of school?

b. For learners with special needs, have them take a picture or draw the sunray collection board. Label each thermometer in the picture with the comparative adjectives: warm, warmer, hot, hotter.

Family Connections

- Students and their families should observe the location of the sun throughout the day. Compare the temperatures during the morning, daytime, evening, and night. Where did they notice the sun in the sky during those times?
- Students practice fluency by reading the seasons information to their family.
- Students collect an index card from at least one adult with the adult's explanation of why the earth has seasons. The students should sort and post these cards onto the compare/contrast board showing accurate information and misconceptions.

Additional Resources

Books

The Seasons of Arnold's Apple Tree, by Gail Gibbons, ISBN 0-15-271246-1

Sun Up, Sun Down, by Gail Gibbons, ISBN 0-15-282782-x

The Reasons for Seasons, by Gail Gibbons, ISBN 0823411745

The Little Island, by Golden MacDonald and Leonard Weisgard, ISBN 0-440-40830-x

Sunshine Makes the Seasons, by Franklyn M. Branley and Michael Rex, ISBN 069004481X

The Real Reasons for Seasons, Great Explorations in Math and Science (GEMS), ISBN 0-924886-45-5

Media

Bill Nye the Science Guy. Earth's Seasons; ISBN 1932644342 9781932644340

Web sites

http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Seasons.shtml

http://www.collinseducation.com/resources/ict%20activity/earth_FULL.swf

http://www.morehead.unc.edu/Shows/EMS/seasons.htm

http://www.nationalgeographic.com/xpeditions/activities/07/season.html

http://www.windows.ucar.edu/tour/link=/the_universe/uts/winter.html&edu=elem

http://www.scienceu.com/observatory/articles/seasons/seasons.html

Organizations

Activities Integrating Mathematics and Science (AIMS)

http://www.aimsedu.org/

Demeter and Persephone: A Reader's Theater

Written by: LuAnn Kluge
Language Arts Specialist, Granite District

Characters:
Narrator 1
Narrator 2
Narrator 3
Demeter
Persephone
Zeus
Hades
Hermes
Boy

Narrator 1: Zeus, the King of the Gods presented Demeter, the goddess of the harvest, grain, and fertility with a beautiful daughter named Persephone. As Persephone was raised among the flowers in the fields of her mother, she began to blossom into a flower herself.

Narrator 2: Persephone was as strong, yet as flexible as the stem of a plant with skin as soft as petals, and beautiful eyes like pansies. She began caring for the flowers in the fields for her mother. She spent her time creating new flowers and giving them names.

Persephone: Mother, I am off to the fields with my paint pot to make the world more glorious with my beautiful flowers.

Demeter: As I am the goddess of planting and harvesting, and a fine lady of growing things, I couldn't be more proud of you, Persephone. My love for you is immense.

Narrator 1: Across a stream, through a grove of trees, and into a little glade, Persephone wandered, a bit further than her normal route had ever taken her.

Narrator 2: Carrying her paint pot, she began giving faces to a stand of tall waxy lilies with her paintbrush. Persephone hummed softly as she worked.

Persephone: (humming) Oh! I haven't ever noticed this strange bush in the meadow before. The leaves are thick, green and glossy. The berries on the branches look like drops of blood. It is ruining the looks of my field of beautiful flowers with its ugliness.

Narrator 1: With a mighty pull, Persephone seized the plant. The bush did not move.

Narrator 2: The strange bush was firmly rooted. However, the young Persephone was used to getting her own way. Again she pulled with all of her might. Up came the bush and with it long roots came dragging out of the ground, leaving a big gaping hole behind.

Narrator 3: Immediately a fierce rumbling began and the gaping hole began spreading and opening like a huge mouth. As the noise grew with great intensity, out leapt six black horses pulling a golden chariot. In the chariot stood a tall figure with a flowing black cape and a black crown on his head.

Hades: (evil laughter) Ha! Ha! Ha! Ha!

Narrator 1: Persephone was snatched away by Hades before she even had time to scream.

Narrator 2: Plunging deep into the hole again, the ground swallowed them up. Just as quickly as the ground had opened, the hole was closed again.

Demeter: Persephone! Persephone! Where are you? (begins to panic) Persephone!

Narrator 3: All night long Demeter searched for Persephone. Only silence answered her.

Narrator 1: As dawn broke across the sky, Demeter came upon an uprooted bush. Leaping from her chariot, she noticed something in the grass that seemed to pierce her heart.

Demeter: (crying) Oh, please….no! It is Persephone's little paint pot. She would never have left her paint pot behind willingly.

Narrator 2: As the sun continued to rise, the birds began chirping. The chirping turned to gossip about the girl, the bush, the hole, the chariot, and the black rider.

Narrator 3: Demeter listened to the birds and wept. She knew Hades, the dark god of the underworld, had captured her lovely Persephone.

Narrator 1: Demeter's sorrow soon turned to furious anger as she fled to Zeus.

Demeter: Zeus! Zeus! Persephone has been captured by Hades and has been taken down to the dark underworld. Until she is returned to me, I will cause a famine to come upon the land. I will see to it that there will be a devastating shortage of food in the land as the plants will all wither and die causing animals and people to starve.

Zeus: Compose yourself, Demeter! This may be a nice arrangement for both Hades and Persephone.

Demeter: Never! Anyone but Hades. This must not be. Persephone is a spring child. She needs sunshine or she will wither and die.

Narrator 2: As Demeter was speaking to Zeus, she noticed Zeus was holding a new thunderbolt. She realized the bearer of the gift was Hades. The gift had been offered in exchange for Persephone. Demeter felt betrayed and defeated.

Demeter: I will return to my Earth.

Narrator 3: Weeks passed. Zeus' sleep was interrupted by loud sighs from Earth below. As he looked down he saw a terrible sight.

Zeus: Nothing is growing! The blazing sun continues to parch the fields, shriveling the wheat, corn, and barley. The soil is hard and cracked. There is no green anywhere. Cattle and people are starving. Something must be done.

Narrator 3: Through their hunger and pain, people lifted their faces to Mount Olympus and prayed for Zeus to help them.

Narrator 1: Zeus sent for Demeter.

Zeus: Do you still wish for your daughter's return?

Demeter: Yes. While she is gone, no crops will grow. No tree will bear. No grass will spring. While she is gone and while I mourn her, Earth will grow dry and shrivel as my heart, and will put forth no green thing.

Zeus: Very well. Your daughter shall be restored to you.

Demeter: Oh! Thank you, Zeus.

Zeus: However, if she has eaten any food while with Hades, she must remain with him. This is the law and even I am powerless to revoke it.

Demeter: No food will have passed her lips. She would have been too sad to eat while she has been away from me.

Zeus: Then, I will send Hermes, the messenger god, to Hades and demand Persephone's release. (calling out) Hermes!

Hermes: Yes, Zeus?

Zeus: You must go to Hades at once with this message, and demand the release of Persephone.

Hermes: My winged shoes will get me there quickly. I am off, Zeus!

Narrator 2: In the meantime, down in the underworld, Persephone had spent her days with the dark king.

Hades: Persephone, your beauty causes a gentleness to come upon me. You are worth more than these rubies and diamonds that I adorn you with.

Persephone: I will not take your gifts. I will never forgive what you have done to me!

Hades: I have had dresses spun of gold and silver for you.

Persephone: I want to go home to my mother!

Hades: Your throne, my lady, is made of the finest ebony and here is a crown of black pearls.

Persephone: I hate you and I always will!

Narrator 3: As Persephone spent her days throwing tantrums at Hades, she was secretly and slowly beginning to enjoy the attention Hades gave her.

Narrator 1: She enjoyed his gifts and his efforts to please her.

Narrator 2: Although she longed for sunshine and flowers, she secretly admired Hades.

Narrator 3: But, Persephone still insisted on pouting and she refused to allow a crumb of food to pass her lips.

Hades: Please eat, Persephone. I have had my cook prepare you the most delicious meals!

Persephone: Never! I will not eat until I am returned to my mother!

Narrator 1: In an effort to please Persephone, Hades gave her some ground in which she could plant a garden.

Narrator 2: Hades gave her rare seeds to plant with magical blooms that did not need sunlight.

Narrator 3: He also gave her a young boy to serve as a helper in her garden. One afternoon as Persephone was gardening she grew especially hungry. It had been so long since she had eaten. She noticed her helper eating something in the distance.

Persephone: Boy, what are you eating?

Boy: (smiling) A juicy, red fruit. It is a pomegranate.

Persephone: I am so hungry.

Boy: We are alone. No one will see you. No one will know. Quickly…….eat!

Persephone: (eating) I have never tasted anything so…delicious…hmmmm, one, two,

Narrator 1: Just as Persephone swallowed the fourth pomegranate seed, a cry that could only be Hermes, the messenger of the gods, split the air.

Narrator 2: Persephone raced to Hades' palace.

Hermes: Good day…Hades…Persephone.

Hades: (scowling) Why are you here?

Persephone: Good day, Hermes!

Hermes: I bring a message from your mother, Persephone. She wants you home. I'm sure you haven't eaten anything during your stay here. (not giving her time to answer) Let's go!

Narrator 3: As the gardener boy rushed to Hades, Persephone and Hermes narrowly escaped.

Boy: Hades, Persephone has eaten four pomegranate seeds!

Narrator 1: By the time Persephone was home, Hades had already been to visit Zeus.

Hades: Persephone has eaten four pomegranate seeds in my kingdom. She must return to me. This is the law, Zeus!

Zeus: That is true, it is the law. Because Persephone ate four seeds of the pomegranate she will return to Hades for four months out of every year.

Demeter: (crying) My heart will break without my Persephone!

Persephone: Don't cry mother! We must be happy for the time that I am here on the earth with you.

Demeter: I will be happy while you are here. Flowers will bloom, grass will grow, and the tree will bear fruit. But, as for the months you are away, as my heart is longing for you, Earth will suffer.

Narrator 1: Because of Demeter's longing for her daughter, we have the seasons of summer and winter.

Narrator 2: Summer is a time for planting and growth. It is the time of Demeter's happiness. Persephone is here on Earth with her mother.

Narrator 3: Winter is a time when Earth sleeps under frost. Winter is Demeter's suffering. Persephone spends this time in Hades' underworld.

Narrator 1: So it remains…year after year as the seasons change from one to another, the law is fulfilled as Persephone returns to Hades four months of every year.

Seasons Brainstorming Chart

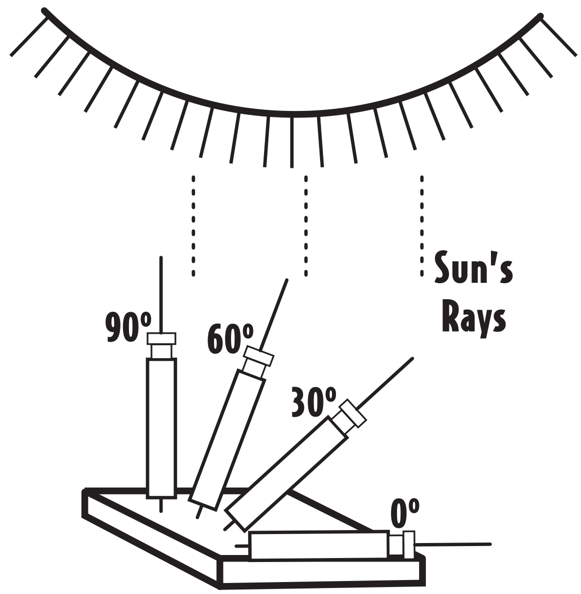
Seasons	Average Temperature	Signs in Nature	People's Activities
winter			
spring			
summer			
fall			

Seasons Brainstorming Chart

Seasons	Average Temperature	Signs in Nature	People's Activities
winter			
spring			
summer			
fall			

Name ________________________________

Sunray Data Collection Sheet



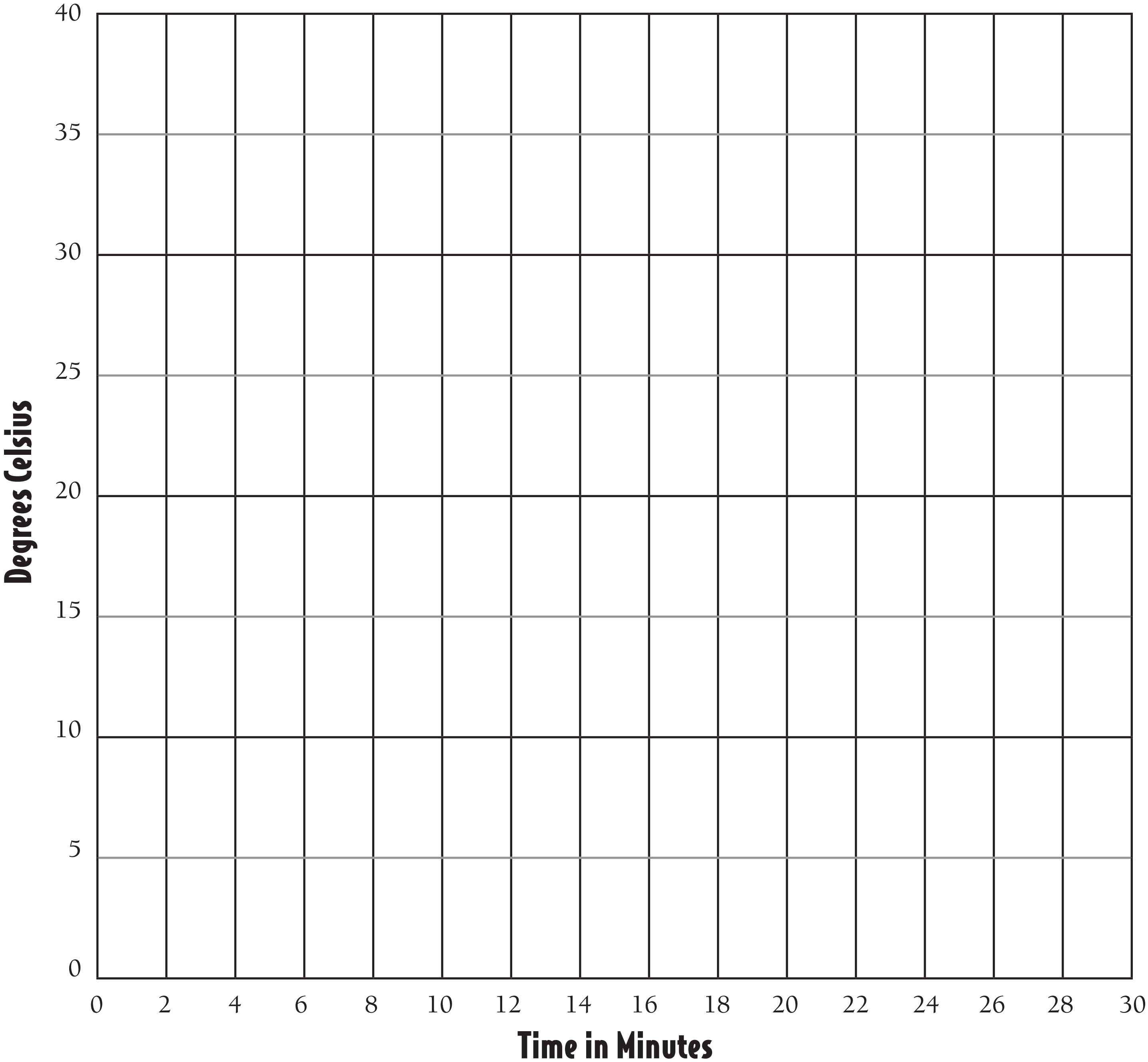
Angle of Thermometer to Sun's Rays

	0 degrees	30 degrees	60 degrees	90 degrees
beginning temperature				
10 minutes				
20 minutes				
30 minutes				
AVERAGE TEMPERATURE				

What did you discover about the angle of the sun's rays and the temperature?

Name ______________________________

Sunray Line Graph

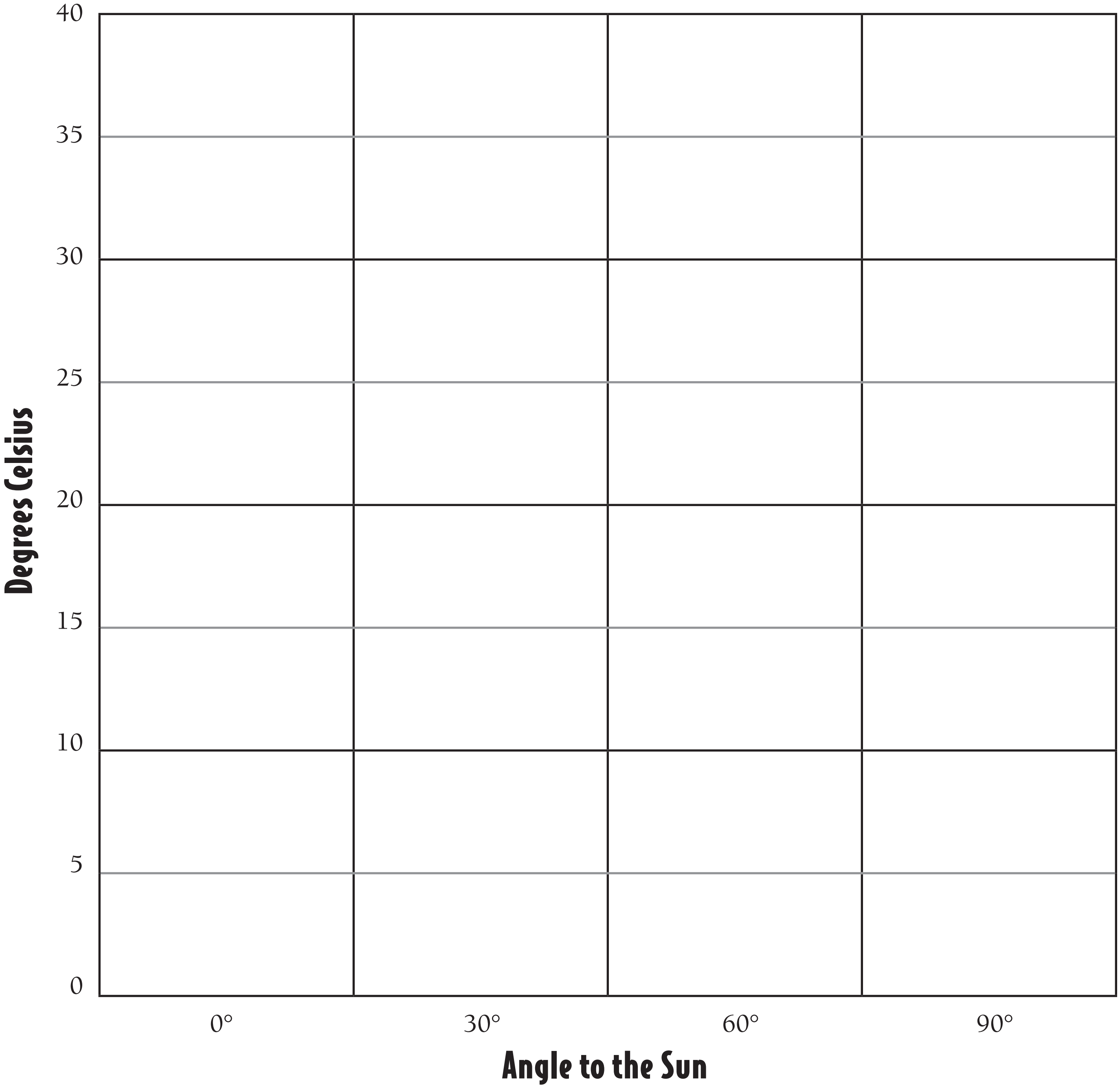


Graph Key

color	angle
	0 degrees
	30 degrees
	60 degrees
	90 degrees

Name ______________________________

Sunray Bar Graph



← Least Direct Sunrays   Most Direct Sunrays →

Centimeter Grid Paper

Seasons: The Reasons

Spring, summer, autumn, and winter bring changes in the weather, plant and animal life, and the length of days and nights. Seasons change because of three factors. Reason number one: Earth is tilted on its axis to one side. Reason number two: Earth rotates, or turns, on its axis every 24 hours. Reason number three: Earth revolves around the sun once every year.

There is an imaginary line that runs through the center of the Earth. This line is called an axis. The two points where the axis passes through the Earth are called poles. The Earth has a North Pole and a South Pole. As the Earth moves around the sun, it spins on its axis. This spinning, called rotation, causes day and night.

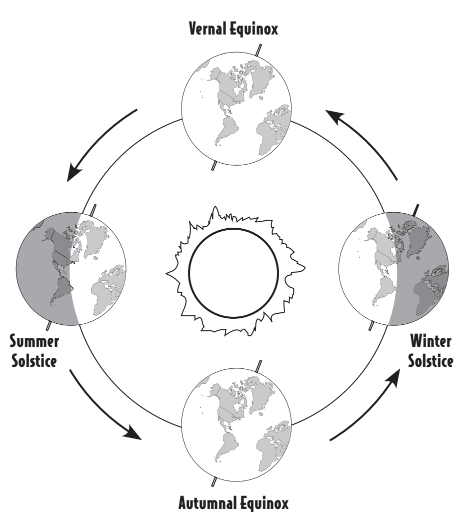
Our planet is always tilted in one direction – towards Polaris, or the North Star. The North Pole is always tilted towards this star as Earth moves in a path around the sun.

Our planet is always moving around the sun in a path called an orbit. This action around the sun is called Earth's revolution. One revolution of Earth takes about 365 days. The days change as Earth orbits the sun. The length of the days changes. The temperatures on Earth also change.

In summer, the Northern Hemisphere, where we live, points toward the sun, bringing more direct and powerful sunrays. Summer days are longer, and the sun is higher in the sky. Temperatures rise in the summer.

In winter, the Northern Hemisphere is tilted away from the sun. The sun is low in the sky, even at midday. The Earth has the year's fewest daylight hours, and receives the least direct rays from the sun. Winter is a time of short days, long nights, and low temperatures.

Because Earth's axis is tilted neither toward nor away from the sun in spring and autumn, equal periods of daylight and darkness result. The directness of the sun's rays are changing, causing warming in spring and cooling in autumn.



The Trip Around the Sun

Standard II:
Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 2:
Explain how the relationship between the tilt of Earth's axis and its yearly revolution around the sun produces the seasons.

Intended Learning Outcomes:
1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Communicate Effectively Using Science Language and Reasoning

Content Connections:
Language Arts VII; Comprehension
Math III; Spatial and logical reasoning
Math V; Basic concepts of probability

Science Standard I

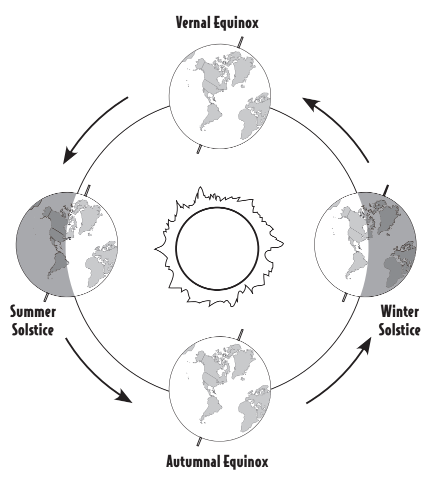
Objective 3

Connections

Background Information

There are many misconceptions about what causes seasons. When people think about Earth's revolution around the sun, many picture a very oval, elliptical shape. Actually, Earth's orbit is a slightly elliptical circle. Thus, the distance between the sun and Earth does not change significantly throughout the year.

Earth spins on its axis, which is what causes day and night. The axis is tilted so that the North Pole points at the North Star, Polaris, all of the time. Because of Earth's tilt and revolution around the sun, each of Earth's poles is tilted towards the sun for part of the year. Consequently, each pole is tilted away from the sun for part of the year. When the Northern Hemisphere is tilted towards the sun, the result is more hours of daylight and more direct sunlight. These two factors create warmer temperatures for the Northern Hemisphere, resulting in the season of summer. When the days are shorter and the sunlight is much less direct, it is the season of winter.



Research Basis

Huitt, W. (2003). Constructivism. Educational Psychology Interactive. Valdosta, GA: Valdosta State University. Retrieved [date], from http://chiron.valdosta.edu/whuitt/col/cogsys/construct.html

The constructivist approach to teaching states that when a student feels safe and secure in his/her learning environment, the processing of new thoughts and ideas will take place. Advocates of constructivism state that it is the stimuli of the environment, rather than the stimuli themselves that most greatly impact student achievement. In most curriculums, knowledge and skills are taught separately and then connected, versus the constructivism-oriented classroom in which students acquire content while carrying out tasks that require higher-order thinking. For example, scientific knowledge is usually taught by working students through information piece by piece, rather than looking at new knowledge from a holistic viewpoint. Teachers need to first consider the knowledge and experiences students bring with them to the lesson. Then, the instruction should be built so that the students can expand and develop new knowledge by connecting it to previous experiences and learning. Teachers should provide a mixture of direct instruction, active practice of the new skill, and feedback. The constructivist approach is centered on a student's pre-existing experiences, filling the gaps and providing ample time, space, experiences, with choice and differentiation for students to display their new knowledge.

Invitation to Learn

Sing the song *"Why Do We Have Seasons"* with students. This is a simple echo song to the tune of "Charlie Over the Ocean". The teacher sings each line and the students echo back. This simple song includes all essential elements on why Earth has seasons throughout the year.

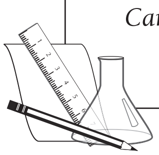
Instructional Procedures

Part One: The Earth's Movements

1. Find an open area where all students in class can stand in a circle so that everyone can see and hear the teacher and each other easily.
2. Show students a length of string that has been previously measured to be about 2 meters in length. This string represents the distance from the sun to Earth. (The average distance of

Materials

- ❏ *"Why Do We Have Seasons"* song
- ❏ *Seasonal Landmark Cards*
- ❏ Polaris & circumpolar stars poster
- ❏ String
- ❏ Meter sticks
- ❏ Styrofoam
- ❏ Four skewers
- ❏ *Earth Models*
- ❏ Tacks
- ❏ Protractor
- ❏ Art paper
- ❏ *Sunlight Through the Year*
- ❏ Rulers
- ❏ Markers
- ❏ Glue
- ❏ *Reasons for Seasons Assessment Choices*
- ❏ *Seasons Pictionary Cards*



Earth to the sun is 150 million kilometers, which scientists call an 'astronomical unit'.) Refer to the string as one astronomical unit.

3. Instruct students to stand around a central point. Choose an object or a student to represent the sun in the center of the circle. Students should face the center of the circle. Use the string to help students create an even, almost circular shape by stretching the string from the central point to each edge of the circle. The students are now in the shape of Earth's yearly revolution around the sun. Explain to the students that they are modeling Earth at various points in its yearly revolution. Ask students to explain to their neighbor and then to the whole group the apparent shape of Earth's orbit in space. (circle) Make a point of noticing that Earth does not appear closer to the center point anywhere in the circle. (Actually, Earth is slightly closer to the sun in January and slightly farther away from the sun in June. However, these slight distances in the huge scale of space do not make any significant differences in Earth's temperature.) When the teacher gives the signal to "Revolve!" the students should start walking in a counter-clockwise motion around the classroom sun.
4. Ask students to demonstrate what Earth does in space each day by turning counterclockwise in place to show rotation. Identify day and night by turning towards and away from the sun. Each time the teacher says "Rotate!" from now on, students should turn around in place once in a counter-clockwise motion.
5. Have students return to their seats and record findings from the model. Pose the following questions to the students: What was the model trying to show? What key vocabulary words need to be used? What does this model help us understand?
6. Students should draw a picture in their science journals of Earth's circular revolution around the sun, and define the words rotation and revolution. Add drawings and helpful reminders to clarify these terms.

Part Two: The Tilt

1. Draw students' attention to the pre-hung poster of the North Star (Polaris) on the wall. Ask students if they know anything about the North Star. Explain to students that one of the reasons the North Star stays in one place throughout the year and can be used as a navigation tool is because Earth's axis is always tilted towards it. Explain to students that no matter

where Earth is in its trip around the sun, the Northern Pole of Earth is always tilted 23.5 degrees towards Polaris.

2. Ask students to imagine that the upper half of their bodies represents Earth. Next, ask students to demonstrate estimating angles by bending their bodies at the waist to degrees called out by the teacher. Start with 90 degrees, go to 60 degrees, 30 degrees, and 0 degrees, the angle measures used in the previous sunray lesson. Make sure students are turned towards the North Star as they are bending, pointing their head (North Pole) consistently at Polaris. Last, students should demonstrate an estimated 23.5-degree tilt towards Polaris. Agree as a group what this tilt might look like.
3. Draw students' attention back to the central object in your model. What is the object that holds Earth in place during its revolution? (The sun.) What force keeps Earth from flying away into space? (The gravitational force from the sun.) Discuss the limitations of the classroom model you are creating. (The scale is not accurate and no energy is coming from our classroom sun.)
4. Students should draw a picture of Earth's tilt towards Polaris in their science journal. Pose these final questions to students: What questions do you have about Earth and the sun in space? Where could the answers to these questions be found? Ask students to meet in teams of three to discuss their journal sketches and wonderings.

Part Three: The Seasons

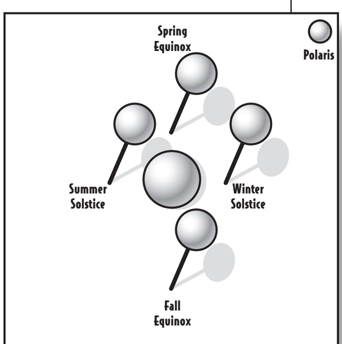
1. As the students are standing in their spots around the sun, explain to students that the sun's energy travels through space and reaches Earth. Ask students to demonstrate the sun's tilt towards Polaris. What part of our circle is tilted towards the sun in the most direct way? Having all students tilt 23.5 degrees towards Polaris and identify the students whose heads are tilted towards the sun. This is the summer section of our circle. Hand one student in the summer section the landmark sign labeled "summer solstice". Briefly describe the summer solstice (June 21st-22nd) as the longest day of the year. This is the day when Earth receives the most hours of daylight from the sun. The sun appears high in the sky as it makes its long trip across the sky. What kinds of temperatures do we experience on summer solstice? What activities would we be doing on summer solstice?

2. Go to the opposite side of the circle from the summer solstice. Ask students to demonstrate Earth's tilt again and point out that this side of the circle is tilted away from the sun (for the Northern Hemisphere). Ask students what season they think it would be if we were tilted away from the sun's energy. (winter) Hand one student the landmark sign labeled "winter solstice". Briefly describe the winter solstice (December 21st-22nd) as the shortest day of the year when Earth receives the least hours of daylight from the sun. The sun appears much lower in the sky as it moves across the sky. What kinds of temperatures do we experience on winter solstice? What activities would we be doing on winter solstice?
3. Ask students to infer what seasons the southern half of Earth is experiencing during the Northern Hemisphere's summer and winter. (The seasons are the opposite because the tilt towards and away from the sun is opposite.) Allow time for students to share personal experiences and connections involving time spent in countries in the Southern Hemisphere.
4. After the summer and winter solstice have been identified and labeled, show students the landmark signs titled "spring equinox" and "fall equinox". Explain to students that spring and fall are in-between seasons, in which the weather is changing from one season to another. Earth is neither tilted towards or away from the sun during these times. Ask students to demonstrate their tilt again, and find the areas of the circle where students are tilted sideways, and not towards or away from the sun. Hand one student the 'spring equinox' sign, and another the 'fall equinox' sign on the opposite side. Briefly explain the dates and the fact that daylight hours will be equal on the equator during these days. If one Earth day is 24 hours, and day and night are equal, how many hours of daylight would Earth experience on an equinox day? Ask students to describe first to a partner and then to the larger group the weather, signs in nature, and activities of spring and fall.
5. Many of the students are not holding signs yet. Ask students to look carefully around the circle at the four identified seasonal landmarks. Show students the stacks of cards labeled for the transitional time between seasons. Instruct all students who do not yet have a card to carefully decide which sign would best describe the seasonal time they represent. (summer to fall, fall to winter, winter to spring, & spring to summer) Students should make their decision and then move to collect their sign and return to the circle. As students hold their cards up in

front of their chests, it is easily assessed whether any mistakes have been made and can be corrected.

6. This demonstration can be quickly replicated on numerous days throughout the school year by using the cards and a central point. With practice, students will be able to quickly and accurately create a model of Earth's orbit around the sun, demonstrate earth's constant tilt towards Polaris, and identify the seasons throughout the year.
7. Students should sketch a picture of Earth revolving around the sun with the four seasonal landmarks labeled and described in their science journals.

Part Four: Creating a Paper Seasonal Model



1. After creating the human model of Earth's yearly revolution, students will next work in teams of four to create a smaller scale model in which the four seasonal landmarks are identified using the Styrofoam board and skewers from the sunray lesson, along with four paper models of Earth.
2. Students should lightly make a line diagonally from opposite corners of their Styrofoam board to identify a central point. At the central point, students should place a tack.
3. Next, measure and cut a piece of string or yarn that approximately 15 centimeters long. This length will represent one astronomical unit. Poke the tack through one end of the string and hold it in place at the center of the Styrofoam. Use the string to guide the pencil around the central point to make a model of Earth's elliptical, circular revolution through space around the sun.
4. Now, color and cut out the four models of Earth. Tape each model to the end of each skewer.
5. By placing a protractor on the Styrofoam, students measure a 23.5-degree angle towards the classroom 'Polaris' and poke the skewers into the Styrofoam in the four seasonal landmark positions around the sun. Which Earth is tilted towards the sun (tack in the center) with its Northern Hemisphere? Label this skewer 'summer solstice'. Label the opposite Earth model, which has its Northern Pole tilted away from the sun 'winter solstice'. Review dates and attributes of these days. Have groups identify the correct position for their 'spring equinox' and 'fall equinox' Earth models and label them. Review dates and attributes of these days.

6. Students should write descriptive sentences about the four seasonal landmarks in their science journals. Include the vocabulary words direct and indirect sunlight in descriptions.

Part Five: Graphing the Sunlight

1. Lay a piece 9” x 13” art paper horizontally so that it forms a long, thin strip. Starting on one edge, measure and make a mark with your pencil at every 3 centimeters. These marks will be the months of the year. Label each mark with the abbreviation of each month. The extra space at the end of the paper will be used later as a tab to glue the paper into a circle.
2. Using the *Hours of Sunlight Data Chart,* measure a line straight up from each month’s tick mark. Make one centimeter equal to one hour of sunlight. After all lines are complete, connect the tops of each line. Shade in the area below the line with a yellow color. The shaded space represents the hours of sunlight that Earth receives throughout the year.
3. Finally, glue the edge of the paper to the opposite side to make the paper into a circle. Stand the circle of graphed sunlight in the center of the Styrofoam model of the seasons. As students look at their model from the side, turn the circled paper so that the months on the paper correspond correctly with the models of Earth on the skewers. Ask students to generalize as a group what they notice about how the hours of sunlight change throughout the year and how this affects Earth’s seasons.
4. Students should record the hours of sunlight graphing activity in their science journals.
5. Pose questions to students for discussion and journaling: What does your graph of the sunlight show? How does the hours of sunlight Earth receives connect to the seasons?

Assessment Suggestions

- Students will write on an index card to explain the reasons for seasons. Post cards on the compare/contrast board involving accurate information and misconceptions.
- Students will make a choice from the *Reasons for Seasons Choice Board* to demonstrate their scientific knowledge of seasons.
- Students will participate in a game of ‘scientific pictionary’ to demonstrate key seasonal vocabulary and concepts.

Curriculum Extensions/Adaptations/ Integration

- For advanced learners, pose 'what if' questions to students to stimulate hypothetical thinking. What if Earth were not tilted? What if Earth revolved every 100 days? What if Earth did not rotate?
- For learners with special needs, ask students to create a simple foldable which shows the position of Earth in the four seasons throughout the year. Each picture should be labeled with the correct heading and with at least three descriptive phrases underneath. (summer solstice: hot, long days, more sun)

Family Connections

- Students should ask 5 adults if they can explain the real reason for Earth's seasons. Bring data collected to school and compile as a class the number of adults who have misconceptions. Add this information to the classroom compare/contrast board.
- Students and families should plan a significant way to 'celebrate' one of the seasonal landmarks. (Get everyone in your family to say "Happy Winter Solstice!" on December 21st.)

Additional Resources

Books

The Seasons of Arnold's Apple Tree, by Gail Gibbons, ISBN 0-15-271246-1

Sun Up, Sun Down, by Gail Gibbons, ISBN 0-15-282782-x

The Reasons for Seasons, by Gail Gibbons, ISBN 0823411745

The Little Island, by Golden MacDonald and Leonard Weisgard, ISBN 0-440-40830-x

Sunshine Makes the Seasons, by Franklyn M. Branley and Michael Rex, ISBN 069004481X

The Real Reasons for Seasons, Great Explorations in Math and Science (GEMS), ISBN 0-924886-45-5

Media

Bill Nye the Science Guy. Earth's Seasons; ISBN 1932644342 9781932644340

Web sites

http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Seasons.shtml

http://www.collinseducation.com/resources/ict%20activity/earth_FULL.swf

http://www.morehead.unc.edu/Shows/EMS/seasons.htm

http://www.nationalgeographic.com/xpeditions/activities/07/season.html http://www.windows.ucar.edu/tour/link=/the_universe/uts/winter.html&edu=elem

http://www.scienceu.com/observatory/articles/seasons/seasons.html

Organizations

Activities Integrating Mathematics and Science (AIMS)

http://www.aimsedu.org/

Clark Planetarium

http://www.spacescience.org/education/instructional_materials.html

Music for Why Do We Have Seasons

Why Do We Have Seasons

(A Song Sung to the Tune of 'Charlie Over the Ocean')

Why do we have seasons?
(echo)
The Earth tilts and revolves.
(echo)
First we blamed the Greek gods,
(echo)
Now the mystery's solved.
(echo)

The tilting of the axis,
(echo)
points us toward the North Star.
(echo)
Earth rotates every day,
(echo)
& that's what causes light and dark.
(echo)

Revolving 'round the sun,
(echo)
the seasons start to change.
(echo)
Direct and indirect energy
(echo)
heat and cool our days.

Why do we have seasons?
(echo)
The Earth tilts and revolves.
(echo)
First we blamed the Greek gods,
(echo)
Now the mystery's solved.
(echo)

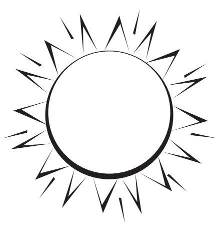
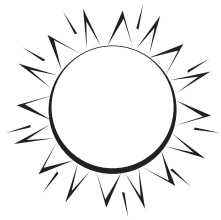
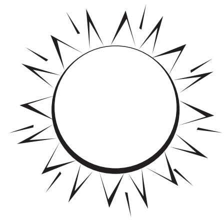
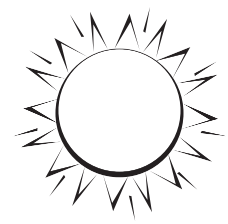
Winter Solstice

December 21st

The first day of winter and the shortest day of the year.

Summer Solstice

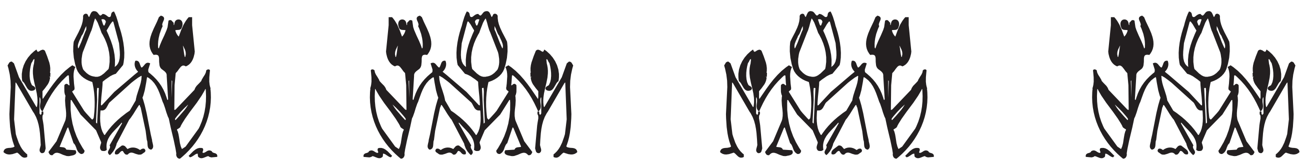
June 21st

The first day of summer and the longest day of the year.

Spring Equinox

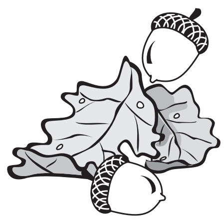
March 21st

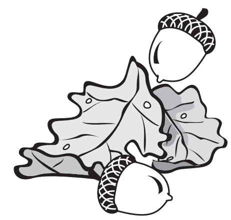


The first day of spring. Daytime and nighttime hours are equal.

Fall Equinox

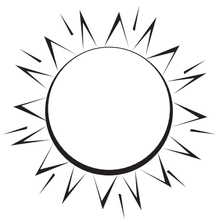
September 21st

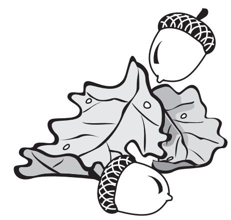


The first day of fall (autumn). Daytime and nighttime hours are equal.

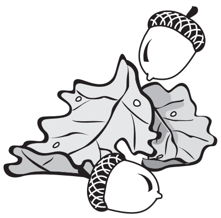
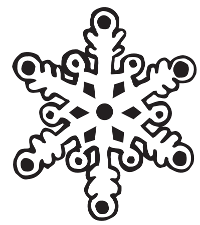
Summer to Fall



The days are getting shorter, the sun appears lower in the sky, and the temperatures are dropping.



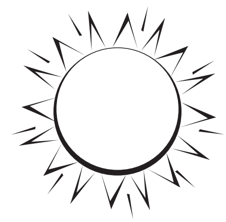
Fall to Winter

 **The days are**  **getting shorter, the sun appears lower in the sky, and the temperatures are dropping.**

Winter to Spring

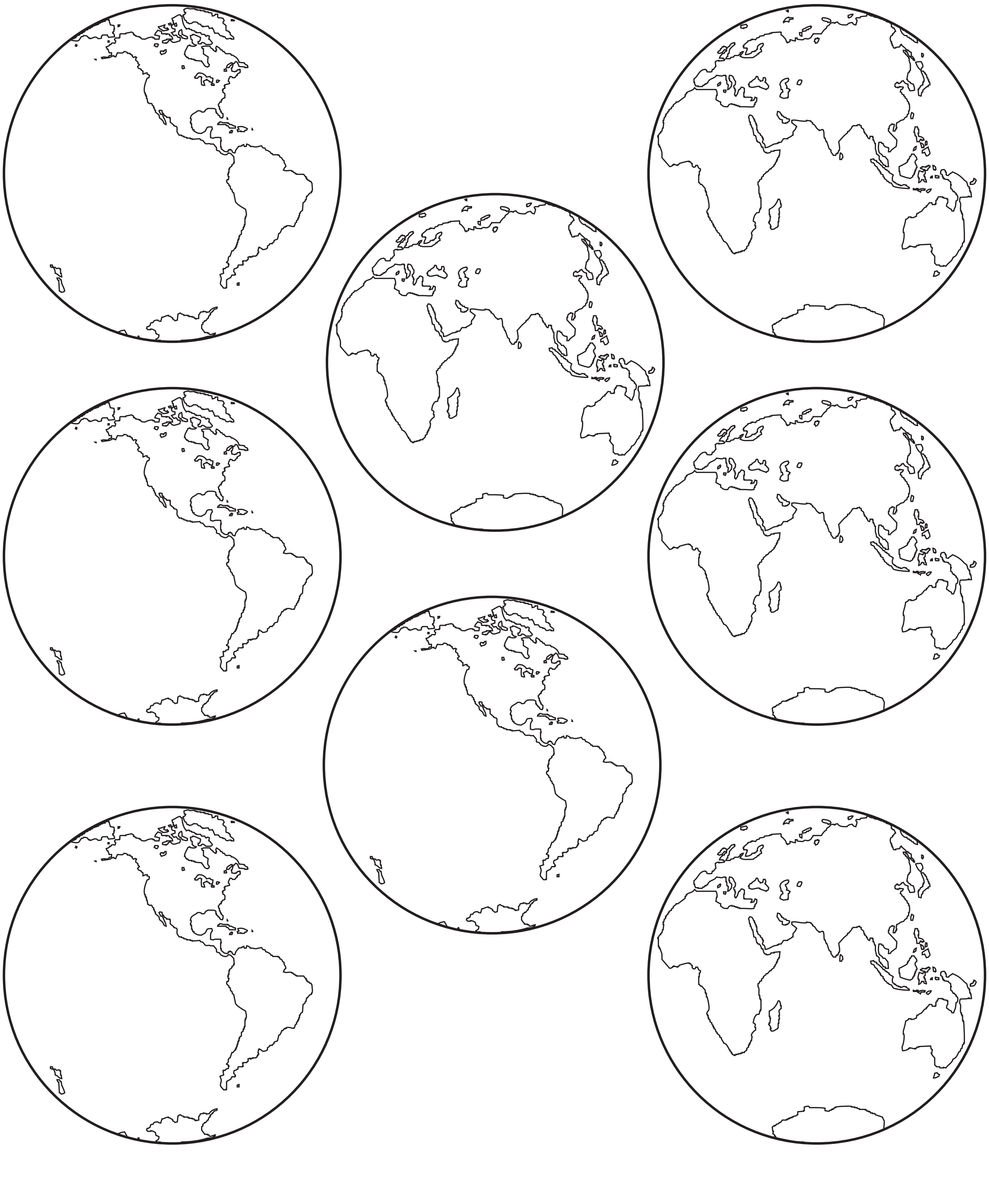
 **The days are**  **getting longer, the sun appears higher in the sky, and the temperatures are rising.**

Spring to Summer

 The days are  getting longer, the sun appears higher in the sky, and the temperatures are rising.

Earth Models

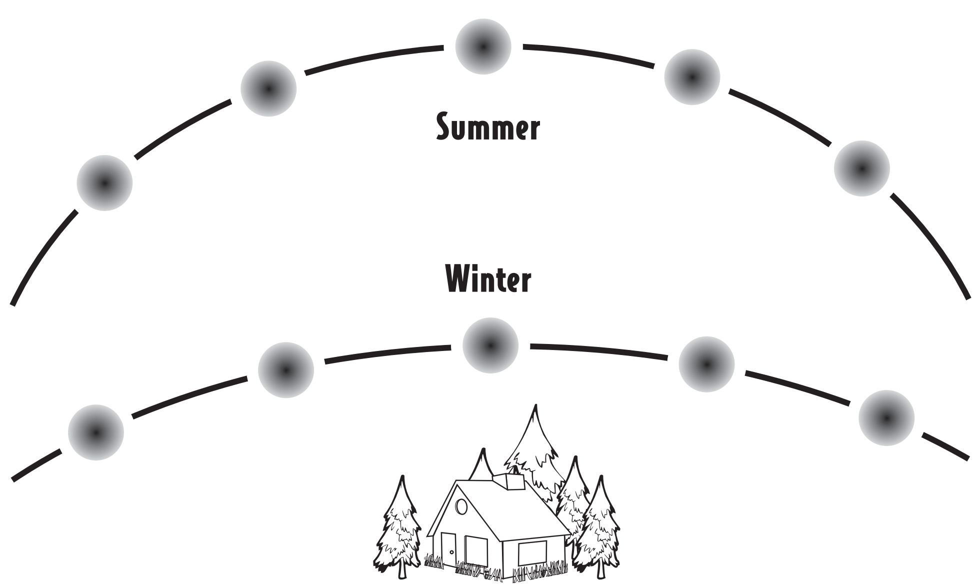
Western Hemisphere **Eastern Hemisphere**



Sunlight Through the Year - Salt Lake City, Utah

January	9 hours 30 minutes
February	10 hours 30 minutes
March	12 hours
April	13 hours
May	14 hours 30 minutes
June	15 hours
July	15 hours
August	14 hours
September	12 hours 30 minutes
October	11 hours
November	10 hours
December	9 hours

source: http://www.sunrisesunset.com/calendar.asp



Reasons for Seasons Assessment Choices

Standard II: Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.
Objective 2: Explain how the relationship between the tilt of Earth's axis and its yearly revolution around the sun produces the seasons.

Science Language to Use: Earth's tilt, seasons, axis of rotation, orbit, revolution

The Reasons for Seasons
Show What You Know!

Choose one of the following assessment choices to show your knowledge of why Earth has changing seasons each year.

Write a one page explanation to help a younger classmate understand the reason Earth has seasons each year.	Write and perform a creative skit describing the reasons for seasons. You may work alone or with a group. (no larger than three students.)
Write and perform a song or rap describing the reasons for seasons. You may work alone or with a partner.	Write a poem that explains the reasons for seasons. Plan to read your poem for the class, or publish the poem in the classroom for others to read.
Draw and label a detailed, scientific drawing explaining the reasons for seasons. Plan to post your drawing in the room for others to view.	Create a multimedia product illustrating the reasons for seasons. Plan to show your product to the class.

Seasons Pictionary Cards

Directions: Form teams with students in the class. One person from the first team comes to the board to draw a Seasons Pictionary card. The students must draw a scientific picture to represent the term on their card. The first team tries to guess what their teammate is drawing. The guessing team gets one minute to figure out the seasonal term their teammate is drawing. If the card is not solved, the other team gets a chance to guess the solution. Play continues, altering teams each turn. Cards that are drawn and solved within the time limit earn a point.

rotation	**revolution**
tilt	**axis**
Polaris (North Star)	**Northern Hemisphere**

Southern Hemisphere	Equator
North Pole	South Pole
sun	Earth
summer solstice	winter solstice

spring equinox	fall equinox
daytime	nighttime
direct sunlight	indirect sunlight

Circumpolar Stars Around Polaris

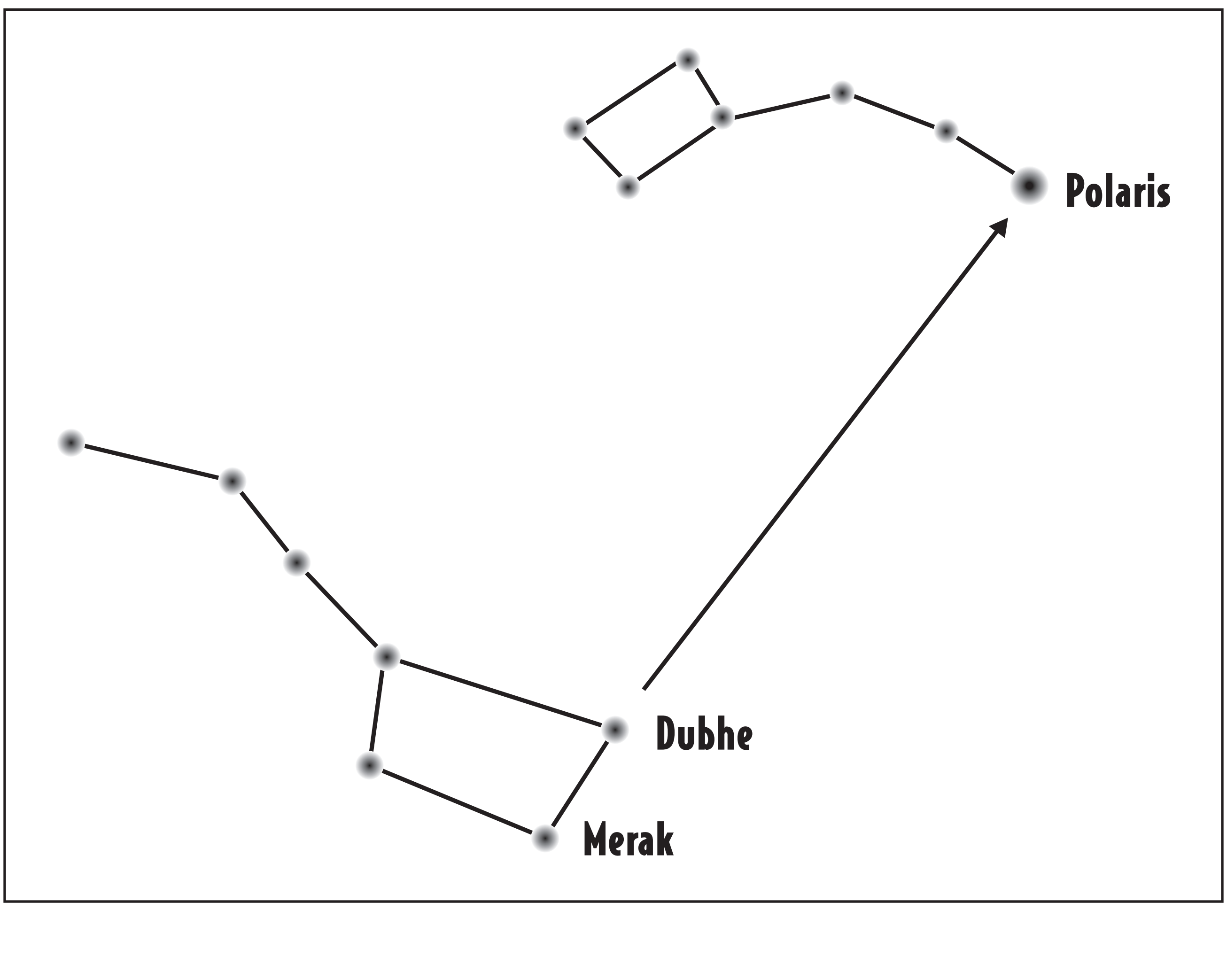
The Big Dipper is an asterism that makes up part of the constellation of Ursa Major (The Big Bear). It is seen here at the lower left of the image. The Little Dipper, part of the constellation of Ursa Minor (The Little Bear), is seen at the upper right. Polaris, the North Star, is at the end of the handle of the Little Dipper.

The two stars at the end of the bowl of the Big Dipper, Merak and Dubhe, are called the "Pointer Stars" because a line drawn between them points to Polaris.

The Big Dipper is a circumpolar constellation for most of the United States. This means it stays above the horizon all night long as it apparently rotates slowly counterclockwise during the night around Polaris due to the Earth's rotation. It is also comprised of very bright stars in an easy-to-locate pattern. The Little Dipper, on the other hand, is comprised of fairly faint stars that do not really stand out, except for second-magnitude Polaris.

Directions: Copy the Big and Little Dipper patterns onto an overhead transparency. Project the pattern onto large paper and trace the stars in each constellation. Hang the poster in your room on a north-facing wall.

Source: http://www.astropix.com/HTML/SHOW_DIG/038.HTM



Math I-2

Activities

Explain Relationships

Exploring Fractions

Standard I:
Students will expand number sense to include operations with rational numbers.

Objective 2:
Explain relationships and equivalencies among rational numbers.

Intended Learning Outcomes:
1. Develop a positive learning attitude toward mathematics.
6. Represent mathematical ideas in a variety of ways.

Content Connections:

Math Standard I

Objective 2

Connections

Background Information:

Students should build their understanding of fractions as parts of a whole and as division. They need to see and explore a variety of models of fractions. By using an area model in which part of a region is shaded, students can see how fractions are related to a unit whole, compare fractional parts of a whole, and find equivalent fractions. It is necessary to develop strategies for ordering and comparing fractions, often using benchmarks, such as ½ and 1. Students should understand that between any two fractions, there is always another fraction (Adapted from NCTM, Principles and Standards for School Mathematics, 2000).

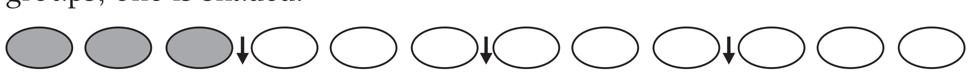
The number line becomes an important model for representing the positions of numbers in relation to benchmarks like ¼, ½, and 1. Number line models are helpful in allowing students to compare fractions. For instance, they can decide that ¾ is greater than 2/5 because 2/5 is less than ½ while ¾ is more than ½.

There are many ways to look at multiplying fractions beyond the traditional algorithm. These ideas will lead to deeper conceptual understanding taking students past the memorization of a rule. This lesson will focus two key aspects. First, multiplying fractions can be looked at as repeated addition.

For example:

¼ x 12= ¼ + ¼ + ¼ + ¼ + ¼ + ¼ + ¼ + ¼ + ¼ + ¼ + ¼ + ¼ = 12/4 or 3

The second way of looking at multiplication is to see ¼ X 12 as one fourth of twelve wholes. The diagram below is divided into four equal groups, one is shaded.



Research Basis

National Council of Teachers of Mathematics. (2000). ***Principles and standards for school mathematics.*** Reston, VA.

The National Council of Teachers of Mathematics (NCTM) has been very outspoken about setting high standards and expectations for all students. All students can learn mathematics; just not all students learn in the same way. The *Principles and Standards for School Mathematics (PSSM)* by NCTM sets forth the ideal vision of all students to become mathematically powerful:

A major goal of school mathematics programs is to create autonomous learners, and learning with understanding supports this goal. Students learn more and better when they can take control of their learning by defining their goals and monitoring their progress. When challenged with appropriately chosen tasks, students become confident in their ability to tackle difficult problems, eager to figure thing out on their own, flexible in exploring mathematical ideas and trying alternate solution paths, and willing to preserve. (NCTM, 2000 p. 21).

Brooks, J. G., & Brooks, M. G. (1993). ***In search of understanding: The case for constructivist classrooms.*** Alexandria, VA: Association for Supervision and Curriculum Development.

According to the constructivist theorists, learning occurs when connections are made with prior knowledge. One tenet of the theory of constructivism focuses on connecting mathematical ideas to promote understanding so that students can apply that knowledge to new topics and to solve unfamiliar problems. Deeper understandings are developed through the construction of relationships like those found in fractions, decimals, and percentages. Only through making these connections in mathematical topics can students develop deeper conceptual understanding.

Invitation to Learn

Let's Talk About Fractions

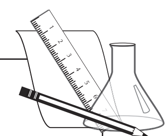
Have the following problem on an overhead transparency or written on the board ready to be uncovered or projected: Today is Student Appreciation Day at I.M. Electronics. That means you get ½ off the marked prices on all items. You decide to buy the iPod of your dreams. The price tag reads $350. While waiting to pay for your iPod you are informed that you are the 100^{th} shopper for the day and will receive an additional 1/10 off your purchase. What will you end up paying for the iPod?"

Discuss with the students their thoughts about what ½ means. What does it represent? What are some everyday examples? (½ ton truck, ½ off a sale item, ½ dozen eggs, etc.). If students give the decimal and fraction equivalent, point out they are correct, but keep the focus more on the fractional representation. Project/uncover the problem and have students work through the problem alone or in small groups. When most students are finished, have a discussion about what they think the correct answer is and HOW they got it. Really focus on the "how". Write student answers on the board/overhead by the problem. Tell them we will be returning to this question at the end math time today. When ready, return to the answers given and discuss methods used to get the answer. Also have several students model their thinking. Conclude by having students write the problem and their method for solving in their math journals.

Instructional Procedures:

Part One: Multiplication of Fractions with a Model

1. State the content objective for the lesson: Students will be focusing on Standard I, looking at developing number sense with multiplication of rational numbers. Narrow the focus in on Objective 4: Model and illustrate meanings of multiplication. By the end of the lesson, students should be able to model multiplication of fractions with manipulatives and be able to explain the activity to a partner.
2. Ask what happens when you multiply a whole number by a fraction.
3. Pass out a sheet of 8½" x 11" white copy paper and approximately 30 beans to each student. Walk through having the students folding it in half. Then, fold again. Now it is divided into fourths. Ask the students to predict the fractional parts when they fold it again. The paper needs to be folded 4 times. (It should have 16 boxes when opened up)
4. Tell the students they are going to explore twelve different problems by modeling each one with beans and show their work pictorially. Hand out a copy of *Modeling Multiplication of Fractions Sheet* to each student.
5. The first problem is 1/6 of 12 or 1/6 X 12. Model for the students on the overhead. We are trying to find 1/6 of the whole number twelve. Therefore, we need 12 beans. Count out 12. Now, take a closer look at the fraction, 1/6. The denominator represents how many ways we need to share 12, which is 6 shares. Divide the beans into 6 shares, like this: ++   ++ ++



Materials

- ❏ *Fraction Cards*
- ❏ Beans
- ❏ Baggies
- ❏ Paper
- ❏ *Modeling Multiplication of Fractions Sheet*
- ❏ *Problem with a Dozen Sheet*
- ❏ Adding machine tape

++ ++ ++. Now, we need to continue to examine the fraction by looking at the numerator, 1. This says how many shares we want, ++. Now students look at how many are in that share: 2.

6. Continue by looking at the next problem: look at whole number, then denominator, and finally the numerator.
7. Have students use beans to model each problem, and then pictorially record the solution.
8. After working on one or two problems together have the students try to model it on their own. Before sharing whole group, have the students discuss strategies and solutions for modeling multiplication of fractions with beans.
9. Continue for the remainder of the problems circulating around the room, asking questions to solidify conceptual understanding:
   a. Ask the students to explain the model and what each part of the model represents.
   b. How did this model relate to the traditional algorithm?
   c. What does it mean to multiply fractions by a whole number?
   d. Can you make any generalizations?
   e. Does this relate to any other operation?
10. After most students have completed the problems, ask the students to generate their own problems from the *Modeling Multiplication of Fractions Reference Sheet*. Have a whole class discussion based around their findings and focus on strategies that they used to solve the problems.

Part Two: Numbers, LINE UP!

1. Discuss that during this activity students will be focusing on sorting fractions, decimals, and percents on a number line using landmark strategies. If needed review what a "landmark" is.
2. Each student will receive an approximate three-foot length of adding machine tape. Each student will need to measure two and one fourth feet of adding machine tape. This will give students practice with measuring, especially lengths longer than a foot. Place strips horizontally on the desk. Write zero on the left end of the strip and one on the right end of the strip. Discuss briefly that the strip now represents one unit. This strip will be used to play a game in the next activity. Model the labeling as you go.
3. Have the students fold the right end of their strip over to the left end and crease. Have them open their strip and observe that the crease makes it divided into two equal parts. Have the

students write "0/2" under the 0 on the left end, "1/2" on the crease, and "2/2" under the 1 on the right end.

4. Students will be adding percentages to the strip. Discuss what would be the appropriate percentages for zero, one half, and one whole. Now write 0% under the zero, 50% under the ½, and 100% under 2/2. Finally, add the decimal equivalents to 0, .5 and 1.
5. Explain that students need a strategy to facilitate examining fractions, decimals and percentages. Explain that they will be using the landmarks of 0%, 50%, and 100%, to approximate where numbers should be placed on a number line. Have students sort the decimals by the following criteria: closest to one, closest to ½ or closest to zero. Direct each group to discuss and then write about the method used to sort the cards. As the teacher, focus on what strategies and skills the students are using to place these decimals on the number line. For example, look the decimal .3, that is less than one half because it only has three tenths. It is two tenths away from .5 and 3 tenths away from zero. It is closer to one-half.
6. Now, students will sort the fractions into the same three groups with a small group (3 to 4 students): closest to one, closest to ½ or closest to zero. Direct each group to discuss and then write about the method used to sort the cards. As the teacher, focus on what strategies and skills the students are using to place these fractions on the number line. For example, look the fraction 1/5. One is less than half of five, so it will be less than 50%. It is 4/5 away from one whole and 1/5 away from zero. Therefore, it is closer to zero.
7. Continue with the percentages and pictures of fractions. See if students can see the connections between the cards.
8. Have the students discuss how they sorted the cards. Discuss which one was the easiest to sort: decimals, fractions, percentages, or fraction pictures. Now, talk to the students about the accuracy of the placement on the number line. Many students will have found decimals the easiest to order on the number line. Talk about this as another strategy to order numbers on the number line by converting all fractions to decimals. Model the algorithm of converting fractions to decimals.

Part Three: Fraction Number Line

1. This activity further expands students thinking on fractions, decimals, and percents and placing them on a number line. Play the game as a class as described below. Then divide into smaller

groups to explore more in depth. Use the fractions, decimal, and percentage cards. Use your adding machine tape as labeled in activity two.

2. Mix up the sorted fractions and decimals. Deal out five cards to each player. Clarify that students are placing both fractions and decimals on the number line at the same time.
3. The goal of the game is place as many cards as you can on the number line. There are certain rules to the game: 1) Once a card is placed on the number line, it may not be moved. 2) Cards must be in increasing order from 0% to 100%.
4. Players must have five cards in their hands at all times until there are no more cards in the deck. On a turn, a player has three options: add a card in their hand to the number line, discard an unwanted card and draw another to see if they can play it, or pass if unable to play.
5. Play continues until no players can add to their number line. If you choose, you can have the kids keep track of points as this motivates most students. +1 point of each card placed on the line and -1 point for each card left in each player's hand.

Assessment Suggestions

1. Use *Fraction NIM* as a pre-assessment of student's ability to decompose and compose numbers.
2. Use the *Problem with a Dozen* activity to assess students understanding (see blackline).
3. Use a clipboard to record observations of students' strategies, fluency and ideas throughout the lesson.
4. Have students create their own number line and think of five fractions and/or decimals to place on a number line. Exchange papers with a partner. Students discuss their strategies for placing numbers on an open number line.
5. Have students write in their journal about how they used the model to multiply fractions. They need to focus on: what does each part of the model mean, how to use the manipulatives, and how to check the accuracy of the answer.

Curriculum Extensions/Adaptations/ Integration

- Play *Fraction NIM*- See explanation on black-line master
- Use the *Numbers, LINE UP!* adding machine strip to discuss probability and list the probability of different events on the

same line using sticky notes (i.e. the sun will rise tomorrow-100%).

- Look at the timelines in the different Ancient cultures: Mesopotamia, Egypt, Greece, and Rome, place the major important events on a number line.
- Examine how the Egyptians looked at fractions. The studies of rational numbers were integral to the building pyramids.

Family Connections

1. Have the students play the *Fraction NIM* game at home with the family. Students should explain their mental math strategies to their family.
2. Search for a recipe containing fractions. Bring to class to create a delicious fraction recipe book. Have each student take his or her recipe and double, triple and/or quadruple the recipe. Have the students write how much each recipe will serve. Have the students draw the original recipe amounts, then draw the new doubled recipe. For example: ¼ cup of flour now is one-half of a cup.
3. Research the game of NIM on the internet. Play the different versions of NIM, using whole numbers and objects.

Additional Resources

Books

Fraction Action, by Loreen Leedy; ISBN 0-8234-1244-X

Fraction Fun, by David A. Adler; ISBN 0-8234-1341-1

Piece = Part = Portion, by Scott Gifford; ISBN 1-58246-102-3

The Grizzly Gazette, by Stuart J. Murphy; ISBN 0-06-000026-0

Multiplying Menace: The Revenge of Rumpelstiltskin, by Pam Calvert; ISBN 1-27091-890-2

Web sites

http://www.rainforestmaths.com

http://mathstar.lacoe.edu/newmedia/integers/intro/media/intro_numberlines.html

http://illuminations.nctm.org/ActivityDetail.aspx?id=18

http://mathstar.lacoe.edu/lessonlinks/integers/integers_main.html

http://illuminations.nctm.org/ActivityDetail.aspx?id=80

http://www.thefutureschannel.com/index.php

http://www.rainforestmaths.com

http://www.mathnets.net

National Library of Virtual Manipulatives http://nlvm.usu.edu

- Fractions Visualizing
- Fractions – Parts of a Whole
- Fractions Bars
- Fractions Naming
- Fractions – Equivalent
- Fraction Pieces

Organizations

National Council of Teachers of Mathematics

1906 Association Drive, Reston VA 20191-1502

(703) 620-9840

http://nctm.org/

National Council of Supervisors of Math

6000 E. Evans Ave. #3-205, Denver, CO 80222

(303) 758-9611

http://www.ncsmonline.org/

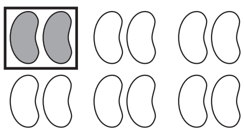
Utah Council of Teachers of Mathematics

http://uctmonline.org/

Modeling Multiplication of Fractions Sheet

Steps to Model Multiplication of Fractions:

1. First, look at the whole number. That determines the number of beans to start with.
2. Next, look at the denominator of the fraction. That shows you how many shares (ways to divide) the whole number.
3. Then, look at the nominator the fraction. That shows you how many shares you want to draw a box around.
4. Finally, look at how many beans you covered. That is the answer.

1. 1/6 of 12  1/6 of 12 = 2	2. 3/4 of 12	3. 7/12 of 12	4. 2/3 of 12
5. 2/5 of 10	6. 2/3 of 9	7. 1/3 of 12	8. 5/6 of 12
9. 3/5 of 10	10. 2/4 of 16	11. 4/5 of 15	12. 3/8 of 16
Now You Try! Make up your own problem by adding a numerator to each problem.			
13. ?/8 of 16	14. ?/9 of 36	15. ?/6 of 24	16. ?/8 of 32

EXPLAIN THIS TO YOUR PARTNER… LET ‘S TALK ABOUT MATH!

Can you see a pattern?

Try this…

1/4 of 12

2/4 or 1/2 of 12

3/4 of 12

4/4 of 12

Problem with a Dozen

Each problem has a dozen eggs. For example: ½ Find ½ of twelve equals 6.

X	X	X			
X	X	X			

Draw a model for each problem. Look at the numerator and denominator for hints on what to do. The denominator tells you how many shares. The numerator tells you the number of shares you need.

1/3	2/3	3/3			
1/4	2/4	3/4	4/4		
1/6	2/6	3/6	4/6	5/6	6/6
1/12	2/12	3/12	4/12	5/12	6/12
7/12	8/12	9/12	10/12	11/12	12/12

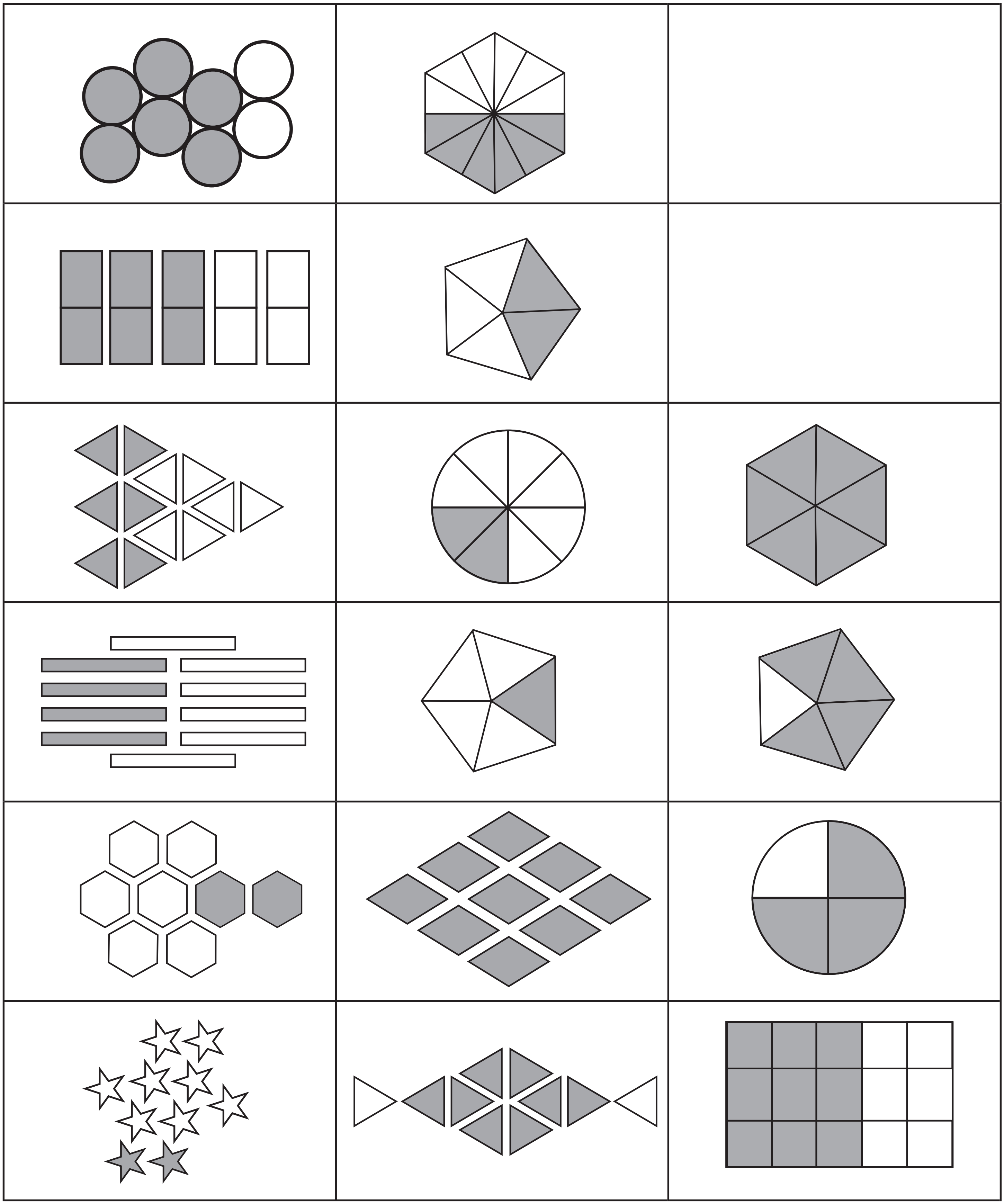
Decimal Sorting Cards

1.00		
.8	0.80	1
.25	0.50	0.75
0.25	.5	.75
0.20	0.40	0.60
.2	.4	.6

Fraction Sorting Cards

$\frac{5}{5}$		
$\frac{8}{10}$	$\frac{4}{5}$	$\frac{15}{15}$
$\frac{2}{8}$	$\frac{8}{16}$	$\frac{15}{20}$
$\frac{1}{4}$	$\frac{5}{10}$	$\frac{3}{4}$
$\frac{2}{10}$	$\frac{4}{10}$	$\frac{6}{10}$
$\frac{1}{5}$	$\frac{2}{5}$	$\frac{3}{5}$

Fraction Picture Sorting Cards



Percent Sorting Cards

20%	25%	40%	50%
60%	75%	80%	100%

Fraction NIM

FOCUS: Students will use mental math to add fractions to a target number.

Directions:

First, choose a target number between 5 and 20.

Next, the first player places a token on the board and states the number.

Then, the next player places another token on the board and mentally adds that number to the first number. Continue taking turns.

Last, the goal is to be the person who adds the last number to equal the target number.

2	2	2	2	2
1	1	1	1	1
¾	¾	¾	¾	¾
½	½	½	½	½
¼	¼	¼	¼	¼

Example Game:

The target number is 5.

- Player 1 chooses ¾
- Player 2 mentally adds ½ = 1 ¼
- Player 1 mentally adds 2= 2 ¼
- Player 2 mentally adds ½ = 2 ¾
- Player 1 thinks about adding 2, but that would give 4 ¾ and the other player just would have to add ¼ to win.
- Player 1 changes their mind and only adds 1 leaving many options open= 3 ¾
- Player 2 adds ¼ and realizes that they have lost the game= 4
- Player 1 adds 1 and wins the game.

2	2	2	2	2
1	1	1	1	1
¾	¾	¾	¾	¾
½	½	½	½	½
¼	¼	¼	¼	¼

Understanding Decimals

Math Standard I

Objective 2

Connections

Standard I:
Students will expand number sense to include operations with rational numbers

Objective 2:
Explain relationships and equivalencies among rational numbers.

Intended Learning Outcomes:
1. Develop a positive learning attitude toward mathematics.
6. Represent mathematical ideas in a variety of ways.

Content Connections:
Language Arts I-1- Develop language through listening and speaking.

Background Information

Students should use models and other strategies to represent and study decimal numbers. Fractions and decimals both represent parts of a whole, and both can represent numbers greater than one. Learners need to investigate the relationship between fractions and decimals, focusing on equivalence. Any fraction can be rewritten as an equivalent decimal and any decimal can be rewritten as an equivalent fraction. Help them understand that a fraction such as ½ is equivalent to 5/10 and that is has a decimal representation of (0.5). After developing and understanding of equivalent fraction and decimal forms, students need to recall fluently the decimal equivalents for common fractions such as ¼= 0.25, ½= 0.5 and ¾= 0.75. For other fractions divide the numerator by the denominator. It is important for students to understand the traditional algorithm, but also be able to use a calculator to convert fractions to decimals. In addition, students can examine that some fractions are terminating decimals and others are not.

Decimals are part of our every day life. We see them in the amount of rainfall in weather reports, sports statistics (e.g. batting averages), and stock market reports. It is important to connect fractions to decimals by numerous conceptual experiences, rather than just memorizing the algorithm.

Research Basis

National Council of Teachers of Mathematics. (2000). ***Principles and standards for school mathematics.*** Reston, VA.

Teaching and learning mathematics is a complex, active, and social activity. The research on problem solving and mathematical reasoning clearly states the great need to create mathematically rich environments for students to deepen their understanding of mathematics. The instructional strategies chosen should match the varied learning needs of students. Effective instruction occurs when teachers choreograph the learning experience by carefully choosing select problems, standard-based materials, and conducting formal and informal assessments. The end goal is to empower students in problem solving by blending conceptual, procedural, and factual knowledge into a powerful learning package.

Van de Walle, J. A. (2001). ***Elementary and middle school mathematics: Teaching developmentally (4th ed.)***. New York: Addison Wesley Longman.

Van de Walle clearly states the importance of constructivism. “Constructivism provides us with insights concerning how children learn mathematics and guides us to use instructional strategies that begin with children rather than ourselves” (2001, p. 26). The whole learning process focuses on learning the concept, instead of the small pieces or procedural parts in the learning process. Effective teachers know their students’ strengths and weaknesses and plan instruction to challenge all learners to meet high standards. To do this, teachers must find ways to learn students’ prior mathematics knowledge and misunderstandings so that knowledge gaps can be addressed, inconsistencies resolved, and understanding deepened.

Invitation to Learn

Demolition Decimals

Ask students if they have ever created new words by taking a word and rearranging its letters. Explain that they are going to do a similar activity only using numbers. Have the students cut three index cards in half the wide way. Then, have students label the card as follows: 7, 5, 4, 0, and a decimal point. Tell the students you are going to ask them to make numbers that will fit a specific rule. Remind students that each number and the decimal must be used for each problem. Have students work in small groups and discuss their findings and discoveries. Start giving rules such as: “Build a number that is greater than 750”, “Build a number that is less than 5”, “Build a number that is between 70 and 70.5”, etc

Materials

- ❏ *The Tile Center Sheet*
- ❏ *Custom Tiles Sheet*
- ❏ *Blank 10x10 Grid Sheet*
- ❏ Index Cards
- ❏ Paper
- ❏ Dice
- ❏ Calculators

Instructional Procedures

Part One: Rolling For One

1. Tell the students they are going to play a game to investigate decimals in more depth. They will be looking at the whole, which is one, 1, and/or 1.0, and exploring adding tenths and hundredths. Students will create a written accounting of all addition of decimals.
2. Model the game as a whole class the first time. To play the game, have students set up a T-chart like this by folding a blank piece of copy paper in half and labeling it as shown:

Player 1	Player 2
Roll 1- _____	Roll 1- ____
Roll 2- _____ New Total: ______	Roll 2- _____ New Total: ______
Roll 3- _____ New Total: ______	Roll 3- _____ New Total: ______

Play the game with the class using the following rules:

1. Each player must roll the die 7 times.
2. After each roll of the die the player will decide whether it should be tenths or hundredths. (e.g. a roll of 3 could be 0.3 or .03)
3. A running total is kept of all seven rolls.
4. To win the game, students must get as close to one without going over 1 whole.
5. If you have a class that is struggling with this concept, show the tenths and hundredths in money form. For example, six hundredths is \$0.06 and six tenths is \$0.60. Students are trying to reach \$1.00. This is great for understanding, but students need to be able to remove the dollar sign and the zeros and still realize that \$0.06 is equal to .06 and \$0.60 is equal to 0.6. Students will make this transfer quickly if they can clearly see the connections between representations.
6. An example of play: One player rolls a six, they must decide whether it is six tenths or six hundredths. Player two repeats the process with his/her own roll. Player one rolls again and

adds the roll to the previous total. For example, player one had six tenths and rolled a six again, the player can not make that into six tenths because it will go over one whole after only two rolls, so the players must make it six hundredths. So, 0.6 + .06= .66. Play continues with each player adding to his previous sum. After seven rolls, the player closest to 1 (without going over) is the winner.

7. Practice the game as a class.
8. Check for understanding of the game. If students are still a little confused have them play the game partners against partners. Circulate questioning the students during the game. If students grasp the idea, play in partner groupings. As you circulate, continue asking questions to see if students can see any patterns that will help them win the game.
9. After everyone has had a chance to play, have the students examine their results. Have students discuss in small groups how numbers were recorded. Did it matter if a student didn't put the zero after a number? (i.e. 0.6 instead of .60), How did each student keep track of their score, etc
10. Students will record in their math journals their responses to the journal prompt "My strategy for playing Rolling One is…"

Part Two: Get the Hint?

1. Explain to the students they are going to explore decimals using a calculator. Many times when students use calculators they get an answer with many digits after the decimal point; students find it difficult to deal with all those decimals. Teachers hear questions like What do the decimals mean?, and What's the real answer?, stated in the classroom. This activity is a simple engaging way to look at decimals. Before starting, be sure to have the students create a recording sheet by folding a regular sheet of 8½" x 11" copy paper into thirds and labeling each column as shown here(information in parentheses is for teacher help, do not have students write it on their page).

Guess (Partner B Guesses a Number Between 1 and 100)	Decimal on the Calculator (Partner A divides the guess by the secret number and writes the decimal)	≈ Approximate Percentage of the Secret Number (Partner B writes the approximate percent and makes another guess using the % to help)
1st guess: 14	= .518518518	.52 ≈ 50%
2nd guess:		
3rd guess:		
4th guess:		

2. For the whole class modeling use an overhead calculator. The first couple of times you model this activity show students the secret number.
3. The goal is to figure out the secret number. (Note: When playing with a partner and not the class as a whole, be sure to remind students to keep the calculators hidden so their partner can not see the secret number.)

   The rules of the game are as follows:

   a. Partner A will choose a secret number between 1-100.

   b. Partner B will try to figure out what partner A's secret number is by guessing a number.

   c. Partner A will take partner B's guess and divide it by the secret number.

   d. Partner A records the decimal on the Record Sheet.

   e. Partner B finds the decimal point and draws a box around the 3 numbers on the right side. Then, determines the approximate percentage of the decimal.

   Reminders:

   - If it has a 1 to the left of the decimal point= 1.34567877679. This means that your guess is greater than the secret number= 135%.
   - If it has does not have a 1= 0.67895546565. Box 0.67895546565. This means that your guess is less than the secret number. It is only approximately 68% of the number.

   f. With your new information, make another guess.

   g. Try to guess the secret number in less than 5 guesses.

4. After modeling and checking for understanding, students will play several games in partners, recording their work on their self-made record sheet.

Part Three: The Tile Company

1. Students are going to look at decimals using a model, the 10-by-10 grid. Discuss how many squares make up a 10-by-10-square grid. Remind the students that one grid represents 1 whole that has been divided into 100 equal parts.
2. Using the Blank 10x10 Grid Sheet, have the student shade in three tenths of grid #1. Have students compare their shading to their partners. Discuss the written notation for this picture in fraction form, decimal form, and as a percent. If needed, have a mini-lesson on how to figure out each one of these notations and how it relates to the illustration.
3. Continue giving the students other numbers to represent in picture and written notation: .25, .4 .66 and so forth until you are confident that the students understand.
4. Inform the students that they have just been hired by the Tile Center Company as financial consultants. Tell them they will be examining different kitchen tile patterns which the Tile Center Company sells. All tiles are 10 inches by 10 inches and sell for $1.60. The company is losing money and needs the students' assistance in determining which tiles need to be changed to have the company make more money, but are still pleasing to the eye. All the white squares are one cent. The shaded squares are twice as expensive.
5. The task: In small groups, "Consultants" (students) will create a presentation to the President of the Tile Center Company.
    1. Students need to determine the fraction, percent, and decimal form of each The Tile Center tiles.
    2. Determine the cost of each tile.
    3. Make a recommendation about which of existing tiles should continue to be manufactured (provide profit) and which should be eliminated and why.
    4. Create six unique grid patterns that will make the company money. State the cost of each tile and the fraction, decimal, and percent shaded for each tile.
    5. Finally suggest a new price that would make the tile company at least $0.05 profit per tile.

6. Write a one page letter to the President discussing #2, #3, #4, and #5.

Assessment Suggestions

- Have students write in their math journals about how decimals relate to fractions and percents.
- Have students self assess how well their presentation met the criteria on a student created rubric.
- Complete the tile company activity with accuracy. During the activity, ask the students to explain the steps they are taking. Check for accurate expression of fractions, decimals and percents, both in written form and in conversation.

Curriculum Extensions/Adaptations/ Integration

- The Tile Company is wanting to release a new line of tiles that are 20 x 20. Suggest to the company a tile price and 6 different tile designs that would make the company money on every sale.
- Play *I Have, Who Has?* Commercial sets are available for purchase, or a Google search of “I Have, Who Has” will return many pre-made sets you can print and use.

Family Connections

- Have the students play *Get the Hint?* with a family member.
- Have the students find batting averages for 10 different baseball players in the newspaper. Record the players names and rank order the players from the best batting average to the worst.
- Watch the nightly news or read a newspaper to find the Dow Jones rate 10 days. Find the difference each day in the decimals. Record and chart.
- Log on the www.weatherbug.com and create a bar graph of the rainfall for two different regions.

Additional Resources

Web sites

Short video on Integers

http://mathstar.lacoe.edu/newmedia/integers/intro/media/intro_numberlines.html

http://illuminations.nctm.org/ActivityDetail.aspx?id=18

http://mathstar.lacoe.edu/lessonlinks/integers/integers_main.html

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http://www.mathnets.net

National Library of Virtual Manipulatives

http://nlvm.usu.edu

http://www.mathwire.com/whohas/whfractions.pdf

Organizations

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(303) 758-9611

http://www.ncsmonline.org/

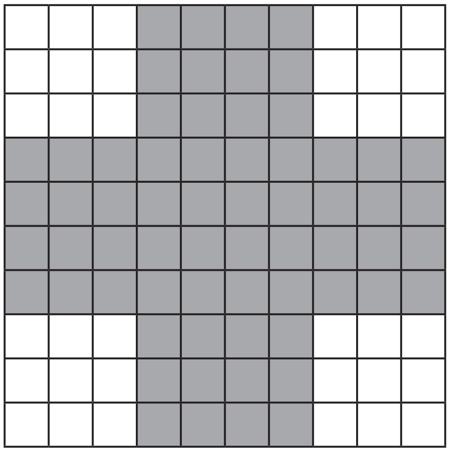
Utah Council of Teachers of Mathematics

http://uctmonline.org/

The Tile Center Sheet

At the Tile Center all tiles are $1.60

Pattern 1



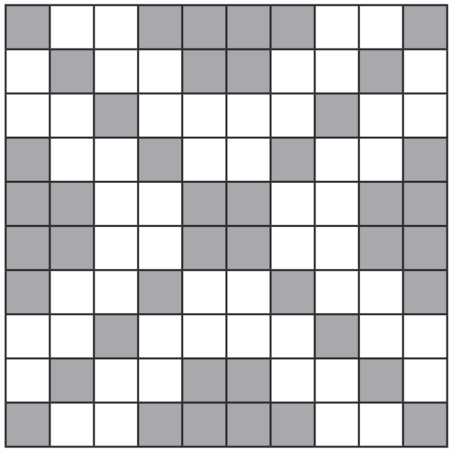
How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________

Pattern 2



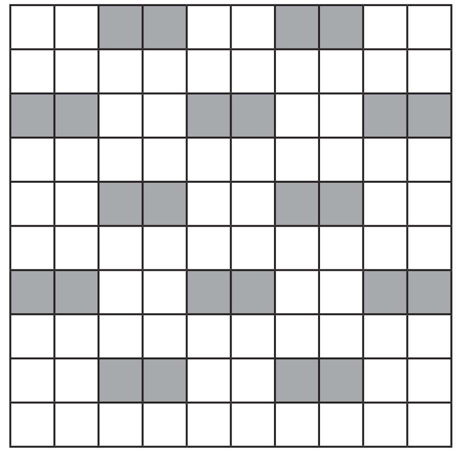
How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________

Pattern 3



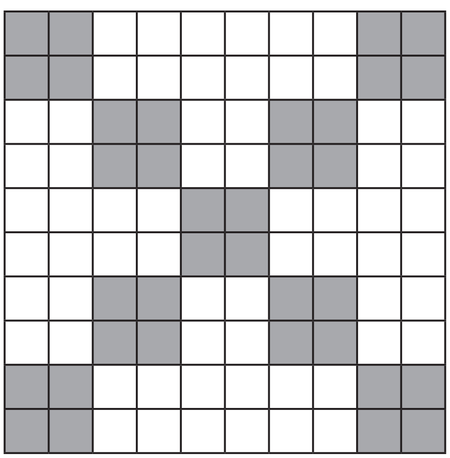
How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________

Pattern 4



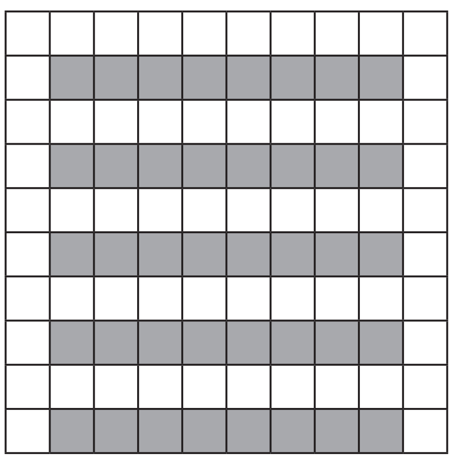
How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________

Pattern 5



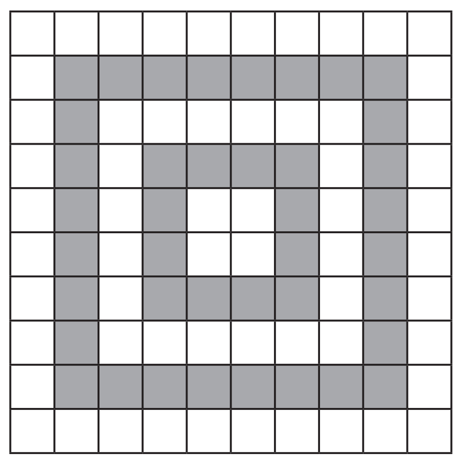
How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________

Pattern 6



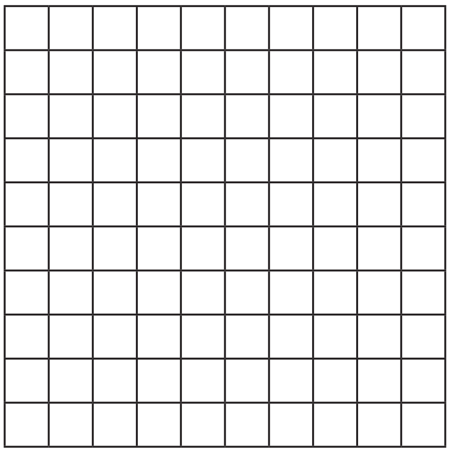
How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________

Custom Tiles Sheet

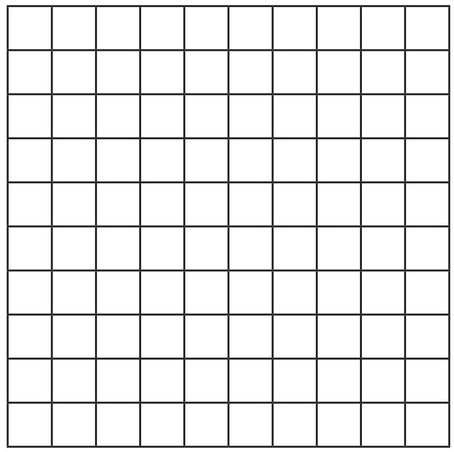


How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________

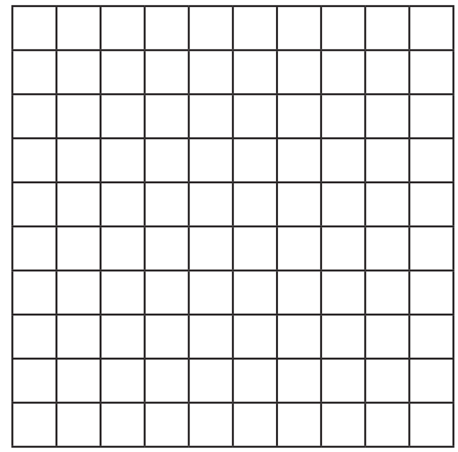


How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________

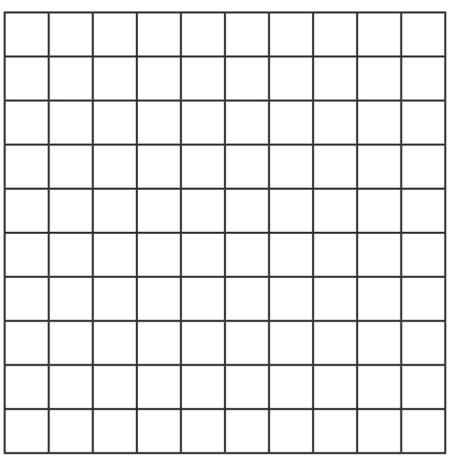


How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________

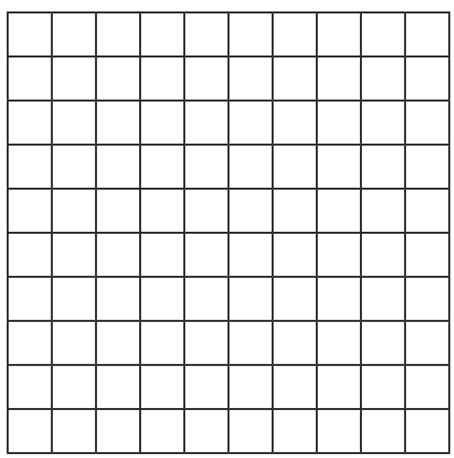


How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________

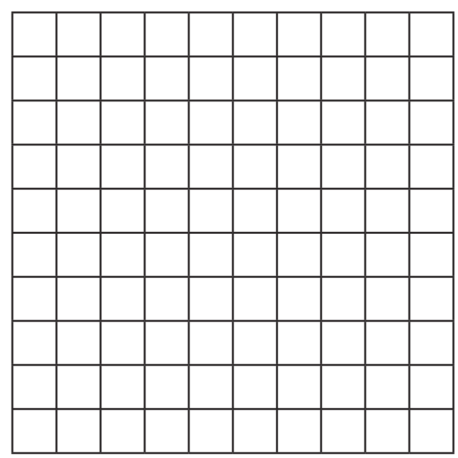


How much is shaded?

Fraction: ______________________

Decimal: ______________________

Percent: ______________________



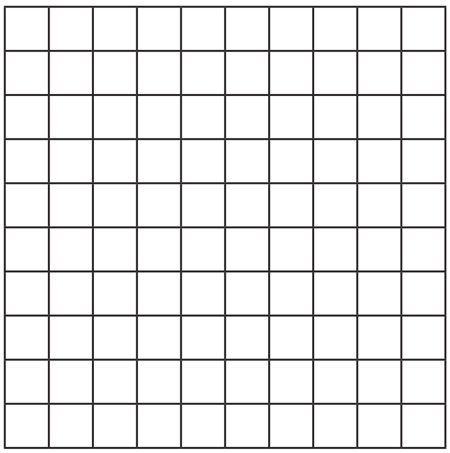
How much is shaded?

Fraction: ______________________

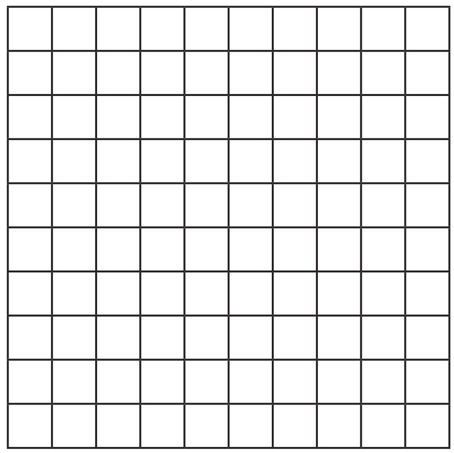
Decimal: ______________________

Percent: ______________________

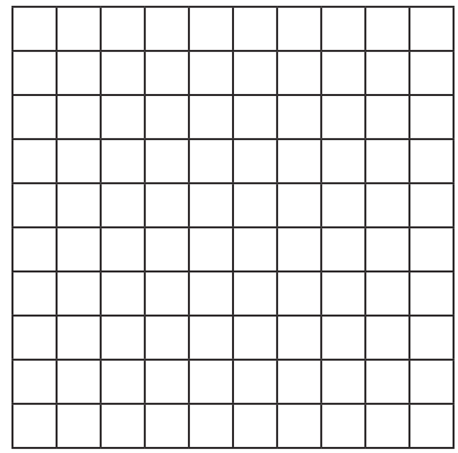
Custom Tiles Sheet



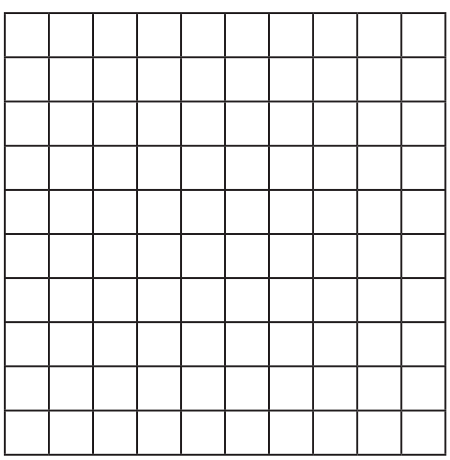
How much is shaded?



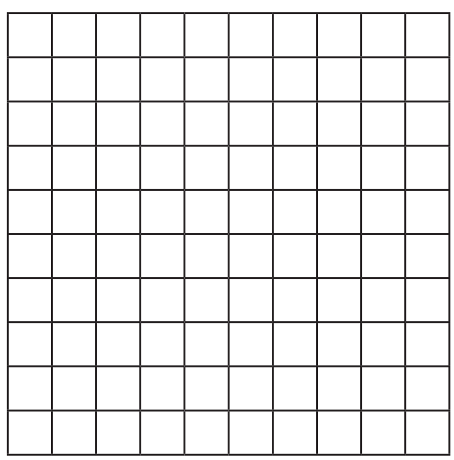
How much is shaded?



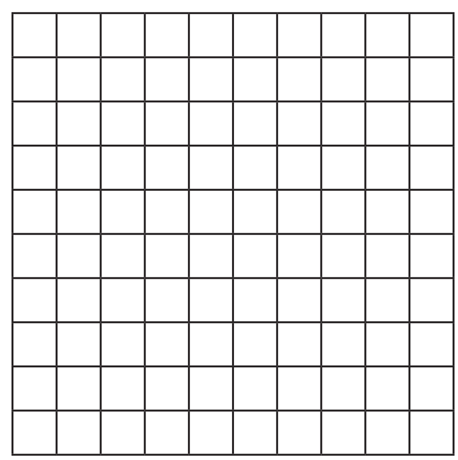
How much is shaded?



How much is shaded?



How much is shaded?



How much is shaded?

Predicting Percents

Math Standard I

Objective 2

Connections

Standard I:
Students will expand number sense to include operations with rational numbers.

Objective 2:
Explain relationships and equivalencies among rational numbers.

Intended Learning Outcomes:
1. Develop a positive learning attitude toward mathematics.
3. Reason mathematically.
6. Represent mathematical ideas in a variety of ways.

Content Connections:
Math I-2; Rational number as a ratio
Math I-6, Four operations with integers

Background Information

The same amount can be represented in multiple ways using fractions, decimals, and percents. Depending on the task at hand, one form may be easier to work with than another, therefore students need to develop fluency converting between the multiple forms. This fluency can be cultivated by identifying relationships between forms throughout our teaching. Teaching these separately and expecting students to make the necessary connections on their own leave a needed learning to chance. Often these concepts are taught independently: fractions as parts of a whole using fraction circles or squares, decimals as parts of a whole number in tenths and hundredths with base ten blocks, and fractions as part of 100 using computation to find the answer. These models should be integrated throughout instruction to foster flexibility between forms. The ability to understand the meaning of a percent as part of a whole and use common percents such as 10 percent, 33 1/3 percent, or 50 percent as benchmarks in interpreting situations they encounter is useful.

Often, textbooks and classroom situations provide problems, numbers are used that compute easily. In real-life contextual problems, things we face daily at the grocers or stores, the calculations do not work out so perfectly. We need to assist our students in developing an ability to find reasonable approximations with fractions, decimals, and percents. Think about how you would figure 33% off $28.95. Your solution may include changing 33% to 1/3 or rounding the dollar amount to either $27 or $30. This skill must be fostered in our classrooms to allow students to reason with numbers.

Research Basis

Van de Walle, J. A. (2001). ***Elementary and middle school mathematics: Teaching developmentally (4th ed.)***. New York: Addison Wesley Longman.

When a student encounters an unfamiliar math problem, students will need some support in developing solutions. This should not occur on test day. Students should encounter these sorts of problems daily and learn to solve them with the support of peers and teachers. "Children rarely give random responses" (Van de Walle, 2001, p. 28). Teachers must understand the mental models that students use to perceive the world and the assumptions they make to support those models.

Youngs, D. (1998). Have you done a good math problem lately? ***AIMS, 13***(2), 18-21.

Dr. Dave Youngs brings up an interesting point in the journal article, "Have You Done a Good Math Problem Lately."

Why does is seem so natural to ask someone if they've read a good book lately, but so odd to ask them if they have done a good math problem? Perhaps this is because most of us don't view mathematics as something that anyone would ever voluntarily choose to do, let alone choose to do "for the fun of it." (Youngs, 1998, p. 18)

Some students would laugh at the thought of having fun at math. Yet, through careful selection of materials and methods, students become motivated to solve problems and discuss their findings. Mathematics must become an exciting, interesting part of the day where students are solving intriguing problems and coming up with new and interesting ways to approach the problem. Puzzles should be a part of the daily classroom activities. Solving real-world problems that occurred in the classroom and situations to that engaged students.

Invitation to Learn

Ask students if they can tell, or model some different ways to show the number 1/2. Have students look around the room and see if they can spot things that would represent or explain what they are thinking. Students may use decimal forms or percents but the majority will find different models or numbers that represent ½. Review real-life examples (students may want to use their journal entry from the previous discussion on ½). At this time, focus on the volume of ideas shared, while observing what the students share and their level understanding. Allow students time to share solutions amongst their groups.

Materials

- ❏ *Piece = Part = Portion*
- ❏ *Estimating Equivalencies*
- ❏ *Fractured Line Game*
- ❏ *Fraction cards*
- ❏ Dice
- ❏ Paper clips

Instructional Procedures

Part 1: Oh, So Close!

1. Ask the students what they think the word "percent" means. Ask them to record in their journals any other words that have "*cent*" as a part of the word. They can use dictionaries if they are struggling with this.
2. Discuss the meaning of the words they come up with. (e.g. century: 100 years, centimeter: 1/100 of a meter, centennial: hundredth anniversary, cent: 1/100 of a dollar.) Some other words may include things that have to do with the center or middle of something. You may want to categorize the words into two groups as we want to focus on the "parts of 100"words.
3. Have students record in their journal what percent means: Percent- a ratio that compares a number to 100.
4. Read the book *Piece=Part=Portion.*
5. On the board list some of the fractions mentioned in the book like 1/2, 1/4, 1/7, 1/12. Ask the students what fractions they think would be easy to change into percent form? Students will probably respond with the familiar fractions like ½ equals 50%. Have someone explain how they know that is true. If it does not come up in the discussion relate the idea of a percent as being part of 100 so how can we find an equivalent fraction form of ½ that is part of 100. 1/2= 50/100 = 50% = .50 or .5) What other fractions are easy to change to hundredths? (fourths, fifths, tenths)
6. Hand out *Estimating Equivalencies*. Have students identify the fractions that are easily changed and fill in those columns by finding an equivalent fraction with a denominator of 100 and then expressing it is a fraction, decimal, and percent.
7. Share with students that sometimes finding a close estimation is enough to help us solve a problem.
8. Start with 1/9. Can you easily get an equivalent fraction with a denominator of 100? (no) How close can you get? (99). Is 99 close to 100? (Yes, very close, just one under)? What would I have to do to change 1/9 into *n*/99? (multiply by 11/11) What do you get? (11/99) So 1/9 is about 11%. Look in *Piece=Part=Portion* and see how close your percent matches.
9. Repeat the process for 1/6. This time it is hard to determine 6 x *n* = 100. So we are going to break it down even more. I don't

know 6 x n = 100 but 6 x 8 gets me pretty close to half way there (6x8 = 48; 1/6 = 8/48). If I double that I'm pretty close to 100 for my denominator (8/48 x 2/2= 16/96). So 1/6 is pretty close to 16% or .16, it's a little low because I only have 96 instead of 100 for my denominator. Have students figure it out mathematically either paper-pencil or using a calculator. The answer is actually 16.666. Pretty reasonable estimate!

10. Depending on your students have them complete the worksheet on their own, in groups, or whole class.

Part 2: Fractured Line Game

1. Give each student the *Fractured Line Game Handout* and a paper clip. Every two students need a set of *Fraction Cards*.
2. Show the students how to fold the game sheet along the dotted fold line and place the paper clip at 0%.
3. The first player draws a fraction card, decides what percent the fraction represents, and slides the paper clip on the percent number line to where he thinks the fraction is located.
4. The second player checks the answer by opening the flap. If the first player is right, he gets a point.
5. The second player now draws a card, figures out what percent the fraction represents, and moves the paper clip to the correct position. Player one checks the answer.
6. If the player draws a word card, he must define that word. (Example: Player 1 draws the card *"What does percent mean?"*. He tells player two the definition while player 2 checks. If player one is correct, he earns a point.
7. Play continues until all of the cards are drawn. The player with the most points wins.

Assessment Suggestions

1. Have students answer the following problem: We surveyed the students at a Utah elementary school about what pets they owned. 8/25 of them owned dogs, 0.04 owned snakes, 3/20 owned birds, 19% owned fish, and 0.3 owned cats. List the pets in order from least to greatest and explain your answer.
2. Have students list in their journals as many everyday examples of fractions, decimals, and percents as possible as why they are important.

3. Give students several fractions and have them write the percent equivalent, explaining their solution.
4. Play the *Fractured Line Game* with individual students to check their understanding.

Curriculum Extensions/Adaptations/ Integration

- Have students glue their *Estimating Equivalencies* in their journal.
- Have students create a flag of an imaginary country. They will determine the percent of each section of the flag; writing this as a decimal, fraction, and percent.
- Play *Equivalent Fractions Spoons*. Create cards that have 8 different sets of 4 equivalent fractions. Play Spoons with original rules.
- Play *Target Percent*. This is similar to *Rolling to One* from the Decimals Activity. Students roll two dice, create a fraction, find its corresponding percent, and write it down. Students may roll again, or stop and take the total at any time. Once they stop, their turn is over. Each round has a winner- the student closest to the target percent. At the end of four rounds, the student with the most wins is the winner.

Family Connections

1. Look for fractions, decimals, and percents in real world situations.
2. Have students figure out the percent off of items when shopping. Example video games are 25% off. What fraction is 25%? If the video game is $59.99, how much is 25%? What is the cost of the video game on sale?
3. Send *Fractured Line* game home to play with parents.

Additional Resources

Books

Piece = Part = Portion, by Scott Gifford; ISBN 1-58246-102-3

The Grizzly Gazette, by Stuart J. Murphy; ISBN 0-06-000026-0

World Cards; ISBN 0-9629962-2-x

Geography Facts, by Dougal Dixon; ISBN 0-88029-925-8

Web sites

Short video on Integers

http://mathstar.lacoe.edu/newmedia/integers/intro/media/intro_numberlines.html

http://illuminations.nctm.org/ActivityDetail.aspx?id=18

http://mathstar.lacoe.edu/lessonlinks/integers/integers_main.html

http://illuminations.nctm.org/ActivityDetail.aspx?id=80

http://www.thefutureschannel.com/index.php

http://www.rainforestmaths.com

http://www.mathnets.net

National Library of Virtual Manipulatives

http://nlvm.usu.edu

Flags

http://www.crwflags.com/fotw/flags/cbk-ne.html

Organizations

National Council of Teachers of Mathematics

1906 Association Drive, Reston VA 20191-1502

(703) 620-9840

http://nctm.org/

National Council of Supervisors of Math

6000 E. Evans Ave. #3-205, Denver, CO 80222

(303) 758-9611

http://www.ncsmonline.org/

Utah Council of Teachers of Mathematics

http://uctmonline.org/

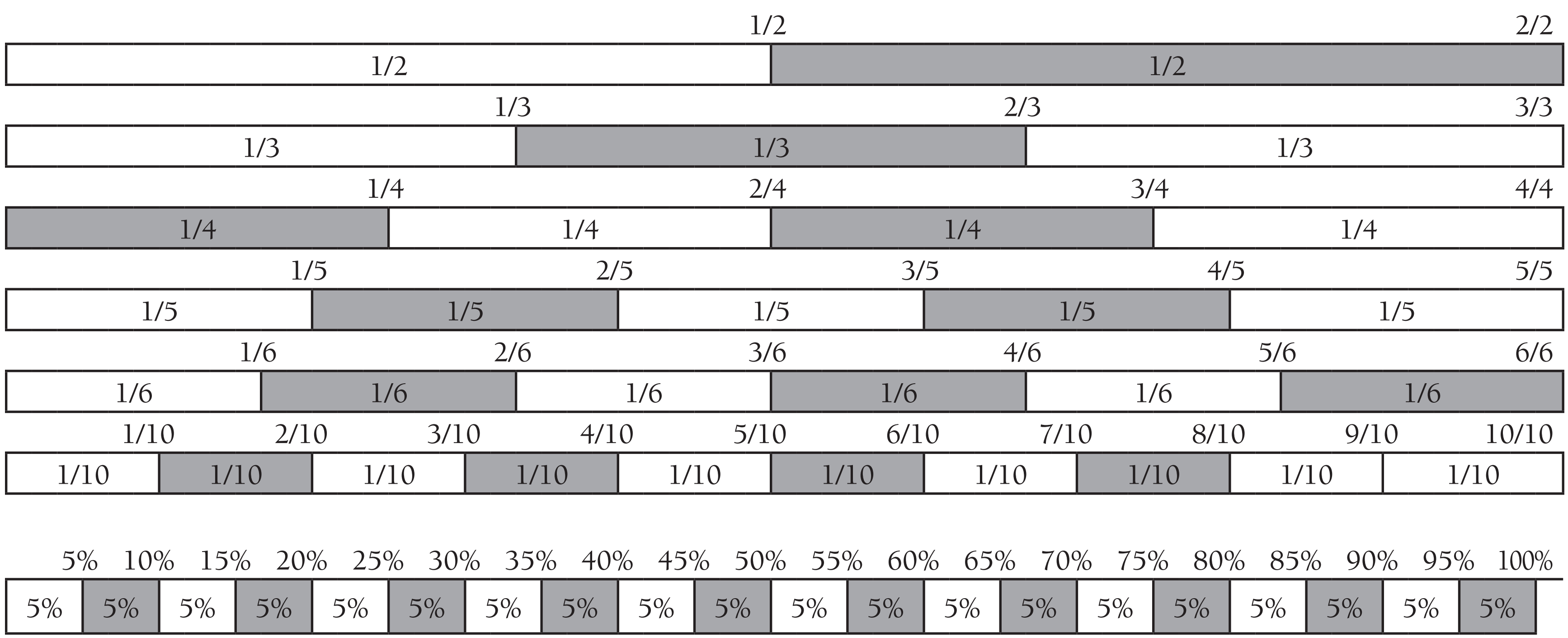
Estimating Equivalencies

Fraction	1/2	1/3	1/4	1/5	1/6	1/7	1/8	1/9	1/10
Can I change my denominator to 100?									
How?									
If no, how close can I get to 100?									
How?									
Multiply the numerator & denominator by the same number!									
Fraction									
Decimal									
Percent									

Fractured Line Game

The top number of a fraction is called the numerator. The bottom number is called the demoninator. 4/5	The numerator tells you how many of the parts you have.The denominator of a fraction tells how many equal parts something has been divided into. n/d	Percent (%) means out of a hundred, per hundred, or hundreths. 1% or .01

fold line



Fraction Cards

$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{6}{6}$	$\frac{5}{10}$	**What does numerator mean?**
$\frac{1}{10}$	$\frac{2}{4}$	$\frac{3}{4}$	$\frac{4}{4}$	$\frac{2}{3}$	$\frac{2}{10}$	$\frac{6}{10}$	**What does denominator mean?**
$\frac{3}{3}$	$\frac{2}{2}$	$\frac{2}{5}$	$\frac{3}{5}$	$\frac{4}{5}$	$\frac{3}{10}$	$\frac{7}{10}$	**What does % mean?**
$\frac{5}{5}$	$\frac{2}{6}$	$\frac{3}{6}$	$\frac{4}{6}$	$\frac{5}{6}$	$\frac{4}{10}$	$\frac{8}{10}$	$\frac{9}{10}$

Science III-2

Activities

Objects in Space

What do you see?

Standard III:
Students will understand the relationship and attributes of objects in the solar system..

Objective 2:
Describe the use of technology to observe objects in the solar system and relate this to science's understanding of the solar system.

Intended Learning Outcomes:
1. Use science process and thinking skills.
2. Manifest scientific attitudes and interests.
3. Understand science concepts and principles.

Content Connections:
Math II-1; Graph data

Science Standard III

Objective 2

Connections

Background Information

This activity will take several days to complete. Students should have a good understanding of the progresses that have been made to help observe objects in space. Students should be familiar with the invention of the telescope and other important benchmarks in the history of science's dealing with space. This activity is designed to give students hands on experience in the scientific process. For this activity to be most beneficial, students should journal their experiences throughout the entire process. Students will be given several opportunities to show self differentiation in the creation of their foam rocket and re-entry shield. Students should have the feeling that they are actually creating important products that will help in the observation of objects in space.

Safety Statement: Request prior approval with administration. Conduct activity outside on a calm day, and store propane off school property or in an appropriate location.

Research Basis

Tomlinson, Carol Ann (2001). Differentiation of instruction in the elementary grades. *ERIC Digest*, Retrieved 11/27/07, from http://www.ericdigest.org

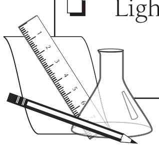
At its most basic level, differentiation consists of the efforts of teachers to respond to variance among learners in the classroom. Whenever a teacher reaches out to an individual or small group to vary his or her teaching in order to create the best learning experience possible, that teacher is differentiating instruction.

Caine, R.N., & Caine, G. (1994). Making connections: Teaching and the human brain. Menlo Park, CA: Addison-Wesley.

Learning from classroom activities with application to real world situations are the lessons students seem to learn from and appreciate the most. Brain research shows the more senses used in instruction, the better learners will be able to remember, retrieve, and connect the information in their memories. "I hear and I forget; I see and I remember; I do and I understand." Students learn best when doing. By incorporating realistic, integrated, or interdisciplinary activities that build on established knowledge and skills and more than one sense, memory pathways become more accessible and cross-referenced for future use. As teachers discover the most effective strategies for better student achievement, they can adapt their lessons accordingly.

Materials

- ❏ *Foam Rocket*
- ❏ *Test Stand*
- ❏ *Re-entry Shield*
- ❏ *Attaching the Shield*
- ❏ Pipe foam insulation
- ❏ #64 rubber band
- ❏ 5/16 flat cut metal washer
- ❏ Propane torch
- ❏ Wooden dowel
- ❏ Aluminum foil
- ❏ Metal screen
- ❏ Machine screw – flat head
- ❏ Machine screw nut
- ❏ Washer
- ❏ Hot glue gun
- ❏ Fire extinguisher
- ❏ Water
- ❏ Safety glasses
- ❏ Lighter



Invitation to Learn

Ask the students to get out of their seats and go to the back of the classroom. At the front of the room display an object that is big enough to be seen with the naked eye, but small enough to make it difficult to make out any real detailed features. On the object place some distinguishing marks or words. Ask the students to make observations of what they see. Ask the students if there are different ways they could observe this object that would help to identify it better. Tell the students when they return to their seats they will record in their journals what they saw and any ideas of how this observation could improve. Before having the students return to their seats, give one student a pair of binoculars to observe the object. Now have the students return to their seats and record their observations. Have a few students share their thoughts. Ask the student who observed the object with the binoculars to share. Ask the students which observation they trust the most and why.

Instructional Procedures

1. Students will be informed that the object that they observed during the "Invitation to Learn" is coming closer to Earth and scientists have determined that more information must be gathered about this object. Discuss with the students the idea that science's understanding of the solar system is determined by the technology used to investigate it. Tell the students that

they have been chosen to create a rocket that will journey to this object with the purpose of gathering information.

2. Handout the materials that will be used to construct a rocket.
3. The student's assignment will be to get the rocket they have designed to travel as close to the unknown object as they can.
4. To create the unknown object the teacher will place a hula hoop some distance (at least 30 feet) from the students, the teacher will need to determine what distance would be appropriate. After the hula hoop has been placed, the teacher will scatter the contents of a puzzle that explains what the object is into the center of the hula hoop.
5. Students will launch their rockets towards the unknown object. Each student will walk to the spot where their rocket landed and take a digital photo of what they see. All of the student's photos will be downloaded to a computer for further observation.
6. The scientist have determined that more information must be gathered about the unknown object and so the student's rockets must be launched again with the purpose of landing and retrieving information from the object's surface and then returned safely to Earth.
7. The scientists feel the rockets the students have designed are great and that they are up to the assignment of getting to the unknown object and land. The problem the students are now faced with is designing a system that will be able to withstand the return trip through Earth's atmosphere.
8. Students will be given the materials needed to create a re-entry shield. The purpose of the shield is to protect the information gathered from the unknown object during re-entry. Teachers will need to create a test stand prior to this.
9. Students will launch their rocket towards the unknown object. If they land within three steps of the hula hoop they can gather one piece of the puzzle. If they land inside the hula hoop they can gather three pieces.
10. After each student has had the opportunity to gather pieces of the puzzle they will then make the attempt to bring the pieces back to Earth. Each student's shield will be exposed to the hostile experience of re-entry. Student's shields will be placed

in the Test Stand to simulate the intense heat of re-entry. The students whose shields maintain protection for a preset amount of time (teacher's choice) will be allowed to delivery their puzzle pieces to the scientists. If a shield does not withstand the re-entry those pieces are lost.

12. Students will help the scientist piece together the pieces that were returned to Earth with the purpose of identifying the unknown object.

Assessment Suggestions

- Have students record the scientific process they experienced as they went through the creation process in a journal.
- Have students reflect on the experience and share what they would have done differently and why.
- Have students use the information gained from their first attempt at creating a re-entry shield to create a second shield.

Curriculum Extensions/Adaptations/ Integration

- Have students record and graph the timed results from the re-entry shield experiment.
- Students may be assigned to those that may be challenge in the construction of the rocket or thermal shield.
- Create small groups to work as teams instead of by themselves.

Family Connections

- Students could take their foam rockets home and perform similar experiments with their families.
- Students could talk with their parents about how they have observed objects in space.

Additional Resources

Media

Beyond The Solar System- Expanding the Universe in the classroom, by Harvard-Smithsonian Center for Astrophysics; ISBN 0-9776402-0-5

Web sites

http://www.futureschannel.com

http://www.spaceplace.nasa.gov

http://www.jpl.nasa.gov

http://www.clarkplanetarium.org

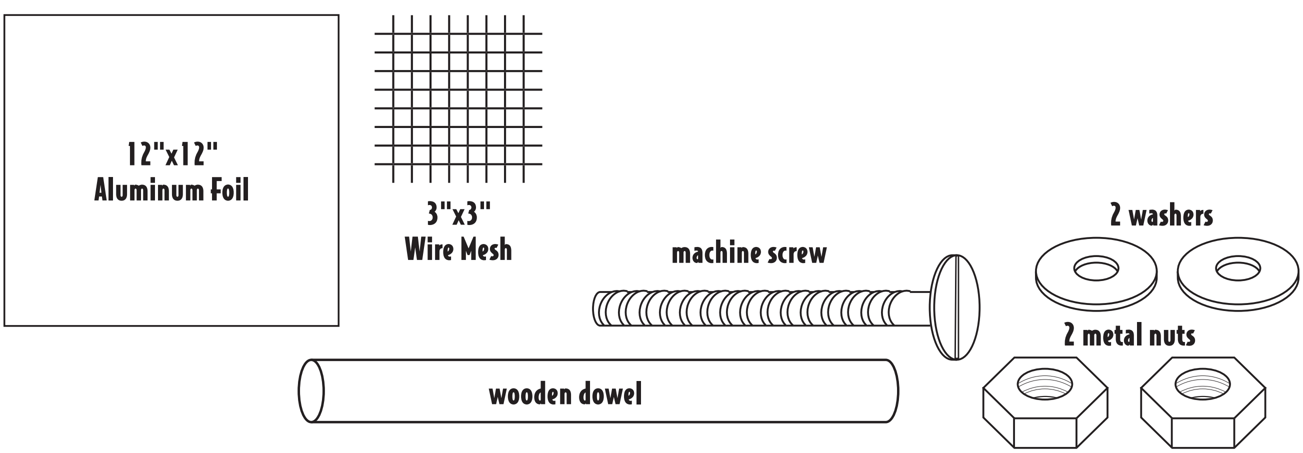
Re-entry Shield

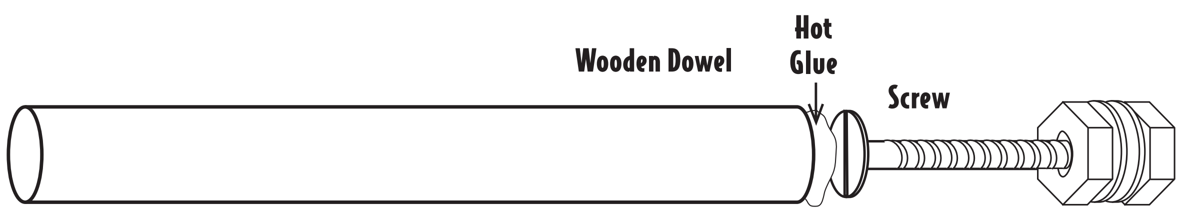
Materials

- 1 square foot sheet of aluminum foil
- 3 inch square piece of metal mesh
- #10-24 x 1 1/2 machine screw – flathead
- 2 #10-24 machine screw nuts
- 2 #10 SAE washers
- Hot glue pot or hot glue gun
- 12 inch long 3/8 inch diameter wooden dowel

Instructions

1. Give each student a sheet of aluminum foil, metal mesh, machine screw, two metal nuts, and two washers and the charge to create a re-entry shield. The students can do anything with the materials as long as they attach the head of the metal screw to the wooden dowel with hot glue.
2. Attach the screw to the dowel with hot glue. When the glue sets you can attach the shield to test stand.
3. The re-entry simulation is conducted by sliding the torch into postition in front of the Test Stand.
4. As soon as the thermal protection shield is directly in front of the flame start the stop watch. Time how long the shield stays attached to the wooden dowel.
5. Have each student record the time in his/her journal.





Orion Constellation Model

Standard III:

Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Objective 2:

Describe the appearance and apparent motion of groups of stars in the night sky relative to Earth and how various cultures have understood and used them.

Intended Learning Outcomes:

1. Use science process and thinking skills.
2. Manifest scientific attitudes and interests.
3. Understand science concepts and principles.

Content Connections:

Math IV-2 Units of measurements

Science Standard III

Objective 2

Connections

Background Information

Many students are under the assumption that the stars that make up a constellation are all on the same plane. Going through the process of creating a model of the constellation Orion, students will have a hands on experience showing them that stars of a constellation are actually not on the same plane.

Research Basis

Klentschy, Michael (2005). Science notebook essentials. *Science & Children*. *43*, 24-27.

When literacy skills are linked to science content, students have a personal and practical motivation to master language as a tool that can help them answer their questions about the world around them. Language becomes the primary avenue that students use to arrive at scientific understanding.

Caine, R.N., & Caine, G. (1994). Making connections: *Teaching and the human brain*. Menlo Park, CA: Addison-Wesley.

Learning from classroom activities with application to real world situations are the lessons students seem to learn from and appreciate the most. Brain research shows the more senses used in instruction, the better learners will be able to remember, retrieve, and connect the information in their memories. "I hear and I forget; I see and I remember; I do and I understand." Students learn best when doing. By incorporating realistic, integrated, or interdisciplinary activities that build on established knowledge and skills and more than one sense, memory pathways become more accessible and cross-referenced for future use. As teachers discover the most effective strategies for better student achievement, they can adapt their lessons accordingly.

Invitation to Learn

We know that light travels 186,000 miles per second. Let's say that a 1 cm string equals the distance light travels in one second. If it takes about 8 minutes for light from the sun to reach us, how long would the string be? (480 cm) The light from the next nearest star takes 4 ½ years to reach us, how long would that string be? (141,912,000 cm)

Materials

- ❏ *Orion Constellation*
- ❏ 7 Beads
- ❏ 150 cm of Thread
- ❏ Black Cardstock
- ❏ Ruler
- ❏ Scissors
- ❏ Pushpin
- ❏ Foam Core Board
- ❏ Tape

Instructional Procedures

1. Hand out to each student a copy of the *Orion Constellation* on cardstock.
2. Give each student 150 cm of string.
3. Give each student 7 beads.
4. Have the students tie a bead on the end of the string.
5. Place the constellation picture on the foam core board and use the pushpin to make a hole big enough for the thread at the location of the 7 labeled stars.
6. From the bead on the thread measure 15 cm long and cut the thread. Thread the end through the star labeled 522 ly until 1 cm is on the back side of the cardstock. Tape the 1cm piece of string securely on the back.
7. Use the measurements below to cut the remaining threads to the appropriate lengths and attach them to the cardstock using 1 cm of string on the back.

243 ly	18 cm
817 ly	12 cm
1342 ly	7 cm
916 ly	11 cm
815 ly	12 cm
773 ly	13 cm

8. Hold the model above your head to see the relative distance from the earth of each star.

Assessment Suggestions

- Ask the students to write in their journals why the star that is farthest from Earth has the shortest thread and the star that is closest to us has the longest thread?
- Ask the students to write about what they learned about the distances of stars in constellations from doing this activity.

Curriculum Extensions/Adaptations/ Integration

- Have students research other constellations and create similar models.
- Partners could help with the construction of the model.

Family Connections

- Have students show their parents the Orion model and explain the different lengths of string to them.
- At home locate Orion in the night sky and identify the correlating stars in the model.

Additional Resources

Media

Beyond The Solar System- Expanding the Universe in the classroom, by Harvard-Smithsonian Center for Astrophysics; ISBN 0-9776402-0-5

Web sites

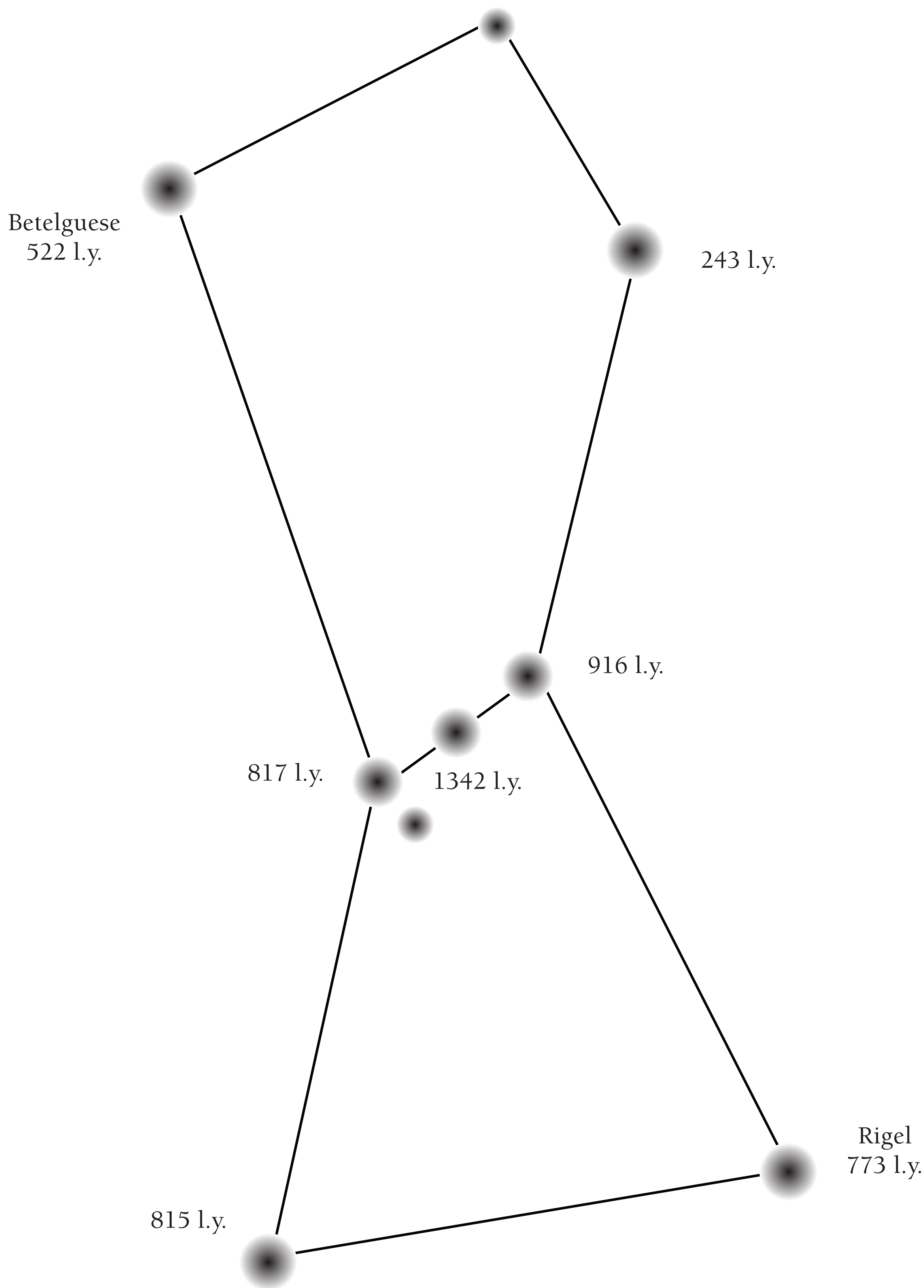
http://www.futureschannel.com

http://www.spaceplace.nasa.gov

http://www.jpl.nasa.gov

http://www.clarkplanetarium.org

Orion Constellation



What time is it?

Standard III:

Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Objective 2:

Describe the appearance and apparent motion of groups of stars in the night sky relative to Earth and how various cultures have understood and used them.

Intended Learning Outcomes:

1. Use science process and thinking skills.
2. Manifest scientific attitudes and interests.
3. Understand science concepts and principles.

Content Connections:

Math V-1; Making predictions

Science Standard III

Objective 2

Connections

Background Information

Students will need to be able to identify stars that are grouped in patterns in the night sky. Students will also understand that these constellations move across the sky in a predictable and measurable way. Relate the changes in the night sky to the movement of Earth.

Research Basis

Caine, R.N., & Caine, G. (1994). Making connections: *Teaching and the human brain*. Menlo Park, CA: Addison-Wesley.

Learning from classroom activities with application to real world situations are the lessons students seem to learn from and appreciate the most. Brain research shows the more senses used in instruction, the better learners will be able to remember, retrieve, and connect the information in their memories. "I hear and I forget; I see and I remember; I do and I understand." Students learn best when doing. By incorporating realistic, integrated, or interdisciplinary activities that build on established knowledge and skills and more than one sense, memory pathways become more accessible and cross-referenced for future use. As teachers discover the most effective strategies for better student achievement, they can adapt their lessons accordingly.

Klentschy, Michael (2005).Science notebook essentials. *Science & Children. 43*, 24-27.

When literacy skills are linked to science content, students have a personal and practical motivation to master language as a tool that can help them answer their questions about the world around them.

Language becomes the primary avenue that students use to arrive at scientific

Invitation to Learn

Materials

- ❑ *Star Clock*
- ❑ Scissors
- ❑ Brad fastener

Ancient cultures used the stars as a way to determine seasons and time. By looking into the night sky can you determine what season of the year it is? Can you tell what time it is by simply looking at the stars? Why would this information be important? Ancient cultures used the stars to know when to plant their crops and prepare for winter.

Instructional Procedures

1. Pass out the blackline *Star Clock*.
2. Cut out the two circles with a pair of scissors.
3. Cut out the notch on the small circle.
4. Place the small circle on top of the large circle. Push a large paper fastener to make a center hole through both circles, and spread open the fastener on the back side of the Star Clock.
5. Find the Big Dipper and the North Star, as shown on the face of your Star Clock.
6. Face the North Star, as shown on the front of the clock.
7. Find the current month around the outside circle of the Star Clock. Put your thumb over the current month. Hold your Star Clock so the current month, marked by your thumb, is AT THE TOP.
8. Holding the large disc firmly with the current date at the top, turn the smaller disc until its stars line up with those in the sky.
9. Read the time in the window.
10. If you are on Daylight Savings Time, add one hour.

Assessment Suggestions

- Have the students create a graphic organizer to record their observations.
- Have the students demonstrate that they can identify how to locate the North Star by using the Big Dipper as a guide.
- Have the students describe their understanding of what forces are at work to make the Star Clock work.

Curriculum Extensions/Adaptations/ Integration

- Students can make predictions of why the big dipper moves through the sky the way it does.
- Students could work with partners.

Family Connections

- Have the students share with their family their new knowledge by demonstrating how the Star Clock works.
- Have the students make a poster showing the movement of the constellations.

Additional Resources

Media

Beyond The Solar System- Expanding the Universe in the classroom, by Harvard-Smithsonian Center for Astrophysics; ISBN 0-9776402-0-5

Web sites

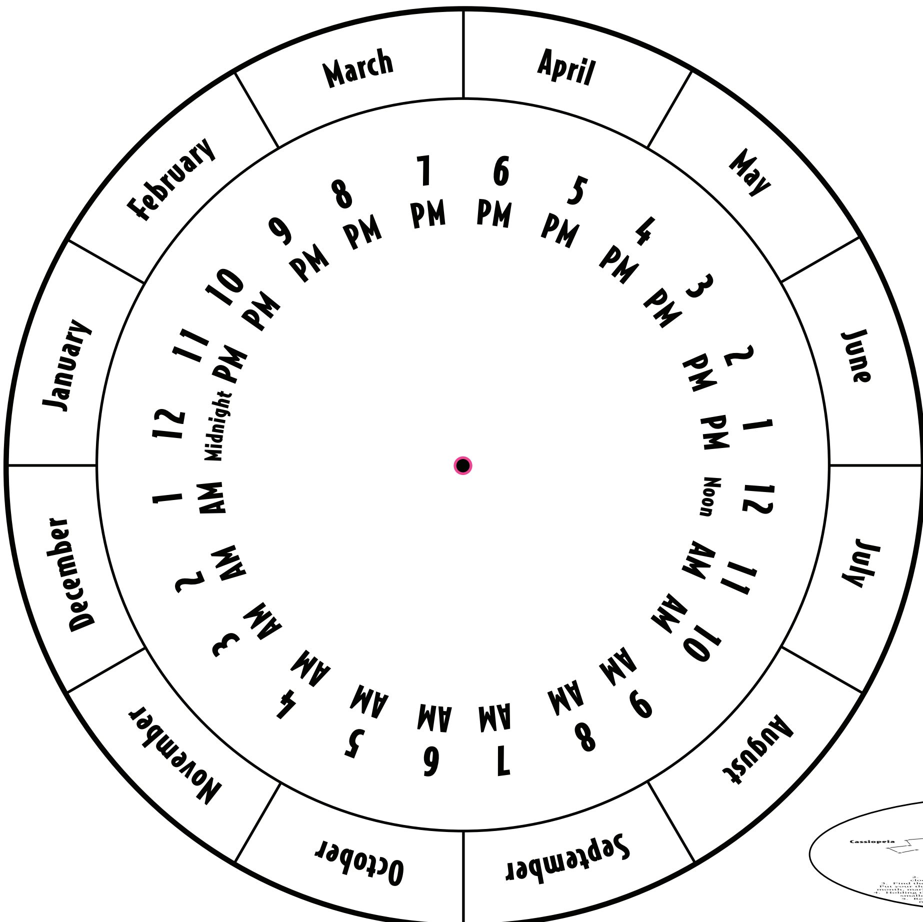
http://www.futureschannel.com

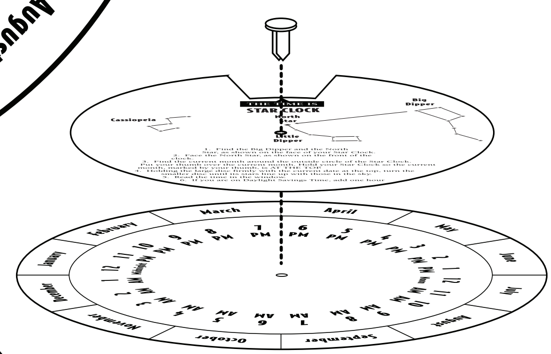
http://www.spaceplace.nasa.gov

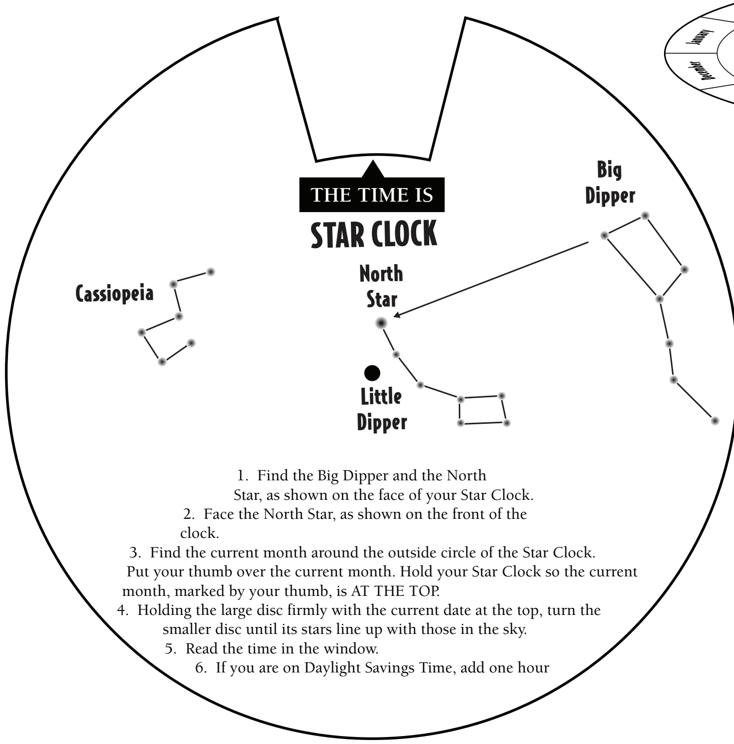
http://www.jpl.nasa.gov

http://www.clarkplanetarium.org

Star Clock


March
April
May
June
July
August
September
October
November
December
January
February
7 PM
6 PM
5 PM
4 PM
3 PM
2 PM
1 PM
12 Noon
11 AM
10 AM
9 AM
8 AM
7 AM
6 AM
5 AM
4 AM
3 AM
2 AM
1 AM
12 Midnight
11 PM
10 PM
9 PM
8 PM




THE TIME IS
STAR CLOCK
Big Dipper
Cassiopeia
North Star
Little Dipper
1. Find the Big Dipper and the North Star, as shown on the face of your Star Clock.
2. Face the North Star, as shown on the front of the clock.
3. Find the current month around the outside circle of the Star Clock. Put your thumb over the current month. Hold your Star Clock so the current month, marked by your thumb, is AT THE TOP.
4. Holding the large disc firmly with the current date at the top, turn the smaller disc until its stars line up with those in the sky.
5. Read the time in the window.
6. If you are on Daylight Savings Time, add one hour

Math V-1

Activities

Data

Candy Bar Graphs

Standard V:
Students will analyze, draw conclusions, and make predictions based upon data and apply basic concepts of probability.

Objective 1:
Design investigations to reach conclusions using statistical methods to make inferences based on data.

Intended Learning Outcomes:
6. Represent mathematical ideas in a variety of ways.

Content Connections:
Science I-1; Explain patterns of changes of the moon

Math Standard V

Objective 1

Connections

Background Information

In sixth grade, students should know a variety of different graphs, as well as being introduced to scatter plots (or scatterplots) and circle graphs (or pie charts). Stem-and-leaf plots, bar graphs, line graphs, and line plots should have been introduced in previous grades. All graphs and plots require appropriate labels and titles. Here is a brief summary and examples of some of the graphs students should be comfortable with reading and creating:

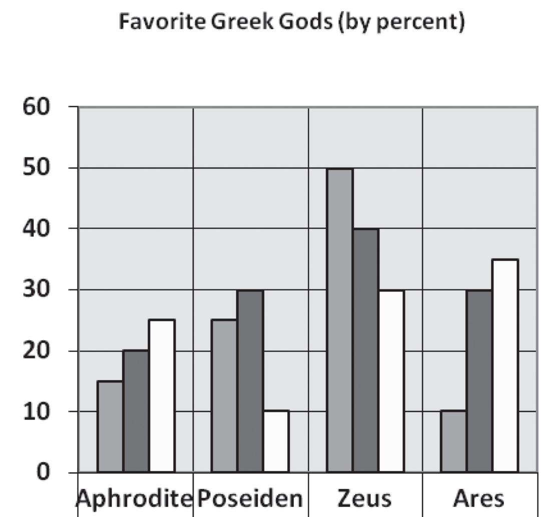
LINE PLOT: A line plot is a quick way to arrange data. The values of data are listed on the horizontal axis, and an X is placed above the axis to represent one item.

Height of Sixth Graders in Ms. Stout's Class

	X						X			
	X			X			X	X		
X	X		X	X		X	X	X	X	
X	X	X	X	X	X	X	X	X	X	X
4'6"	4'8"	4'9"	4'10"	4'11"	5'	5'1"	5'3"	5'4"	5'5"	5'7"

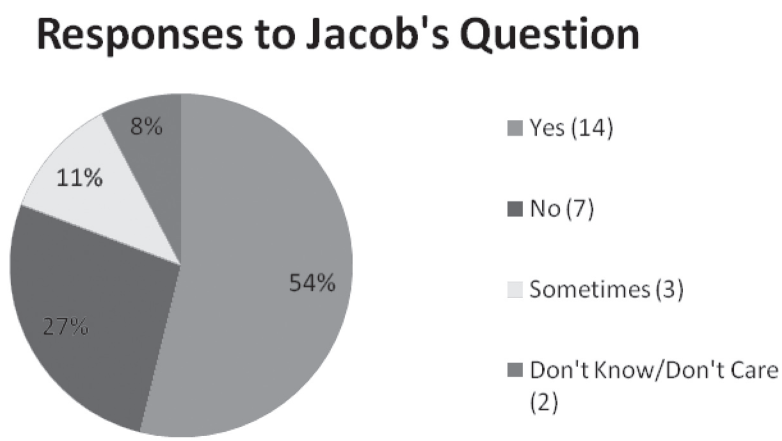
Height of Students

BAR GRAPH: A bar graph is one of the most commonly used and easy to read graphs. Bar graphs show frequency of defined data values in a set of data. The length of the bar shows the frequency of the data for that item. Bars may be drawn horizontally or vertically and should be the same width to avoid confusion. Stacked bar graphs and double (or triple, quadruple, etc.) bar graphs compare additional sets of data within the same graph. Below is an example of a triple bar graph.



	Aphrodite	Poseiden	Zeus	Ares
Mr. Russon's class	15	25	50	10
Mrs. Powell's class	20	30	40	30
Ms. Stewart's class	25	10	30	35

CIRCLE GRAPH: Also known as a pie chart, this graph is partitioned in different segments equaling one hundred percent. This graph is great for comparing data within a set and is very visual.



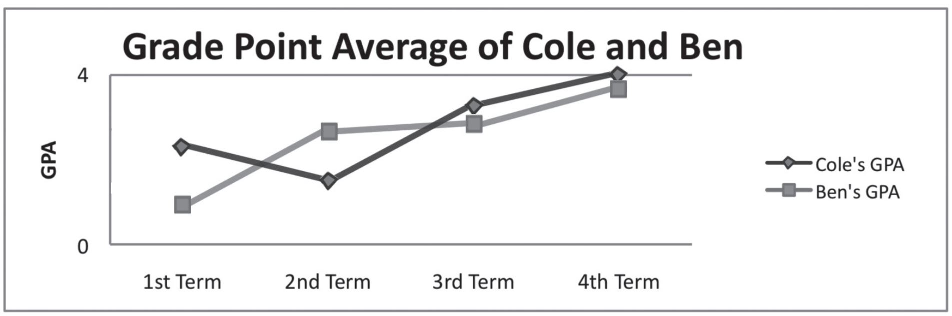
STEM-AND-LEAF PLOT: Also known as a stem plot, this graph separates the tens place from the ones place (or hundreds and tens from ones). This is minimizes confusion for the viewer because there are less digits; also, it creates a graph to show the frequency of numbers within the tens digits. The tens digits are the *stems* and the ones digits are the *leaves*. Each leaf represents one of the pieces of data.

To make reading the graph simpler, the leaves should be in numerical order. A back-to-back stem plot can be used to compare two sets of data.

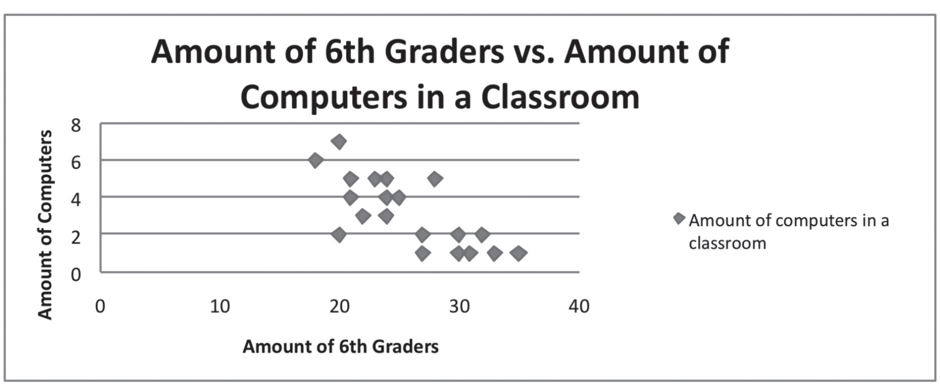
Math Test Scores

5	2,6,6,8
6	0,1,4,9
7	1,1,2,4,6,6,7
8	0,0,3,4,5,5,7,8,9
9	0,1,1,2,6,9

LINE GRAPH: This graph type is great for showing data over time. The time is shown on the horizontal axis and the other data is on the vertical axis. The points are plotted based on the correlation of the time and the data. The points are connected together by line segments. This creates a visual way of seeing the data change over periods of time. The scale of the vertical axis can greatly change the way the information looks.



SCATTER PLOT: This graph consists of a grid using Cartesian coordinates to graph points. The two points are determined by the two characteristics of the data. After the coordinates are graphed, the viewer can determine whether or not the two characteristics correlate (are related). A scatter plot is an excellent way to show whether or not the two measurements correlate.



Research Basis

Blakemore, C. L. (2003). Movement is essential to learning. *JOPERD: The Journal of Physical Education, Recreation & Dance,* 74(9), 22-26.

This article strongly asserts that student learning is greatly enhanced by movement. Studies have shown that students learn and remember better through physical activity. A variety of movements, such as cross-lateral exercises, are suggested. However, any type of movement will improve student learning.

Invitation to Learn

24 Hour Circle Graphs

Materials

- ❑ *What Have I Done for the Past 24 Hours?*
- ❑ Colored pencils/crayons

1. Ask students what they did yesterday. Have students write a list of what they have done for the past 24 hours. Make sure they keep things pretty general (for example, if they watched television, they don't need to provide each show they watched). Students will make a rough estimate of how long each activity took and round to the nearest half-hour.
2. When students have created a list that equals exactly 24 hours, they will create a circle graph (or pie chart) representing their data. You may use the worksheet *What Have I Done for the Past 24 Hours?*, which has 24 wedges, one for each hour. Students will color the appropriate wedges to represent each activity. They will also create a key (or legend) describing what each color represents.

Instructional Procedures

Candy Bar Graphs

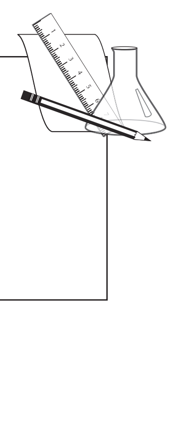
Materials

- ❑ Candy bars

1. Tell the students the different types of candy bars you will be using. Students will gather data about the favorite candy bar of every student in the class (including themselves). Let the class determine the most efficient way to collect the data. For example; ask everyone individually, or conduct a class poll. Each student will record the data.
2. Place students in groups of four. Each student will be in charge of one of the candy bars. Students in the group will compare their data (it should be the same). After verifying the ratio (e.g. 5 out of 25) of their candy bar, they will find the equivalent percentage.

3. Inform students the length of one miniature candy bar is equal to 20%. Therefore (5) miniature candy bars is equal to, or the same as 100%. They will need to cut (or bite!) until only their approximate percentage is left.
4. Have each student that has charge over a certain candy bar hold up the length that represents the percentage. Repeat with each type of candy bar. If the students figured correctly, their lengths will match.
5. On poster paper or graph paper, each group will draw an X and Y axis and label the X axis with the names of the candy bars, and the Y axis with the percentages. Also remind them to title the graph. They will then create a bar graph with the candy bars actually being the bars. You may have them glue the candy bars on, or draw an outline of the candy bars.
6. Next, have each student create a bar graph for their favorite miniature candy bar. The candy bar company would want to use this graph to try to sell the candy bar on an advertisement. Stress to them that changing the scale can influence the appearance of the data display (Math Standard V:1d).

Moon Graphs



Materials

- ❏ Moon phase of student's birth
- ❏ String

1. Begin by posing the situation: A hospital has contacted the school and would like to know if a certain old wives' tale (or urban legend) is true. They would like our class to determine if more babies are born on a full moon than any other moon phase. Let students predict whether or not they think that statement is valid and why.
2. Each student will find out which moon phase they were born on by visiting the website http://tycho.usno.navy.mil/vphase.html. Ideally, they will print out their phase and have it to reference during the activity.
3. Move desks or go to an open space (outside, gym, or hallway). Create human graphs of the data. You may want to start out with standing in the middle with students lined up around you according to their moon phase. Students should be able to see quickly whether or not that old wives' tale is true for your class. This can lead into a discussion about validity of small amounts of data. Would your findings hold true if 1,000 people were polled? The state of Utah? The United States? The world?
4. Bar graphs, stacked bar graphs, double bar graphs, and line plots are simple graphs to make as a group. Circle graphs would require string to separate groups. Try to determine percentages

before making that graph. Line graphs could also be created with string.

Assessment Suggestions

- To assess the ability to put information into a circle graph, students will take the data collected from the Candy Bar Graphs activity and create a circle graph.
- After writing the moon phase data on the board, have students create a variety of graphs on paper.

Curriculum Extensions/Adaptations/Integration

- To extend the candy bar graphs, students could find the exact percentage by using a ruler.

Additional Resources

Books

Navigating Through Data Analysis in Grades 6-8, by Bright, Brewer, McClain, and Mooney; ISBN 0-87353-547-2

Web sites

http://www.nces.ed.gov/nceskids/createagraph/

You can create a variety of line, pie, and bar graphs as well as scatter plots

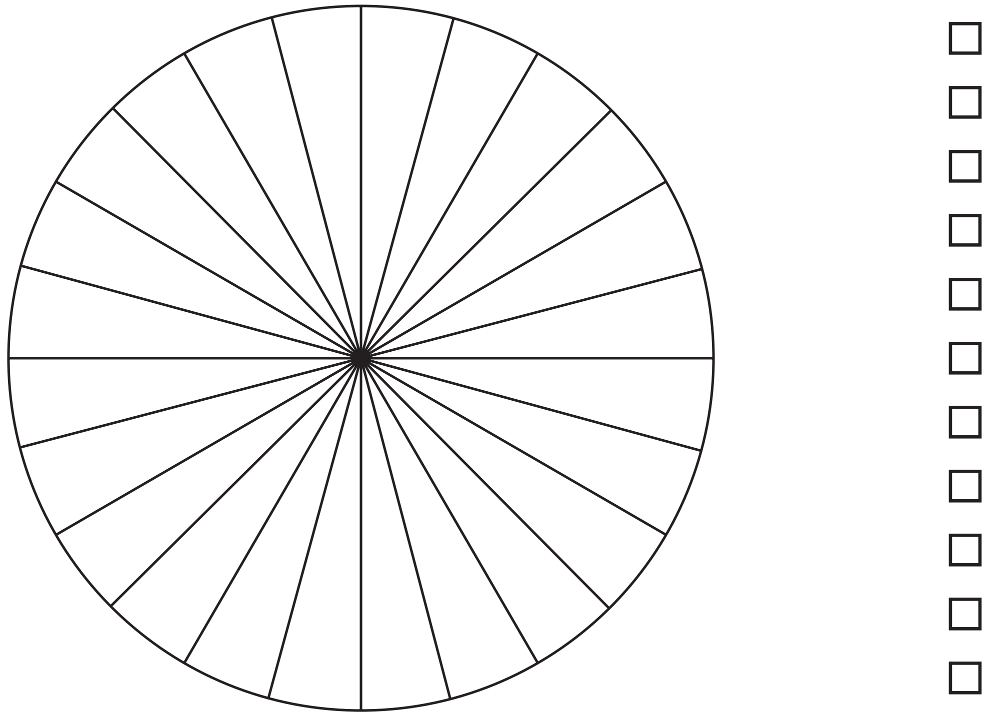
http://tycho.usno.navy.mil/vphase.html

This site will determine the moon phase of any day of any year, including past, present, or future

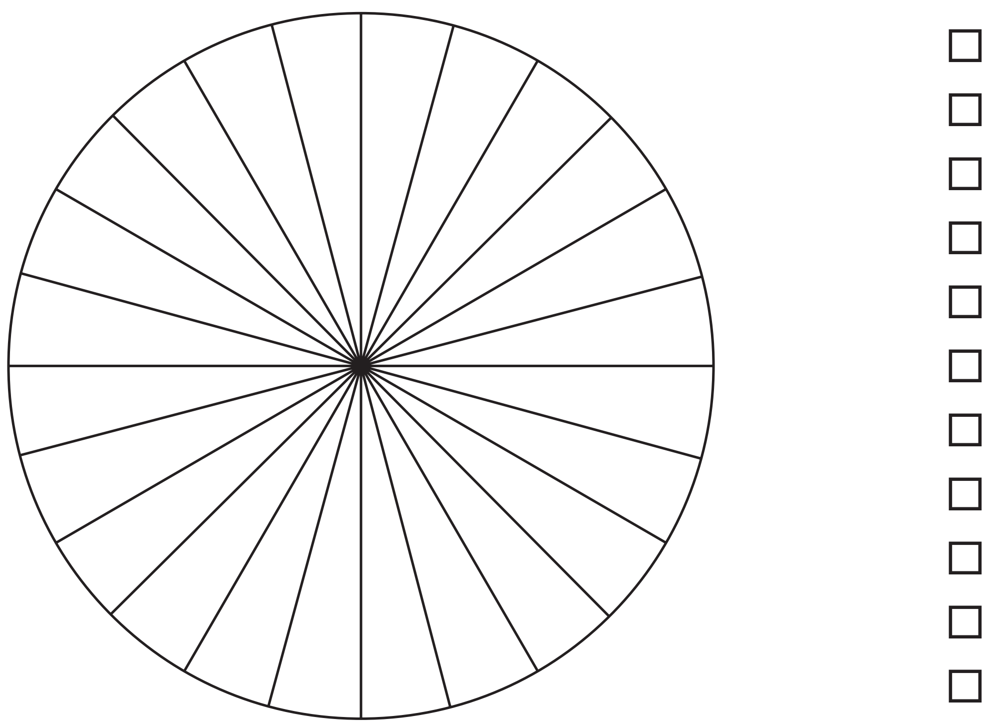
http://www.almanac.com/astronomy/moon/index.php

Shows a moon phase calendar

What Have I Done for the Past 24 Hours?



What Have I Done for the Past 24 Hours?



Situational Data

Math Standard V

Objective 1

Connections

Standard V:

Students will analyze, draw conclusions, and make predictions based upon data and apply basic concepts of probability.

Objective 1:

Design investigations to reach conclusions using statistical methods to make inferences based on data.

Intended Learning Outcomes:

5. Connect mathematical ideas within mathematics, to other disciplines, and to everyday experiences.

Content Connections:

Science V-2; Conduct an experiment on microorganisms and display results

Background Information

Graphs are found in so many aspects of everyday life that it is vital that students can read, analyze, and create them. Graphs are used in many subjects in school, as well. Social studies, math, science, and language arts rely on graphs to present information that would otherwise be difficult to understand or boring to read. Since graphs are so important in different subject areas, it is easy to integrate math in multiple subjects.

As yeast is combined with sugar and water, it produces carbon dioxide. This is what makes bread rise. Yeast is microscopic. One gram of yeast has about 25 billion cells.

There are variations on the scientific process. The following steps keep it simple for students and encourage discovery based upon previous results.

Step 1: Question

Step 2: Predict

Step 3: Plan (discuss)

Step 4: Observation (claim and evidence)

Step 5: What I learned

Step 6: Wonderings/questions

Research Basis

Klentschy, M. (2005). Science Notebook Essentials. *Science & Children.* 43(3) 24-27.

Notebooks and journals can be an effective tool to further scientific understanding. As students follow the six essential steps for journals, especially in their experiments, they will have a deeper understanding of the scientific process; they will be more motivated to continue investigating and learning.

McKinnon, D. H. & Others (1997). Curriculum innovation involving subject integration, field-based learning environments and information technology: A longitudinal case study of student attitudes, motivation, and performance. *Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, March 24-28, 1997)*.

This was a longitudinal study conducted in New Zealand to determine the effectiveness of integrating subjects. Technology, mathematics, history, and language arts were integrated for 3 years. Academic achievement was higher than the control group in science, math, and English, and students enjoyed their experience more.

Invitation to Learn

Materials
- ❏ *The Data Song*

The Data Song

"*The Data Song*" goes to the tune of "*We Will Rock You*" by Queen. This song was chosen because it requires students to create the rhythm. After singing it a couple of times, have students join in. The lyrics can lead to a great beginning discussion and is an informal way to ascertain student background knowledge about data and graphing.

Instructional Procedures

Materials
- ❏ *Data Dice*
- ❏ *Situational Data*

Data Dice

1. First, students need to have a pretty good knowledge of the different types of graphs (bar, line, line plot, scatter plot, circle, and stem-and-leaf plot) and their purposes. To accomplish this, have students create a simple semantic map in their math journals, such as the following:

	Points	Lines	Bar or X	Good for Comparing	Good for finding trends/tendencies
Bar Graph			X	X	
Double Bar			X	X	
Stacked Bar			X		
Line Plot			X	X	X
Circle Graph				X	
Scatter Plot	X				X
Stem-and-Leaf Plot				X	X
Line Graph	X	X			X
Double Line Graph	X	X		X	X

Your class may come up with additional categories.

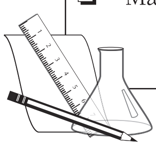
2. Students will cut and paste their cubes. Pass out the *Situations* worksheet.
3. Students will work in pairs. One student will roll the newly made die and will graph the data given with whichever graph was rolled. While they are creating their graph, their partner will also create a graph with the same data, but they may choose whichever graph best suits the data.
4. The pair will switch off until they have completed the graphs for the data.

Instructional Procedures

Graphing Yeast

Materials

- ❏ Erlenmeyer flasks
- ❏ Yeast
- ❏ Sugar (Variety)
- ❏ Warm water
- ❏ Balloons
- ❏ Masking tape



1. Explain to students the experiment that will be conducted. As a class, come up with a graph that will be used. A line graph would be ideal. Be sure to include labels and a title.
2. You may give each student (or pair of students) the choice of what type, and amount of sugar they will use (up to 10 teaspoons or about 40 grams). Make sure that at least one student uses the ideal amount of sugar. Students will put the sugar in their Erlenmeyer flask.

   **Teacher info: The ideal amount of sugar is 5 teaspoons of sugar (about 20 grams)
3. Put about 75 mL of warm water in each student's flask. The water should be 95-105° F (35-40° C). Have students swoosh around sugar/water mixture until dissolved.
4. Give each student 1.25 teaspoons of yeast (5 grams), which is ½ of a packet. Students will put the yeast in a balloon. This is best accomplished by one student holding the balloon open while the other carefully pours the yeast in.
5. The student will put the balloon on around the top of the flask. They will then use masking tape to seal the flask, if desired.
6. Every minute, they will measure the height from their desk to the highest part of the balloon. Students will record their data on a chart and on their graphs.

Assessment Suggestions

- Give students situations and data and have them graph the data. Their score is based on the appropriateness of the graph used, labels and title of the graph, and if the data was graphed correctly.

Curriculum Extensions/Adaptations/ Integration

- A possible extension would be for students to create their own experiments that can be graphed.

Family Connections

- Students will look for graphs in newspapers, magazines, books, or the Internet and bring examples to show the class.

Additional Resources

Web sites

http://www.mathplayground.com/Math_Millionaire.html

This is a fun variation of "Who Wants to be a Millionaire?" that is motivating for students.

Organizations

National Council of Teachers of Mathematics (NCTM), www.nctm.org

Membership provides journals, ideas, lessons, as well as access to the NCTM Standards and Focal Points.

The Data Song

To the tune of *"We Will Rock You"* by Queen
Lyrics by Jeff Russon

First you have a question, then you gather data,
Don't get discouraged, you just organize
Try to predict, make the numbers fit,
Plug them in a graph, and there you have it.
Graphing data rocks, yeah (sing it!)
Graphing data rocks, yeah

So you have your numbers, put them in their spot
Choose from a circle graph, or a line plot,
There are a lot, a stem and leaf plot,
Don't forget the scatter plot, these graphs are hot!
Graphing data rocks, yeah (graph it!)
Graphing data rocks, yeah

Put numbers on the graph, get ready to compare,
Try to predict where you think they may go,
Wanna get them in line, in order of time,
Now that they're together, they show data climb
Graphing data rocks, yeah (think about it!)
Graphing data rocks, yeah
Everybody, graphing data rocks, yeah
Graphing data rocks, yeah!!!!!

The Data Song

To the tune of *"We Will Rock You"* by Queen
Lyrics by Jeff Russon

First you have a question, then you gather data,
Don't get discouraged, you just organize
Try to predict, make the numbers fit,
Plug them in a graph, and there you have it.
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Everybody, graphing data rocks, yeah
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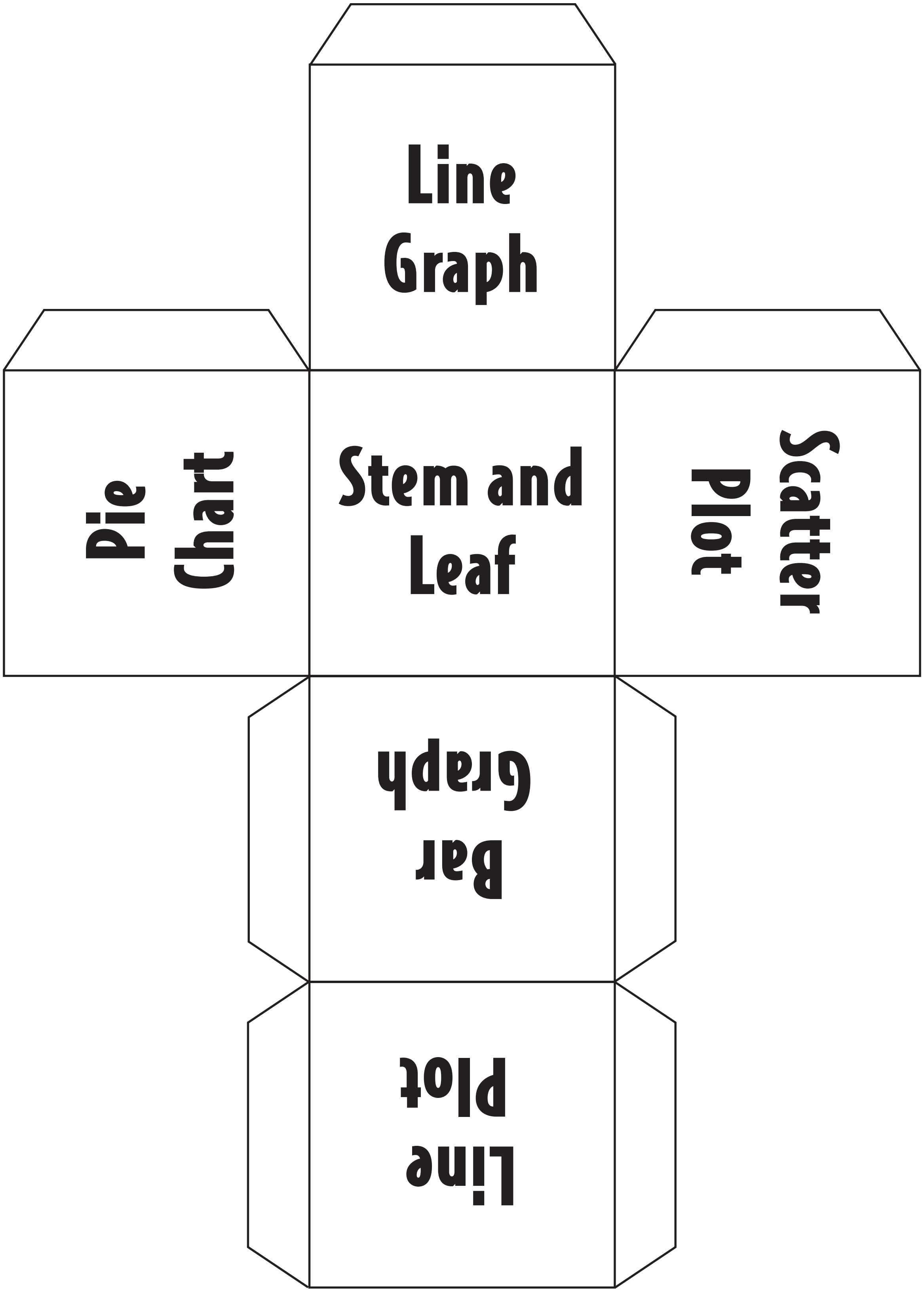
Data Dice


Line Graph
Pie Chart
Stem and Leaf
Scatter Plot
Bar Graph
Line Plot

Name ______________________ Partner ______________________

Situational Data

Directions: One partner will roll the dice and create a graph based on what was rolled, using the data for #1. The other partner will choose and create a different graph with the same data. After #1, the roles will reverse. Remember to title and label each graph!

1. A scientist made the following observations:

Hour	Microorganisms
1	2
2	4
3	8
4	16
5	32
6	128
7	

How many microorganisms will there be in the 7th hour? Graph your prediction.

2. Results of the boys' high jump event at the track meet:

Participant	Height (feet & inches)
Jacob	4' 10"
Cole	4' 6"
Ben	3' 10"
Jeff	2' 10"
Kenny	4' 8"
Rico	4' 2"

3. Planet distances, in Astronomical Units (AU), from the Sun:

Planet	Distance (AU)
Mercury	0.4
Venus	0.7
Earth	1.0
Mars	1.5
Jupiter	5
Saturn	10
Uranus	20
Neptune	30
Pluto (minor planet)	39.5

4. Growth of the Earth's human population:

Year (A.D.)	Number of People (in billions)
1650	.50
1750	.70
1850	1.0
1925	2.0
1956	2.5
1976	4.0
1991	5.5
2000	6.0
2004	6.4

5. Major military and civilian casualties in World War II, by country:

Country	Casualties
USSR	21,300,000
China	11,324,000
Germany	7,060,000
Poland	6,850,000
Japan	2,000,000
Yugoslavia	1,706,000
Rumania	985,000

6. Countries with the largest population:

Country	Population
China	1,323,000,000
India	1,128,000,000
United States	303,000,000
Indonesia	231,000,000
Brazil	186,000,000
Pakistan	162,000,000
Bangladesh	158,000,000

Reflection:

1. Which graph was most useful overall? ______________________
2. Which graph would be most effective for the data in #1 (time)? ______________________
3. Which graph do you have a hard time understanding? ______________________

Science VI-1

Activities

Heat

Conduction, Convection, and Radiation: An Introduction

Standard VI:
Students will understand properties and behavior of heat, light, and sound.

Objective 1:
Investigate the movement of heat between objects by conduction, convection, and radiation.

Intended Learning Outcomes:
2. Manifest science attitudes and interests
3. Understand science concepts and principles.

Content Connections:
Science VI-2; Effect of light on materials

Science Standard VI

Objective 1

Connections

Background Information

Heat is the transfer of thermal energy between substances that are at different temperatures. Energy is always transferred from the warmer object (which has a higher temperature) to the cooler one (which has a lower temperature). Similarly, molecules with a lot of energy move faster than molecules with a smaller amount of energy, thus causing the former to have more heat. Heat transfer will continue until both objects have reached the same temperature or the same speed.

For example, an ice cube in a glass of water eventually melts. This is because the heat from the water, which is warmer, flows to the ice cube until both are at the same temperature, and therefore no ice cube is left.

There are three methods of heat transfer: conduction, convection, and radiation. Conduction occurs through direct contact. When two substances come into contact, their particles collide. The energy from the faster-moving substance is transferred to the slower-moving substance until they are moving at the same speed. At this point, their temperatures will be the same. An example of conduction is a spoon warming up when it is placed into a cup of hot cocoa.

Convection is the transfer of heat in air or a fluid through currents. An example is a pot of water warming up on a hot stove. As it heats up, the particles spread out and become less dense. The warm water on the bottom of the pot rises and displaces the cold water. As this occurs, the cold water sinks. So hot air rises, cools, and falls.

Radiation is the transfer of energy as electromagnetic waves. It does not need to directly touch anything or move particles as in conduction and convection. Radiation occurs through empty space, as in the sun heating the earth or feeling warm in front of a fire.

Many demonstrations are needed for this experiment. Prior to beginning the lesson, prepare several cups of beans and BBs. Lay cloth and a piece of glass on the snow or colored paper and glass on the pavement at least an hour before the lesson. Plug in the hot plate. Heat a cup of water to almost boiling. Set up the candle spinner or create the paper spinner. Make a transparency of *Hogle Zoo Heat!* Make sure the radiation portion of this lesson is done on a sunny day.

This lesson is divided into heat concepts and could be done over a two or three day period if desired.

Research Basis

Loucks-Horsley, S., & Olson, S. (Eds.). Inquiry and the National Science Education Standards: *A Guide for Teaching and Learning.* Washington, D.C: National Academies Press, 2000.

Word Smith as you Choose discusses engaging students in exploring and communicating their thinking through writing, which has shown tremendous benefits in science and mathematics. Writing explorations help students in understanding concepts more deeply, improving problem solving strategies, assessing their personal thinking skills, learning to consider themselves as deep thinkers, and overall becoming better learners in and out of the classroom. Journals are concrete and visible evidence of student thinking, effort, and progress. They should show if students have or have not achieved the desired learning, if they have misconceptions, their reflections, their journey towards understanding a concept, and/or if more instruction is needed.

Kruger, A., & Sutton, J. (Eds.). (2001). ***EdThoughts: What we know about science teaching and learning***. Colorado: Mid-continent Research for Education and Learning.

This book supports standards-based reform of science education. Research and best practices are provided, as well as ways to improve classroom instruction. A list of additional resources is also available for those desiring deeper understanding of certain concepts. All articles rely on the national standards for best practices. A common theme is the importance of quality science education for all students.

Invitation to Learn

Turn a hot plate to high temperature. Obtain the metal ball and ring set and instruct students to obtain their science journals. Show how the ball easily passes through the ring. Now place the ball on top of the hot plate. Allow it to warm, then try to place the ball through the ring again. It will not work. Ask the students to write the following in their journals: What happened when the ball was heated? Why do you think it won't it go through the ring now? What do you think will happen when both the ball and ring are heated? Set the ball and ring on the hot plate as the students write. When finished, again place the ball through the ring. This time, it will work. Were their predictions correct?

Materials

- ❏ Ball and ring set
- ❏ Hot plate
- ❏ Science journals

Instructional Procedures

Materials

- ❏ Hot and cold water
- ❏ Hot plate
- ❏ Saucepan
- ❏ 3 clear glass cups
- ❏ Food coloring
- ❏ Measuring cup
- ❏ Science journals

Heat is made up of molecules

1. After completing the invitation to learn, leave the hot plate on and begin heating up a cup of water.
2. Ask if anyone has an idea of how or why heat affected the metal of the ball and ring. After listening to a few students, explain that metal expands when heated and contracts when cooled. Metal is a high conductor of heat. In other words, metal will quickly become hot when it is touched by heat. The handle of the ball and ring is made of wood because wood is not a high conductor of heat. Heat flows more quickly through metals than it does through woods.
3. Write this definition of heat on the board: Heat is the transfer of energy between two objects at different temperatures. Instruct students to write the definition in their journals.
4. Explain that everything is made up of small particles called atoms, which have energy and are constantly in motion. Heat is directly associated with groups of atoms, called molecules. The hotter something is, the faster its molecules are moving. This means that molecules in cold objects move slower than the molecules in hot objects. For heat to transfer, one molecule has to bump into another molecule.
5. Obtain the three clear glass cups (do not use plastic), the food coloring, and the measuring cup. Fill one glass with a cup of very cold water, one with a cup warm water, and one with the cup of almost boiling water. Ask the students to make a prediction in their journals: what will happen when I put one drop of food coloring in each glass?
6. Allow time for writing then drop the food coloring in each. Watch the food coloring spread out, paying special attention to the streaks and whether it spreads out evenly within the water. Watch the clock and have the students write down observations after 0 seconds, 30 seconds, and 60 seconds. They will notice

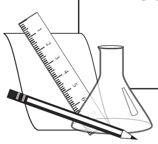
how quickly the coloring in the glass of boiling water spreads compared to the others.

7. Ask what this proves about molecules and allow time to share. Then explain that water and food coloring are both made up of molecules. The food coloring molecules in a glass of water are pushed around by the water molecules and eventually spread throughout the glass, even if you don't shake or stir the water. Since molecules in hotter objects move faster than molecules in slower objects, the food coloring spreads more quickly in the hottest water.

Conduction

Materials

- ❏ Bag of beans
- ❏ Carton of BBs
- ❏ Plastic cups
- ❏ Hot plate
- ❏ Compound bar
- ❏ Science journals

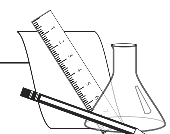


1. Ask what situations the students can think of that involve heat. List the ideas on the board. These may include heating a home in the winter, sitting by a campfire, cooking or baking, getting into a hot tub, blowing on your hands on a cold day, hot car seats in the summer, sitting on a beach, touching a hot curling iron, etc. Think of as many ideas as possible. Leave the list on the board.
2. Tell the students that there are three types of heat transfer which will be demonstrated today. To introduce the concept of conduction, bring out several cups of beans and BBs. Allow each student to put a finger into one cup, then the other. Which is colder? Ask students to write their observations in their journals.
3. If you measure the temperature of the beans and BBs, you'll find they are about the same. The students probably though the BBs were colder. Explain that this was caused by conduction.
4. Explain that conduction occurs when objects touch. The heat from the warmer object is transferred to the cooler object, eventually evening out the temperatures. In other words, the faster molecules from the warmer object bump into the slower molecules of the cooler object until they are all traveling at the same speed. Think of "can touch" when you think of conduction. Have students write down their own definition of conduction in their journals.
5. Remind the students about the invitation to learn. What was the ball and ring made of? (metal) What did we learn about metal? (conductor of heat) Brainstorm types of metals: steel, iron, gold, silver, copper, etc. Tell the students that BBs are also made of metal. Since metal is a conductor of heat, the BBs

only feel colder than the beans because the metal is conducting heat away from your hand. You perceive the heat that is leaving your hand as cold.

6. Remind your students about heating up the water for the food coloring on the hot plate. Since the saucepan touched the hot plate, heat was transferred from the hot plate to the pan via conduction.
7. Next, obtain the compound bar. Tell the students that this bar is made of two different metals. Allow the students to share their ideas about what they think will happen when you touch the bar to the hot plate.
8. Turn the hot plate to high and place the bar on top. Watch it bend. Explain that the curving results from the two metals expanding unequally. Run the bar under cold water or place in a container of water. It will immediately resume its straight shape.
9. Look at the list of ideas on the board and ask the students which of these have to do with conduction. If a student response is correct, have him/her explain why. Put a star next to the correct responses.

Convection



Materials

- ❏ *Paper Spinner Directions*
- ❏ Tissue paper
- ❏ Aluminum pie tin
- ❏ Lighter or matches
- ❏ Hot plate
- ❏ Science journals

1. Looking at the list, ideas will remain that do not have to do with conduction. Introduce the second form of heat transfer.
2. Tell the students that convection is the transfer of heat through air or fluid through currents. Ask if they have ever noticed the difference in temperature on the top floor of their house verses the basement. That is convection. Heat goes higher; cold creeps lower. This is why heating vents in homes are located along the floor, while air-conditioning outlets are located near the ceiling (although in Utah the heating vents are sometimes located near the ceiling in basements so the builders do not have to put in another set of HVAC ducts).
3. Again remind the students about heating the water for the food coloring demonstration. The hot plate caused the saucepan to get hot via conduction. But the water got hot due to convection. The hot water at the bottom of the pan expanded and became lighter than the colder water above it. So the heavier water sank to the bottom and the warmer, lighter water

rose to the top. Eventually, after changing places several times, the water became hot enough to boil.

4. Obtain a candle spinner or the pre-cut paper spiral attached to a string. Light the candles of the spinner and watch the vanes spin. If using the paper spinner, hold it above a hot plate. Be careful to hold it high enough that the paper will not burn. Watch it spin.
5. Ask the students why they think this is happening. After listening to ideas, remind the students that hot air rises. The hot plate produces a current of hot air. As the air rises, the convection produced causes the vanes or spinner to turn.
6. Set up another example of convection by folding a piece of tissue paper in half widthwise, then in half widthwise again. Create a prism out of the paper. Stand it on top of the aluminum pie tin. Using safety precautions, use a lighter or match to light the top of each edge of the triangle formed. The flames will quickly travel down the prism and get trapped inside, then gently raise the tissue paper in the air. Eventually the tissue paper will float down. Catch it with the aluminum tin, let it cool, and then discard.
7. Ask the students what is happening this time. Heat is again rising. When the heat escapes from the flames, it falls.
8. Look at the remaining list of ideas on the board and ask the students which of these have to do with convection. Also ask the students if any of the starred ideas also have to do with convection. If a student response is correct, have him/her explain why. Put a smiley face next to the correct responses.

Radiation

1. Introduce radiation, the transfer of energy as electromagnetic waves. It does not need to directly touch anything or move particles as in conduction and convection. Radiation occurs through empty space, as in the sun heating the earth or feeling warm in front of a fire.
2. For the last time, remind the students about boiling water on the hot plate. Tell them that before the sauce pan was even placed on the hot plate, the heat could be felt without touching the burner. That is radiation.
3. Tell the class that Ben Franklin, one of our founding fathers, experimented with radiation in the 1700s. One sunny winter

Materials

- ❏ Colored patches of cloth
- ❏ A pane of glass
- ❏ Infrared temperature gun
- ❏ *Hogle Zoo Heat!*
- ❏ Overhead projector
- ❏ *Test Yourself: Conduction, Convection, and Radiation sheet*
- ❏ *Test Yourself: Conduction, Convection, and Radiation answer key*
- ❏ Science journals

day, he and a friend laid colored cloth patches and a pane of glass out on the snow and noted how deeply each eventually sank into the melting snow below it. Ask the students what they think the results might have been.

4. After listening to the ideas, bring a pad of paper, a pencil, and a heat gun outside to the pre-set cloth patches (if it is a snowy day) or the paper (if there is no show) set out prior to beginning the lesson. Using the infrared temperature gun, test the temperature of each and record the data. The students will see that the black cloth/paper and the glass pane will be significantly warmer than the white cloth/paper. Dark colors will also be warmer compared to the lighter colors. If you did use cloth, lift up each piece and note the indentation in the snow. The white will make little to no indentation; the black will be the deepest. Likewise, if using a light pane of glass, it too will sink as deep as the black paper.
5. Return to the classroom and have the students note their observations in their journals. Explain that it took a long time for the results of Franklin's experiment to make sense. We now know that black absorbs light and heat, while white reflects them. Similarly, since glass is clear, light travels right through it, but absorbs the heat radiated by the sun – the infrared – and therefore gets just as hot as the black cloth. Infrared radiation is reflected by the cloth patches because they are opaque.
6. Look at the list of ideas on the board and ask the students if any of these have to do with radiation. Again, items involving conduction and convection may involve radiation, as well. If a student response is correct, have him/her explain why. Circle the correct responses.
7. To wrap it up, tell the students that heat is usually transferred in all three ways, as in the boiling water discussed throughout the lesson. As another example, place the *Hogle Zoo Heat!* transparency on an overhead projector. Cover the pictures. Take students through the situation presented, uncovering each picture as the time comes. You may also cover all of the words of the transparency and allow students to explain the type of heat transfer at each step to check for understanding.
8. Pass out a copy of *Test Yourself: Conduction, Convection, and Radiation* to each student to assess their understanding of heat

transfer. Have them write down any questions they have about these concepts in their journals.

Assessment Suggestions

- Ask students to try any or all of the questions on the *Test Yourself: Conduction, Convection, and Radiation* sheet.
- Over a three-day period, have students write down three encounters with heat per day in their journals. How did these experiences have to do with conduction, convection, and radiation? After the three days, collect the journals to check and assess.

Curriculum Extensions/Adaptations/ Integration

- Invite a health care professional to discuss how your body maintains temperature and why you might have a fever when you are sick.
- Show either or both of the DVDs *The Convection of Heat* or Bill Nye's *Heat* to reinforce the concepts of energy, conduction, convection, and radiation.
- Show the seven-minute video from NASA entitled *Infrared: More Than Your Eyes Can See* to learn more about infrared radiation.
- Invite a firefighter to discuss fire prevention, how knowledge of heat transfer is important to get out alive, why a fire must be vented, and the difference in temperature between the top of a room and the floor.
- Learn about the importance of heat when blowing glass. If possible, attend a glass blowing demonstration. The Bill Nye video contains a small section about glass blowing.

Family Connections

- Cook a meal using a Dutch or solar oven. Discuss how conduction, convection, and radiation help in the cooking process.
- Carefully place a paper cup full of water in a fire and watch it boil. Make sure the cup is surrounded by glowing embers. Discuss how conduction, convection, and radiation prevent the cup from burning.

Additional Resources

Media

The Convection of Heat, by Eureka! (Films for the Humanities and Sciences, PO Box 2053, Princeton, NJ 08543, www.films.com)

Bill Nye the Science Guy: Heat (Disney Educational Products, (800) 295-5010, http://dep.disney.go.com/educational/billnye); ISBN 1-932644-98-9

Web sites

http://www.nasa.gov/audience/foreducators/topnav/schedule/programdescriptions/Infrared-More_Than_Your_Eyes_Can_See_5-8.html

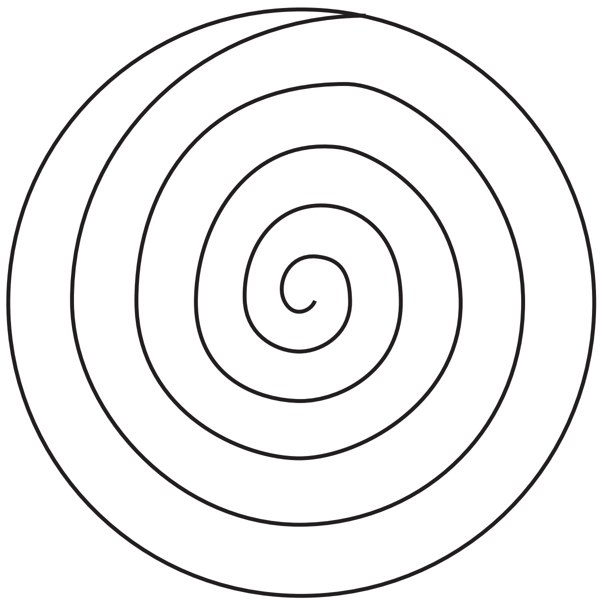
Paper Spinner Directions

You will need:

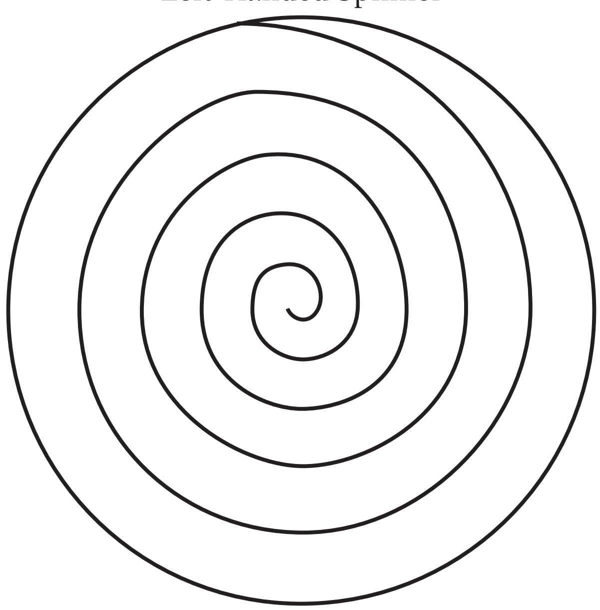
One spiral	Scissors
A short piece of cotton string	A heat source (candle, hot plate, etc.)

1. Cut out the appropriate circle, then cut along the spiral.
2. Carefully cut a slit in the mark in the center.
3. Put the piece of string through the slit and knot the end to hold it in place.
4. Turn on the heat source.
5. Hold the string of the spinner above the heat source and watch it turn!

Right-Handed Spinner



Left-Handed Spinner



Test Yourself: Conduction, Convection, and Radiation

Choose _____ of the following situations and write your responses in your journal. Please use at least one of the three types of heat transfer in each response.

1. In the evening, snow falls on a cement sidewalk and on a black top playground. Which surface will melt the snow faster and why?

2. Two identical cups of hot cocoa are sitting on a table. One has a metal spoon in it and one does not. After five minutes, which cup is cooler?

3. When a person steps from a shower on a cold morning, why does the tile floor seem so much colder than the air?

4. On a hot summer day, should you close all of the blinds and curtains in your home or leave them open? Why?

5. Although you do not touch the flames, your chest feels warm while you are sitting in front of a fireplace. Why does your back still feel cold?

6. The outdoor temperature is 85°F, and your friend comes to school in a dark blue outfit. Was this a smart clothing choice for today? Why or why not?

7. Why is your house warmer on the top floor and colder in the basement?

8. Your mom bakes a cake in a glass pan and you use a metal pan. How does heat transfer affect each pan?

9. Explain how the following situation occurs using conduction, convection, and radiation: A pot of water boils on a hot stove.

10. Explain how the following situation occurs using conduction, convection, and radiation: On a hot day, an ice cream cone in your hand falls on the sidewalk and immediately begins melting.

Test Yourself: Conduction, Convection, and Radiation answer key

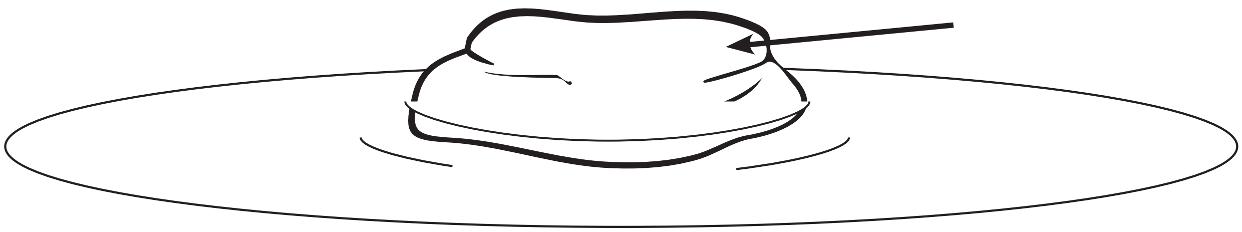
Choose _____ of the following situations and write your responses in your journal. Please use at least one of the three types of heat transfer in each response.

1. In the evening, snow falls on a cement sidewalk and on a black top playground. Which surface will melt the snow faster and why? (The playground because it is black and absorbs more heat; the cement is white and reflects the heat.)
2. Two identical cups of hot cocoa are sitting on a table. One has a metal spoon in it and one does not. After five minutes, which cup is cooler? (Since the spoon was cooler than the cocoa, some of the heat transferred out of the cup into the spoon, thus making that cocoa cooler.)
3. When a person steps from a shower on a cold morning, why does the tile floor seem so much colder than the air? (Your warm body directly touches the tile, so the warmth transfers to the floor and the floor feels cold.)
4. On a hot summer day, should you close all of the blinds and curtains in your home or leave them open? Why? (You should close the blinds. Because the windows are clear glass, the infrared will go right through it to warm your home. Opaque blinds and curtains will block the heat from coming inside.)
5. Although you do not touch the flames, your chest feels warm while you are sitting in front of a fireplace. Why does your back still feel cold? (The fire radiates heat on your chest. It does not go through your body to the other side.)
6. The outdoor temperature is 85°F, and your friend comes to school in a dark blue outfit. Was this a smart clothing choice for today? Why or why not? (No! She'll be hot because of the heat the dark color will absorb. Lighter colors reflect; pink or another light color would have been a better choice.)
7. Why is your house warmer on the top floor and colder in the basement? (Convection currents cause hot air to rise to the top floor, so the cold air stays below.)
8. Your mom bakes a cake in a glass pan and you use a metal pan. How does heat transfer affect each pan? (The metal conducts the heat and through conduction, cooks the brownies; conduction also cooks the brownies in the glass pan, but since infrared goes right through the glass, they also cook by radiation.)
9. Explain how the following situation occurs using conduction, convection, and radiation: A pot of water boils on a hot stove. (You can feel the radiation from the burner, the pot gets hot because of conducting the heat from the burner, and the water boils because of the convection currents which push the hottest water to the top.)
10. Explain how the following situation occurs using conduction, convection, and radiation: On a hot day, an ice cream cone in your hand falls on the sidewalk and immediately begins melting. (Radiation comes from the sun; conduction occurs when the hot sidewalk transfers heat to the ice cream, heat felt above the sidewalk is convection and aides in the melting process.)

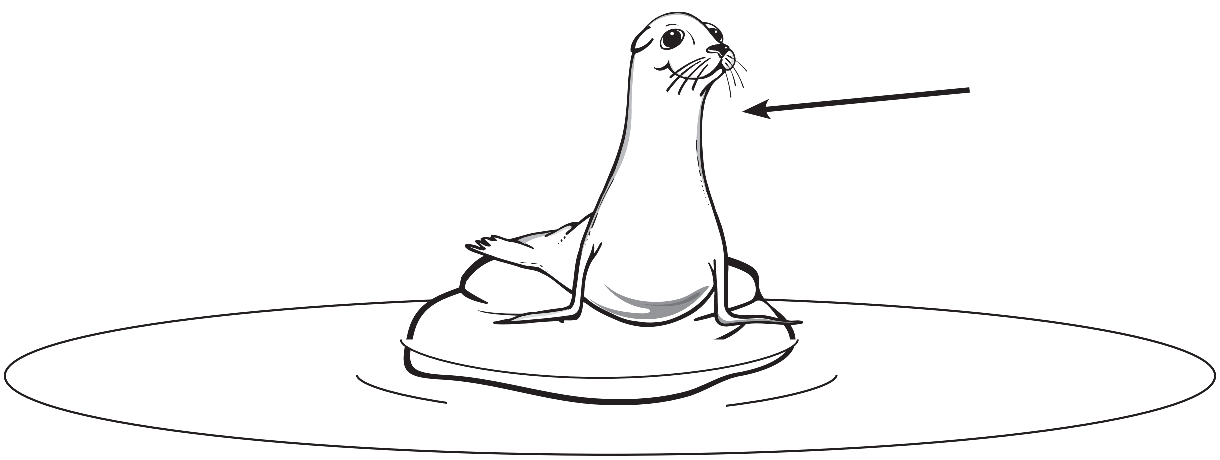
Hogle Zoo Heat!

How do conduction, convection, and radioation work together?

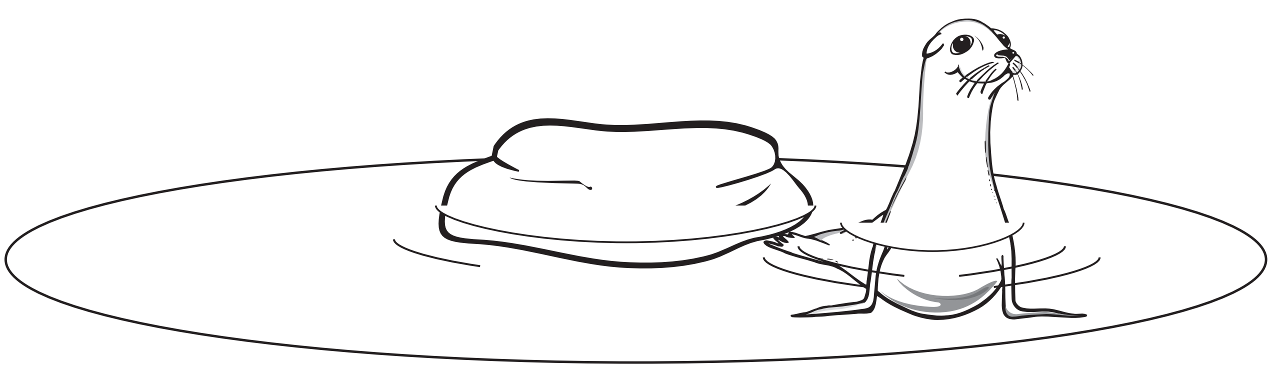
It's a hot morning at Utah's Hogle Zoo. The sun warms the rocks inside the sea lion home. The rocks become hot due to radiation from the sun.



A sea lion waddles over to a rock and lays down to nap on top of it. Now the sea lion is warmed by the radiation from the sun, but she is also warmed by the conduction from the hot rock below her.



When the sea lion wakes up, she is quite hot and decides to jump deep into the water below her. The deeper water is cool and she instantly cools off. This is because of convection and conduction. The heat from the hot sea lion transfers to the cool water by conduction, and the water at the bottom of ther pool is cooler because of convection.



Insulation Experimentation

Science Standard VI

Objective 1

Standard VI:

Students will understand properties and behavior of heat, light, and sound.

Objective 1:

Investigate the movement of heat between objects by conduction, convection, and radiation.

Intended Learning Outcomes:

1. Use science process and thinking skills
2. Manifest scientific attitudes and interests

Content Connections:

Social Studies IV-2; culture of Ancient Rome

Connections

Background Information

This lesson explores conduction, convection, and radiation in respect to insulation, the method of preventing heat from escaping a container or entering a container. An understanding of conduction, convection, and radiation are needed for optimal understanding of these concepts.

As the students will engage in a group experiment, they will need background in the scientific method. The steps in this method are ask a question; gather background research; form a hypothesis; experiment; analyze your data; draw conclusions; and record your results.

It is helpful if the students have already done several guided experiments using this method in class. If not, differentiation should be used to help those students who need more guidance, whereas more advanced students may discover on their own.

Baby food jars and several insulation materials are needed for this lesson. These include: down, gloves/mittens, cotton sock, wool sock, other types of cloth or clothing, sand, plastic foam, dirt, large piece of paper, foam packing peanuts, wood, aluminum foil, leaves, paper towels, cardboard, cotton balls, shredded paper, fiberglass insulation, etc. Collect them on your own before the experiment or have your students bring in items easily accessible from home. If using fiberglass insulation, you will need gloves so the material does not irritate the skin.

The ability to transfer heat within an object is called thermal conductivity. It varies for different materials. Gold, silver and copper have high thermal conductivity so these materials are also good conductors of electricity. Other materials, such as glass and mineral wool, have low thermal conductivity. This quality makes them good insulators. A good insulator is a poor conductor. Less dense materials are better insulators. Thus, gases insulate better than liquids, which in turn insulate better than solids.

An interesting fact is that poor conductors of electricity are also poor heat conductors.

Research Basis

Osman, M., & Hannafin, M.J. (1994). Effects of advance organizing, questioning and prior knowledge on science learning. *Journal of Educational Research, 88(1)*, 5-13.

Good questioning requires skill and planning. Learning is maximized in classes where questions are encouraged, elaboration and explanation are expected, and feedback is frequent. Effective science teachers ask many higher-lever thinking and follow-up questions throughout a lesson. Better teacher questioning practices lead to better learning by all students. The foundation to good questioning is strong content knowledge and a firm understanding of how students learn so that misunderstandings may be anticipated.

Chapman, C. & King, R. (2005). 11 Practical Ways to Guide Teachers Toward Differentiation. *ERIC Source* (ERIC EJ752246). Retrieved December 17, 2007, from http://www.eric.ed.gov

Differentiated learning takes student differences into account. By focusing on the needs of the individual learner, students will do better in school. Eleven steps are presented to help teachers move toward a differentiated curriculum, including knowing the standards, varying instructional strategies and activities, creating a positive learning climate, providing a wide variety of materials, knowing the students, and adjusting assignments when necessary.

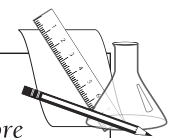
Invitation to Learn

Pass out a *Which Uses More Energy?* sheet to each student. Allow between five and ten minutes for completion and journaling.

Instructional Procedures

1. When students finish the invitation to learn, read each energy question and allow students to raise their hands to indicate their guess. Then read each correct answer and the reasoning behind it. Discuss any surprises or reactions to this information. Ask if the kids have any ideas of how we as Americans can cut back on using energy.
2. Introduce the term energy conservation (saving energy) in relationship to heat. What do we do to stay warm outside on

Materials



- ❏ *Which Uses More Energy? half-sheet*
- ❏ *Which Uses More Energy? answer key*
- ❏ *Insulation Experimentation Planning Sheet*
- ❏ Baby food jars (size 2 recommended)
- ❏ Various insulating materials
- ❏ Small disposable containers
- ❏ Plastic Wrap
- ❏ Scissors
- ❏ Tape
- ❏ Research materials about insulation
- ❏ Microwave
- ❏ Microwave-safe bowl
- ❏ Water access
- ❏ Thermometers
- ❏ 50 mL measuring syringes
- ❏ *Insulation Table*
- ❏ *Insulation Graph*
- ❏ Stopwatches
- ❏ *Insulation Experimentation Sample Table & Graph*
- ❏ *Insulation in Ancient Rome* PowerPoint
- ❏ Science journals

a cold day? (wear a coat) How do we save money on heating our homes in the winter? (appropriate insulation) What are some examples of insulation? (animal fur, towel, blanket, portable cooler, fiberglass, wool, foam, down, etc.)

3. Insulators are materials that help prevent any of the three types of heat transfer to keep heat in one place (either in or out). This aids in energy conservation. Homes need insulation on the roof for protection from the sun (radiation); on the floor to protect from the cold ground (conduction); and on the walls to protect from the wind (convection). A well insulated home will not have wasted energy and will therefore not use as much heat in the winter or air conditioning in the summer.
4. Explain that the students are going to participate in an experiment that explores different types of insulation. They will select a material to insulate a jar of warm water and determine whether or not it is a good insulator. Various insulation materials are needed and should be set out prior to the lesson. Fabrics should be labeled. You will need about 40 baby food jars for this experiment. You may ask the students to bring some materials from home.
5. Students should be in groups of about four. Give each group a copy of the *Insulation Experimentation Planning Sheet* to guide preparations in their journals. Allow for differentiation when appropriate; some students may be ready to plan an experiment on their own and will not need the planning sheet. See that all students are using their journals to record each step of the scientific method.
6. Before the students begin, discuss some of the following questions: What are the variables in your project? (insulation materials) How can you make sure to only test one variable? (jars should be the same size; water should be the same amount and initial temperature in each jar; all temperature readings should be recorded at the same time) What time intervals are appropriate for temperature testing? (I would suggest 1-3 minutes between each reading. Stopwatches may be used for accuracy.) How will you record your observations? (tables, graphs, report format) Where will you keep your jars? (students may opt to take them outside if the temperature is cooler)
7. While the students are working, begin warming water in microwave. Ensure it is hot, but not hot enough to burn someone. You may also want to walk around to each group and

review how to read the thermometers. It is also helpful to pre-cut small pieces of the Glad Press'n Seal Wrap for easy assembly later.

8. After forming a hypothesis, each student in the group should surround a baby food jar or something similar with one type of material, making sure to keep a small amount of the jar available on top for sealing. Each jar should be the same size, and each material should be different. If using dirt or sand, set the baby food jar in the center of a small disposable container and surround it with the selected material.
9. When one or two jars per person are finished, use a measuring syringe to fill each jar with 100 mL of water, or enough to almost fill the jars you are using. Then place a thermometer in each. Students should immediately record the temperature. Seal with the Glad Press'n Seal Wrap while keeping the thermometer in the jar for easy readings.
10. One unsealed jar with a thermometer and no insulation should act as the control. Timed temperature readings should be recorded every few minutes. Observations should be recorded. Pass out the *Insulation Table* and *Insulation Graph* to those who need help recording their data.
11. As the students are working, monitor student progress by asking thought provoking questions that focus on student understanding. Use the *Insulation Experimentation Sample Table & Graph* as a tool to help guide your students' thinking.
12. When students are finished, they should record and analyze their data and draw conclusions to answer their question. Remind them that all parts of the scientific method need to be written up in their science journals.
13. On day two, have a class discussion about the experiment. Based on all data, which insulation was the best? Which was the worst? Did any jars remain the same temperature? Share differences in experimentation and data. At the conclusion of your discussion, instruct the students to share their conclusions in their journals, as well as write any questions they still wonder about.

Assessment Suggestions

- Hypothesize about what might happen if you tried the experiment again, this time recording the temperature for a longer amount of time (one, two, even three hours). Which materials might work better? Will there be a point when none of the jars are insulated well enough to keep the water warm? To assess a students' understanding of the scientific method and the experiment done in class, have them write up how to set up this experiment. If more time is available, try it!

- Remind the students that metals are excellent conductors of heat. Based on your experiment, did that make them good or poor insulators? Why? (Good conductors cannot be insulators because conductors remove heat, not sustain it.)
- Could you design an experiment to measure keeping things cool? Ask students to journal their ideas.

Curriculum Extensions/Adaptations/ Integration

- Invite an HVAC (heating, ventilation, and air conditioning) professional to explain how he/she knows how many radiators or ducts are needed to heat a room.
- Challenge advanced students to research how insulation techniques have changed over time, or how different societies throughout history have heated their living environment.
- Research extreme temperatures throughout the world at http://members.iinet.net.au/~jacob/worldtp.html and energy conservation techniques used in those regions.
- Visit the Utah Energy Conservation Coalition website at www.utahenergy.org to learn about energy conservation techniques used in homes in Utah.
- Show the PowerPoint presentation entitled *Insulation in Ancient Rome*. This explores the concept of hypocausts, most likely developed by the Ancient Romans, and how they were used. You may also build a model of a hypocaust using bricks and tiles. Simple instructions can be found at www.mylearning.org/learning/investigate-archaeology/Roman%20Central%20Heating.pdf.

Family Connections

- Have students learn about the amount and type of insulation in their own homes, including techniques used by their families to stay warmer in the winter (i.e. plastic on windows, towels on floor by doors, electric blankets, etc.).

- Have students and their families design and put into place an energy conservation plan in their homes to save on energy bills.

Additional Resources

Web sites

www.mylearning.org/learning/investigate-archaeology/Roman%20Central%20Heating.pdf

http://members.iinet.net.au/~jacob/worldtp.html

Organizations

National Insulation Association, 99 Canal Center Plaza, Suite 222, Alexandria, VA 22314, (703) 683-6422, insulation.org

Utah Energy Conservation Coalition, Inc. and Energy Rated Homes of Utah, 112 South Mountain Way Drive, Orem, UT 84058-5118, (800) 550-8322, www.utahenergy.org

Which Uses More Energy?

Energy is the *ability to do work*. Circle the option that you think uses the most energy.

1. All electric power plants or all U.S. cars?
2. Coal power plant or space shuttle?
3. 20 light bulbs or a horse?
4. The space shuttle or 50 airplanes?
5. A big ship or a big airplane?
6. An SUV or 100 horses?
7. 2,000 light bulbs or a small car?
8. On average, one American or two people from somewhere else in the world?

In your science journal, brainstorm a list of daily activities that use energy. Try to think of at least ten.

Which Uses More Energy? Answer Key

Energy is the ability to do work. Circle the option that you think uses the most energy.

1. All electric power plants or all U.S. cars? All U.S. cars (all U.S. cars = 7 times all power plants)
2. Coal power plant or space shuttle? Space shuttle (space shuttle = 14 plants)
3. 20 light bulbs or a horse? 20 light bulbs (20 light bulbs = 2 horses)
4. The space shuttle or 50 airplanes? Space shuttle (space shuttle = 56 airplanes)
5. A big ship or a big airplane? Big airplane (4 airplanes = 5 ships)
6. An SUV or 100 horses? SUV (SUV = 160 horses)
7. 2,000 light bulbs or a small car? Light bulbs (car = 1,000 light bulbs)
8. On average, one American or two people from somewhere else in the world? One American (Americans use 5 times as much power: 100 light bulbs a year compared to 20 light bulbs a year)

In your science journal, brainstorm a list of daily activities that use energy. Try to think of at least ten. These may include: television, computer, lights, music players and other electronics, stove, oven, washer/dryer, car, bath, outside doors, thermostat, fireplace, windows, appliances, such as toaster, blow dryer, can opener, etc.

Insulation Experimentation Planning Sheet

You will need:

1. Your science journal and a pencil
2. One or two baby food jars for each member of your group, plus an extra
3. One thermometer for each jar
4. One type of insulation for each jar
5. Tape, scissors, or other to secure your insulator
6. Plastic wrap
7. A stopwatch, timer, or watch with a second hand

Consider the following as you plan your experiment. Write your responses in your journal.

1. Write down the question: Which insulator will keep a jar of warm water warmest the longest?
2. What background knowledge do you have to answer this question? Think about conduction, convection, and radiation.
3. Based on your background knowledge, what is your hypothesis? You may use the classroom resources to do some research if you choose.
4. Identify the variables in your experiment.
5. Identify the controls.
6. Obtain one jar and one type of insulation for each person in your group. Will you put the insulation around the bottom of each container or just the sides?
7. Each jar should contain the same amount of water. Test the temperature immediately after adding the water to each glass. Seal quickly with plastic wrap. Leave one jar of water with no insulation as a control.
8. Record the temperature every one to three minutes. When will you stop recording the temperature?

Consider the following during your experiment. Write your responses in your journal. You may want to use pictures, graphs, or tables to help.

1. How does the temperature change over time?
2. Record your data. How did you make sure all results are accurate?
3. While recording your data, begin a table and graph to show your results.
4. Write a conclusion based on your results. Which was the best insulator and which was the worst? How do you know? Don't forget to state whether or not your hypothesis was correct.

Insulation Table

Materials, Time, & Degrees (F)	Control	Material 1 _________	Material 2 _________	Material 3 _________	Material 4 _________	Material 5 _________
Starting Temp						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
Change in temp from start to finish						

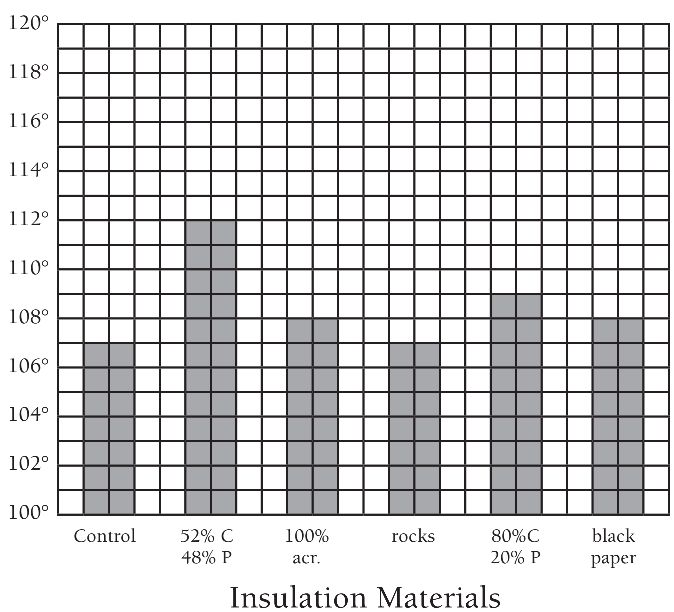
Insulation Graph

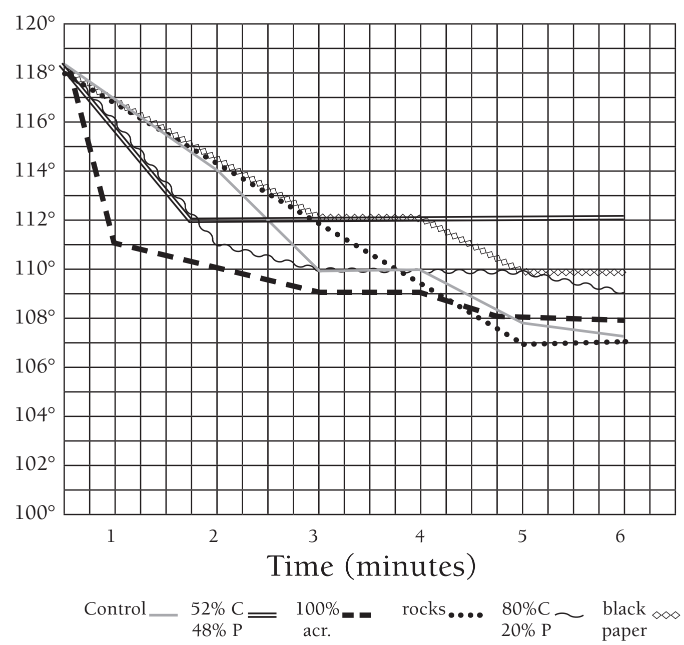
Insulation Experimentation Sample Table

Materials, Time, & Degrees (F)	Control	52% cotton; 48% poly fabric	100% acrylic fabric	rocks	80% cotton; 20% poly fabric	black paper
Starting Temp (in °)	118	118	118	118	118	118
1 min	116	116	111	115	116	116
2 min	114	112	110	113	111	114
3 min	110	112	109	111	110	112
4 min	110	112	109	109	110	112
5 min	108	112	108	107	110	110
6 min	107	112	108	107	109	110
Change in temp from start to finish	11 degrees	6 degrees	10 degrees	11 degrees	9 degrees	8 degrees

Since the 52% cotton/48% polyester fabric only had a change of 6 degrees, it is the best insulator.

Insulation Experimentation Sample Graph





Was Goldilocks Telling the Truth?

Science Standard VI

Objective 1

Connections

Standard VI:
Students will understand properties and behavior of heat, light, and sound.

Objective 1:
Investigate the movement of heat between objects by conduction, convection, and radiation.

Intended Learning Outcomes:
2. Manifest Scientific Attitudes and Interests
6. Understand the Nature of Science

Content Connections:
Language Arts VIII-1, 2, 3, 4; use the writing process

Background Information

The students will need background in the scientific method. The steps in this method are ask a question; gather background research; form a hypothesis; experiment; analyze your data; draw conclusions; and record your results.

It is helpful if the students have already done several guided experiments using this method in class. If not, a planning sheet is provided to allow for differentiation.

Prior to beginning this lesson, set up the oatmeal, bowls, and other materials. Plan enough time to use a microwave or hot plate to heat up the oatmeal and water mixture. You may also want to have a couple of crock pots on hand to keep the oatmeal hot. The ratio for making porridge from oatmeal and water is one cup of water to ½ cup of oatmeal. Time for warming in the microwave will vary based on how much is used. Cook on high for three minutes at a time and stir in between.

Students should use a different thermometer for each set of bowls. They should also have a small ice bath available to store the thermometer between readings.

Since the students will be using bowls of different materials in this experiment, they may use any knowledge of insulation materials when making their choice of which to use. If you have multiple sets of bowls, they may choose to test two different materials.

The porridge portion of the story of Goldilocks and the Three Bears will be proven wrong in this experiment. Goldilocks said the big bowl was too hot, the medium-sized bowl was too cold, and the smallest bowl was "just right." The students will learn that bigger things lose heat more quickly and smaller things sustain heat the longest, thus making the big bowl too cold, the small bowl too hot, and the medium-sized bowl "just right."

Research Basis

Rossman, Alan D. "Managing Hands-On Inquiry." Science and Children 31(1993): 35-37.

Science teaching has moved from conventional teaching to actively involving students in meaningful, hands-on inquiry experiences. These experiences are centered on student investigation and problem solving, cultivating positive attitudes toward science and learning in general, and enabling them to learn to think critically and creatively for themselves. With inquiry, teachers become facilitators, not presenters, while students become not passive learners, but participants in the creation of understanding.

Klentschy, M. (2005). Science Notebook ESSENTIALS. *ERIC Source* (ERIC EJ721629). Retrieved November 30, 2007, from http://www.eric.ed.gov

Science journals should be a record of students' questions, predictions, evidence, conclusions, and reflections. All should lead to an understanding of "big ideas" of science, as well as act as a literary tool to help students answer questions about the world around them. Language is the most important way for students to arrive at scientific understanding.

Invitation to Learn

Write the following instructions on the board: In your journals, write or draw what you remember about the story of Goldilocks and the Three Bears. What does this story have to do with heat?

Instructional Procedures

1. Prior to beginning this lesson, prepare the oatmeal/water mixture and set out all supplies, including the microwave or hot plate and saucepan. You may want to warm the porridge before beginning the lesson and keep it warm in a crock pot until using.
2. Read and share the pictures of *Goldilocks and the Three Bears* by Caralyn and Mark Buehner, or another version of your choosing. A Big Book version may be available at your district media center.
3. Ask the students what the story has to do with heat. They should recognize the too hot, too cold, and just right

Materials

- ❏ *Goldilocks and the Three Bears*
- ❏ *Was Goldilocks Telling the Truth? Experiment Planning Sheet*
- ❏ Multiple sets of bowls
- ❏ Oatmeal
- ❏ Hot water
- ❏ Microwave
- ❏ Crock pot
- ❏ 1 cup and ½ cup measuring cups
- ❏ *Was Goldilocks Telling the Truth? Sample Table and Graph*
- ❏ *Goldilocks Table*
- ❏ *Goldilocks Graph*
- ❏ Science journals
- ❏ Thermometers

temperatures of the bowls of porridge. Reread this portion of the story. Ask the students to think about what they have learned about heat. Is this scenario really possible?

4. Explain that students will design an experiment to test this question. Students should be in groups of three. Steps of the scientific method should be followed. All documentation should be written in their science journals.
5. Before assigning groups, allow students time to design the experiment on their own. Provide the *Was Goldilocks Telling the Truth? Experiment Planning Sheet* for those students who need some assistance with this process.
6. Organize the small groups once students have had time to think about the experiment on their own. Students should share their ideas with their group members and come to a consensus on the procedure. They may test two different sets of bowls if enough materials are available.
7. Begin warming the porridge in the microwave as the students are planning the project with their group members. Exercise safety precautions while using the hot oatmeal and make sure your students do the same.
8. Before the students begin, discuss some of the following questions: What are the variables in your project? (the size of the bowls) How can you make sure to only test one variable? (the amount of oatmeal in each bowl should be the same) What time intervals are appropriate for temperature testing? (I would suggest 1 ½ - 3 minutes between each reading. Stopwatches may be used for accuracy.) How will you record your observations? (tables, graphs, report format)
9. As the students work, prompt their thinking with questions from the *Was Goldilocks Telling the Truth? Experiment Planning Sheet*. Make sure the students are continually logging their observations in their journals. You may provide the *Goldilocks Table* or *Goldilocks Graph* to help with this process. You may also use the *Was Goldilocks Telling the Truth? Sample Table and Graph* to guide your questions for your students.
10. When the students finish, ensure that they have written all of their conclusions in their journals. Also ask them to write down any other wonderings as well.

Assessment Suggestions

- Watch for claims, evidence, and correct data and conclusions in the students' journals.
- Instruct students to rewrite the story of *Goldilocks and the Three Bears* using creativity and what they have learned from the experiment.

Curriculum Extensions/Adaptations/ Integration

- Try the experiment with substances other than porridge like soup or hot chocolate. Were the results the same?
- Record class results in graphs and tables. Have the students determine the average drop in degrees or the range of temperatures for each bowl.

Family Connections

- Have students share their rewritten story of Goldilocks with a younger sibling.

Additional Resources

Books

Goldilocks and the Three Bears, by Caralyn and Mark Buehner; ISBN 0803729391

Was Goldilocks Telling the Truth?

Experiment Planning Sheet

You will need:

1. Your science journal and a pencil
2. One set of three bowls of the same material. You may try another set of a different material if desired.
3. 1 ½ cups of warm "porridge" (½ cup oatmeal: 1 cup water)
4. One thermometer for every set of bowls
5. A bowl of very cold water
6. A stopwatch, timer, or watch with a second hand

Please plan the following prior to your experiment:

1. What is your question?
2. What background knowledge do you have to answer this question?
3. Based on your background knowledge, what is your hypothesis?
4. Identify the variables in your experiment.
5. Identify the controls.
6. What types of containers will you use? Why?
7. What time intervals will you use to test the temperature?
8. Use a different thermometer for each set of bowls. Store them in an ice bath between readings.

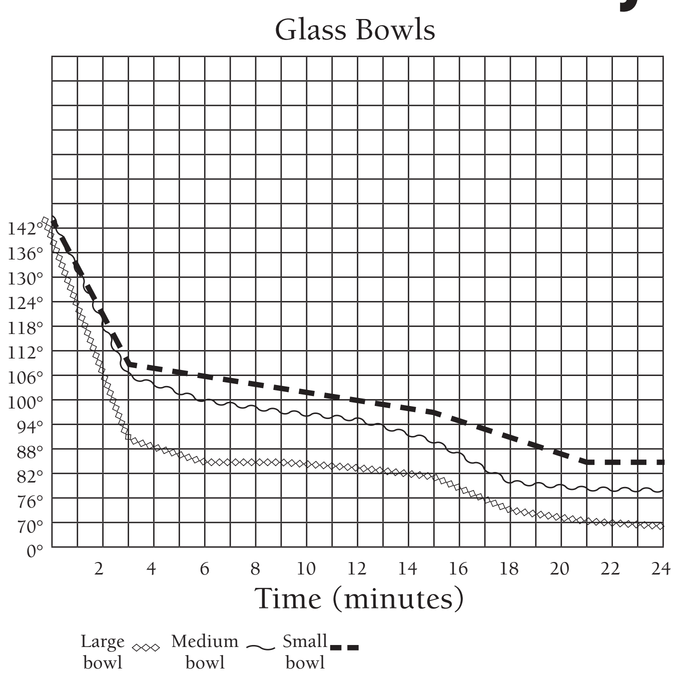
Consider the following during your experiment. Write your responses in your journal. You may want to use pictures, graphs, or tables to help.

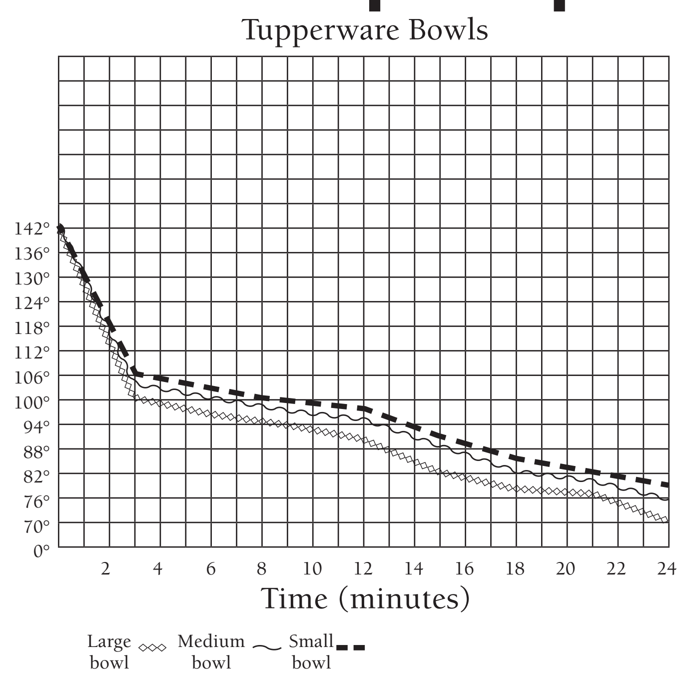
1. How does the temperature change over time?
2. Did the size of the container affect the loss of heat? How?
3. Did the type of material of the container affect the loss of heat? How?
4. Record your data. How did you make sure all results are accurate?
5. While recording your data, begin a table and graph to show patterns in heat loss. Can you predict how much the temperature will drop each time you check the thermometer?
6. Write a conclusion based on your results. Don't forget to answer your question and state whether or not your hypothesis was correct.
7. What questions do you still have? Write these wonderings in your journal.

Was Goldilocks Telling the Truth? Sample Table

Bowls, Time, & Degrees (F)	Large Glass	Medium Glass	Small Glass	Large Tupperware	Medium Tupperware	Small Tupperware
Starting Temp (in °)	142	142	142	142	142	142
3 min	90	105	110	99	103	103
6 min	86	99	105	97	100	101
9 min	85	98	101	93	98	99
12 min	84	95	99	90	95	98
15 min	80	89	95	82	88	91
18 min	73	81	91	79	82	85
21 min	71	80	84	78	80	83
24 min	70	79	84	71	75	80
Change in temp from start to finish	75 degrees	66 degrees	61 degrees	74 degrees	70 degrees	65 degrees

Was Goldilocks Telling the Truth? Sample Graphs





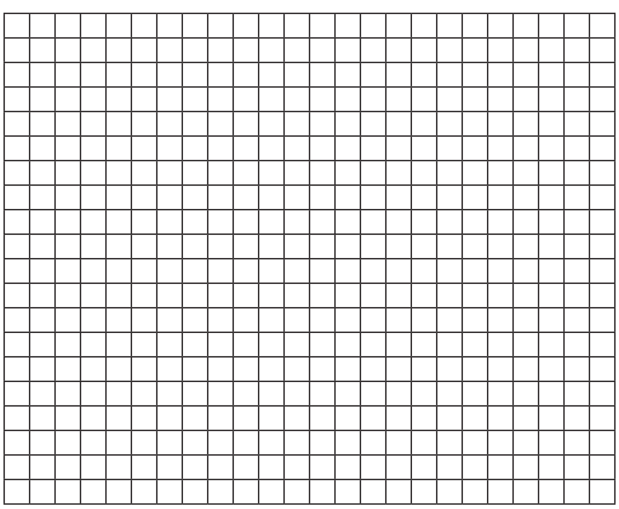
Goldilocks Table

Bowls, Time, & Degrees (F)	Large Bowl	Medium Bowl	Small Bowl	Large Bowl 2	Medium Bowl 2	Small Bowl 2
Starting Temp (in °)						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
Change in temp from start to finish						

Goldilocks Graphs

Glass Bowls

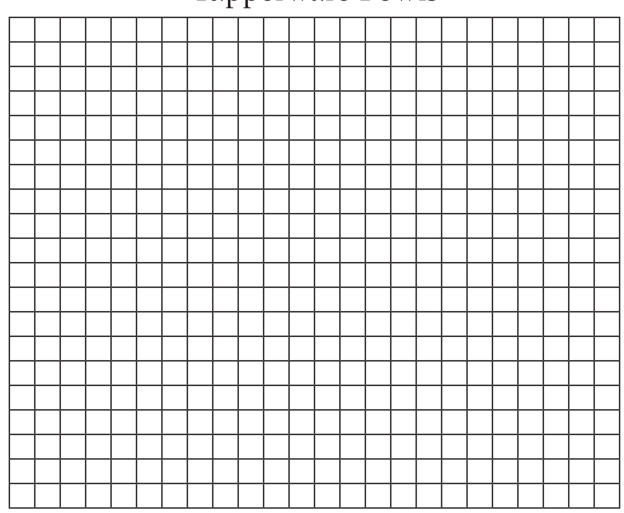
Temperature



Time (minutes)

Tupperware Bowls

Temperature



Time (minutes)

Math IV-2

Activities

Measurement

Make It Metric

Standard IV:
Students will understand and apply measurement tools and techniques and find the circumference and area of a circle.

Objective 2 :
Identify and describe measurable attributes of objects and units of measurement, and solve problems involving measurement.

Intended Learning Outcomes:
1. Develop a positive learning attitude toward mathematics.
3. Reason logically, using inductive and deductive strategies and justify conclusions.
4. Communicate mathematical ideas and arguments coherently to peers, teachers, and others using the precise language and notation of mathematics.

Content Connections:
Math I-1; Using powers of ten

Math Standard IV

Objective 2

Connections

Background Information

Most countries use the metric system. With the increasingly global marketplace, citizens of the United States are exposed to more usage of this system. It is important for students in the educational system to have a knowledge of the metric system—its components, organization, and common benchmarks—to be able to use the system in the real world.

The metric system is based on powers of ten. This makes calculations and conversions simple. The prefixes are used across the measurement types to denote the magnitude, or power of ten of the measurement.

Prefix	kilo	hecto	deka	UNIT	deci	centi	milli
Unit: meter	kilometer	hectometer	dekameter	meter	decimeter	centimeter	millimeter
Abbreviation	km/K	hm	dam	m	dm	cm	mm
Meaning	1000 m	100 m	10 m	1 m	0.1 m	0.01 m	0.001 m
Power of Ten	10^3	10^2	10^1	10^0	10^-1	10^-2	10^-3

Prefix	kilo	hecto	deka	UNIT	deci	centi	milli
Unit: meter	kilogram	hectogram	dekagram	gram	decigram	centigram	milligram
Abbreviation	kg	hg	dag	g	dg	cg	mg
Meaning	1000 g	100 g	10 g	1 g	0.1 g	0.01 g	0.001 g
Power of Ten	10^3	10^2	10^1	10^0	10^-1	10^-2	10^-3

Prefix	kilo	hecto	deka	UNIT	deci	centi	milli
Unit: meter	kiloliter	hectoliter	dekaliter	Liter	deciliter	centiliter	milliliter
Abbreviation	kL	hL	daL	L	dL	cL	mL
Meaning	1000 L	100 L	10 L	1 L	0.1 L	0.01 L	0.001 L
Power of Ten	10^3	10^2	10^1	10^0	10^-1	10^-2	10^-3

Research Basis

Peterson, Shelley Stagg. Teaching content with the help of writing across the curriculum. *Middle School Journal,* November 2007, Vol. 39, Number 2, p26-33.

This study investigated the value of "discovery writing," a type of writing in which students have some control over the format, topic, purpose, and audience, to "staccato writing," a type of writing with little or no control such as filling in blanks, copying notes from the board, and short answers to questions, in the content areas. The author found that student control led to greater understanding of content area concepts. "Discovery writing" required greater concentrated attention to sorting through and making sense of ideas on the part of the learner.

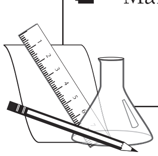
Tomlinson, Carol Ann. Differentiating instruction. *Middle Ground,* August 2005, Vol. 9, Number 1, p12-14.

The author gives guidelines to help teachers use differentiation. Teachers must have "clear learning goals that are rich in meaning and provide various avenues and support systems to maximize the chance of each student succeeding." Through specific examples such as pre-assessment, meeting with small groups, using multiples presentation and teaching modes, creating differentiated homework, scaffolding reading, and allowing varied learning products, the author concretely helps teachers to provide for the diversity of learners in the classroom.

Invitation to Learn

Materials

- ❏ Post-It® notes
- ❏ Poster Paper
- ❏ Markers



There are so many things that we measure every day using the metric system. Pre-assess what your students know about this measurement system by having them brainstorm terms related to metric measurement. Have students work in cooperative groups of two to four students. Students should write each item on a separate Post-It® note. Allow three to five minutes for this activity.

Ask students to come up with a way to group or classify the items on their Post-It® notes. Sort the Post-It® notes into columns of like items and attach them to a sheet of poster paper for each group to display. Write a heading for each column created. Some possible headings students might use include length, capacity, volume, mass, weight, or temperature. Take time to have groups share their methods of classification. It is possible that there may be some items in columns that are not mathematically accurate. Be sure to clear up any misconceptions as needed. Leave the classification posters created by the groups hanging up in the room for future reference.

Instructional Procedures

(NOTE: The activities outlined in Instructional Procedures are intended to be taught sequentially. They will take several lessons/ days to complete with students.)

1. Read the book *Millions to Measure* to the class. Draw comparisons from the story to the classification posters students made in the Invitation to Learn.
2. Tell students *King Henry's Story*. This story will introduce the acronym being used to help students learn the sequence of metric prefixes and to make conversions within the metric system. Although many acronyms are possible, these activities will be using **King Henry Does Usually Drink Chocolate Milk.**
3. Tape the *Prefix Cards* on the board in a "staircase" pattern to match the foldable students will be making later in this lesson. The cards should be placed in the following order: kilo, hector, deka, UNIT, deci, centi, and milli.
4. Select four students to play the roles of King Henry, the Royal Jester, the Royal Magician, and the Royal Carpenter. The other members of the class will be the Royal Subjects. King Henry will wear a crown and hold the canister with *King Henry's Commands*. The Royal Jester will wear a hat and hold the *Digit Cards*. The Royal Magician will wear a hat and hold the decimal point wand. The Royal Carpenter will wear a tool belt containing the *Royal Carpenter's Tools*.
5. King Henry will select a card from *King Henry's Commands* and read it to the class. An example might read: I command that a royal coach 15 meters in length be built to carry me to the ball. The Royal Jester then places *Digit Cards* to represent 15 under the UNIT card on the board. The Royal Magician steps in to hold the decimal point wand after the number 15. The Royal Carpenter then reaches into the tool belt without looking and pulls out a *Royal Carpenter's Tools* card to see what measurement is available. If the Royal Carpenter pulls out "I, the Royal Carpenter, have centi______ units available for measurement today," then the 15 meters must be converted to centimeters.

Materials

- ❏ *Millions to Measure*
- ❏ *King Henry's Story*
- ❏ *Prefix Cards*
- ❏ *Digit Cards*
- ❏ Costume items
- ❏ *King Henry's Commands*
- ❏ *Royal Carpenter's Tools*
- ❏ *Metric Measurement*
- ❏ *Metric Measurement Steps*
- ❏ Scissors
- ❏ Gluesticks
- ❏ *Metric Conversion Record Sheet*
- ❏ Calculators
- ❏ *Make It Metric Dominoes*
- ❏ *Metric Tic Tac Toe*

The King may then call on a Royal Subject to help decide which direction and how many places the decimal point should move to convert the meters to centimeters. The Royal Magician must move the decimal point to the correct place indicated by the Royal Subject. The other members of the Royal Court may help decide if the answer is correct. Rotate the roles to other members of the class to get everyone involved.

6. Have students make the *Metric Measurement* foldable to use in converting within the metric system. This is a smaller version of the steps from the role playing that students can put in their journals. First, have them cut out the seven steps and fold each one in half on the double line. Students will attach them to the *Metric Measurement* paper using glue sticks as you explain each one as described in the procedural steps below:
   a. Start with the center step labeled “USUALLY.” Have students open the paper step and record inside that the word USUALLY stands for “Unit.” Record that the basic units of measurement in the metric system are meter, liter, and gram and they have a value of 1 or 10^0.
   b. Have students open the step labeled “drink.” This step is to be labeled “deci,” and it has a value of 0.1 or 10^-1.
   c. Have students open the step labeled “chocolate.” This step is to be labeled “centi,” and it has a value of 0.01 or 10^-2.
   d. Have students open the step labeled “milk.” This step is to be labeled “milli,” and it has a value of 0.001 or 10^-3.
   e. Have students open the step labeled “does.” This step is to be labeled “deka,” and it has a value of 10 or 10^1.
   f. Have students open the step labeled “Henry.” This step is to be labeled “hector,” and it has a value of 100 or 10^2.
   g. Have students open the step labeled “King.” This step is to be labeled “kilo,” and it has a value of 1000 or 10^3.
7. Complete *Metric Conversion Record Sheet*. Use the *Metric Measurement* foldable to help make the conversions. Have a class discussion of patterns found. Have students write about the patterns in their journals.
8. Play the game Metric Dominoes. Students should be allowed to use their journal notes, their foldable, and/or a calculator to help make the conversions necessary on each domino to find matches in this game. Copy two sets of *Make It Metric Dominoes* on cardstock for each pair of students to play the

game. Have students cut apart the dominoes. The rules of play are as follows:

a. Give each player five dominoes. Place the remaining dominoes in a draw pile.

b. Player 1 places a domino on the table.

c. Player 2 puts down a domino with a metric equivalent. For example, 40 cm and 400 mm are equivalent.

d. Players continue to take turns putting down dominoes one at a time. If a player does not have a metric equivalent, that player must continue to draw from the pile until a match is possible.

e. The first player to use all of his dominoes is the winner.

Assessment Suggestions

- Correct the *Metric Conversion Record Sheet* for a grade.
- Have students complete the *Metric Tic Tac Toe* handout.
- Have students design their own Tic Tac Toe grid for a peer to solve.

Curriculum Extensions/Adaptations/ Integration

- Have students write their own acronym for the metric prefixes.
- Have students write their own story to fit their metric prefix acronym.
- Have students use calculators to complete the *Metric Conversion Record.* Dividing by ten as they move to the left and multiplying by ten as they move to the right will help students to see the patterns on the calculator.
- Have students make visual representations of some of the linear metric measurements. Lay out one meter of masking tape on the students' tables. Have students line up base ten rods the length of the meter to help them remember that ten decimeters are equivalent to one meter. Have students line up centimeter cubes the length of the base ten rods to discover that ten centimeter cubes are equivalent to one decimeter, and one hundred centimeters is equal to one meter.
- Have students look at a teacher-made visual representation of one dekameter. Purchase one dekameter of rope. Tie knots

in the rope to mark off each meter. Color each knot with a marker. Stretch out the rope to show students the length of a dekameter to help them remember that a dekameter is equivalent to ten meters.

Family Connections

- Have students share the story of King Henry and their Metric Measurement foldable with their family.
- Have students go on a metric scavenger hunt in their home. Record items and/or ways that the metric system is evident in their home. Come back and report their findings to the class.
- Have students play Metric Dominoes with their family.

Additional Resources

Books

Millions to Measure, by David M. Schwartz; ISBN 0-688-12916-1

Web sites

http://nlvm.usu.edu/en/nav/frames_asid_272_g_3_t_4.html?open=instructions&from=category_g_3_t_4.html

http://www.purplemath.com/modules/metric.htm

http://www.mathnstuff.com/math/spoken/here/2class/110/milli/metric.htm

King Henry's Story

Once upon a time in a faraway land there lived a king who loved chocolate milk. His name was King Henry.

Throughout his kingdom, King Henry made sure that all of the cows were fed great supplies of chocolate to continue to provide him with his beloved chocolate milk drink.

King Henry drank chocolate milk with his breakfast. He drank chocolate milk with his lunch. He drank chocolate milk with his dinner. He even drank chocolate milk for his bedtime snack. King Henry drank chocolate milk by the liters!

King Henry wanted all living creatures in his kingdom to enjoy chocolate milk as much as he enjoyed chocolate milk. However, a liter was not the best serving size for every creature.

The Royal Carpenter was called for and the command was given for new serving vessels to be created to fit every creature in the kingdom.

For the creatures smaller than the king, the Royal Carpenter designed deciliters that were $1/10^{th}$ the size of a liter, centiliters that were $1/100^{th}$ the size of a liter, and milliliters that were $1/1000^{th}$ the size of a liter. The milliliters were just right for the Royal Beetles and Bugs of the kingdom.

For the creatures greater than the king, the Royal Carpenter designed dekaliters that were 10 times the size of a liter, hectoliters that were 100 times the size of a liter, and kiloliters that were 1000 times the size of a liter. The kiloliters were just right for the Royal Giants of the kingdom.

The Royal Carpenter lined the vessels up in his workroom from largest to smallest to show the king. The king's vessel was in the center of the line, for the king was the center of the kingdom. The vessels were arranged in the following order:

kiloliter hectoliter dekaliter liter deciliter centiliter milliliter

King Henry loved the new vessels that were designed larger and smaller than his own for all of the living creatures in his kingdom. The Royal Carpenter explained that the sizes increased and decreased from the king's liter, the original unit of measurement, by multiples of ten. He explained how to convert between the sizes by multiplying by ten or dividing by ten. King Henry wondered how he would ever remember the order of the vessels.

The Royal Carpenter said that he remembered them by thinking of a saying. He said, "I remember the order by saying '**King Henry Does Usually Drink Chocolate Milk**' and then I have no problem remembering the order."

"That is exactly right!" said King Henry. "Now I shall remember the sizes of the vessels!"

King Henry Does Usually Drink Chocolate Milk

Prefix Cards

kilo

0

hecto
0

deka
0

UNIT **meter · liter · gram**
0

deci
0

centi
0

milli
0

Digit Cards

0	0
0	1

2	3
4	5

6	7
8	9

King Henry's Commands

I COMMAND that a royal coach 15 meters in length be built to carry me to the ball.	**I COMMAND** that a royal table be built that is 2 dekameters in length to seat the royal family for dinner.
I COMMAND that a royal comb be made that is 17 centimeters in length to comb my royal hair.	**I COMMAND** that a royal throne be built that is 900 decimeters in height from which I may rule over my royal subjects.
I COMMAND that a royal doghouse be built for the royal great dane that is 5000 millimeters in length.	**I COMMAND** that a royal sword be made that is 16 decimeters in length to slay the dragons that threaten the royal kingdom.
I COMMAND that a royal tub be made that will hold 142 liters of water for my royal bath.	**I COMMAND** that a royal flower vase be made that will hold 214 centiliters water for the royal roses.

I COMMAND that a royal trough be made that will hold 23 dekaliters of water for the royal horses in the royal stables.	**I COMMAND** that a royal pitcher be made that will hold 8 hectoliters of chocolate milk for my royal birthday party celebration.
I COMMAND that a royal bowl be made that will hold 6 deciliters of royal stew for my royal supper.	**I COMMAND** that a royal plate with a jeweled edge be made that weighs 3 hectograms for my royal supper.
I COMMAND that a royal crown be designed that weighs 398 grams for my royal self to wear to the royal ball.	**I COMMAND** that a royal statue of myself be built that weighs 567 kilograms to be placed in the royal town square.
I COMMAND that a royal goblet encrusted with jewels be designed that weighs 986 decigrams for my royal self to use every day to drink my chocolate milk.	**I COMMAND** that a royal scepter be designed that weighs 64 dekagrams to be used at royal knighting ceremonies.

Royal Carpenter's Tools

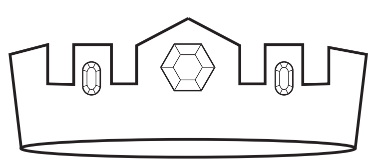
I, the Royal Carpenter, have kilo______ units available for measurement today.	I, the Royal Carpenter, have hecto_______ units available for measurement today.
I, the Royal Carpenter, have deka_______ units available for measurement today.	I, the Royal Carpenter, have base units of meters, liter, or grams available for measurement today.
I, the Royal Carpenter, have deci_______ units available for measurement today.	I, the Royal Carpenter, have centi________ units available for measurement today.
I, the Royal Carpenter, have milli_______ units available for measurement today.	

Name ___________________________

Metric Measurement

To convert to a smaller unit, move the decimal point to the right the same number of steps taken by King Henry. This is the same as multiplying by ten for each step taken by King Henry. Moving to a smaller unit means you will have a greater number.

To convert to a larger unit, move the decimal point to the left the same number of steps taken by King Henry. This is the same as dividing by ten for each step taken by King Henry. Moving to a larger unit means you will have a lesser number.



Metric Measurement Steps

King	**Henry**	**does**	**USUALLY**

drink	**chocolate**	**milk**

Name ____________________________

Metric Conversion Record Sheet

	10^3	10^2	10^1	10^0	10^-1	10^-2	10^-3
	kilo	hecto	deka	UNIT	deci	centi	milli
	k	h	da	1	d	c	m
ex.	0.012	0.12	1.2	12	120	1200	12000
1		56					
2					192		
3				30			
4							
5	8.19						
6			654				
7						7	
8							984
9				6.26			
10		0.43					
11	681						
12					3.22		
13			94.2				
14						0.5	
15				97.2			

Make It Metric Dominoes

0.4 m	0.4 m	4 m
4,000 m	4,000 m	40,000 dm

4 m	0.04 m	0.04 m
40,000 dm	40 cm	40 cm

40 mm	40 mm	4 cm
4,000 mm	4,000 mm	4 dm

4 cm	40 dm	40 dm
4 dm	4 km	4 km

Name ______________________________

Metric Tic Tac Toe

Directions: Find three equivalent measures in a row to complete a Tic Tac Toe.

5 kg	5000 g	50 hg
5 mg	5000 cg	5 g
5 hg	50 cg	500 cg

7 km	700 dam	7 m
7 m	70 cm	700 cm
7 cm	7 dam	70 dm

80 mL	8 kL	8 L
8 dL	80 cL	800 mL
800 L	80 hL	8 daL

2 kg	20 mg	20 g
20 hg	2 dag	200 g
200 dg	2 cg	2 hg

3 hm	30 cm	3000 m
30 m	30 dam	300 dam
300 cm	3 m	300 m

9000 L	90 hL	900 daL
90 L	90 daL	900 L
900 dL	9000 cL	9 kL

Getting Serious About Cylinders – Surface Area and Volume

Standard IV:
Students will understand and apply measurement tools and techniques and find the circumference and area of a circle.

Objective 2:
Identify and describe measurable attributes of objects and units of measurement, and solve problems involving measurement.

Intended Learning Outcomes:
1. Develop a positive learning attitude toward mathematics.
2. Become effective problem solvers by selecting appropriate methods, employing a variety of strategies, and exploring alternative approaches to solve problems.
3. Reason logically, using inductive and deductive strategies and justify conclusions.

Content Connections:
Mathematics II-1; Using patterns, Social Studies 4-1; Explore cultures of ancient civilizations

Math Standard IV

Objective 2

Connections

Background Information

To find the surface area and volume of a cylinder, students must first be able to look at the parts of this geometric solid. A cylinder has two circular faces known as bases that are connected by a curved surface known as the lateral surface. The two circular bases are parallel and have the same area.

The volume of the cylinder is the amount of space inside the cylinder. To find the volume, students will first need to know the area of the circular base. The formula for the area of the circle is the same as that used in surface area or πr^2. They next must know the height of the cylinder. To find the volume, they must multiply the area of the circle by the height of the cylinder. The formula is $V = Bh$ where $B =$ the area of the circular base or πr^2 and $h =$ the height of the cylinder. Thus, the final formula is $V = \pi r^2h$. Volume is measured in cubic units.

It is helpful to consider the net of the cylinder to see how surface area is determined. When a cylinder is taken apart and looked at as a net, there are two congruent circles and a rectangle. The surface area includes the sum of the areas of each circle (the bases) and the rectangle (the lateral surface). Thus, students must have previously learned how to find the areas of circles and rectangles. The formula for the area of a circle is πr^2. The formula for the area of a rectangle is bh. When looking at the net, students will need to see that the dimensions of the rectangle are equal to the circumference of the circle and the height of the cylinder. The formula is developed as follows: $S = 2\pi r^2 + 2\pi rh$ where S is the surface area, r is the radius of the base, and h is the height of the cylinder. Surface area is measured in square units.

Research Basis

Pierce, Rebecca L., & Adams, Cheryll M. Tiered lessons. ***Gifted Child Today,*** Spring 2004, Vol. 27, Number 2, p58-65.

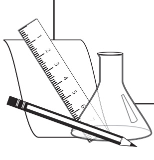
Based on tenets of differentiated instruction supported by the NCTM, the authors of this article define tiered lessons and outline eight steps to designing them. The three main ways to differentiate a lesson are guided by student's readiness, interest, or learning profile. Grouping for differentiated instruction is designed to be flexible from one lesson to the next.

Pugalee, David K. Writing, mathematics, and metacognition: looking for connections through students' work in mathematical problem solving. ***School Science and Mathematics,*** May 2001, Vol. 101, Number 5, p236-245.

This study looked for evidence of a metacognitive framework based on students' writing about mathematical problem-solving processes. Students' writing was analyzed from the introduction of a topic through the execution of problems on the same topic. The findings proved that a metacognitive framework is established through the process of writing. Furthermore, the author emphasizes the importance of writing as an integral part of mathematics curriculum.

Materials

- ❏ *Which Is Larger?*
- ❏ Measuring tapes
- ❏ Collection of cylinders



Invitation to Learn

Hold up a cylinder. Ask students to identify the geometric solid. Review the parts of a cylinder with the students, focusing on the two circular faces called bases and the curved surface. Note that the two circular bases are parallel and congruent. Point out the circumference of the circular bases and the height of the cylinder.

Tell students we are going to play a game with some cylinders. Each student will need a copy of the handout *Which Is Larger?* on which to mark their answers. The teacher will need to have a collection of ten cylindrical objects hidden from student view in a tub. Have each cylinder numbered one through ten. One at a time, hold up a cylinder and have students predict through their powers of observation which is larger, the height of the cylinder or the circumference of the base. After students have recorded their estimate for all ten objects, it is time to check their answers. One at a time, measure the height and circumference of each cylinder in front of the group. A possible discovery is that the circumference is often larger than the height. It is a common misconception that the reverse is true.

Instructional Procedures

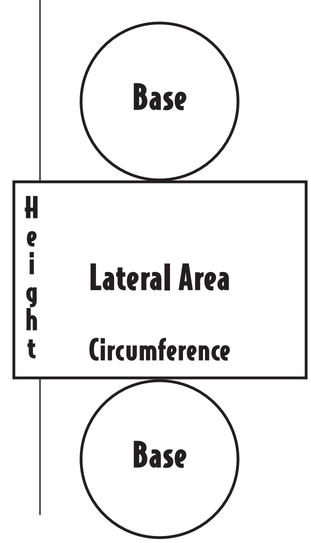
(NOTE: The activities outlined in Instructional Procedures are intended to be taught sequentially. They will take several lessons/ days to complete with students.)

Surface Area

1. Give each student a roll of Lifesavers® candy. Discuss with students what the package/label of this cylindrically-shaped candy would look like if it were opened up and laid out flat. This would be called a net. Have students carefully open up the package and lay out the net. Discuss with students what the net of a closed cylinder (top and bottom included) looks like. Have students attach the wrapper/net of the cylinder in their journals and write about its parts.
2. Provide students with a copy of *Net of Cylinder*. Cut out the net and construct the cylinder, but do not tape it together. It is important for students to see how the construction works and how to lay it flat to see the components. Students may need to put the cylinder together and lay it flat several times as they are learning. Note how the circumference of the circle is actually the base of the rectangle. Write "circumference" along the base of the rectangle. Next, point out that the height of the cylinder is also the height of the rectangle. Write "height" along the height of the rectangle. This net can also be saved and placed in student's journals for future reference.
3. Tell students that knowing the parts of a cylinder can help to find its surface area. Have a discussion on the definition of surface area. It is the "wrapper" or "skin" of the cylinder because it includes the top, bottom, and curved side. Discuss why people might want to find the surface area of a cylinder. A possible answer might be to know how much tin is needed to make a tin can in order to calculate the material cost of production.
4. Give each student a copy of *Surface Area of Cylinder.* Ask students to determine the area of the cylinder by counting the squares. For the rectangle, students can multiply base times height. Have students record their answer for the rectangle on the net. For the circles, have students count the whole squares and then estimate the partial squares by putting them together to create whole squares. The answers will not be perfect, but should be close. Have students record their answers for each

Materials

- ❏ Roll of Lifesavers®
- ❏ *Net of Cylinder*
- ❏ *Surface Area of Cylinder*
- ❏ *Surface Area Patterns*
- ❏ Cardstock paper
- ❏ Scotch tape
- ❏ Filler materials
- ❏ *Volume Discoveries*
- ❏ Model of rectangular prism
- ❏ *Effects on Volume*
- ❏ Calculators
- ❏ *Will You Be Wet or Dry?*
- ❏ Water collection cans
- ❏ Measuring tapes
- ❏ Water
- ❏ Graduated cylinders
- ❏ Rain poncho
- ❏ Towels
- ❏ Paper
- ❏ Whiteboards
- ❏ Scissors



circle on the net. Have students add together the area of the rectangle plus the area of each circle to find the total surface area. They may record their answers on the handout.

5. Discuss whether counting squares is the most efficient method for finding the surface area of a cylinder. Make sure students see that the surface area is "2 x area of circle + area of rectangle."
6. Guide students to use the formula for each part of the cylinder. First, remember that the top and bottom bases are both congruent circles. Review how to find the area of a circle. The formula for this is πr^2. Some students may present this as π x radius x radius. Find the area of a circle on the *Surface Area of Cylinder* net together as a class using the formula and compare it to the students' estimates by counting squares. Remind students that there are two circles, so the first part of the formula for finding surface area is $2\pi r^2$. Next, find the area of the rectangle. One edge of the rectangle is actually equal to the circumference of the circle which is$2\pi r$. The other side is equal to the height of the cylinder. Thus, the formula for the rectangle is $2\pi rh$. Calculate the area of the rectangle together as a class using the formula and compare it to the students' estimates by counting squares. Help students to put together the final formula. The final formula is $S = 2\pi r^2 + 2\pi rh$ where S is the total surface area, r is the radius, and h is the height. All final answers on surface area are measured in square units.
7. Have students complete the handout *Surface Area Patterns*. Set 1 has cylinders that double in radius and height each time. The pattern students should discover is that the surface area quadruples each time. Set 2 has cylinders that triple in radius and height each time. The surface area is nine times larger in this pattern. Students must then determine the surface area of a fourth cylinder in each set.

Volume

8. Have students work in cooperative groups of four students to complete this activity. Give each group two sheets of cardstock paper of the same size. For example, one group will have two sheets of 8 1/2" x 11", another group will have two sheets of 8" x 9", another group will have two sheets of 6 ½" x 10", and so forth. Roll the first sheet into a tall, thin open cylinder (has no top or bottom) and tape the sides together with no overlap or gap. Fill the cylinder with popcorn or other filler. Roll the second sheet the opposite way and tape it into

a shorter, wider open cylinder with no overlap or gap. Place it around the first cylinder. Have students predict in their journals if it will have the same volume of the filled cylinder. Slowly, lift and remove the tall cylinder, allowing the filler to go into the second cylinder. Students will find that the contents of the first cylinder do not completely fill the second cylinder. By completing this activity, students will be able to determine which cylinder has the larger volume. They should also discover that cylinders with the same lateral surface area (rectangle) do not always have the same volume. The size of the circular base affects the total surface area and, consequently, affects the volume of the cylinder. Students should discover that the shorter cylinder of the two has a larger volume. Discuss each group's findings as a class, and record the findings on an overhead transparency of *Volume Discoveries*. Have students write about their conclusions from this activity in their journals, including sketches as needed.

9. Explain to students that knowing the parts of a cylinder can help to find its volume. Remind students that the volume of the cylinder is the amount of space inside the cylinder. Show the students a rectangular prism. Ask them to remember how to find the volume of a rectangular prism. Have students discuss in groups how they might be able to find the volume of a cylinder. Have students share their ideas. If it has not been brought up in discussion already, remind students that the formula for volume is base times height or $V = Bh$. In this case, the base is a circle so students will need to review how to find the area of a circle. The formula for the area of the circle is πr^2. To find the volume, students must multiply the base by the height. Substituting πr^2 in the formula for B, the formula is thus $V = \pi r^2h$. All final answers on volume are measured in cubic units.

10. Have students answer the following question in their journals: "Which produces a greater effect on the volume of a cylinder—changing the radius or changing the height?" After sharing student's ideas, have them complete *Effects on Volume* handout to justify their conclusions. Students should be able to use calculators to complete the computational work.

11. Explain the steps to the activity *Will You Be Wet or Dry?* to the class. Have each cooperative group of four students select a can from the teacher's collection. Students will need to find the measurements of the can and fill out the data required on the handout *Will You Be Wet or Dry?* as a group. After the volume

is calculated, groups will take turns presenting their data to the teacher and other class members. The teacher will then fill the can with the volume of water determined by the group over a team member's head. If the calculation is too high, the water will overflow onto the student's head. If the calculation is too low, then all of the water will get poured on their head. An inexpensive rain poncho should be available for students to use if they would like. Be ready for some fun and have the towels handy.

Assessment Suggestions

- Have students design a net of a cylindrical can for a new brand of peanut butter. After students have completed the writing and design work, they can put the cylinder together. Have students compute the surface area and volume of their can.
- Have students place three different cylinders in order from least to greatest volume using estimation. Have students calculate the actual volumes of each cylinder to check their work.
- Have students correct the *Surface Area Patterns* handout for an assessment grade.
- Have students correct the *Effects on Volume* handout for an assessment grade.

Curriculum Extensions/Adaptations/ Integration

- Have students look for cylinders in their environment and make a list of their findings in their math journals.
- Have students compare the parts of cylinders to the parts of cones and pyramids.
- Have students learn how to draw cylinders and other geometric shapes.
- Have students learn how the Mesopotamians used the cylindrical shape to invent cylinder seals, a method of marking property and signing documents in ancient times. Have students make cylinder seals from clay and put them on strings to wear as necklaces as did the Mesopotamians.
- Have students learn how the ancient Greeks used the cylindrical shape to design columns as part of their architecture. Have students work in groups of five. Give each member of the

group one sheet of 8 ½ x 11 paper. Tell students that their task is to create cylinders of any size to support a 12 x 12 whiteboard that will balance as many textbooks as possible on top. Tell students you have also heard that it is possible to balance a person on the whiteboard placed on paper cylinders instead of textbooks. Students may use scissors to cut their paper, and they may use scotch tape to hold the cylinders closed.

- Have students explore volume and surface area of other geometric solids.

Family Connections

- Have family members look for cylinder shapes at home. Share how cylinders are used.
- Have students look for cylindrical food cans. Compare the volumes listed on the labels. Explain to family members why certain cans have a greater volume.

Additional Resources

Books

Ancient Egyptians and Their Neighbors, An Activity Guide, by Marian Broida; ISBN 1-55652-360-2

An Ancient Greek Temple, by John Malam; ISBN 1904194680

Cubes, Cones, Cylinders, & Spheres, by Tana Hoban; ISBN 0-688-15326-7

How To Draw What You See, by Rudy de Reyna; ISBN 0-8230-2375-3

Web sites

http://www.mathopenref.com/cylindervolume.html

http://mathforum.org/brap/wrap/midlesson.html

http://www.aaaknow.com/geo79x10.htm

http://mykhmsmathclass.blogspot.com/2007/10/class-xactivity-11.html

http://nlvm.usu.edu/en/nav/frames_asid_275_g_3_t_4.html?from=category_g_3_t_4.html

http://nlvm.usu.edu/en/nav/frames_asid_273_g_3_t_4.html?from=category_g_3_t_4.html

http://www.youtube.com/watch?v=PVQ23DjT4sk

http://archaeology.about.com/od/mesopotamiaarchaeology/ig/Mesopotamian-Art/Cylinder-Seal.htm

http://illuminations.nctm.org/LessonDetail.aspx?ID=U122

http://www.harcourtschool.com/activity/mmath/mmath_dr_gee.html

http://io.uwinnipeg.ca/~jameis/PAGES/MYR64.html

Name ______________________________

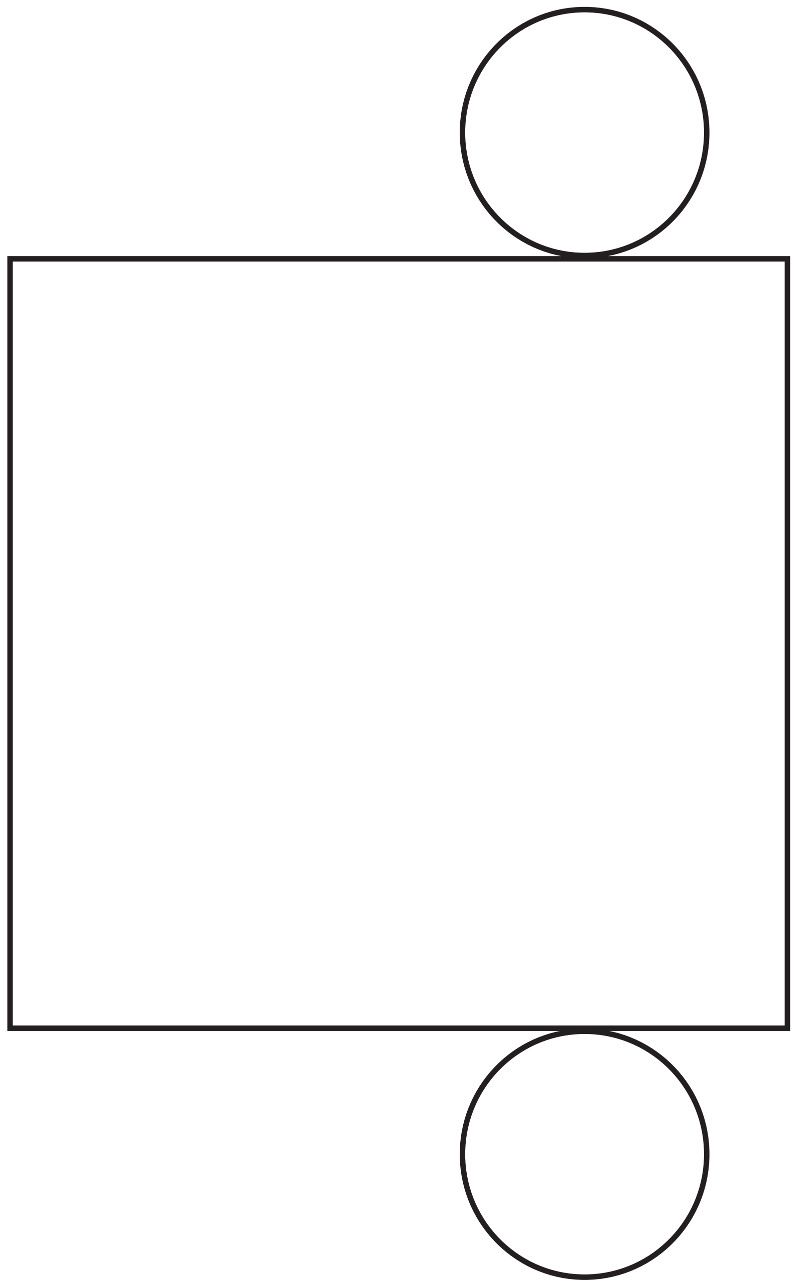
Which is Larger?

Directions: Carefully look at each cylinder. Decide whether you think the height or the circumference is larger. Mark an X under height or circumference to indicate your visual guess.   After the cylinder is measured, write yes if you guessed correctly or no if you guessed incorrectly.

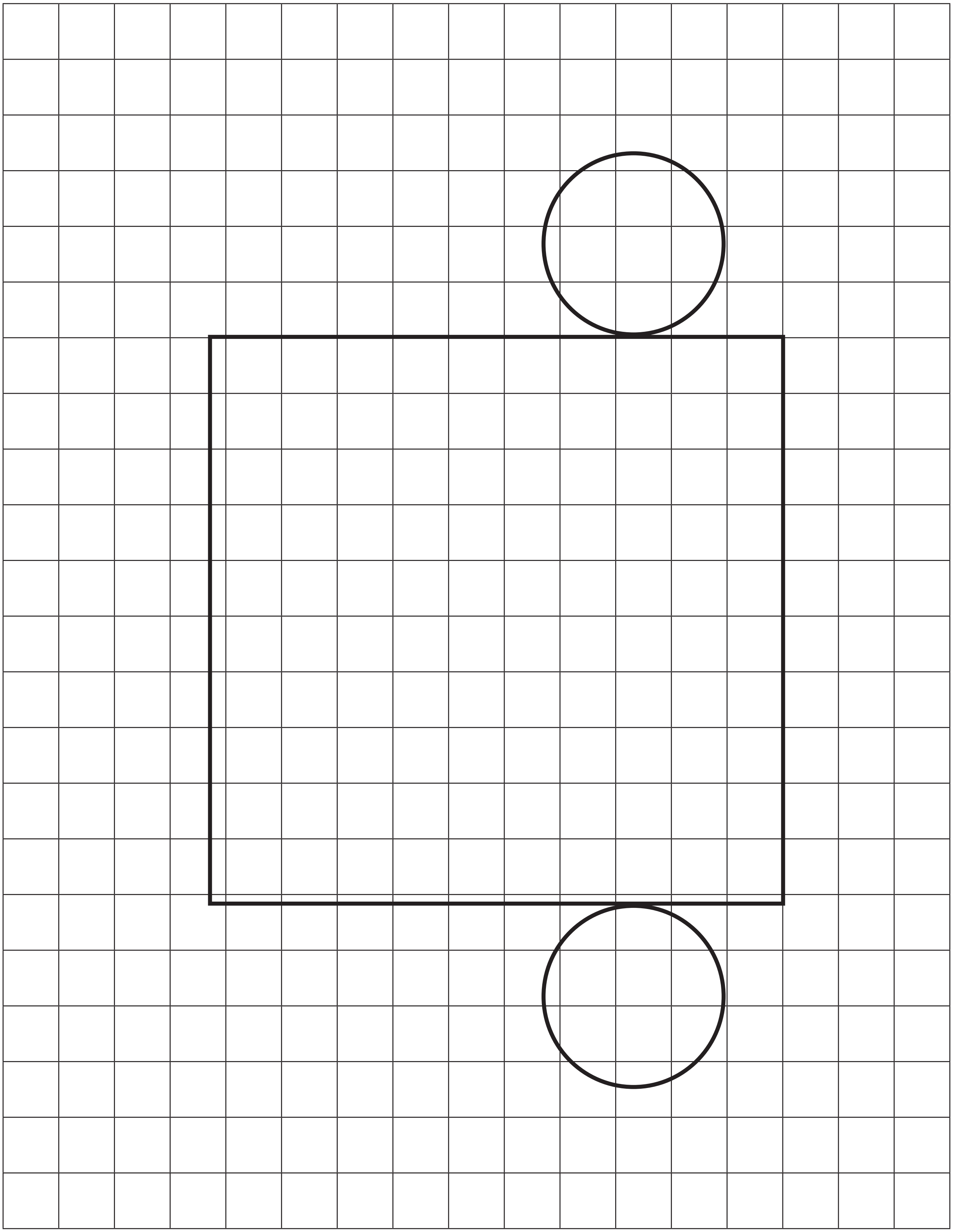
Cylinder Number	Height	Circumference	Correct?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

What conclusions might you draw from this activity? ____

Net of Cylinder



Surface Area of Cylinder



Name ______________________________

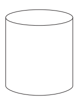
Surface Area Patterns

Find the surface area of the following cylinders:

Surface Area = $2\pi r^2 + 2\pi rh$

Set 1- Doubling

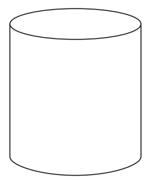
Cylinder 1



r = 2 cm.
h = 3 cm.

S = ________

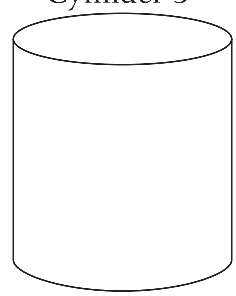
Cylinder 2



r = 4 cm.
h = 6 cm.

S = ________

Cylinder 3



r = 8 cm
h = 12 cm.

S = ________

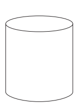
What pattern is produced in the surface area as the radius and height of the cylinders in Set 1 are doubled? Explain your answer. ____

____

What would the surface area be of a fourth cylinder in Set 1? ______________________

Set 2 - Tripling

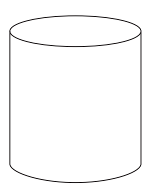
Cylinder 1



r = 2 cm.
h = 3 cm.

S = ________

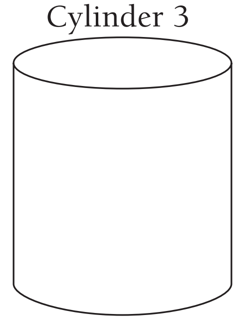
Cylinder 2



r = 6 cm.
h = 9 cm.

S = ________

Cylinder 3



r = 18 cm.
h = 27 cm.

S = ________

What pattern is produced in the surface area as the radius and height of the cylinders in Set 2 are tripled? Explain your answer. ____

____

What would the surface area be of a fourth cylinder in Set 2? ______________________

Volume Discoveries

Paper Dimensions	Height of Cylinder	Which held more?
8 ½" x 11"	8 ½"	
8 ½" x 11"	11"	

Paper Dimensions	Height of Cylinder	Which held more?
8" x 9"	8"	
8" x 9"	9"	

Paper Dimensions	Height of Cylinder	Which held more?
6 ½" x 10"	6 ½"	
6 ½" x 10"	10"	

Paper Dimensions	Height of Cylinder	Which held more?
4" x 11"	4"	
4" x 11"	11"	

Name ______________________________

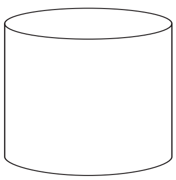
Effects On Volume

Find the volume of the following cylinders:

$$V = \pi r^2 h$$

Set 1

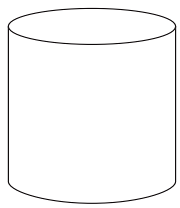
Control



r = 4 cm.
h = 5 cm.

V = ________

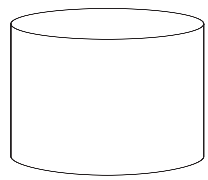
Change height



r = 4 cm.
h = 6 cm.

V = ________

Change radius

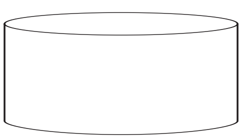


r = 5 cm
h = 5 cm.

V = ________

Set 2

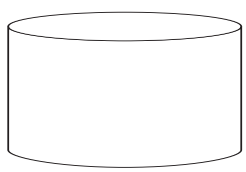
Control



r = 6 cm.
h = 3 cm.

V = ________

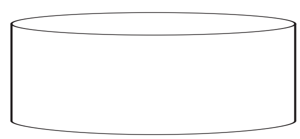
Change height



r = 6 cm.
h = 4 cm.

V = ________

Change radius



r = 7 cm.
h = 3 cm.

V = ________

Question

Which produced a greater effect on the volume of a cylinder—changing the radius or changing the height? Explain your answer. ____

____

Name ________________________________

Will You Be Wet or Dry?

1. Select a can from the teacher's collection for your cooperative group to use for this activity.

2. Use a measuring tape to measure the diameter and height of the can to the nearest tenth of a centimeter.

   Diameter = ________________

   Height = __________________

3. As a group, determine the volume of the can based on your measurements. You may refer to your math journals as needed. Show your work below and explain how you found the volume of your can. Make sure that your units are correct. (Hint: One cubic centimeter is the same as one milliliter.)

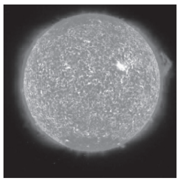
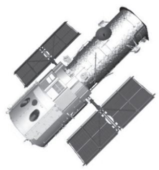
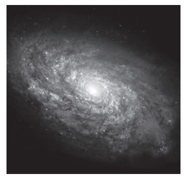
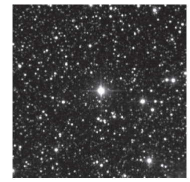
   VOLUME = __________________________

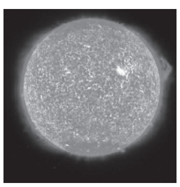
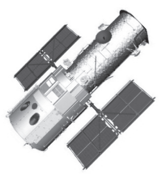
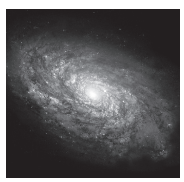
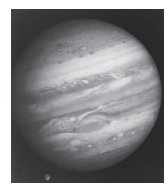
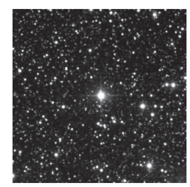
4. Bring your can and your volume calculation to the teacher. One member of your team will be selected to test your calculations. The test will be done by having the teacher fill your can with water over the team member's head. Remember: If you calculate too high of a number, the water will overflow on the person's head. If you calculate too low of a number, then all of the water will be dumped on the person's head.

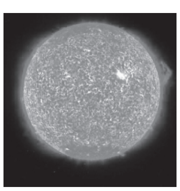
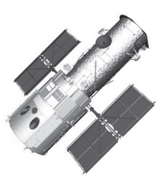
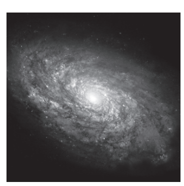
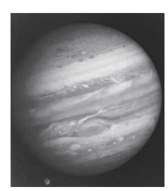
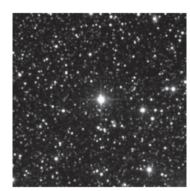
Appendix

What MI am I? Graph

verbal/ linguistic	logical/ mathematical	visual spatial	musical/ rhythmic	bodily kinesthetic	naturalist	inter personal	intrapersonal

					
Sun	Hubble Space Telescope	Galaxy	Moon	Jupiter	Alpha Centarui

					
Sun	Hubble Space Telescope	Galaxy	Moon	Jupiter	Alpha Centarui

					
Sun	Hubble Space Telescope	Galaxy	Moon	Jupiter	Alpha Centarui

Name ________________________________

Interest Grouping

Please rate these on a scale of 1 - 6, with 1 being your most favorite and 6 being your least favorite.

[ ] Write

[ ] Draw

[ ] Act (Drama)

[ ] Build

[ ] Research

[ ] Music/Singing

Name ________________________________

Interest Grouping

Please rate these on a scale of 1 - 6, with 1 being your most favorite and 6 being your least favorite.

[ ] Write

[ ] Draw

[ ] Act (Drama)

[ ] Build

[ ] Research

[ ] Music/Singing

Name ________________________________

Interest Grouping

Please rate these on a scale of 1 - 6, with 1 being your most favorite and 6 being your least favorite.

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[ ] Build

[ ] Research

[ ] Music/Singing

Name ________________________________

Interest Grouping

Please rate these on a scale of 1 - 6, with 1 being your most favorite and 6 being your least favorite.

[ ] Write

[ ] Draw

[ ] Act (Drama)

[ ] Build

[ ] Research

[ ] Music/Singing

Tic-Tac-Toe Menu Astronomy

You should select any three of the following activities to complete your Astronomy Project.

Due Dates: 1st activity:
2nd activity:
3rd activity:

Venn Diagram Create a Venn Diagram in a creative shape comparing one object in space to another. Choose from: planets, comets, asteroids, meteoroids, constellations, or satellites.	**News Article** Write a newspaper article detailing a significant event in astronomy. Be sure to include the 5 W's: who, what, where, when, and why. You may also write a news brief about an upcoming event.	**Acrostic poem** Create an acrostic poem or phrases and sentences about one of the planets. Your phrases should apply specifically to your planet, not just planets in general.
Letter Write a one-page letter to the President explaining the benefits of continuing the funding for space exploration. Include at least five "Space Spinoffs" used today from the space program (for example: velcro).	**Free Space** You create a fun activity about your subject. Remember to have it approved by your teacher before you begin.	**Space Glossary** Create a glossary of at least 10 astronomical terms. Define each term and provide an example of how that object is used/found in space.
Diary Entries Write seven diary entries that might have been written by an astronaut or someone working in the space program.	**Conflict Paper** Should Pluto have been demoted to the status of a Dwarf Planet, or remained classified as a planet? Write a 5-paragraph essay stating your opinion of this.	**Scrapbook Pages** Create two scrapbook pages of a space launch. Include the purpose of the launch, people involved, and time line of the launch. (jpl website)

Tic-Tac-Toe Rubric

Type of Activity	A Grade	B Grade	C Grade
Venn Diagram			Venn Diagram Drawn 3 similarities, 3 differences, and 3 things in common
News Article			News article, at least 2 paragraphs, and includes 5 Ws
Acrostic Poem			One word per letter of a planet
Letter			Written in letter format, includes 2 ways we use Space Spinoffs
Space Glossary			Includes at least 7 technology terms and definitions
Diary Entries			Includes 5 diary entries of at least 3 sentences each.
Conflict			Includes a thesis statement and 2 - 3 paragraphs why Pluto should be a planet.
Scrapbook Pages			Two scrapbook pages that include 1 of the 3 requirements

拳術 NIM 秋天

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

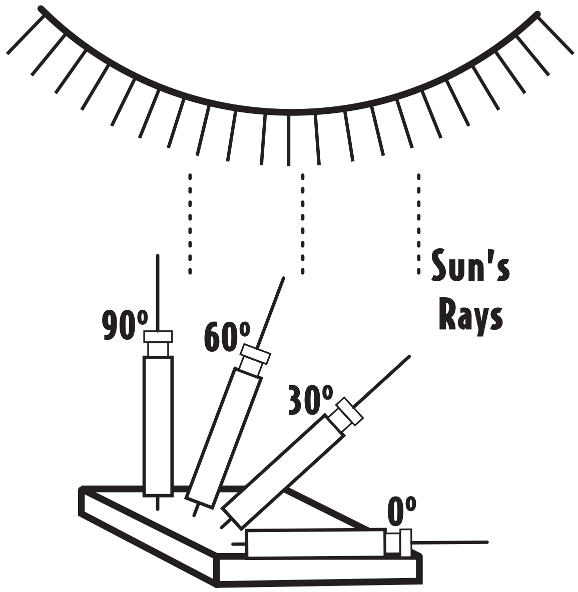
Instructions for Play:

You cannot

Winning Strategies:

Name ________________________________

Sunray Data Collection Sheet



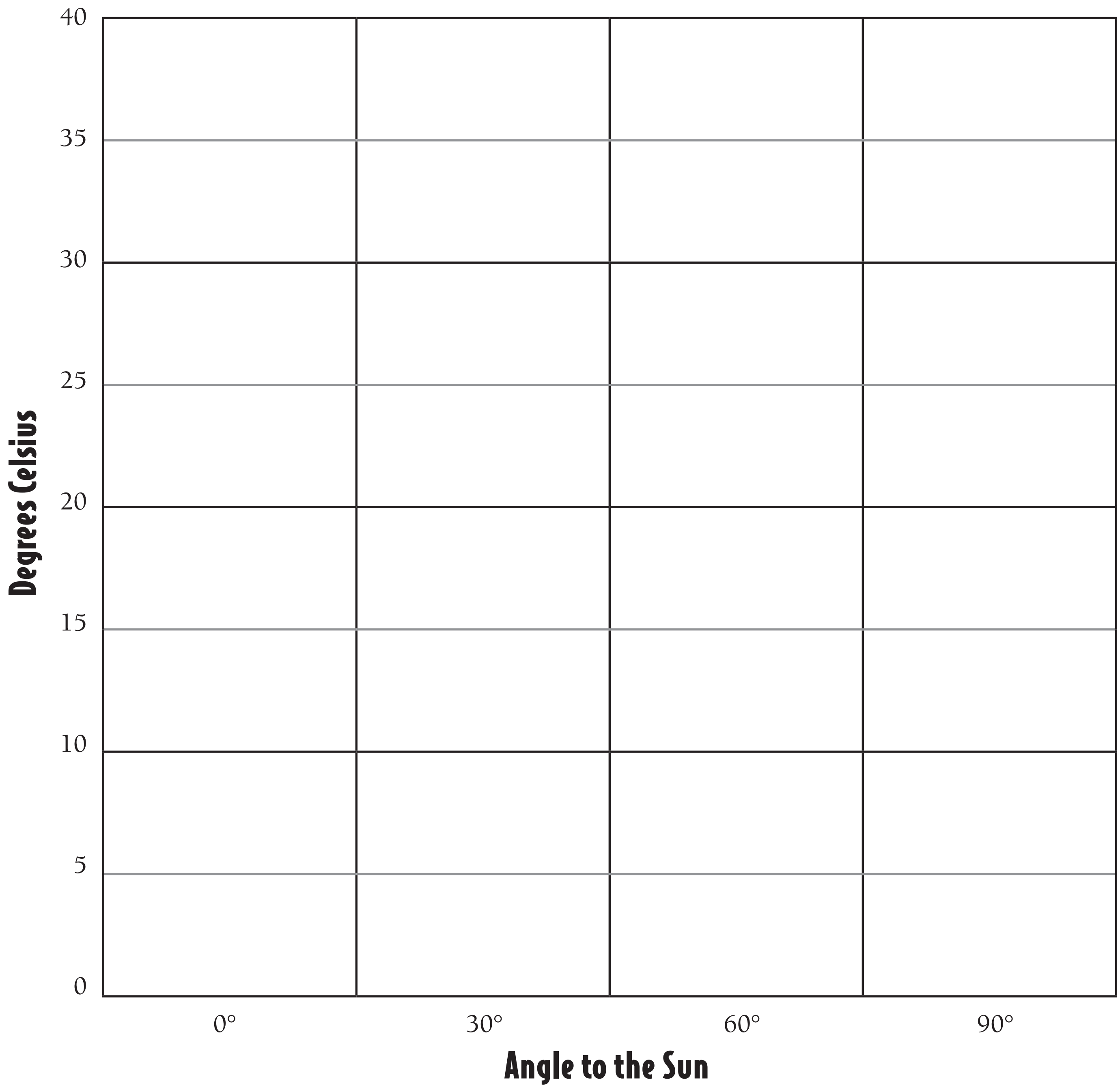
Angle of Thermometer to Sun's Rays

	0 degrees	30 degrees	60 degrees	90 degrees
beginning temperature				
10 minutes				
20 minutes				
30 minutes				
AVERAGE TEMPERATURE				

What did you discover about the angle of the sun's rays and the temperature?

Name ________________________________

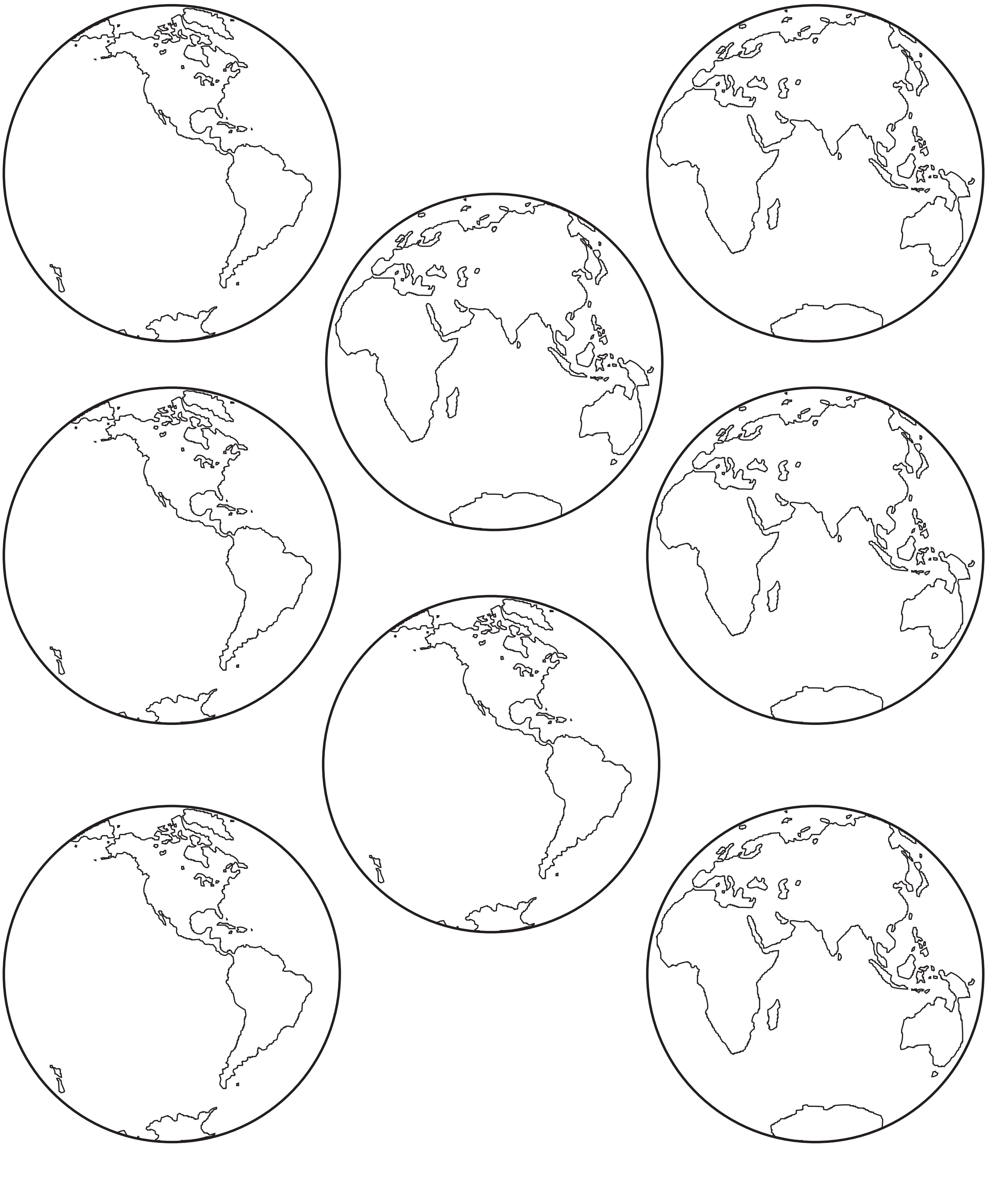
Sunray Bar Graph



← Least Direct Sunrays   Most Direct Sunrays →

Earth Models

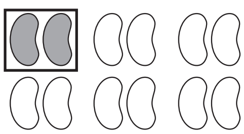
Western Hemisphere **Eastern Hemisphere**



Modeling Multiplication of Fractions Sheet

Steps to Model Multiplication of Fractions:

1. First, look at the whole number. That determines the number of beans to start with.
2. Next, look at the denominator of the fraction. That shows you how many shares (ways to divide) the whole number.
3. Then, look at the nominator the fraction. That shows you how many shares you want to draw a box around.
4. Finally, look at how many beans you covered. That is the answer.

1. 1/6 of 12  1/6 of 12 = 2	2. 3/4 of 12	3. 7/12 of 12	4. 2/3 of 12
5. 2/5 of 10	6. 2/3 of 9	7. 1/3 of 12	8. 5/6 of 12
9. 3/5 of 10	10. 2/4 of 16	11. 4/5 of 15	12. 3/8 of 16
Now You Try! Make up your own problem by adding a numerator to each problem.			
13. ?/8 of 16	14. ?/9 of 36	15. ?/6 of 24	16. ?/8 of 32

EXPLAIN THIS TO YOUR PARTNER… LET ‘S TALK ABOUT MATH!

Can you see a pattern?

Try this…

1/4 of 12

2/4 or 1/2 of 12

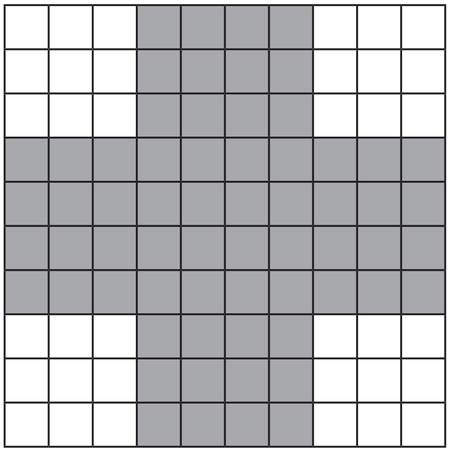
3/4 of 12

4/4 of 12

The Tile Center Sheet

At the Tile Center all tiles are $1.60

Pattern 1



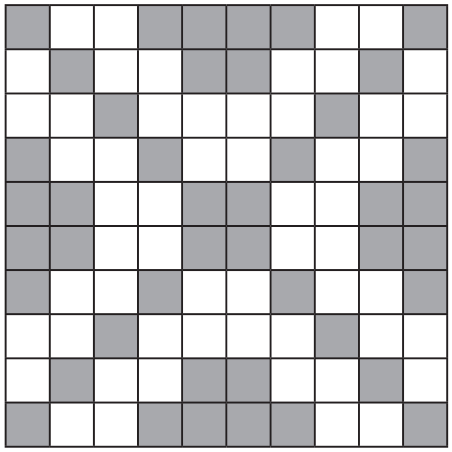
How much is shaded?

Fraction: ____________________

Decimal: ____________________

Percent: ____________________

Pattern 2



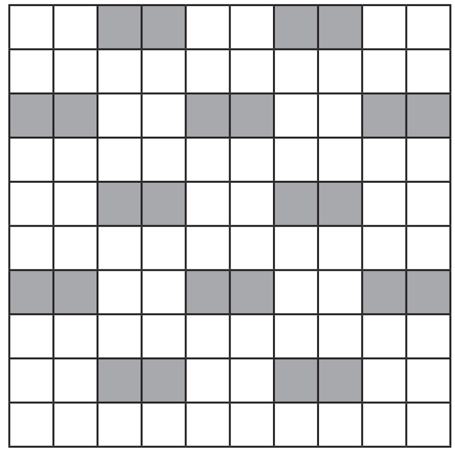
How much is shaded?

Fraction: ____________________

Decimal: ____________________

Percent: ____________________

Pattern 3



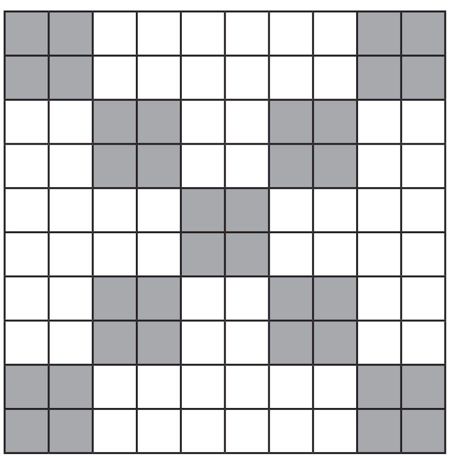
How much is shaded?

Fraction: ____________________

Decimal: ____________________

Percent: ____________________

Pattern 4



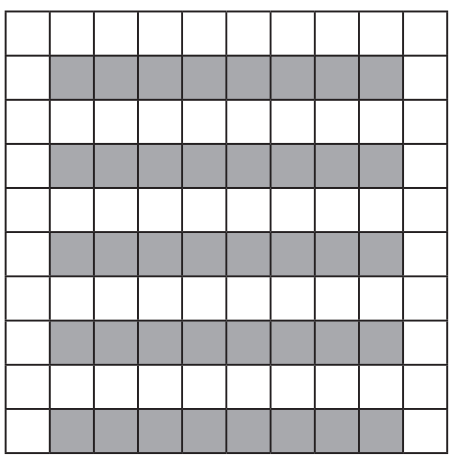
How much is shaded?

Fraction: ____________________

Decimal: ____________________

Percent: ____________________

Pattern 5



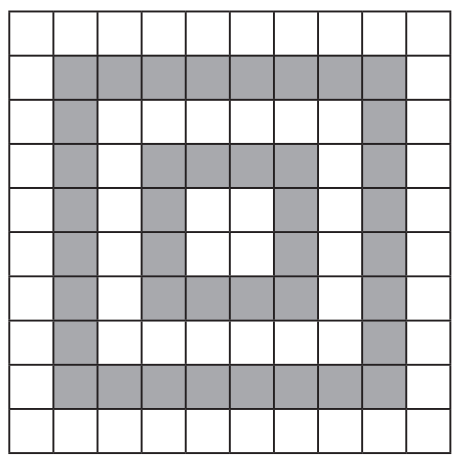
How much is shaded?

Fraction: ____________________

Decimal: ____________________

Percent: ____________________

Pattern 6



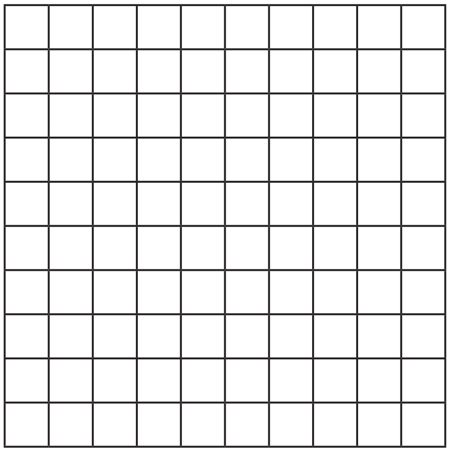
How much is shaded?

Fraction: ____________________

Decimal: ____________________

Percent: ____________________

Custom Tiles Sheet

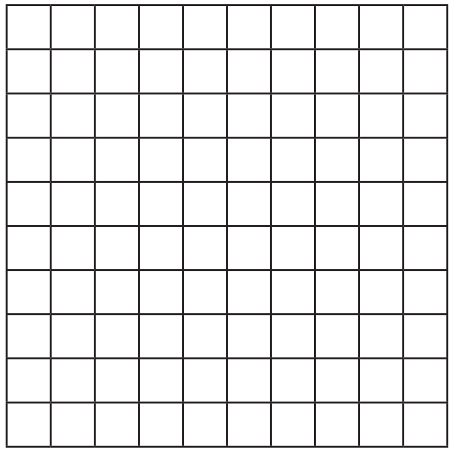


How much is shaded?

Fraction: __________

Decimal: __________

Percent: __________

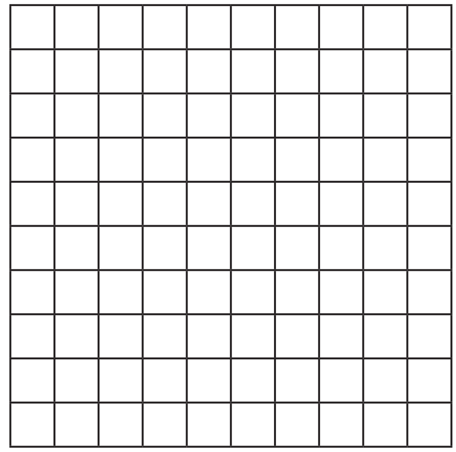


How much is shaded?

Fraction: __________

Decimal: __________

Percent: __________

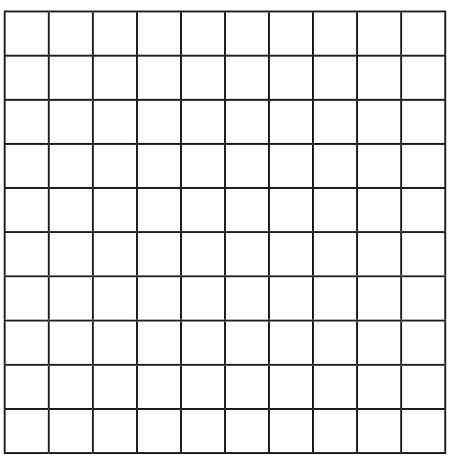


How much is shaded?

Fraction: __________

Decimal: __________

Percent: __________

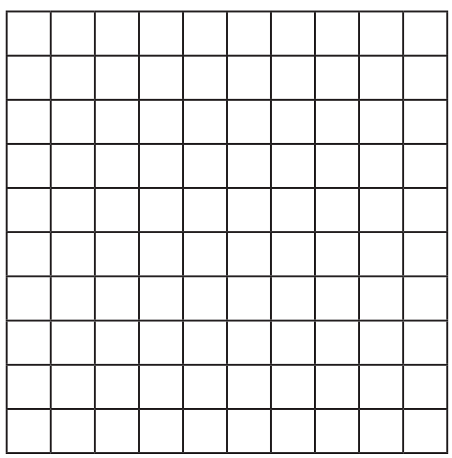


How much is shaded?

Fraction: __________

Decimal: __________

Percent: __________

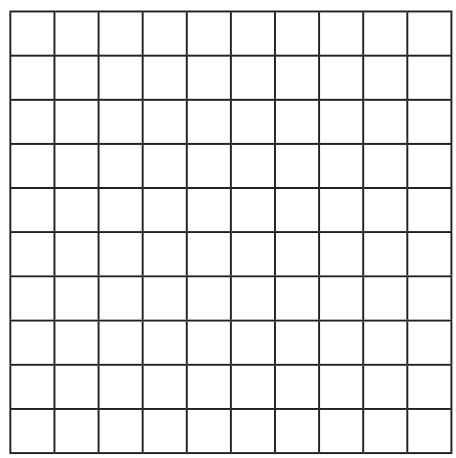


How much is shaded?

Fraction: __________

Decimal: __________

Percent: __________



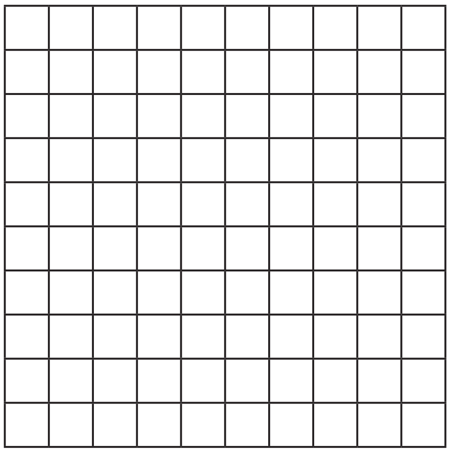
How much is shaded?

Fraction: __________

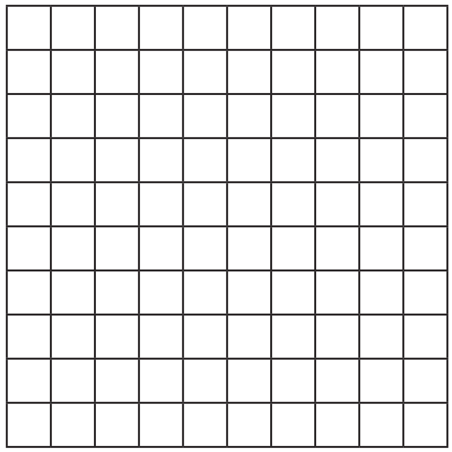
Decimal: __________

Percent: __________

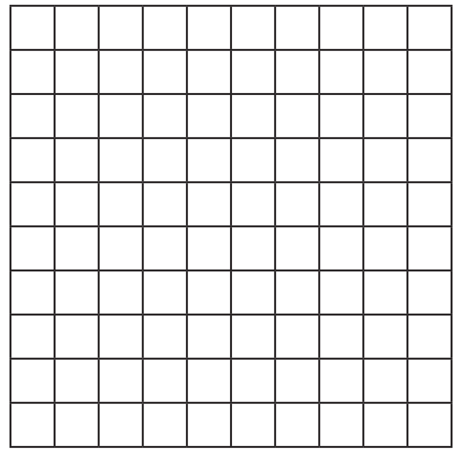
Custom Tiles Sheet



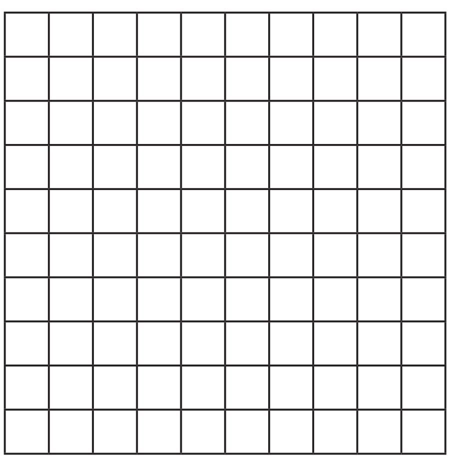
How much is shaded?



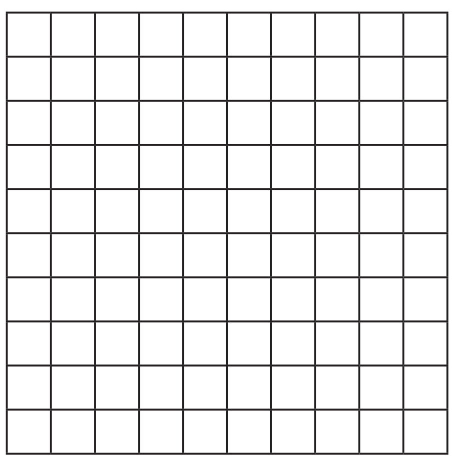
How much is shaded?



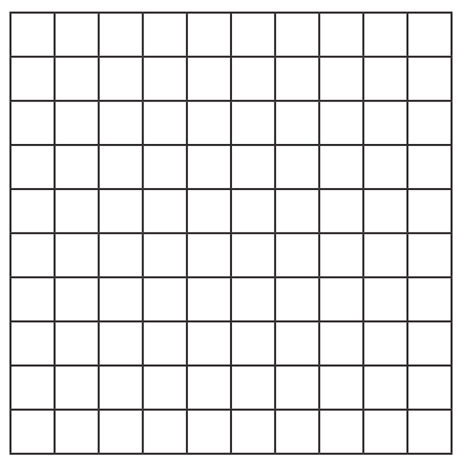
How much is shaded?



How much is shaded?



How much is shaded?



How much is shaded?

Estimating Equivalencies

Fraction	1/2	1/3	1/4	1/5	1/6	1/7	1/8	1/9	1/10
Can I change my denominator to 100?									
How?									
If no, how close can I get to 100?									
How?									
Multiply the numerator & denominator by the same number!									
Fraction									
Decimal									
Percent									

Fractured Line Game

The top number of a fraction is called the numerator. The bottom number is called the demoninator. 4/5	The numerator tells you how many of the parts you have.The denominator of a fraction tells how many equal parts something has been divided into. n/d	Percent (%) means out of a hundred, per hundred, or hundreths. 1% or .01

fold line

	1/2	2/2
	1/2	1/2

	1/3	2/3	3/3
	1/3	1/3	1/3

	1/4	2/4	3/4	4/4
	1/4	1/4	1/4	1/4

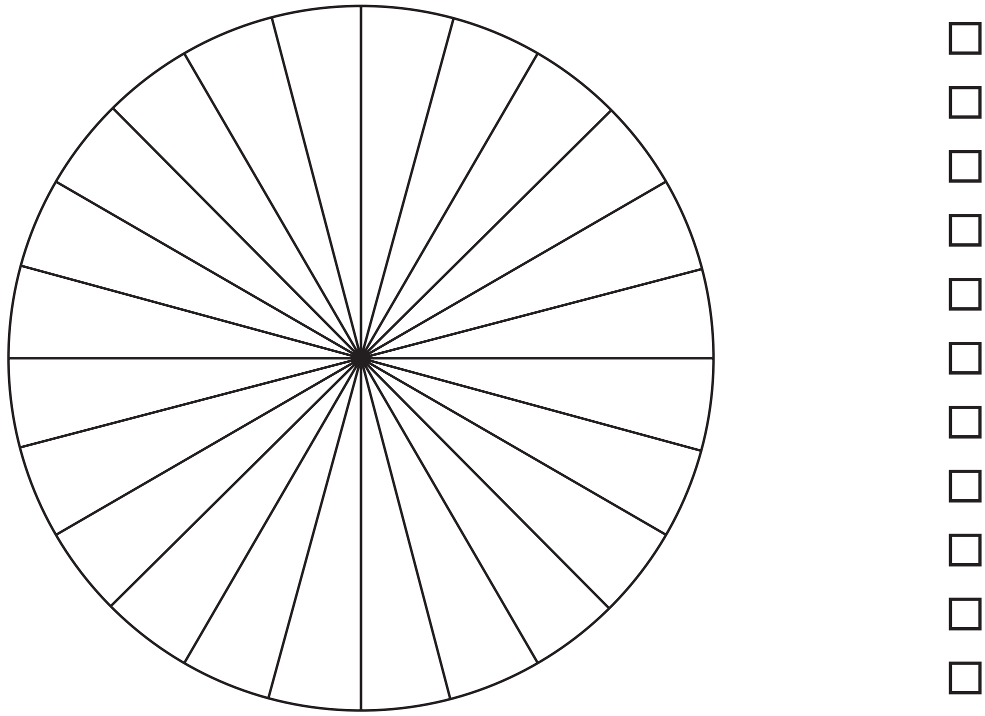
	1/5	2/5	3/5	4/5	5/5
	1/5	1/5	1/5	1/5	1/5

	1/6	2/6	3/6	4/6	5/6	6/6
	1/6	1/6	1/6	1/6	1/6	1/6

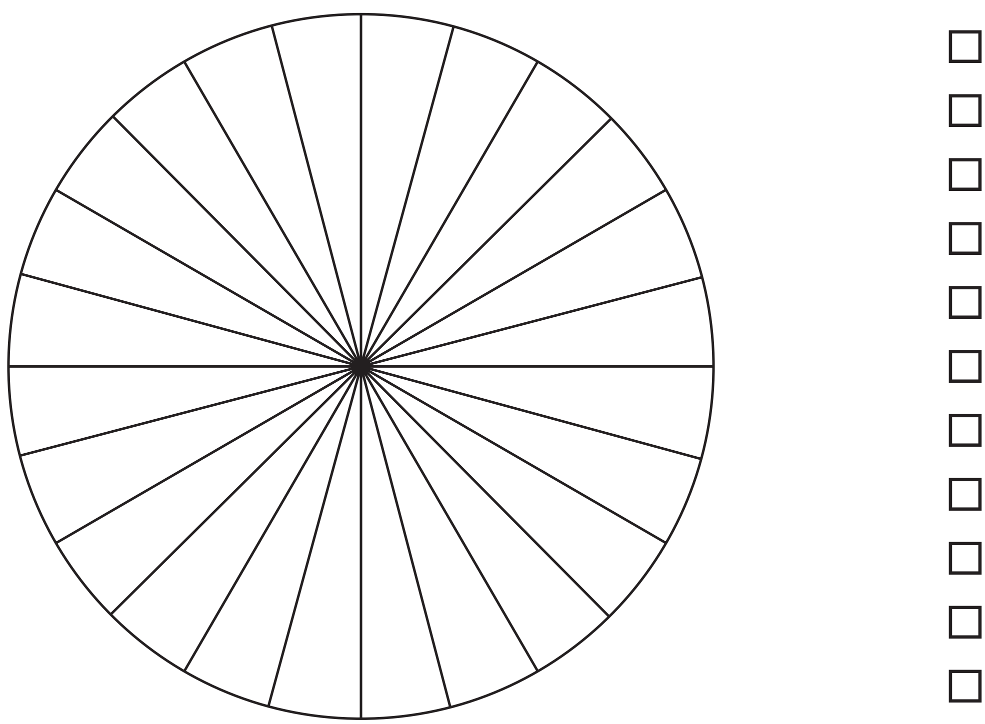
	1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10
	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10

	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

What Have I Done for the Past 24 Hours?



What Have I Done for the Past 24 Hours?



Name ______________________ Partner ______________________

Situational Data

Directions: One partner will roll the dice and create a graph based on what was rolled, using the data for #1. The other partner will choose and create a different graph with the same data. After #1, the roles will reverse. Remember to title and label each graph!

1. A scientist made the following observations:

Hour	Microorganisms
1	2
2	4
3	8
4	16
5	32
6	128
7	

How many microorganisms will there be in the 7th hour? Graph your prediction.

2. Results of the boys' high jump event at the track meet:

Participant	Height (feet & inches)
Jacob	4' 10"
Cole	4' 6"
Ben	3' 10"
Jeff	2' 10"
Kenny	4' 8"
Rico	4' 2"

3. Planet distances, in Astronomical Units (AU), from the Sun:

Planet	Distance (AU)
Mercury	0.4
Venus	0.7
Earth	1.0
Mars	1.5
Jupiter	5
Saturn	10
Uranus	20
Neptune	30
Pluto (minor planet)	39.5

4. Growth of the Earth's human population:

Year (A.D.)	Number of People (in billions)
1650	.50
1750	.70
1850	1.0
1925	2.0
1956	2.5
1976	4.0
1991	5.5
2000	6.0
2004	6.4

5. Major military and civilian casualties in World War II, by country:

Country	Casualties
USSR	21,300,000
China	11,324,000
Germany	7,060,000
Poland	6,850,000
Japan	2,000,000
Yugoslavia	1,706,000
Rumania	985,000

6. Countries with the largest population:

Country	Population
China	1,323,000,000
India	1,128,000,000
United States	303,000,000
Indonesia	231,000,000
Brazil	186,000,000
Pakistan	162,000,000
Bangladesh	158,000,000

Reflection:

1. Which graph was most useful overall? ______________________
2. Which graph would be most effective for the data in #1 (time)? ______________________
3. Which graph do you have a hard time understanding? ______________________

Test Yourself: Conduction, Convection, and Radiation

Choose _____ of the following situations and write your responses in your journal. Please use at least one of the three types of heat transfer in each response.

1. In the evening, snow falls on a cement sidewalk and on a black top playground. Which surface will melt the snow faster and why?

2. Two identical cups of hot cocoa are sitting on a table. One has a metal spoon in it and one does not. After five minutes, which cup is cooler?

3. When a person steps from a shower on a cold morning, why does the tile floor seem so much colder than the air?

4. On a hot summer day, should you close all of the blinds and curtains in your home or leave them open? Why?

5. Although you do not touch the flames, your chest feels warm while you are sitting in front of a fireplace. Why does your back still feel cold?

6. The outdoor temperature is 85°F, and your friend comes to school in a dark blue outfit. Was this a smart clothing choice for today? Why or why not?

7. Why is your house warmer on the top floor and colder in the basement?

8. Your mom bakes a cake in a glass pan and you use a metal pan. How does heat transfer affect each pan?

9. Explain how the following situation occurs using conduction, convection, and radiation: A pot of water boils on a hot stove.

10. Explain how the following situation occurs using conduction, convection, and radiation: On a hot day, an ice cream cone in your hand falls on the sidewalk and immediately begins melting.

Which Uses More Energy?

Energy is the *ability to do work*. Circle the option that you think uses the most energy.

1. All electric power plants or all U.S. cars?
2. Coal power plant or space shuttle?
3. 20 light bulbs or a horse?
4. The space shuttle or 50 airplanes?
5. A big ship or a big airplane?
6. An SUV or 100 horses?
7. 2,000 light bulbs or a small car?
8. On average, one American or two people from somewhere else in the world?

In your science journal, brainstorm a list of daily activities that use energy. Try to think of at least ten.

Which Uses More Energy? Answer Key

Energy is the ability to do work. Circle the option that you think uses the most energy.

1. All electric power plants or all U.S. cars? All U.S. cars (all U.S. cars = 7 times all power plants)
2. Coal power plant or space shuttle? Space shuttle (space shuttle = 14 plants)
3. 20 light bulbs or a horse? 20 light bulbs (20 light bulbs = 2 horses)
4. The space shuttle or 50 airplanes? Space shuttle (space shuttle = 56 airplanes)
5. A big ship or a big airplane? Big airplane (4 airplanes = 5 ships)
6. An SUV or 100 horses? SUV (SUV = 160 horses)
7. 2,000 light bulbs or a small car? Light bulbs (car = 1,000 light bulbs)
8. On average, one American or two people from somewhere else in the world? One American (Americans use 5 times as much power: 100 light bulbs a year compared to 20 light bulbs a year)

In your science journal, brainstorm a list of daily activities that use energy. Try to think of at least ten. These may include: television, computer, lights, music players and other electronics, stove, oven, washer/dryer, car, bath, outside doors, thermostat, fireplace, windows, appliances, such as toaster, blow dryer, can opener, etc.

Insulation Table

Materials, Time, & Degrees (F)	Control	Material 1 _________	Material 2 _________	Material 3 _________	Material 4 _________	Material 5 _________
Starting Temp						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
Change in temp from start to finish						

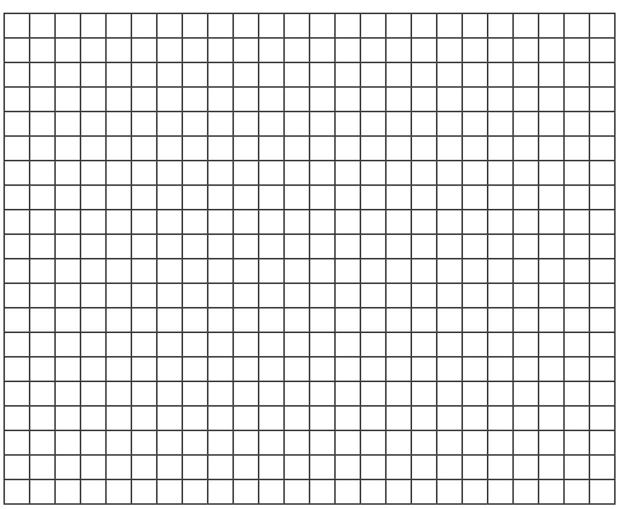
Insulation Graph

Goldilocks Table

Bowls, Time, & Degrees (F)	Large Bowl	Medium Bowl	Small Bowl	Large Bowl 2	Medium Bowl 2	Small Bowl 2
Starting Temp (in °)						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
___ min						
Change in temp from start to finish						

Goldilocks Graphs

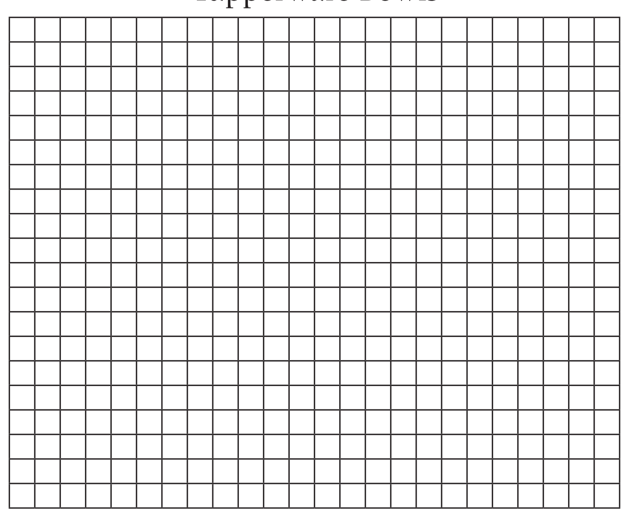
Glass Bowls



Temperature

Time (minutes)

Tupperware Bowls



Temperature

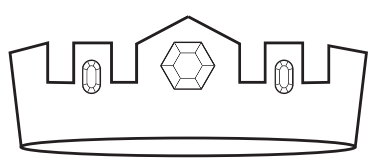
Time (minutes)

Name ______________________________

Metric Measurement

To convert to a smaller unit, move the decimal point to the right the same number of steps taken by King Henry. This is the same as multiplying by ten for each step taken by King Henry. Moving to a smaller unit means you will have a greater number.

To convert to a larger unit, move the decimal point to the left the same number of steps taken by King Henry. This is the same as dividing by ten for each step taken by King Henry. Moving to a larger unit means you will have a lesser number.



Metric Measurement Steps

King	Henry	does	USUALLY

drink	chocolate	milk

Name ______________________

Metric Conversion Record Sheet

	10^3	10^2	10^1	10^0	10^-1	10^-2	10^-3
	kilo	hecto	deka	UNIT	deci	centi	milli
	k	h	da	1	d	c	m
ex.	0.012	0.12	1.2	12	120	1200	12000
1		56					
2					192		
3				30			
4							
5	8.19						
6			654				
7						7	
8							984
9				6.26			
10		0.43					
11	681						
12					3.22		
13			94.2				
14						0.5	
15				97.2			

Name ________________________________

Metric Tic Tac Toe

Directions: Find three equivalent measures in a row to complete a Tic Tac Toe.

5 kg	5000 g	50 hg
5 mg	5000 cg	5 g
5 hg	50 cg	500 cg

7 km	700 dam	7 m
7 m	70 cm	700 cm
7 cm	7 dam	70 dm

80 mL	8 kL	8 L
8 dL	80 cL	800 mL
800 L	80 hL	8 daL

2 kg	20 mg	20 g
20 hg	2 dag	200 g
200 dg	2 cg	2 hg

3 hm	30 cm	3000 m
30 m	30 dam	300 dam
300 cm	3 m	300 m

9000 L	90 hL	900 daL
90 L	90 daL	900 L
900 dL	9000 cL	9 kL

Name ______________________________

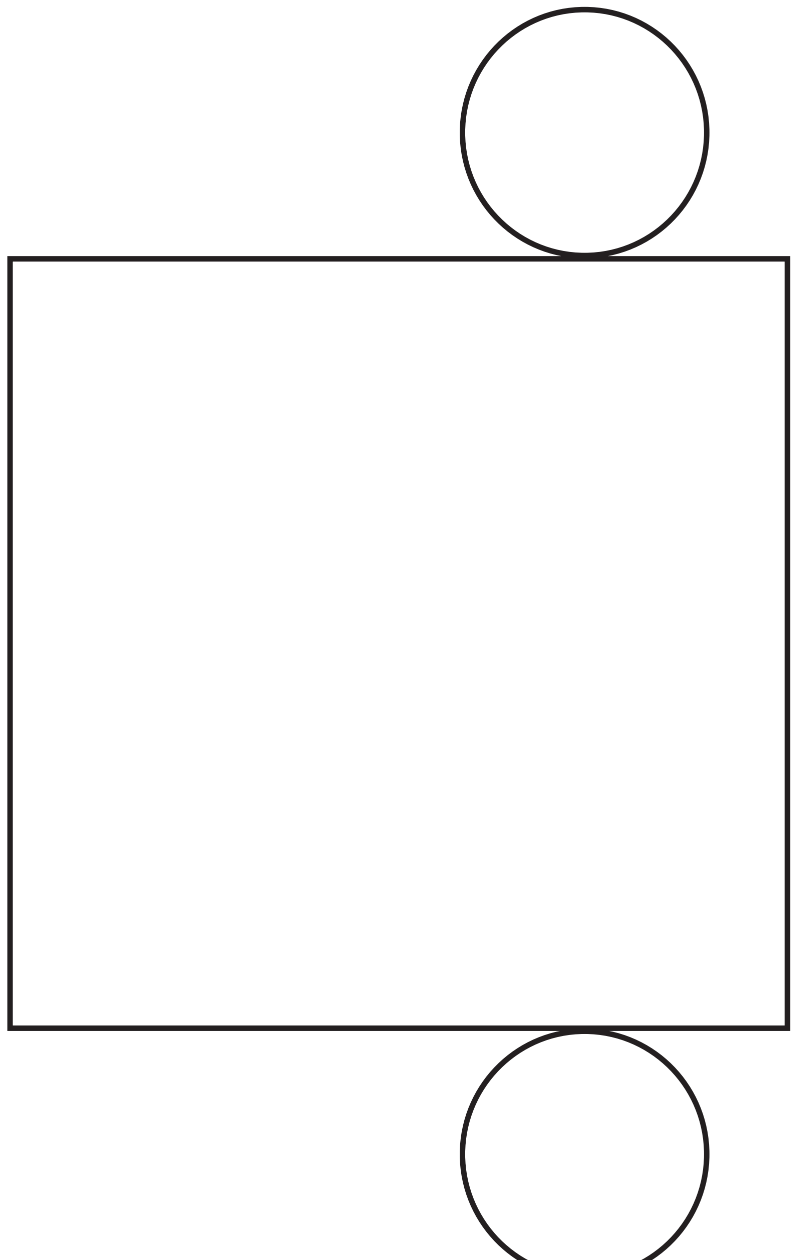
Which is Larger?

Directions: Carefully look at each cylinder. Decide whether you think the height or the circumference is larger. Mark an X under height or circumference to indicate your visual guess. After the cylinder is measured, write yes if you guessed correctly or no if you guessed incorrectly.

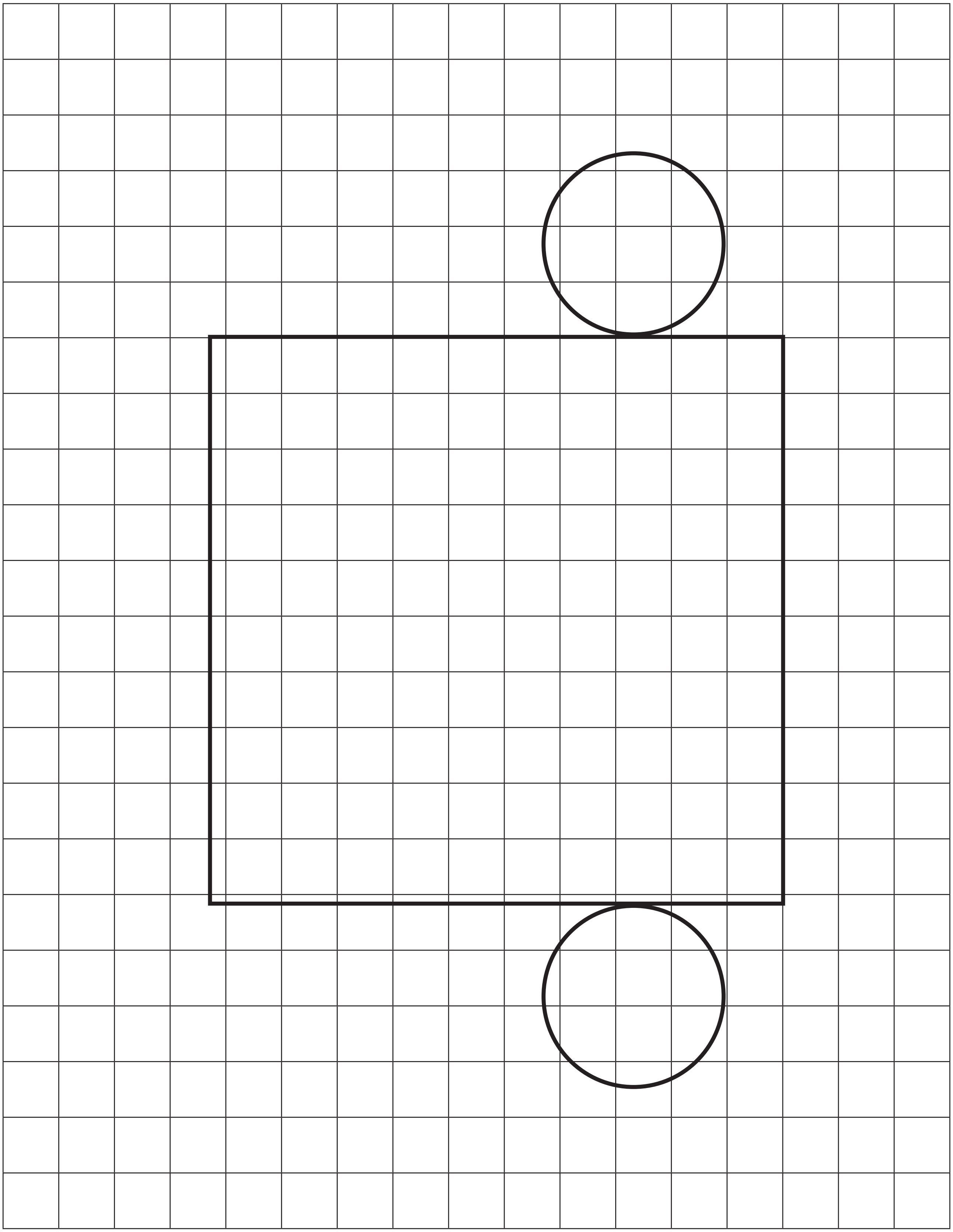
Cylinder Number	Height	Circumference	Correct?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

What conclusions might you draw from this activity? ____

Net of Cylinder



Surface Area of Cylinder



Name ______________________________

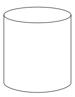
Surface Area Patterns

Find the surface area of the following cylinders:

$$\text{Surface Area} = 2\pi r^2 + 2\pi rh$$

Set 1- Doubling

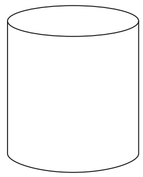
Cylinder 1



r = 2 cm.
h = 3 cm.

S = ________

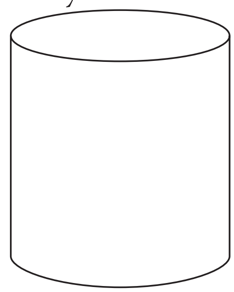
Cylinder 2



r = 4 cm.
h = 6 cm.

S = ________

Cylinder 3



r = 8 cm
h = 12 cm.

S = ________

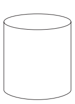
What pattern is produced in the surface area as the radius and height of the cylinders in Set 1 are doubled? Explain your answer. ____

____

What would the surface area be of a fourth cylinder in Set 1? ____________________

Set 2 - Tripling

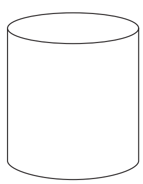
Cylinder 1



r = 2 cm.
h = 3 cm.

S = ________

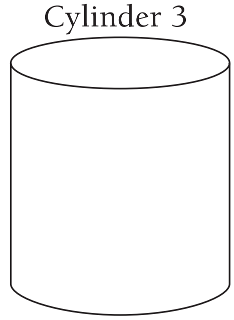
Cylinder 2



r = 6 cm.
h = 9 cm.

S = ________

Cylinder 3



r = 18 cm.
h = 27 cm.

S = ________

What pattern is produced in the surface area as the radius and height of the cylinders in Set 2 are tripled? Explain your answer. ____

____

What would the surface area be of a fourth cylinder in Set 2? ____________________

Volume Discoveries

Paper Dimensions	Height of Cylinder	Which held more?
8 ½" x 11"	8 ½"	
8 ½" x 11"	11"	

Paper Dimensions	Height of Cylinder	Which held more?
8" x 9"	8"	
8" x 9"	9"	

Paper Dimensions	Height of Cylinder	Which held more?
6 ½" x 10"	6 ½"	
6 ½" x 10"	10"	

Paper Dimensions	Height of Cylinder	Which held more?
4" x 11"	4"	
4" x 11"	11"	

Name ________________________________

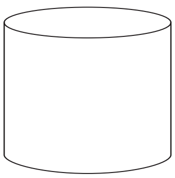
Effects On Volume

Find the volume of the following cylinders:

$$V = \pi r^2 h$$

Set 1

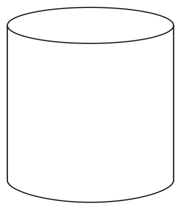
Control



r = 4 cm.
h = 5 cm.

V = ________

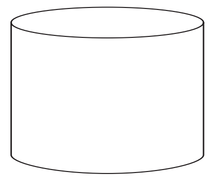
Change height



r = 4 cm.
h = 6 cm.

V = ________

Change radius

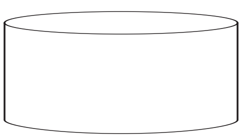


r = 5 cm
h = 5 cm.

V = ________

Set 2

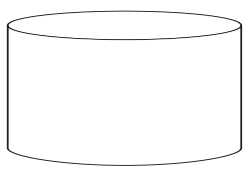
Control



r = 6 cm.
h = 3 cm.

V = ________

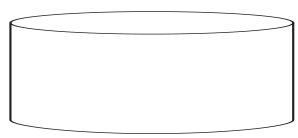
Change height



r = 6 cm.
h = 4 cm.

V = ________

Change radius



r = 7 cm.
h = 3 cm.

V = ________

Question

Which produced a greater effect on the volume of a cylinder—changing the radius or changing the height? Explain your answer. ____

____

Name ________________________________

Will You Be Wet or Dry?

1. Select a can from the teacher's collection for your cooperative group to use for this activity.

2. Use a measuring tape to measure the diameter and height of the can to the nearest tenth of a centimeter.

   Diameter = _______________

   Height = _________________

3. As a group, determine the volume of the can based on your measurements. You may refer to your math journals as needed. Show your work below and explain how you found the volume of your can. Make sure that your units are correct. (Hint: One cubic centimeter is the same as one milliliter.)

   VOLUME = _________________________

4. Bring your can and your volume calculation to the teacher. One member of your team will be selected to test your calculations. The test will be done by having the teacher fill your can with water over the team member's head. Remember: If you calculate too high of a number, the water will overflow on the person's head. If you calculate too low of a number, then all of the water will be dumped on the person's head.