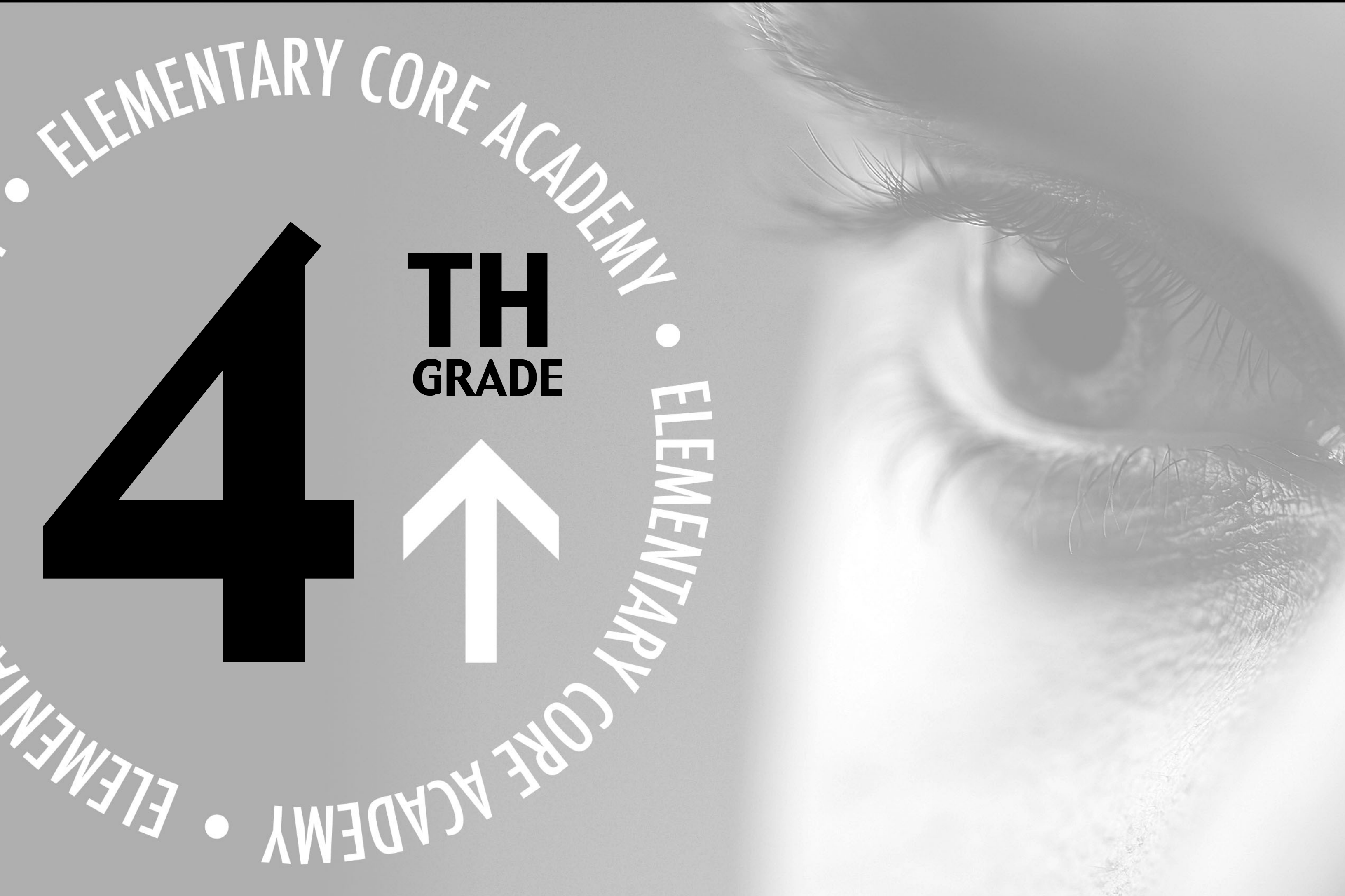

ELEMENTARY CORE ACADEMY

TEACHERS OF UTAH, LOCAL SCHOOL DISTRICTS,
UTAH STATE OFFICE OF EDUCATION, & UTAH STATE UNIVERSITY

Utah State UNIVERSITY

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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)
WestEd Eisenhower Regional Consortium

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Dear Core Academy Teachers:

Your involvement in the Core Academy represents a significant investment by you, your school, and district in educational excellence for the students of Utah. I commend you for your dedication and willingness to engage in meaningful professional growth. Efforts by teachers and administrators to develop, provide, and participate in high quality professional development programs must continue if we desire quality learning experiences for all children.

As the needs of students change, it is critical that educators adjust to meet those needs. Teachers should continue to gain expertise in the collection and use of accurate data and analysis of each student's level of achievement. This investment in accountability will empower teachers, parents, and others educators to be more effective.

Exemplary models of instruction, practical application, and collegial support must be an integral part of all professional development. Embedding sound instructional methods that specifically align to the state Core Curriculum will equip teachers with the skills and tools to meet the needs of Utah students.

It is my belief that educators care deeply about their students and work hard to create successful experiences in the classroom. Despite some challenges facing our schools, dedicated and professional educators make profound differences each day.

Sincerely,

Steven O. Laing

Steven O. Laing, Ed.D.
State Superintendent of Public Instruction

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

Major funding for the Academy comes from the following sources:

State Funds:

Utah State Office of Education
- Staff Development Funds
- Special Education Services Unit

Federal Funds: ESEA Title II

WestED Eisenhower Regional Consortium

District Funds:

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

School Funds:

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Utah State Office of Education Special Education Services

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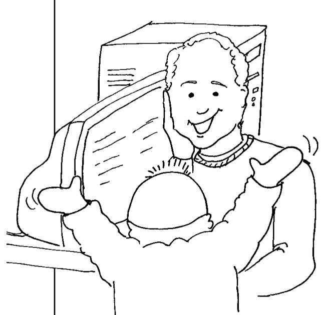
Additionally, numerous school districts, individual schools, and principals in Utah have sponsored teachers to attend the Academy. Other educational groups such as the Utah Division of Water Resources, National Energy Foundation, Utah Energy Office, and the Utah Mining Association have assisted in the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

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



Goals of the Elementary CORE Academy

Overall

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

The Academy will provide elementary teachers in Utah with:

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

Learning a limited set of facts will 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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Fourth Grade Mathematics and Science Core Curriculum

Utah Elementary Mathematics Core Curriculum

Introduction

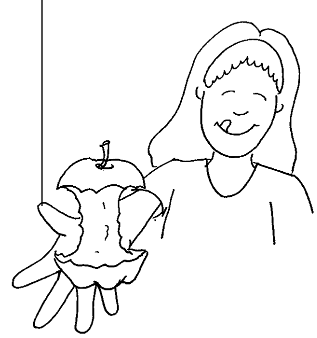
Most students enter school confident in their own abilities; they are curious and eager to learn more. They make sense of the world by reasoning and problem solving. Young students are active, resourceful individuals who construct, modify, and integrate ideas by interacting with the physical world as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

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

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

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

The most important observation about the five strands of mathematical proficiency is that they are interwoven and interdependent. This observation has implications for how students acquire mathematical proficiency, how teachers develop that proficiency in their students, and how teachers are educated to achieve that goal. At any given moment during a mathematics lesson or unit, one or two strands might be emphasized. But all the strands must eventually be addressed so that the links among them are strengthened. The integrated and balanced development of all five strands of mathematical proficiency should guide the teaching and learning of school mathematics. Instruction should not



be based on extreme positions that students learn solely by internalizing what a teacher or book says or solely by inventing mathematics on their own.

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

Organization of the Elementary Mathematics Core

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

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

Guidelines Used in Developing the Elementary Mathematics Core

The Core is:

Consistent With the Nature of Learning

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

Coherent

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

Developmentally Appropriate

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

Reflective of Successful Teaching Practices

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

Comprehensive

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

The Core is:

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

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

Feasible

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

Useful and Relevant

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

Reliant Upon Effective Assessment Practices

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

Engaging

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

Intended Learning Outcomes for Fourth Grade Mathematics

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

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

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

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

1. **Demonstrate a positive learning attitude toward mathematics.**
   a. Display a sense of curiosity about numbers and patterns.
   b. Pose mathematical questions about objects, events, and processes.
   c. Demonstrate persistence in completing tasks.
   d. Apply prior knowledge and processes to construct new knowledge.
   e. Maintain an open and questioning mind toward new ideas and alternative points of view.
2. **Become mathematical problem solvers.**
   a. Determine the approach, materials, and strategies to be used in setting up a problem.
   b. Model problem situations in a variety of ways.
   c. Develop understanding of new mathematical concepts and vocabulary by answering questions such as: What made you think that? Did anyone think of this in a different way? Where have we seen a problem like this before?
   d. Construct and use concrete, pictorial, symbolic, and graphical models to represent problem situations.
   e. Know when to select and how to use grade-appropriate mathematical tools and methods as a natural and routine part of the problem-solving process.
   f. Build new mathematical knowledge through problem solving.
   g. Solve problems in both mathematical and everyday contexts.
   h. Recognize that there may be multiple ways to solve a problem.

3. **Reason mathematically.**
    a. Draw logical conclusions and make generalizations.
    b. Determine the approach, materials, and strategies to be used in solving problems.
    c. Use models, known facts, and relationships to explain reasoning.
    d. Make precise calculations and check the validity of the results in the context of the problem.
    e. Analyze mathematical situations by recognizing and using patterns and relationships.
    f. Justify answers and solution processes.
4. **Communicate mathematically.**
    a. Represent mathematical ideas with objects, pictures, and symbols.
    b. Express mathematical ideas to peers, teachers, and others through oral and written language.
    c. Engage in mathematical discussions through brainstorming, asking questions, and sharing strategies for solving problems.
    d. Explain mathematical work and justify reasoning and conclusions.
5. **Make mathematical connections.**
    a. Use one mathematical idea to extend understanding of another.
    b. Recognize the role of mathematics in the classroom, school, and community.
    c. Explore problems and describe and confirm results using various representations.
6. **Represent mathematical situations.**
    a. Create and use representations to organize and communicate mathematical ideas.
    b. Represent mathematical concepts using concrete, pictorial, and symbolic models.

Fourth Grade Mathematics Standards

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

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

a. Model, read, and write numerals from tenths to 100,000.

b. Write a *whole number* up to 99,999 in *expanded form* (e.g., 76,539 is 7 ten-thousands, 6 one-thousands, 5 hundreds, 3 tens, 9 ones or 70,000+6,000+500+30+9).

c. Identify the place and the value of a given digit in a five-digit numeral, including decimals to tenths.

d. Demonstrate multiple ways to represent numbers by using models and symbolic representations (e.g., 36 is the same as the square of six, three dozen, or 9x4).

e. Identify *square numbers* using models.

Objective 2: Identify relationships among whole numbers and decimals.

a. Identify the number that is 100 more, 100 less, 1,000 more, or 1,000 less than any *whole number* up to 10,000.

b. Compare the relative size of numbers (e.g., 100 is small compared to a million, but large compared to 5).

c. Compare whole numbers up to five digits using the symbols <, >, and =.

d. Identify a whole number that is between two given whole numbers.

e. Order and compare whole numbers and decimals to tenths on a number line.

Objective 3: Model and illustrate meanings of the four operations and describe how they relate.

a. Use models to represent multiplication of a one- or two-digit factor by a two-digit factor (up to 30) using a variety of methods (e.g., rectangular *arrays*, manipulatives, pictures) and connect the representation to an *algorithm.*

b. Recognize that division by zero is not possible (e.g., 6∏0 is undefined).

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

c. Select and write a multiplication or division sentence to solve a problem related to the students' environment and write a story problem that relates to a given equation.

d. Represent division of a two-digit *dividend* by a one-digit *divisor*, including whole number remainders, using various methods (e.g., rectangular arrays, manipulatives, pictures) and connect the representation to an algorithm.

e. Demonstrate that multiplication and division are inverse operations (e.g., 3x4=12; thus, 12÷4=3 and 12÷3=4).

f. Describe the effect of place value when multiplying whole numbers by 10 and 100.

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

a. Divide regions and sets of objects into equal parts using a variety of models and illustrations.

b. Name and write a fraction to represent a portion of a unit whole for halves, thirds, fourths, fifths, sixths, eighths, and tenths.

c. Relate fractions to decimals that represent tenths.

d. Determine which of two fractions is greater using models or illustrations.

e. Find equivalent fractions for one-half, one-third, and one-fourth using manipulatives and pictorial representations.

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

a. Determine when it is appropriate to use estimation, mental math strategies, paper and pencil, or a calculator.

b. Find the *sum* and *difference* of four-digit numbers and describe the process used.

c. Multiply two- and three-digit *factors* by a one-digit factor and describe the process used.

d. Divide a two-digit *whole number dividend* by a one-digit *divisor*, with a *remainder* of zero, and describe the process used.

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

Objective 1: Recognize, describe, and use patterns and identify the attributes.

a. Represent and analyze *repeating* and *growing patterns* using objects, pictures, numbers, and tables.

b. Recognize and extend multiples and other number patterns using a variety of methods.

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

a. Solve equations involving equivalent *expressions* (e.g., 6x2= ~x3 or 6x~=9+9).

b. Use the <, >, = symbols to compare two expressions involving addition, subtraction, multiplication, and division (e.g., 5x4◇9÷3).

c. Recognize that a given variable maintains the same value throughout an equation or expression (e.g., ~+~=8; ~=4).

d. Demonstrate that changing the order of factors does not change the *product* (e.g., 2x3=6, 3x2=6) and that the grouping of three or more factors does not change the product (e.g., (2x3)x1=6; 2x(3x1)=6).

e. Demonstrate the distribution of multiplication over addition using a rectangular *array* (e.g., 8x14=8 rows of 10 plus 8 rows of 4).

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

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

Objective 1: Describe, identify, and analyze characteristics and properties of geometric shapes.

a. Identify and draw pa*rallel lines* and *intersecting lines*.

b. Identify and draw lines of symmetry on a variety of *polygons*.

c. Identify and describe *quadrilaterals* (i.e., rectangles, squares, *rhombuses*, *trapezoids*, kites).

d. Identify *right*, *obtuse*, and *acute* angles.

e. Compare two polygons to determine whether they are *congruent* or *similar*.

f. Identify and describe *cylinders* and *rectangular prisms*.

Objective 2: Specify locations and describe spatial relationships using grids and maps.

a. Locate positions on a map of Utah using *coordinates* or *regions*.

b. Give the coordinates or regions of a position on a map of Utah.

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

a. Identify a *slide* (*translation*) or a *flip* (*reflection*) of a geometric shape using manipulatives.

b. Relate *cubes*, *cylinders*, *cones*, and *rectangular prisms* to the *two-dimensional* shapes (*nets*) from which they were created.

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

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

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

a. Describe the relationship among *metric* units of length (i.e., millimeter, centimeter, meter), between metric units of volume (i.e., milliliter, liter), and between metric units of weight (i.e., gram, kilogram).

b. Identify a mile as a measure of distance and its relationship to other *customary* units of length.

c. Describe the relationship among customary units of *capacity* (i.e., cup, pint, quart, gallon).

d. Estimate length, capacity, and weight using metric and customary units.

Objective 2: Determine measurements using appropriate tools and formulas.

a. Measure the length of objects to the nearest centimeter, meter, quarter-inch, foot, and yard.

b. Measure *capacity* using milliliters, liters, cups, pints, quarts, and gallons and measure weight using grams, kilograms, and pounds.

c. Read, tell, and write time to the nearest minute, identifying a.m. and p.m.

d. Read and record the temperature to the nearest degree, in Fahrenheit, using a thermometer.

e. Determine the value of a combination of coins and bills that total $20.00 or less.

f. Count back change for a single-item purchase and determine the amount of change to be received from a multiple-item purchase.

g. Determine possible *perimeters*, in whole units, for a rectangle with a fixed *area* and determine possible areas when given a rectangle with a fixed perimeter.

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

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

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

a. Identify a question that can be answered by collecting data.

b. Collect, read, and interpret data from tables, graphs, charts, surveys, and observations.

c. Represent data using tables, line plots, line graphs, and bar graphs.

d. Identify and distinguish between *clusters* and *outliers* of a data set.

Objective 2: Use basic concepts of probability.

a. Describe the results of investigations involving random outcomes as simple ratios (e.g., 4 out of 9, 4/9).

b. Predict outcomes of simple experiments, including with and without replacement, and test the predictions.

Standard V:
Students will collect and organize data to make predictions and use 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.

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

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.

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

Eight Guidelines Were Used in Developing the Elementary Science Core

Reflects the Nature of Science

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

As described in these ILOs, students will:

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

Coherent

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

Developmentally Appropriate

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

Encourages Good Teaching Practices

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

Comprehensive

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

Feasible

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

Useful and Relevant

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

Encourages Good Assessment Practices

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

The Most Important Goal

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

Fourth Grade Science Core Curriculum

The theme for the fourth grade Science Core curriculum is **Utah natural history**. Students will learn about Utah environments including; weather, water cycle, rocks, fossils, soils, plants and animals. Understanding the concepts of **cycles** is an essential component of science literacy and is introduced at this grade level. Emphasis should be placed on skills to classify many things. Students should come to value and use science as a process of obtaining knowledge based on observable evidence, and their curiosity should be encouraged and sustained as they develop the abilities associated with inquiry in science.

- **The theme for the fourth grade Science Core curriculum is *Utah natural history*.**

Good science instruction requires that attention be paid to providing students with hands–on science investigations in which student inquiry is an important goal. Their curiosity should be encouraged and sustained. Teachers should provide opportunities for all students to experience many things. Fourth graders should feel the excitement of a rainstorm, hunt for fossils in rocks, observe the patterns in a spider web, and teach their parents to recognize the song of the lark. They should have many opportunities to observe and predict, to infer and to classify. They should come to enjoy science as a process of learning about their 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 fourth 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 fourth grade; the *Sci-ber Text* –an electronic science text book specific to the Utah Core; and the science test item pool. This pool includes multiple-choice questions, performance tasks, and interpretive items aligned to the standards and objectives of the fourth grade Science Core. These resources are all available on the Utah Science Home Page. 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. 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 Fourth Grade Science

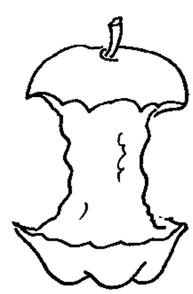
The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should learn as a result of science instruction. They are an essential part of the Science Core Curriculum and provide teachers with a standard for evaluation of student learning in science. Instruction should include significant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

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

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

1. **Use Science Process and Thinking Skills**
   a. Observe simple objects and patterns and report their observations.
   b. Sort and sequence data according to a given criterion.
   c. Make simple predictions and inferences based upon observations.
   d. Compare things and events.
   e. Use instruments to measure length, temperature, volume, and weight using appropriate units.
   f. Conduct a simple investigation when given directions.
   g. Develop and use simple classification systems.
   h. Use observations to construct a reasonable explanation.
2. **Manifest Scientific Attitudes and Interests**
   a. Demonstrate a sense of curiosity about nature.
   b. Voluntarily read or look at books and other materials about science.
   c. Pose questions about objects, events, and processes.
3. **Understand Science Concepts and Principles**
   a. Know science information specified for their grade level.
   b. Distinguish between examples and non-examples of science concepts taught.
   c. Explain science concepts and principles using their own words and explanations.

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



4. Communicate Effectively Using Science Language and Reasoning

a. Record data accurately when given the appropriate form and format (e.g., table, graph, chart).

b. Report observation with pictures, sentences, and models.

c. Use scientific language appropriate to grade level in oral and written communication.

d. Use available reference sources to obtain information.

Fourth Grade Science Standards

Science Benchmark

Matter on Earth cycles from one form to another. The cycling of matter on Earth requires energy. The cycling of water is an example of this process. The sun is the source of energy for the water cycle. Water changes state as it cycles between the atmosphere, land, and bodies of water on Earth.

STANDARD I: Students will understand that water changes state as it moves through the water cycle.

Objective 1: Describe the relationship between heat energy, evaporation and condensation of water on Earth.

a. Identify the relative amount and kind of water found in various locations on Earth (e.g., oceans have most of the water, glaciers and snowfields contain most fresh water).

b. Identify the sun as the source of energy that evaporates water from the surface of Earth.

c. Compare the processes of evaporation and condensation of water.

d. Investigate and record temperature data to show the effects of heat energy on changing the states of water.

Objective 2: Describe the water cycle.

a. Locate examples of evaporation and condensation in the water cycle (e.g., water evaporates when heated and clouds or dew forms when vapor is cooled).

b. Describe the processes of evaporation, condensation, and precipitation as they relate to the water cycle.

c. Identify locations that hold water as it passes through the water cycle (e.g., oceans, atmosphere, fresh surface water, snow, ice, and ground water).

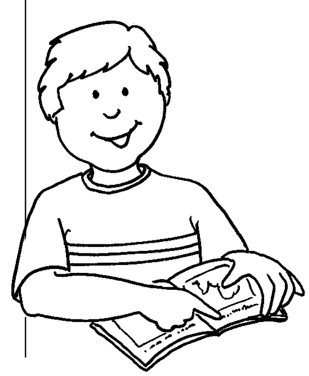
d. Construct a model or diagram to show how water continuously moves through the water cycle over time.

e. Describe how the water cycle relates to the water supply in your community.

Science language students should use:

vapor, precipitation, evaporation, clouds, dew, condensation, temperature, water cycle

STANDARD I:
Students will understand that water changes state as it moves through the water cycle.



Science Benchmark

Weather describes conditions in the atmosphere at a certain place and time. Water, energy from the sun, and wind create a cycle of changing weather. The sun's energy warms the oceans and lands at Earth's surface, creating changes in the atmosphere that cause the weather. The temperature and movement of air can be observed and measured to determine the effect on cloud formation and precipitation. Recording weather observations provides data that can be used to predict future weather conditions and establish patterns over time. Weather affects many aspects of people's lives.

STANDARD II: **Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns.**

STANDARD II: Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns.

Objective 1: Observe, measure, and record the basic elements of weather.

a. Identify basic cloud types (i.e., cumulus, cirrus, stratus clouds).

b. Observe, measure, and record data on the basic elements of weather over a period of time (i.e., precipitation, air temperature, wind speed and direction, and air pressure).

c. Investigate evidence that air is a substance (e.g., takes up space, moves as wind, temperature can be measured).

d. Compare the components of severe weather phenomena to normal weather conditions (e.g., thunderstorm with lightning and high winds compared to rainstorm with rain showers and breezes).

Objective 2: Interpret recorded weather data for simple patterns.

a. Observe and record effects of air temperature on precipitation (e.g., below freezing results in snow, above freezing results in rain).

b. Graph recorded data to show daily and seasonal patterns in weather.

c. Infer relationships between wind and weather change (e.g., windy days often precede changes in the weather; south winds in Utah often precede a cold front coming from the north).

Objective 3: Evaluate weather predictions based upon observational data.

a. Identify and use the tools of a meteorologist (e.g., measure rainfall using rain gauge, measure air pressure using barometer, measure temperature using a thermometer).

b. Describe how weather and forecasts affect people's lives.

c. Predict weather and justify prediction with observable evidence.

d. Evaluate the accuracy of student and professional weather forecasts.

e. Relate weather forecast accuracy to evidence or tools used to make the forecast (e.g., feels like rain vs. barometer is dropping).

Science language students should use:
atmosphere, meteorologist, freezing, cumulus, stratus, cirrus, air pressure, thermometer, air temperature, wind speed, forecast, severe, phenomena, precipitation, seasonal, accuracy, barometer, rain gauge, components

Science Benchmark

Earth materials include rocks, soils, water, and gases. Rock is composed of minerals. Earth materials change over time from one form to another. These changes require energy. Erosion is the movement of materials and weathering is the breakage of bedrock and larger rocks into smaller rocks and soil materials. Soil is continually being formed from weathered rock and plant remains. Soil contains many living organisms. Plants generally get water and minerals from soil.

STANDARD III: Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 1: Identify basic properties of minerals and rocks.

a. Describe the differences between minerals and rocks.

b. Observe rocks using a magnifying glass and draw shapes and colors of the minerals.

c. Sort rocks by appearance according to the three basic types: sedimentary, igneous and metamorphic (e.g., sedimentary–rounded-appearing mineral and rock particles that are cemented together, often in layers; igneous–with or without observable crystals that are not in layers or with or without air holes or glasslike; metamorphic –crystals/minerals, often in layers).

d. Classify common rocks found in Utah as sedimentary (i.e., sandstone, conglomerate, shale), igneous (i.e., basalt, granite, obsidian, pumice) and metamorphic (i.e., marble, gneiss, schist).

Objective 2: Explain how the processes of weathering and erosion change and move materials that become soil.

a. Identify the processes of physical weathering that break down rocks at Earth's surface (i.e., water movement, freezing, plant growth, wind).

b. Distinguish between weathering (i.e., wearing down and breaking of rock surfaces) and erosion (i.e., the movement of materials).

c. Model erosion of Earth materials and collection of these materials as part of the process that leads to soil (e.g., water moving sand in a playground area and depositing this sand in another area).

d. Investigate layers of soil in the local area and predict the sources of the sand and rocks in the soil.

STANDARD III: Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 3: Observe the basic components of soil and relate the components to plant growth.

a. Observe and list the components of soil (i.e., minerals, rocks, air, water, living and dead organisms) and distinguish between the living, nonliving, and once living components of soil.

b. Diagram or model a soil profile showing topsoil, subsoil, and bedrock, and how the layers differ in composition.

c. Relate the components of soils to the growth of plants in soil (e.g., mineral nutrients, water).

d. Explain how plants may help control the erosion of soil.

e. Research and investigate ways to provide mineral nutrients for plants to grow without soil (e.g., grow plants in wet towels, grow plants in wet gravel, grow plants in water).

Science language students should use:
mineral, weathering, erosion, sedimentary, igneous, metamorphic, topsoil, subsoil, bedrock, organism, freeze, thaw, profile, nonliving, structural support, nutrients

Science Benchmark

Fossils are evidence of living organisms from the past and are usually preserved in sedimentary rocks. A fossil may be an impression left in sediments, the preserved remains of an organism, or a trace mark showing that an organism once existed. Fossils are usually made from the hard parts of an organism because soft parts decay quickly. Fossils provide clues to Earth's history. They provide evidence that can be used to make inferences about past environments. Fossils can be compared to one another, to living organisms, and to organisms that lived long ago.

STANDARD IV: **Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.**

STANDARD IV: **Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.**

Objective 1: Describe Utah fossils and explain how they were formed.

a. Identify features of fossils that can be used to compare them to living organisms that are familiar (e.g., shape, size and structure of skeleton, patterns of leaves).

b. Describe three ways fossils are formed in sedimentary rock (i.e., preserved organisms, mineral replacement of organisms, impressions or tracks).

c. Research locations where fossils are found in Utah and construct a simple fossil map.

Objective 2: Explain how fossils can be used to make inferences about past life, climate, geology, and environments.

a. Explain why fossils are usually found in sedimentary rock.

b. Based on the fossils found in various locations, infer how Utah environments have changed over time (e.g., trilobite fossils indicate that Millard County was once covered by a large shallow ocean; dinosaur fossils and coal indicate that Emery and Uintah County were once tropical and swampy).

c. Research information on two scientific explanations for the extinction of dinosaurs and other prehistoric organisms.

d. Formulate questions that can be answered using information gathered on the extinction of dinosaurs.

Science language students should use:

infer, environments, climate, dinosaur, preserved, extinct, extinction, impression, fossil, prehistoric, mineral, organism, replacement, trilobite, sedimentary, tropical

Science Benchmark

Utah has diverse plant and animal life that is adapted to and interacts in areas that can be described as wetlands, forests, and deserts. The characteristics of the wetlands, forests, and deserts influence which plants and animals survive best there. Living and nonliving things in these areas are classified based on physical features.

STANDARD V: Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 1: Describe the physical characteristics of Utah's wetlands, forests, and deserts.

a. Compare the physical characteristics (e.g., precipitation, temperature, and surface terrain) of Utah's wetlands, forests, and deserts.

b. Describe Utah's wetlands (e.g., river, lake, stream, and marsh areas where water is a major feature of the environment) forests (e.g., oak, pine, aspen, juniper areas where trees are a major feature of the environment), and deserts (e.g., areas where the lack of water provided an environment where plants needing little water are a major feature of the environment).

c. Locate examples of areas that have characteristics of wetlands, forests, or deserts in Utah.

d. Based upon information gathered, classify areas of Utah that are generally identified as wetlands, forests, or deserts.

e. Create models of wetlands, forests, and deserts.

Objective 2: Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live.

a. Identify common plants and animals that inhabit Utah's forests, wetlands, and deserts.

b. Cite examples of physical features that allow particular plants and animals to live in specific environments (e.g., duck has webbed feet, cactus has waxy coating).

c. Describe some of the interactions between animals and plants of a given environment (e.g., woodpecker eats insects that live on trees of a forest, brine shrimp of the Great Salt Lake eat algae and birds feed on brine shrimp).

d. Identify the effect elevation has on types of plants and animals that live in a specific wetland, forest, or desert.

STANDARD V:
Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

e. Find examples of endangered Utah plants and animals and describe steps being taken to protect them.

Objective 3: Use a simple scheme to classify Utah plants and animals.

a. Explain how scientists use classification schemes.

b. Use a simple classification system to classify unfamiliar Utah plants or animals (e.g., fish/amphibians/reptile/bird/mammal, invertebrate/vertebrate, tree/shrub/grass, deciduous/conifers).

Objective 4: Observe and record the behavior of Utah animals.

a. Observe and record the behavior of birds (e.g., caring for young, obtaining food, surviving winter).

b. Describe how the behavior and adaptations of Utah mammals help them survive winter (e.g., obtaining food, building homes, hibernation, migration).

c. Research and report on the behavior of a species of Utah fish (e.g., feeding on the bottom or surface, time of year and movement of fish to spawn, types of food and how it is obtained).

d. Compare the structure and behavior of Utah amphibians and reptiles.

e. Use simple classification schemes to sort Utah's common insects and spiders.

Science language students should use:
wetland, forest, desert, adaptation, deciduous, coniferous, invertebrate, vertebrate, bird, amphibian, reptile, fish, mammal, insect, hibernation, migration

Common plants:
sagebrush, pinyon pine, Utah juniper, spruce, fir, oak brush, quaking aspen, cottonwood, cattail, bulrush, prickly pear cactus

Common animals:
jackrabbit, cottontail rabbit, red fox, coyote, mule deer, elk, moose, cougar, bobcat, deer mouse, kangaroo rat, muskrat, beaver, gopher snake, rattlesnake, lizard, tortoise, frog, salamander, red–tailed hawk, barn owl, lark, robin, pinyon jay, magpie, crow, trout, catfish, carp, grasshopper, ant, moth, butterfly, housefly, bee, wasp, pill bug, millipede

Starter Activities

Starter Activities

Starter Activity 1—Math

Number sense: How many ways can you show or represent the number three on one hand?   Answer: ten

Possible materials needed: a pencil and paper with 20 hand prints so you can cross off the fingers

Starter Activity 2—Math

Number sense: Have the participants finish a simple addition chart from 1 - 9 or have it all ready prepared. Have the participants examine their chart and color patterns and describe to the other participants how to use the chart to add or subtract simple numbers.

Materials needed: Colored pencils and addition chart

Starter Activity 3—Science

Water Cycle: Create and play the game from Project Wet.

Materials: dice and posters and a set of the rules for each teacher

Starter Activity 4—Science

Water Cycle: Discuss with a partner your understanding of the following: (write the questions on the board)

1. What is needed for weather?
2. How do rain and snow form?
3. What are the steps in the water cycle?

Materials: note-taking materials

** Remind them to risk answering even if they are not sure of the correct answer**

Starter Activity 5—Math

Patterns and Relations: Have the participants again use a simple addition chart from 1 - 9. Have the participants examine their chart and use a colored pencil to put red squares around all the numbers that are multiples of three. Then have them use a blue pencil to circle all the numbers that are multiples of four. As students look for "Common Multiples," point out that they are the numbers with both red square and blue circles around the number.

Materials needed: Colored pencils and addition chart

Starter Activity 6—Math

Patterns and Relations: Have the participants finish a simple multiplication chart from 1 - 9 or have it already prepared. Have the participants examine their chart and color patterns and describe to the other participants how to use the chart to multiply or divide simple numbers.

Materials needed: Colored pencils and multiplication chart

Starter Activity 7—Math

Patterns and Relations: Explain to the participants that a palindrome is a number or word that is the same front to back and back to front (e.g. dad, 7,665,667, mom, stats). Have them find the next date on which there will be a palindrome using mm/dd/yy. Are there any other creative dates using patterns (e.g., 03/03/03 at 03:03 in the day)? What pattern day is next?

Materials: pencil and paper

Starter Activity 8—Science

Weather: Create a cloud in a 2-liter bottle. Put hot water and smoke in a clear 2-liter bottle. Cap the bottle, squeeze hard, and you will see a small cloud form as you are squeezing. "Why do you need smoke in the bottle? And if pollution is needed in the bottle, what role does pollution play in weather and the formation of clouds, rain, and snow?"

Materials: Clear 2-liter bottle with a cap, hot water, matches for smoke

(Corresponding Pages in TRB[3] Section 6.1)

Starter Activity 9–Science

Weather: For another model of a cloud, fill a plastic clear cup 2/3 full with warm water. Put a lid (preferably clear) on the container. Put two ice cubes on the top of the lid. After a few minutes, water droplets should appear at the top of the container on the inside.

Materials: one clear cup with a clear lid per participant, warm water

Starter Activity 10–Math

Geometry: Have the participants start a geometry journal and have them make lists of vocabulary words and pictures to go with their words to help explain and understand geometry. Vocabulary words may include point, line, line segment, angle, plane, intersecting lines, perpendicular lines, parallel lines, ray, triangle, square, rectangle, polygon, circle, same, similar, etc.

Materials needed: pencils and paper (geometry journal)

Starter Activity 11–Science

Rocks and Minerals: Have a selection of rocks and minerals available for students to observe and classify. Have hand held microscopes and hand lenses available for observation. Have the teachers classify their samples based upon observations.

Materials: Samples of 10 rocks or minerals that the teachers can observe, hand lenses, a couple of hand held microscopes (Radio shack)

Starter Activity 12–Science

Rocks and Minerals: Get 4-5 soil sand samples from the same vicinity. Try to get different colors. Then find a sand pile with similar sized particles. See if the teachers through observation, can pick the soil samples that belong to each other in comparison to the implanted sample. This is a great activity for using inquiry skills.

Materials needed: 4-5 sand samples, hand held microscopes or hand lenses

(Corresponding Pages in TRB[3] Section 6.1)

Starter Activity 13—Science

How hot is hot? How cold is cold? How long is long? Short? Tiny? Big? Small? There are a lot of words we use to describe terms and objects in science. This is a great way to help participants understand that comparisons need to be made in quantifiable measurements rather than general statements. Give the participant an object in a bag and have them describe it (e.g., ice cube).

Inquiry

Using Inquiry with Students

4th Grade—Science

Inquiry is knowledge gained through investigation. Inquiries may be teacher-initiated or student-initiated. The Learning Cycle is one of the most familiar and effective models for science instruction using an inquiry approach. The following is the 5-E model of the Learning Cycle:

1. **Engagement Phase:** The teacher sets the stage for learning by getting the students' attention and focus. The teacher creates ways to "hook" the students into learning. This provides an opportunity for the teacher to activate learning, assess prior knowledge, and have students share prior experiences about the topic.
2. **Exploration Phase:** Students are engaged in inquiry in response to teacher-posed or student-posed questions. They are encouraged to develop and test a hypothesis without direct instruction from the teacher. They collect evidence and data, record and organize information, share observations, and work in cooperative groups. This stage also provides opportunities for students with diverse experiences to share their different understandings and broaden the perspectives of the entire class. At the end of this phase, students discuss what was discovered and learned from the investigation.
3. **Explanation Phase:** During this teacher-directed stage, the teacher facilitates data-processing techniques from the information collected during the exploration. As the information is discussed, the teacher often explains the scientific concepts associated with the investigation, introducing vocabulary which provides a common language for the class to use. This helps students to articulate their thinking and describe their experiences in scientific terms. The teacher can then continue to introduce details using direct instruction or lecture, audiovisual resources, on-line sources, or computer software programs. This phase is sometimes called the concept development stage because newly developed concepts are assimilated into the cognitive structure of the students.
4. **Elaboration or Extension Phase:** During this stage, the teacher provides activities that reinforce the concept. This can be accomplished by applying the evidence to new or real-world situations or through further investigation and/or research.

- **Engagement Phase**
- **Exploration Phase**
- **Explanation Phase**
- **Elaboration or Extension Phase**
- **Evaluation Phase**

5. **Evaluation Phase:** The teacher brings closure to the lesson by helping students summarize what was learned and making connections between the concepts learned and the students' prior knowledge. The teacher then provides a means to assess students' learning. Assessment strategies may include a number of different options, including more traditional summative evaluations (i.e., paper and pencil tests, written descriptions of what has been learned, presentations, and performance assessments).

One way to better understand the difference between a guided inquiry lesson and a more traditional, expository lesson (like direct instruction) is to consider the Expository-Discovery Continuum. Teaching methods or lesson plans can be arranged on the basis of the relative amounts of teacher and learner contribution to the learning situation. The following continuum represents a succession of teaching methodologies between a hypothetical totally teacher-dominated expository method on the left and a hypothetical totally student-dominated free discovery method on the right. Any lesson can be located somewhere on this continuum. Guided inquiry, where teachers facilitate children in their investigations of teacher-established topics or questions, fits somewhere in the middle.

Expository | Guided Inquiry | Free Discovery

Activity—How Can We Classify Rocks?

Standard III
Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 1
Identify basic properties of minerals and rocks and sort rocks by appearance.

Standard III

Objective 1

Connections

Activity Option 1: Guided Inquiry Lesson (Teacher-Initiated Inquiry)

Adapted from activities described in: *Hands-on earth science activities for grades K-8* by M. N. Tolman (Parker Publishing)

Materials

For each group of 3-4 students:

- ❏ a collection of rocks (including some sedimentary, igneous, and metamorphic rocks)
- ❏ 3-4 hand lenses
- ❏ Encyclopedia
- ❏ Other reference books (on rocks) as available
- ❏ Large piece of chart paper
- ❏ Markers
- ❏ Science Journal (for each student)

Instructional Procedures

Engagement

1. Ask each student to list five ways they know of to classify things in their science journals (How can things be classified or grouped?)
2. Have students pair and share their ideas.
3. Invite students to share their ideas with the entire class. As they share, write the comments on the board. Point out that we can classify or group many kinds of things in different ways.

Exploration

1. Explain that today they will be using the knowledge they already have about classification to investigate rocks.
2. Divide them into teams of 3-4 students. Give each team a collection of rocks and 3-4 hand lenses.
3. Pose the question: "How can you sort or classify this collection of rocks?" Make observations of the rocks, noting and discussing similarities and differences in the observable characteristics. (Remember that in science, observation requires the use of all five senses.) Look for relationships among the rocks and then sort or classify the rocks according to the criteria you develop within your team.
4. Invite the teams to assign a name to each of their groups of rocks and to describe the criteria they used for sorting the rocks. Ask students to record this in their science journals.

Explanation

1. After the investigations are completed, give each group a large piece of chart paper and markers. Ask teams to record the names they assigned to each of the groups of rocks and the characteristics they used to classify them on the chart paper. Post all charts.
2. Each team will have 1-2 minutes to share their method of classification with the whole class, presenting their poster and explaining the criteria they used for classification.

Elaboration or Extension

1. Ask students to look up "rocks" in the encyclopedia, other reference books provided, or the internet to find out what characteristics geologists use to classify rocks. Ask students to record what they find in their science journals.
2. Invite students to share what they have learned in a class discussion.
3. After the class discussion (or during if appropriate), suggest that one way experts classify rocks is by the way they are formed: sedimentary, igneous, and metamorphic. We can sort rocks by their appearance into these basic types of rocks: a) sedimentary (rounded-appearing mineral and rock particles that are cemented together, often in layers), b) igeneous (with or without observable crystals that are not in layers or with or without air holes or glasslike), and c) metamorphic (crystals/minerals, often in layers).
4. Then invite each team to classify their collection of rocks according to the criteria.

Evaluation

There are a number of ways to assess students' understanding of the concept taught. One might be to ask them to write a paragraph summarizing what they learned from their original investigation. Invite them to illustrate their paragraph with sketches or diagrams.

Activity—Exploring Ice Hands

Standard I
Students will understand that water changes state as it moves through the water cycle.

This is an exploration that accomplishes two goals:
1 allows students to investigate the properties of water, and
2 provides students with the opportunity to generate more questions to investigate.

Standard I

Objective 2

Connections

Activity Option 2: Guided Inquiry Lesson (Student-Initiated Inquiry)

Adapted from an activity described in: *Inquire within: Implementing inquiry-based science standards* by D. Llewellyn (Corwin Press)

Procedure

Engagement

1. Ask each student to write 5 things they know about ice in their science journal.
2. Have students pair and share their ideas.
3. Invite students to share their ideas with the entire group. As they share, write and arrange the comments on the board using a conceptual map. Point out that we already know a lot about ice.
4. Explain that today they will be using the information they already have to make investigations about ice hands. Students are to make observations about the ice hands and record the data in their science journals.
5. Divide into teams of 3-4 students. Each team is given a plastic kitty litter pan, an ice hand (after removing it from the latex glove that formed the hand), the hand lenses, and metric rulers.
6. After about 10-15 minutes, fill each pan about half full of water. Ask students to continue to make and record observations/measurements. They will want to add drawings or illustrations to show how their ice hands change. Ask them to make a list—in their journals—of any questions they have. ("Think of several questions you would like to investigate about ice. It may be about the melting or freezing rates of ice. It may be about what kinds of things affect the melting or freezing, etc. Later, we will go over the questions and decide which ones you will want to investigate.")

Materials

For each group of 3-4 students:

- ❑ 1 ice hand (made by filling a latex surgical glove with water, tying the end with a twist tie, and freezing it overnight)
- ❑ 1 plastic kitty litter pan
- ❑ 2-4 hand lenses
- ❑ 2-4 metric rulers
- ❑ Large piece of chart paper
- ❑ Markers
- ❑ Inquiry Data Sheet
- ❑ Science Journal (for each student)

7. After 15-20 minutes—it takes about that long for the ice to completely melt—give each team a piece of chart paper and markers. Ask each group to choose 3-4 of their investigative questions and record them on the chart paper. Post all of the lists.
8. Review each question as a class, sorting them into categories that a) are "testable," or b) could not be answered without assistance from an outside expert—library research or other outside sources.
9. Ask each student to choose a question to investigate. Groups (of 3-4 participants) will be formed according to these choices.
10. ** If this is the first time students have been engaged in a real experiment (or a "fair experiment") on their own, take one question and lead them through an explanation on how to design an experiment so that only one variable would affect the results of the investigation.**

Exploration

1. Ask each team to plan how they will go about answering their questions, including the materials they will need to complete their investigations (see Inquiry Data Sheet).
2. Students would then carry out their investigation.

Explanation

1. Ask teams to review the results of their investigation and draw a conclusion based on the data. This requires them to organize their data into charts, tables, or graphs for presentation to the whole group.
2. Each team then presents what they learned about ice (2-3 minutes).
3. Bring out original concept map and add newly acquired knowledge about ice and what causes water to change from one state to another.

Elaboration or Extension

Discuss real world experiences with states of water and what causes those changes (based on the ideas investigated by the teams).

Evaluation

There are a number of ways to assess students' understanding of the concept taught. One might be to ask them to write a paragraph summarizing what they learned from their original investigation. Invite them to illustrate their paragraph with sketches or diagrams.

Inquiry Data Sheet

Our question:

We predict (our hypothesis is):

The materials we used:

The steps we followed (our procedure is):

1.
2.
3.
4.
5.
6.

The observations we made (my data are):

The answer to the question (our conclusion is):

What are characteristics of effective homework in mathematics?

Research and Best Practice

- **The home should be a place to extend mathematics learning.**

Daily, children hurry home from school and arrive to face the obligatory question from parents, "What did you learn in school today?" They return to school the following day, and their teacher asks, "Do you have your homework assignment?" Perhaps a better question would be "What did you learn at home?" The home should be a place to extend mathematics learning.

Student learning in mathematics should always focus on understanding the set of skills and knowledge needed to investigate the world. Homework must emphasize developing students' mathematics skills to solve problems, which will help them understand the world. These mathematics skills are described as "process skills" in the *NCTM Principles and Standards for School Mathematics* and "habits of mind" in *Benchmarks for Science Literacy*. Mathematics educators and mathematicians agree that knowing mathematics is more than being able to recall facts. Research indicates that individuals with expertise in mathematics understand mathematics concepts, how to apply them to challenging, non-routine real-life problem-solving situations, and how to learn from their own problem-solving efforts.

Homework assignments provide the opportunity for students to do long term projects that require multiple levels of understanding. Students take ownership when they spend weeks following stock prices in the newspaper, paying close attention to favorites, predicting industry trends, interviewing traders, or perhaps even participating in an investment club. Watching TV and timing commercial breaks one night may be interesting, but when students keep data over a few weeks — timing commercials in different types of programs, making charts, and drawing graphs — their learning will go beyond the curriculum.

Homework time is an opportunity for students to reflect on learning and synthesize their mathematics understandings. Well-designed homework can bring parents and other adults into a student's community of mathematics learners. Assignments should include students discussing their learning with others. This can be done through student learning teams, parent involvement, or the teacher using e-mail to have discussion groups. Mathematics is in every aspect of life. Teachers should take advantage of the opportunity to provide students with authentic learning opportunities at home.

Classroom Implications

The value placed on various aspects of mathematics learning can be seen in the allocation of instructional time in class and by the nature of homework assigned. Teachers who value problem-solving skills will provide time in class to develop students' ability to solve problems and then will assign homework that uses these skills in new settings. What goes on in class should match the homework assigned.

Mathematics homework should not be schoolwork done at home. The home provides a unique opportunity for students to gain mathematics understanding by solving mathematics problems. Placing the major emphasis on basic skills and drill for skill development in mathematics is somewhat of a waste of student, parent, and teacher time and effort.

- **Mathematics homework should not be schoolwork done at home.**

Teaching for understanding requires carefully designed tasks. Homework assignments should have clear criteria and/or written rubrics that describe expectations and establish student goals. The teacher must be certain that students have access to the materials and resources they will need to complete the assignment.

It is important for students to do their best, and for teachers to examine student work. Less is often more when it comes to homework. A product that has been refined by the student results in more effective learning than a large volume of work completed with little thought. The quality of student work is often determined by the standards a teacher sets on the assignment, time spent reviewing the expectations, and suggestions for improvements. A homework assignment should be a major event in student learning. Selling students on the importance of an assignment as a learning event is important: their ownership will determine the depth and breadth of their learning.

References

American Association for the Advancement of Science, Project 2061. (1993). Benchmarks for science literacy.

National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics.

National Science Foundation. (1999). Inquiry thoughts, views, and strategies for the K–5 classroom.

Perkins, D. (1993). Learning for understanding.

To obtain copies of EDThoughts:

What We Know About Mathematics Teaching and Learning, contact McREL at 303-337-0990 (voice), 303-337-3005 (fax), or info@mcrel.org

What are characteristics of effective homework in science?

Research and Best Practice

Every day children hurry home from school and arrive to face the obligatory question from parents, “What did you learn in school today?” They return to school the following day, and their teacher asks, “Do you have your homework assignment?” Perhaps a better question would be “What did you learn at home?” The home should be a place to extend science learning.

- **A homework assignment should be a major event in student learning.**

Student learning in science should always focus on understanding the set of skills and knowledge needed to investigate the world. Science knowledge is growing too quickly to to learn it as a body of knowledge. We must rely on developing students’ science skills to do investigations, which will help them understand the world. These science skills are described as “inquiry” in the *National Science Education Standards* and “habits of mind” in *Benchmarks for Science Literacy*. Science educators and scientists agree that knowing science is more than being able to recall facts. Research indicates that individuals with expertise in science understand science concepts and how to learn from their own investigations and inquiry.

Homework assignments provide the opportunity for students to do longterm projects that require multiple levels of understanding. Students take ownership when they spend months observing an ecosystem, finding the names of organisms in an environment, suggesting ways to maintain diversity in that environment, interviewing wildlife managers and perhaps even taking action to protect the environment. Observing the night sky on one night may be interesting, but when students keep a night sky journal for six months — drawing diagrams, tracing movements, and identifying objects in the sky — their learning will go beyond the curriculum.

Homework time is an opportunity for students to reflect on learning and synthesize their science understandings. Well-designed homework can bring parents and other adults into a student’s community of science learners. Assignments should include students discussing their learning with others. This can be done through student learning teams, parent involvement, or the teacher using e-mail to have discussion groups. Science is in every aspect of life. Teachers should take advantage of the opportunity to provide students with authentic learning opportunities at home.

Classroom Implications

The value placed on various aspects of science learning can be seen in the allocation of instructional time in class and by the nature of homework assigned. Teachers who value investigation skills will provide time in class to develop students' ability to do investigations, and then will assign homework that uses these skills in new settings. What goes on in class should match the homework assigned. Science homework should not be school work done at home. The home provides a unique opportunity for students to gain science understanding by doing science investigations.

Teaching for understanding requires assignments designed for understanding. Assignments should have clear criteria and written rubrics that describe expectations and establish student goals.

It is important for students to do their best and for teachers to examine student work. Less is often more when it comes to homework. A product that has been refined by the student results in more effective learning than a large volume of work completed with little thought. The quality of student work is often determined by the standards a teacher sets on the assignment, time spent reviewing the expectations, and suggestions for improvements. A homework assignment should be a major event in student learning. Selling students on the importance of an assignment as a learning event is important: their ownership will determine the depth and breadth of their learning.

Getting students involved in science news events helps students understand the nature of science. Students should be aware, curious, and interested in newsworthy events such as a solar eclipse, shuttle launch, or the discovery of a new gene therapy. Connecting newsworthy science events to the science learning in school helps students take an important step toward science literacy.

The public is fascinated with science and nature. PBS science programs such as "Nature," "Nova," and "National Geographic Explorer" should be part of a student's life. Teachers should encourage students to watch specific educational programs that connect with their science learning. As homework, students can watch and discuss specific educational television programs with their parents and fellow students. School time is far too precious to spend watching a video.

References

American Association for the Advancement of Science, Project 2061. (1993). Benchmarks for science literacy.

Chiappetta, E. (1997). Inquirybased science.

National Science Foundation. (1999). Inquiry thoughts, views, and strategies for the K-5 classroom.

Perkins, D. (1993). Learning for understanding.

Sachse, T. P. (1989). Making science happen.

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Inquiry Notes

Assessment Strategies

Assessment Resource Pages

Two Basic Outcomes for Assessment

Formative—Formative assessment is ongoing through the course of instruction. The intent is to evaluate the progress of learning. Modifications in instruction, correction of misunderstanding, and emphasis of under-developed concepts are the outcome of this type of assessment.

Summative—Summative assessment evaluates the final outcome of instruction. It is used for final evaluations.

- **Formative**
- **Summative**

Two Basic Methods for Assessment

Informal—Informal assessment usually involves personal interaction between teacher and student. Monitoring the responses from whole group discussion and keying in on individuals through carefully used questions provides the teacher with important feedback. Moving from student to student asking them to explain important concepts exemplifies this type of assessment. Summaries, quick question responses (both oral and written), hand signals, analogy prompts, creating flow charts or timelines, responding to misconception checks, all of these and more can be effective ongoing assessment of student understanding.

Formal—Formal assessment calls for responses to specific questions or tasks. Generally some written form of response is required so as to document understanding.

- **Informal**
- **Formal**

Common Forms of Formal Assessment

Multiple Choice—Multiple choice assessments target important content. Items include a stem (a simple statement or question which presents a problem or task to the student) and options (responses to the stem from which students choose the correct or best answer).

Open Response—Open response questions allow students to construct a response that demonstrates their understanding of important concepts. Students respond to a prompt (a statement designed to assess a targeted academic expectation with directions for student response) and their response is evaluated based on a criteria established in a scoring guide (a rubric designed to evaluate the quality of the student response).

- **Multiple Choice**
- **Open Response**
- **Performance Task**

Performance Task—Performance task questions allow students to both show and apply what they have learned. Students respond to a prompt. Performance of some kind of hands-on task is required. Students then answer questions about the product. Their response, including the product, is evaluated based on criteria established in a scoring guide (rubric).

Multiple Choice Assessment Item

Directions

Use the box of minerals labeled A, B, C, and D, and the hand lens to help you answer the following question.

Stem

On which of the following minerals can you make a visible scratch mark with your fingernail?

Options

A. fluorite

B. gypsum

C. quartz

D. calcite

Scoring Key

B. gypsum

Rationale

Students are to categorize rocks and minerals according to observed properties, which include hardness. This question employs the process of investigation by performing a scientific behavior and evaluating the results.

Open-Response Assessment Item

Prompt

A scientist removed a one-liter sample of water from the Pacific Ocean and brought it to Utah. After studying the water sample, the scientist poured the water into the gutter along the road outside the lab. Explain the processes of evaporation, condensation, precipitation, and run off. Explain how these processes are involved for at least one drop of this water to return to the Pacific Ocean and how each process leads to the next.

Scoring Guide

SCORE	DESCRIPTION
4	The response shows a complete understanding of the processes of evaporation, condensation, precipitation, and run off and how these processes relate to one another.
3	The response shows a complete understanding of the processes of evaporation, condensation, precipitation, and run off but an incomplete understanding of how these processes relate to one another.
2	The response shows a limited understanding of the processes of evaporation, condensation, precipitation, and run off and a minimal understanding of how the processes relate to one another.
1	The response shows a minimal understanding of the processes of evaporation, condensation, precipitation, and run off and little or no understanding of who the processes relate to one another.
0	The response is totally incorrect or irrelevant
BLANK	Blank/no response

Rationale

This question assesses the student's understanding of the stated processes and how they relate to one another. The question allows students to demonstrate a diversity of conceptualization since there are a variety of appropriate scientific scenarios to accomplish the task set forth.

Performance Task Assessment Item

Prompt

Accurately identify each of the sample materials in the containers before you. Use the materials to construct a scientifically correct mock soil profile in your plastic vial. Make a drawing of your soil profile and explain the science reasons why you constructed the soil profile as you did.

Scoring Guide

SCORE	DESCRIPTION
4	The response accurately identifies each of the sample materials of gravel, sand, silt or clay, and organic matter. The construction, drawing, and explanation show an accurate and thorough understanding of the composition of a soil profile and are consistent with each other.
3	The response accurately identifies each of the sample materials of gravel, sand, silt or clay, and organic matter. The construction, drawing, and explanation show a mostly accurate and at least partial understanding of the composition of a soil profile. There may be some minor inconsistencies as they relate to one another.
2	The response accurately identifies at least three of the sample materials of gravel, sand, silt or clay, and organic matter. The construction, drawing, and explanation show some understanding of the composition of a soil profile, but may contain significant inconsistencies as they relate to one another.
1	The response accurately identifies at least one of the sample materials of gravel, sand, silt or clay, and organic matter. The construction, drawing, and explanation, show minimal or inaccurate understanding of the composition of a soil profile.
0	The response is totally incorrect or irrelevant
BLANK	Blank/no response

Rationale

The tasks involved demonstrate some recall, but invite the student to reach into higher levels of comprehension and analysis.

General Guidelines for Creating a Scoring Guide (Rubric)

SCORE	DESCRIPTION
4	• Follows all directions and finishes all parts of the question. • Answers the question clearly so that others can understand. • Shows complete understanding of the information requested. • Shows and/or explains the quickest and best way to get an answer. • Shows and explains what knowledge using complex examples, by showing connections between ideas and the real world, by comparing different ideas, and/or by showing how the ideas work together.
3	• Follows the directions and finishes most of the parts of the question. • Answers the question clearly so that other can understand. • Shows and/or explains understanding of the big ideas about the question but there are a few little mistakes or wrong ideas.
2	• Follows some of the directions and finishes some parts of the question. • Answer may not be complete but it is clear enough so that others can understand. • Shows understanding of only parts of the information necessary to answer the question.
1	• Understands only a small part of the information asked for in the question. • Answers only a small part of the question.
0	• The response is totally incorrect or irrelevant.
BLANK	• Blank/no response

Additional Resources

Understanding by Design by Grant Wiggins and Jay McTighe
Help with designing evaluation rubrics: http://rubistar.4teachers.org

Assessment Strategies Notes

Assessment Strategies Notes

Misconceptions

Misconceptions

Misconceptions have been referred to as misunderstandings, misleading ideas, non-scientific beliefs, misinterpretations of facts, preconceived notions—you get the idea. In most cases, when a person has developed a misconception, they are unaware that their ideas are incorrect. What is of even more concern is that they continue to build knowledge on their current understandings. Having misconceptions can have serious impacts on learning. People work very hard to process information and arrive at their ideas. It takes just as much work to let go of the misconceptions and reconstruct new ideas.

- **After a lifetime of learning, students graduate from college with the same misconceptions they had upon entering grade school.**

"After a lifetime of learning, students graduate from college with the same misconceptions they had upon entering grade school. Every time we communicate, new concepts compete with the preconceived ideas of our listeners. All students hold these ideas, but they are unaware of their private theories. We must make them aware. Only then can we enable them to learn and free them from this 'Private Universe'."

From the video "A Private Universe; Misconceptions That Block Learning."

Produced at the Harvard-Smithsonian Center for Astrophysics.

Distributed by: The Astronomical Society of the Pacific
390 Ashton Ave.
San Francisco, CA 94112

Examples of common misconceptions:

Grade 3

Misconception: Wool clothing produces heat.

The loose fibers of the wool clothing trap your body heat and make you feel warmer.

Grade 4

Misconception: Both steam and clouds are water as a gas.

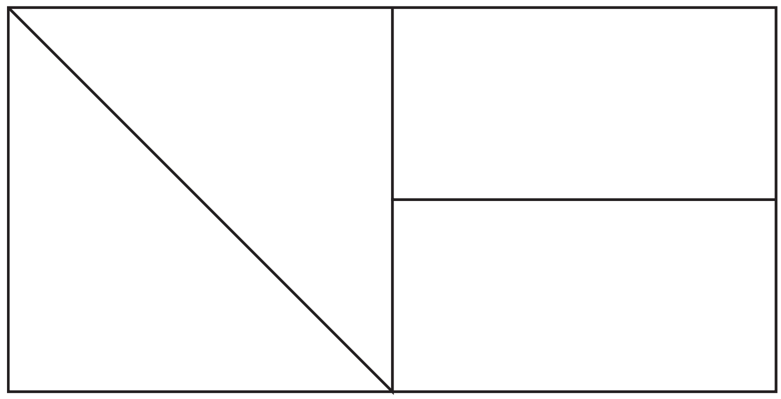
If you can see it, it is a solid or a liquid, not a gas.

Misconception: A larger number cannot be subtracted from a smaller number.

5 - 8 = -3 Draw a number line and prove this misconception.

Misconception: The four pieces of this rectangle are not equal shares.

Cut/tear a rectangular piece of paper to prove your theory.



Misconceptions Notes

Misconceptions Notes

Journaling Ideas

Journaling

Background Information

Science and math concepts have been compared to a brick building where, course by course, each brick provides the cement foundation for the information that is to follow. The foundation of radioactivity research was the life work of the great French physicists, Pierre and Marie Curie. Madame Curie's carefully preserved journals minutely detailed step-by-step the process of their work which has become the basis for innumerable advancements in science.

Purdue University research focused on using children's journals as a tool for teaching, learning, and assessing science. The findings showed that journals were valuable in teaching communication and literacy techniques during science lessons. Journals also provided documentation that students had a better understanding of scientific concepts and had begun an inquiry-based self-learning process.

It is vital to introduce student journals at the elementary school level to create the habit of journaling as a lifelong learning tool. Both formal and informal journaling models have been found to be equally effective. Journaling experiences are described in *Jordan School District Science TRB*[3] as:

1. Drawing pictures and labeling them
2. Writing short paragraphs about observed changes and interactions
3. Noting reactions to different stimuli
4. Making predictions
5. Recording observations
6. Analyzing reasoning
7. Keeping measurements
8. Comparisons

1. Drawing pictures and labeling them

2. Writing short paragraphs about observed changes and interactions

3. Noting reactions to different stimuli

4. Making predictions

5. Recording observations

6. Analyzing reasoning

7. Keeping measurements

8. Comparisons

Journaling Examples

From *Dinah Zike's Big Book of Books and Activities*

1. Layered Look Book p. 70-78
2. Pop-Up Book p. 112-115 *Remember the rule–Always cut on a fold, and Never glue on a fold.
3. Top Tab Book p. 80-83
4. Pyramid Book p. 38-41
5. Circle Book p. 64-65

Materials

- ❏ scissors
- ❏ paper
- ❏ glue sticks
- ❏ markers
- ❏ staplers and staples

Additional Resources

Jordan School District Science TRB3
Dinah Zike's Big Book of Projects, by Dinah Zike (M. Ed.)
Big Book of Books and Activities, by Dinah Zike (M. Ed.)

Journaling Notes

Journaling Notes

Math
Standard I
Activities

Activity—Mental Math: Addition and Subtraction

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

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

Intended Learning Outcomes
1. Demonstrate a positive learning attitude toward mathematics.
2. Become mathematical problem solvers.
3. Reason mathematically.
4. Communicate mathematically.
5. Make mathematical connections.
6. Represent mathematical situations.

Standard
I

Objective
5

Connections

Background Information

Calculating in your head is a practical life skill. Many types of everyday computation problems can be solved mentally. Mental calculation provides the cornerstone for all estimation processes, allowing a variety of alternative nonstandard techniques or strategies for finding answers. Mental computation encourages students to think about numbers and number relationships developing strong number sense and mathematical confidence. A survey from the National Assessment of Educational Progress in mathematics found that most children were unaware that a mental calculation is often the most convenient method to find a solution. Most students claimed that either a paper and pencil or calculator was needed to determine solutions.

It would be helpful if students have had prior experience with compatible numbersBin this case pairs of numbers that "make ten." In this lesson students will use the mental math skill of adding and subtracting by making multiples of ten and adjusting (compensation). These suggested strategies should be discussed in two separate lessons.

Lesson One: Trading Off (Compensation)

Invitation to Learn

Give one student 4 books and another student 3 books. Ask: "If you take part of the books from one student and give it to the other student does it change the total amount of books? How can this idea help you to add numbers?"

Materials

- ❏ 7 books
- ❏ counters for each pair of students
- ❏ 2 stools/chairs exactly the same height

Instructional Procedures:

1. Students work in pairs. Have each student count out a certain number of counters and find the total. Determine how many counters would be needed to make one group a multiple of 10. Move this amount of counters from one group to the other group. Does this change the total amount? (No) Repeat this activity several times with different numbers of counters.
2. Give the students an addition problem and have them "make tens" by adding a compatible number to one of the addends. Go back and subtract the same amount from the other addend to compensate. Then add the two adjusted addends.
3. Practice trading off numbers in order to make a nice even group of tens for easier computation. Problems for practice:

29 + 62	37 + 69
28 + 45	43 + 49
49 + 26	55 + 19

Lesson Two: Balancing Subtraction (Compensation)

Invitation to Learn

Have two students of different heights help to demonstrate the idea that if you add the same amount to both the number you are subtracting and the number you started with, the difference will be the same.

Ask who is taller and approximately what is the difference in height? Give the shorter student a small stool/chair to stand on. (This student should now be taller). Many of the students will pick up on the idea that the difference changed when the shorter student had something to stand on. In order to keep the difference the same, the taller student would need something the same size to stand on. How can you use this idea to help you subtract numbers?

Instructional Procedures

1. Students need to understand renaming subtraction. Write a simple subtraction problem on the board. Have the students count out the first number of counters and subtract the second number. (e.g., 6 - 2 = 4).

2. Use the same problem and add "1" to each of the numbers. (e.g., 7 - 3 = 4). What happened to the difference when we renamed the problem by adding the same quantity to both numbers? (stayed the same). Try adding "2" to each of the original numbers. Three. Four. Does the difference stay the same?
3. Give students several problems to subtract using the balancing subtraction strategy. Make sure students understand that we want to "make tens" with the number we are subtracting (subtrahend), not the one we are subtracting from (minuend). It is much easier to subtract a nice even group of tens from another number B no borrowing, etc.

   Problems for practice:

65 - 49	44 - 28
43 - 19	81 - 58
72 - 29	71 - 47

Possible Extensions/Adaptations/Integration

Use these strategies to find the sum and difference of 3 and 4 digit numbers.

Assessment Suggestion

Have students write instructions for how to perform the skill they have just learned in their journals.

Additional Resources

Mental Math in the Middle Grades, Dale Seymour Publications, 1987.

Homework & Family Connections

Have students teach a member of their family a new way to mentally add or subtract and return a note indicating the shared mathematical experience between the family member and the student.

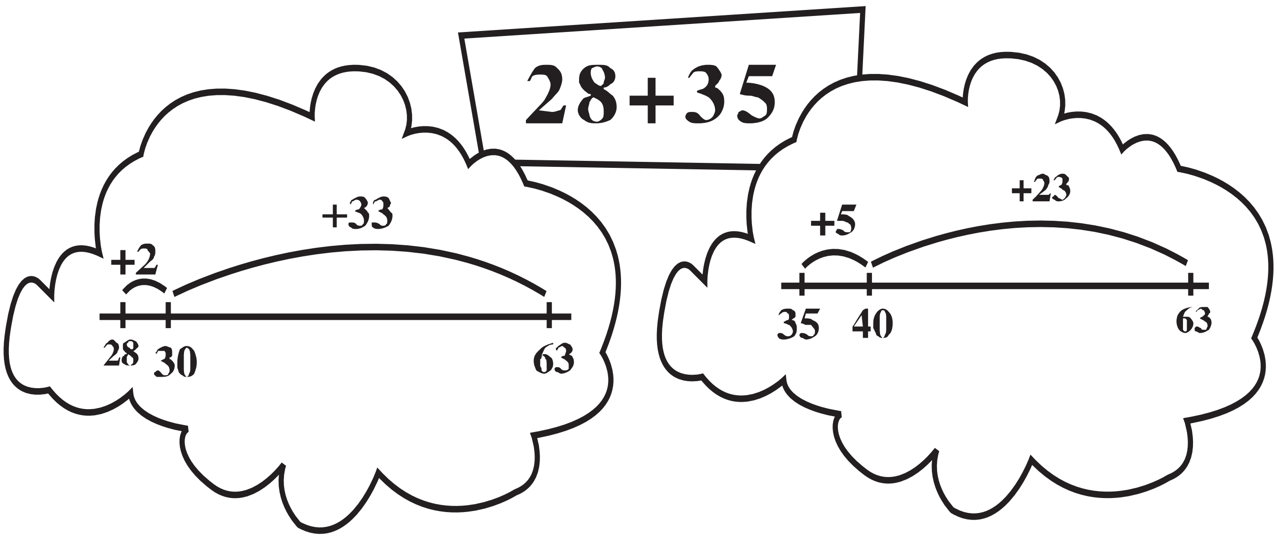
Trading Off Worksheet

Find the two numbers that total 10.

It is easier to use tens.

5	6	1		4	9
5	2	7	8		3

You can "make tens" to make mental addition easier. Here's how...



"Make tens" with 28 then adjust the 35.

OR

"Make tens" with 35 then adjust the 28.

Mental Math:
Make tens with one number and adjust the other.

1. 59 +33
2. 38+46
3. 47+55
4. 37+49
5. 67+34
6. 38+67
7. 54+29
8. 47+26
9. 28+36
10. 55+49

Balancing Subtraction Worksheet

$$\begin{array}{r} 47 \\ -28 \\ \hline \end{array} \qquad \begin{array}{r} 49 \\ -30 \\ \hline \end{array}$$

$$\begin{array}{r} 33 \\ -15 \\ \hline \end{array} \qquad \begin{array}{r} 38 \\ -20 \\ \hline \end{array}$$

$$\begin{array}{r} 77 \\ -40 \\ \hline \end{array} \qquad \begin{array}{r} 76 \\ -39 \\ \hline \end{array}$$

Which problem in each pair is easier? Why?

"Making tens" can help you subtract in your head.

Adding 2 to 28 makes 30. That's easier to subtract. Then adjust 45, too, to balance.

$$\begin{array}{r} 45 \\ -28 \\ \hline \end{array}$$

$$\begin{array}{rcr} 45+2 & \longrightarrow & 47 \\ -28+2 & \longrightarrow & -30 \\ \hline & & 17 \end{array}$$

Remember: Adding the same amount to both numbers leaves the difference unchanged!

MENTAL MATH:
Make tens and balance.

1. $\begin{array}{r} 73 \\ -28 \\ \hline \end{array}$

2. $\begin{array}{r} 54 \\ -29 \\ \hline \end{array}$

3. $\begin{array}{r} 62 \\ -45 \\ \hline \end{array}$

4. $\begin{array}{r} 71 \\ -54 \\ \hline \end{array}$

5. 50 – 33

6. 75–38

7. 80–36

8. 72–47

9. 65–17

10. 83–39

Activity–Square Numbers

Standards I & II

Objective 1

Connections

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

Objective 1
Represent whole numbers and decimals in a variety of ways.

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

Objective 1
Recognize, describe, and use patterns and identify the attributes.

Intended Learning Outcomes
1. Demonstrate a positive learning attitude toward mathematics.
2. Become mathematical problem solvers.
3. eason mathematically.
4. Communicate mathematically.
5. Make mathematical connections.
6. Represent mathematical situations.

Background Information

A squared number is a number that is a result of multiplying an integer by itself. Any squared number of counters can be arranged in a square array. You can write each squared number as a product using an exponent..

$4^2 = 16$

"Four squared equals sixteen, or four to the second power equals sixteen."

Invitation to Learn

Read the book *Sea Squares*. Ask: "What are squared numbers?"

Instructional Procedures

1. Have students use square tiles to build a 1 x 1 square, 2 x 2 square, 3 x 3 square, etc.
2. Record the total number of cubes added to make each new square, perimeter, and total squares.
3. Have students look for patterns and record them on a chart. (For example, students may describe patterns they see in the "growing squares," such as the fact that new squares add change in a predictable way–it increases by the next odd number with each new square.)

Materials

- ❏ square tiles
- ❏ Square Facts Worksheet
- ❏ crayons
- ❏ *Sea Squares*, by Joy N. Hulme. 2001 (Buena Vista Books, Inc.)

Possible Extensions/Adaptations/Integration

Color in the square numbers on a multiplication chart. Look for patterns (e.g., the square numbers are on a diagonal, the square numbers increase by 2 each time, etc.) Use the calculator to further explore square numbers.

Assessment Suggestions

Journal: Have students explain what square numbers are. Use pictures, words and numbers to explain what 5^2 is.

Homework & Family Connections

Ask students to look for arrays at home and record them. Which arrays form a perfect square? Some students may want to bring in arrays to show the class.

Name:______________________

Square Facts

1 x 1 = ______

2 x 2 = ______

3 x 3 = ______

4 x 4 = ______

5 x 5 = ______

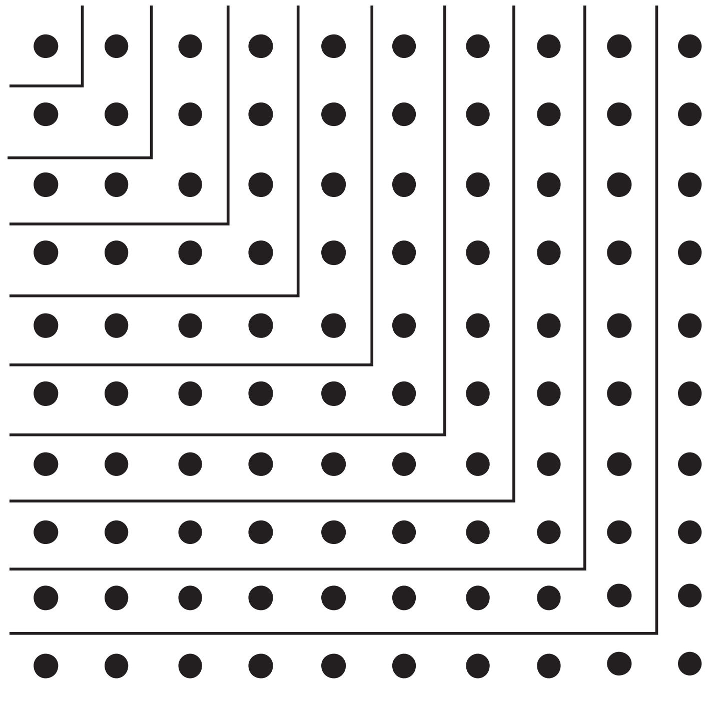
6 x 6 = ______

7 x 7 = ______

8 x 8 = ______

9 x 9 = ______

1 0 x 1 0 = ______



Generation	Model	New Added	Total Squares	Perimeter
1				
2				
3				
4				
5				

Activity—Multi-Digit Multiplication

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

Objective 3
Model and illustrate meanings of the four operations and describe how they relate

Intended Learning Outcomes:
1. Demonstrate a positive learning attitude toward mathematics.
3. Reason mathematically.
4. Communicate mathematically.
5. Make mathematical connections.
6. Represent mathematical situations.

Standard I

Objective 3

Connections

Background Information

Multiplication instruction traditionally has focused on two objectives: memorizing the multiplication facts and using one consistent, standard algorithm to multiply multi-digit numbers. Knowing the multiplication facts and computing efficiently are very important goals, but a deeper conceptual view of multiplication is essential. These lessons offer concrete experiences to minimize the risk of students learning how to do procedures or learning facts without understanding why they make sense. The students will develop key mathematical understandings through building rectangular arrays to help them visualize that a problem like 4 x 27 can be considered (4 x 20) + (4 x 7). They will mentally multiply multiples of 10 or 100, and use the distributive property to calculate products.

Students in third grade have developed the multiplication concepts with a variety of concrete methods and can relate the representation to an algorithm. Fourth grade will extend this foundation by multiplying multi-digit numbers using rectangular arrays, and a variety of mental math strategies. The students will be able to explain how multiplication relates to rectangular arrays, multiply mentally by multiples of 10, and use the distributive property to calculate products. These activities will take several weeks to complete. Allow ample time for students to build rectangular arrays and determine the area before making a connection to the algorithm.

Invitation to Learn

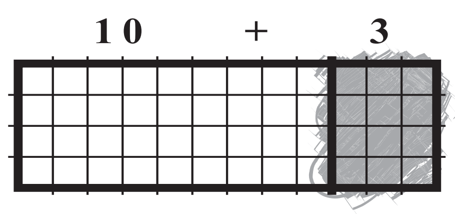
Read *One Hundred Hungry Ants*.

Materials

- ❏ base ten blocks
- ❏ crayons
- ❏ grid paper
- ❏ *One Hundred Hungry Ants*, Pinczes, Elinor J., Houghton Mifflin Co.

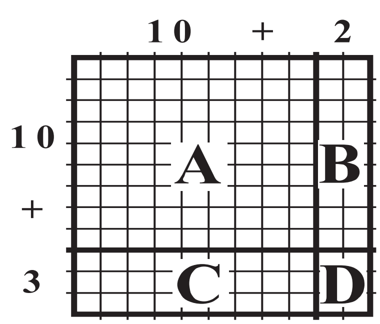
Instructional Procedures

1. Have student make an 8-fold book (see handout). Challenge them to draw all the different ways the 100 ants could travel, staying in equal rows.
2. Build various models of two digits x one digit (e.g., 4 x 13), draw on grid paper, and connect to the algorithm. Explore with the students ways to find the area of rectangles using base 10 blocks and making smaller rectangles with groups of 10's and 1's on grid paper..



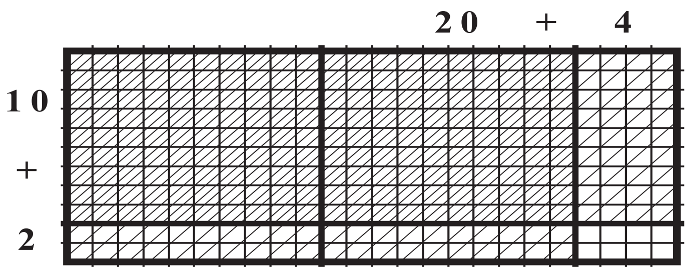

```
 13
x 4
 40
+12
 52
```

3. The above example shows 4 rows of 10 plus 3. There are 4 groups of 10 which is 40, and 12 ones altogether; 40 + 12 = 52. This activity uses the distributive property: 4 (10 + 3) = (4 x 10) + (4 x 3). The ability to break down a large problem into smaller, more manageable ones is vital to conceptual understanding.
4. Build various models of two digits x two digits, draw on grid paper, and connect to the algorithm. The example below shows the area representation of 13 x 12. This rectangle is composed of 4 smaller rectangles. A is composed of a hundred's board, B and C are composed of tens, and C is composed of singles. The area of the original rectangle is determined by adding the areas of rectangles A, B, C, and D. When moving to paper and pencil, have the students record the partial products to help illustrate the steps involved in the standard algorithm and bring meaning to this process. It may be helpful to have the students use base 10 grid paper. Have students practice the following problems: 15 x 14, 12 x 18, 16 x 16, 11 x 14.




```
  12
 x13
 100 (10x10)    A
  20 (10x2)     B
  30 (3x10)     C
   6 (3x2)      D
 156
```

Have the students build 12 x 24 with their base 10 blocks, sketch, and find the area using partial products. The example below shows 2 hundreds in the darker shaded region, 8 tens in the lighter shaded region, and 8 singles in the unshaded area. Therefore the total area of the rectangle is 288. Have students build rectangles to help find products to various problems (i.e., 16 x 23; 22 x 27; 21 x 19; etc.)




```
 24
x12
---
200 (10x20)
 40 (10x4)
 40 (2x20)
  8 (2x4)
-----------
288
```

Curriculum Integration

Math/Science—Have students collect data on dinosaurs. They will need to record the height and length of each specific dinosaur. Determine the area that each dinosaur would take up. (e.g., a Tyrannosaurus is about 40 feet long and 20 feet high, 40' x 20' = 800 sq ft.). Use grid paper to show each rectangular array. Students will take their grid paper diagram outside and use chalk to roughly sketch the dinosaurs actual size using the dimension boundaries determined from research. As the groups finish their sketches, have them write the dinosaur’s name and dimensions near the sketch. Have students write in their journal about what may have surprised them about the real-life size of the dinosaurs.

Possible Extensions/Adaptations

Have the students mentally solve the problem 4 x 27, then as a group, share their strategies for finding the answer. Have the class solve 6 x 32 using each of the student’s methods.

Assessment Suggestion

Have students multiply two-digit numbers through building, sketching, and showing the computation with partial products.

Additional Resources

Lessons for Introducing Multiplication, by Marilyn Burns (Math Solutions Publications)
Lessons for Extending Multiplication, by Maryann Wickett and Marilyn Burns (Math Solutions Publications)

Homework & Family Connections

Teach a member of your family how to multiply using partial products. Return a note indicating the shared mathematical experience between the family member and the student.


One
Hundred
Hungry Ants

Graph Paper

Activity—Long Division

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

Objective 3
Model and illustrate meanings of the four operations and describe how they relate.

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

Intended Learning Outcomes:
1. Demonstrate a positive learning attitude toward mathematics.
3. Reason mathematically.
4. Communicate mathematically.
5. Make mathematical connections.
6. Represent mathematical situations.

Standard
I

Objectives
3 & 5

Connections

Background Information

Students use division informally long before they receive any classroom instruction. One type of division strategy is known as sharing or partitioning. Students divide objects by sharing them one by one until there aren't any more or there aren't enough to go around. For example, if they want to share 20 cubes in 4 rows, they place one cube in each row until each row has five cubes. The goal of this lesson is to further develop the sharing concept of division by using objects. Students will have one and two digit quotients with and without remainders. These concepts will take several days to develop.

Prior to this lesson, the students should already know that multiplication and division are inverse operations. They should have some experience with building arrays by dividing individual cubes into equal rows with a A0" remainder. (For example, if 15 cubes are divided equally into 3 rows, there will be 5 in each row. I can check this answer because an array with 3 rows of 5 cubes have a total of 15 cubes.) The students would also be able to interpret this information in a simple story problem (e.g., if 15 pencils are divided equally among 3 students, how many will each student get?).

Invitation to Learn

Read the book *Remainder of One*. Have students use 25 cubes to make the rectangular arrays discussed in the story (e.g., 2 rows of 12, 3 rows of 8, 4 rows of 6, and 5 rows of 5).

Materials

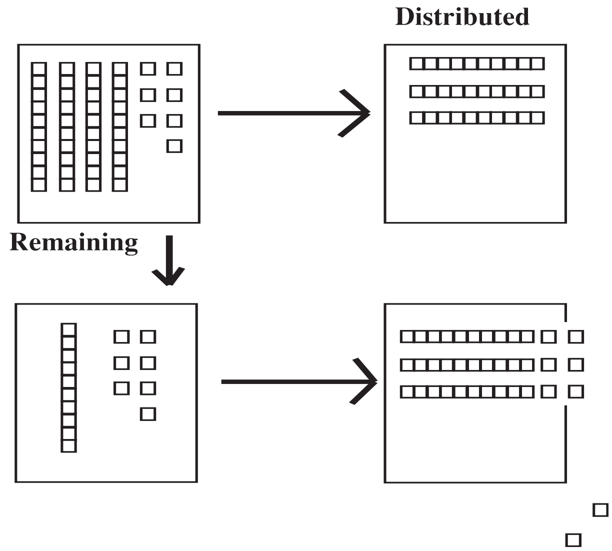
- ❏ base 10 blocks
- ❏ *Remainder of One*, Pinczes, Elinor J.,
- ❏ centimeter cubes
- ❏ 2 sheets of paper per student (for book)
- ❏ bugs in an array handout
- ❏ hundreds board
- ❏ calculator (optional)
- ❏ glue, crayons, and scissors
- ❏ die (one for each pair of students)

Instructional Procedures:

1. Record the various arrays from *Remainder of One* by creating an array book. Use the bugs in an array handout. Have the students cut out the various arrays, glue them into their book, and connect each array to the symbolic algorithm.
2. Give the students a hundreds board. Ask, "If you were marching 5 bugs in each row, how many leftover bugs would there be if there were only 16 bugs altogether?" (1). Try building various numbers. Color the numbers on the hundreds chart with one color for a remainder of 1, a second color for a remainder of 2, and so on. Are there any patterns? Do you think the pattern will change if the bugs marched in a row of six instead of five?
3. Play the game of Leftovers in partners. Players start with 20 counters. The first player rolls a number cube, divides the current number of counters by that number, and states the division problem (e.g., if I take 20 counters and divide them equally into 3 rows, there will be 6 in each row with 2 left over). The player takes the remainder counters and tells the other player how many counters to start with. The game continues until no counters remain. To determine the winner, roll a number cube. If you get an odd number, the player with the most counters wins. If you get an even number, the player with the least counters wins.
4. Remainder of One Riddles. Have students choose a number between 1 and 25. Write Remainder of One Riddles (see handout).
5. Have the students use base ten blocks to explore the following problem: $47 \div 3 = ?$
   a. The student can show the dividend as 4 tens and 5 singles. The divisor is the number of equivalent rows to be formed (e.g., $47 \div 3 = ?$ Divide the blocks equally among 3 rows).
   b. Distribute 1 ten to each of the 3 rows.
   c. A record should also show that a total of 3 tens has been removed from the dividend.
   d. The remaining ten cannot be distributed among three rows. They are traded for 10 singles, and the other seven singles are joined with them. This is shown by "bringing down" the 7.
   e. The 17 singles are then distributed equally among the three rows. Distribute 2 singles to each of the 3 row.
   f. A record should show that only 15 singles could be distributed in equal rows.
   g. A remainder of 2 singles is left.

Answer: 12 R 2

2	E
10	B
3)47	A
30	C
17	D
15	F
2	G



Possible Extensions/Adaptations

Play Leftovers Game using larger numbers and a 4 - 9 number cube.

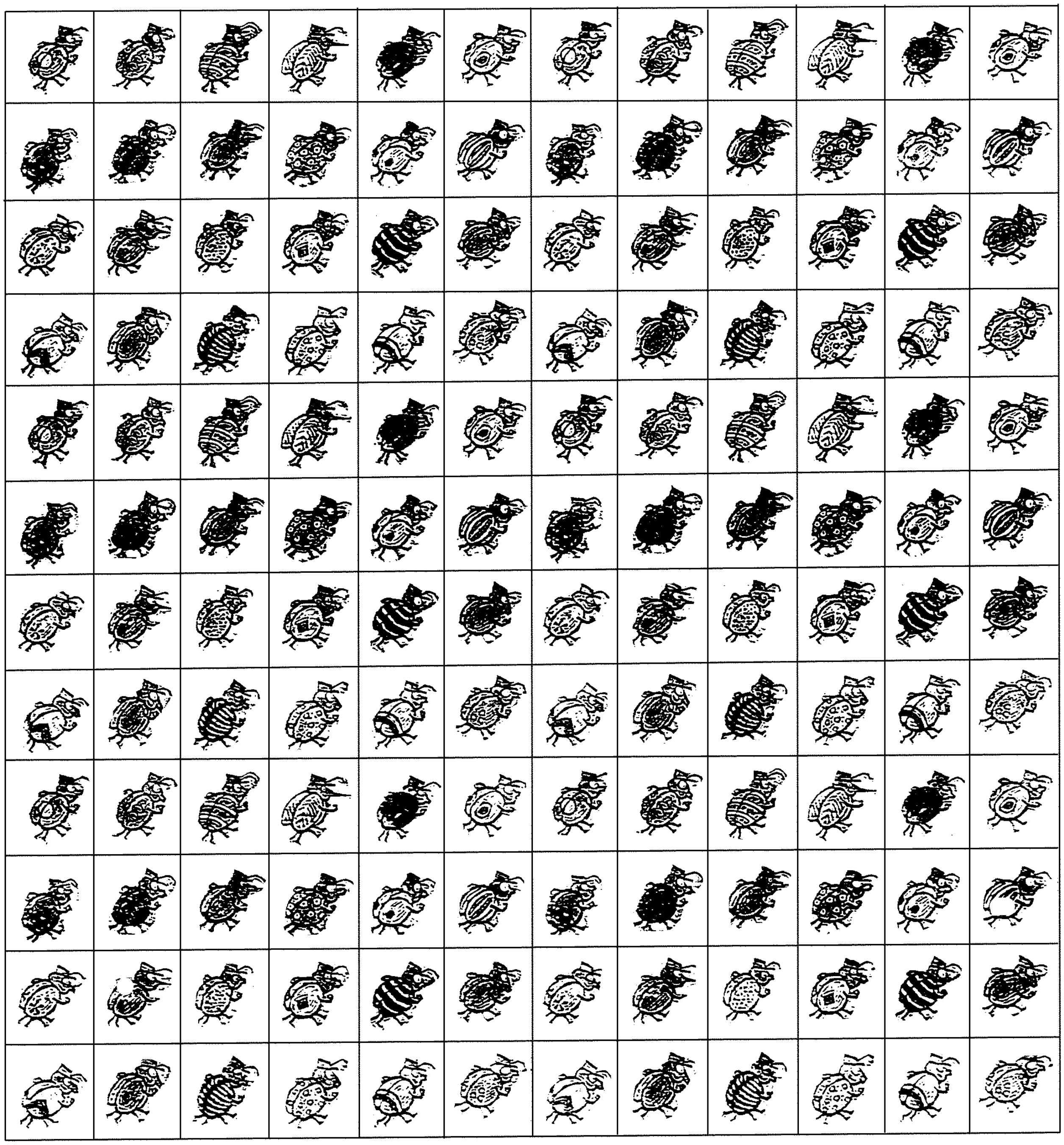
Additional Resources

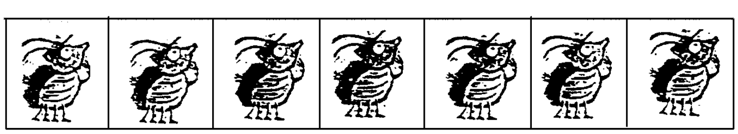
Lessons for Introducing Division, by Maryann Wickett, Susan Ohanian, and Marilyn Burns (Math Solutions Publications)

Homework & Family Connections

Play Leftover game. Teach a member of your family how to do long division. Return a note indicting the shared mathematical experience between the family member and the student.

Bugs in an Array





Hundreds Board

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
51	**52**	**53**	**54**	**55**	**56**	**57**	**8**	**59**	**60**
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**

Remainder of One Riddle

Written by: ___________________________________

Solved by: ____________________________________

1. When you divide my number by 1, R=
2. When you divide my number by 2, R=
3. When you divide my number by 3, R=
4. When you divide my number by 4, R=
5. When you divide my number by 5, R=
6. When you divide my number by 6, R=
7. When you divide my number by 7, R=

1 2 3 4 5 6 7 8 9 10

11 12 13 14 15 16 17 18 19 20

21 22 23 24 25

Activity—Fantastic Fractions

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

Objective 4
Use fractions to communicate parts of a whole.

Intended Learning Outcomes
1. Demonstrate a positive learning attitude toward mathematics.
2. Become mathematical problem solvers.
3. Reason mathematically.
4. Communicate mathematically.
5. Make mathematical connections.
6. Represent mathematical situations.

Standard
I

Objective
4

Connections

Background Information

The goal of this lesson is to help students see the sense in fractions through hands-on experience and reasoning. If students are expected to memorize and practice procedures, the main goal of making sense of mathematics takes a back seat. When talking with students about fractions, it is important to make sure they understand what the whole is. In this lesson, students will use pattern blocks to visually understand halves, thirds, and sixths through comparing shapes and their areas. They first look at all the different ways they can make a congruent yellow hexagon using other pattern block pieces. After the investigation, they represent their solutions using pictures and fractional notation. They will also play a game to increase an understanding of equivalence.

Invitation to Learn

Have students use different pattern blocks to build hexagons that are the same size and shape as the yellow hexagon pattern block. Try to find all the different ways.

Instructional Procedures

1. Make a book to record the above hexagons. Trace a yellow hexagon on the front cover and give the book a title (e.g., My Fraction Book)
2. Trace 2 red trapezoids on the next page and ask what the fractional value of each piece is. (1/2) Write the fraction sentence 1/2 + 1/2 = 2/2 or one whole hexagon. Explain that it is 1/2 because it is one out of two equal pieces.

Materials
- ❏ pattern blocks
- ❏ 2 sheets of paper per student
- ❏ scissors, crayons
- ❏ 1 die per partner
- ❏ Exchange Game score sheet

3. Record each different hexagon combination with picture and symbolic notation.
4. Play the Exchange Game in partners.
   a) Use the yellow hexagons, red trapezoids, blue rhombuses, green triangles, and one die.
   b) The first partner rolls the die and takes the number of green triangles that appear on the die (e.g., If a two results in a roll, they take 2 green triangles).
   c) Check to see if there is another fractional piece that could be exchanged for the same shape (e.g., 2 green triangles can be exchanged for 1 blue rhombus 2/6 = 1/3). This fraction is now in simplest form B showing the least amount of pieces to make a shape. Students will be exchanging fractional pieces to make simplest form.
   d) The second partner rolls the die and repeats the steps above.
   e) The first person to build 5 hexagons is the winner. Once a yellow hexagon is formed, color one of them on the score sheet and return the yellow hexagon to the pile of pattern blocks.
   f) Remember that when you simplify you have to use all the same color (e.g., 4 green triangles = 2 blue rhombuses 4/6 = 2/3). If a five is rolled, neither 2 red trapezoids nor 2 blue rhombuses would work. So 5/6 must already be in simplest form. The student would need to wait for their next turn to add more pieces to create a hexagon. They will need to build all green (6/6), all blue (3/3), or all red (2/2) to make one hexagon.

Possible Extensions/Adaptations

Have various pattern blocks represent one whole and determine the fractional value of each pattern block piece (e.g., if the red trapezoid represents one whole, what would the fractional value of the green pattern block be? One-third because it is one out of three equal pieces). See attached handout.

Assessment Suggestions

Have students write which of two fractions is larger and how they know. Have them identify equivalent fractions for 1/2, 1/3, etc. and explain how they know.

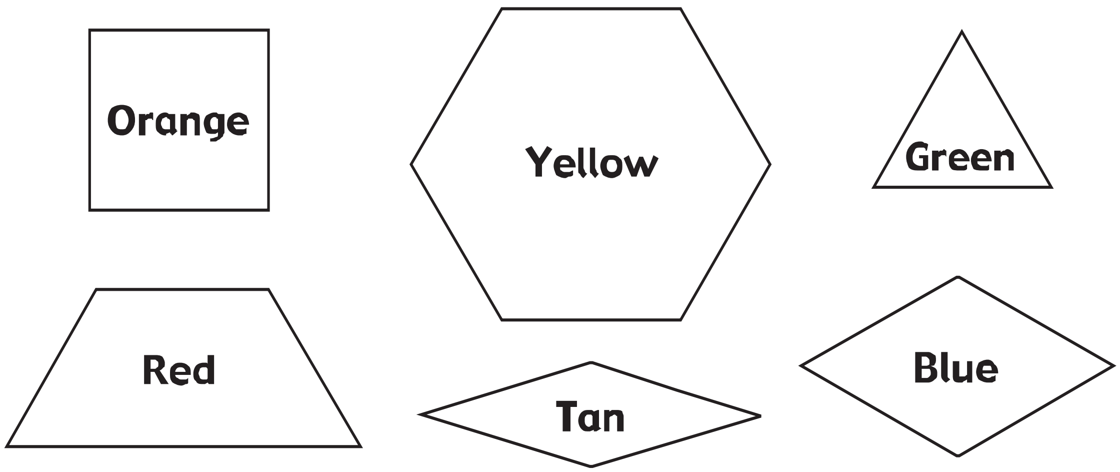
Additional Resources

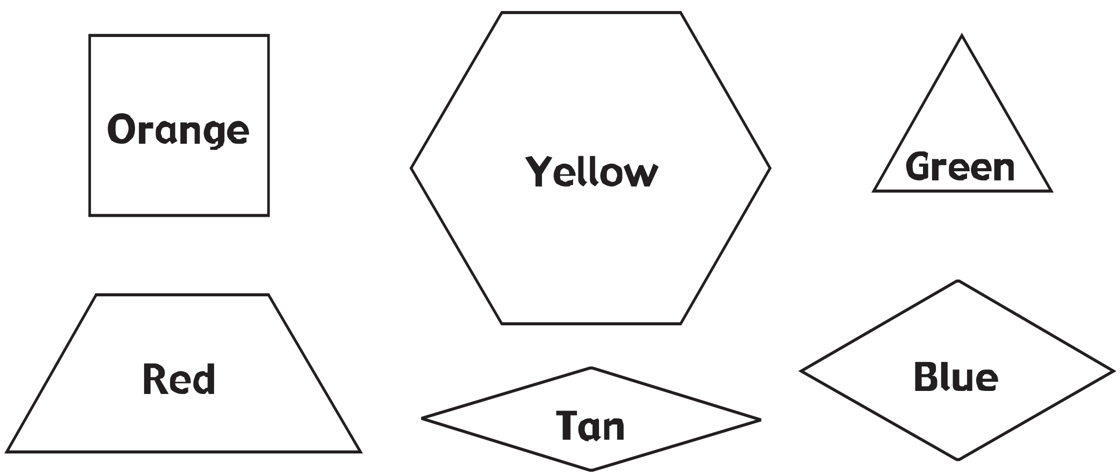
Lessons for Introducing Fractions by Marilyn Burns (Math Solutions Publication)

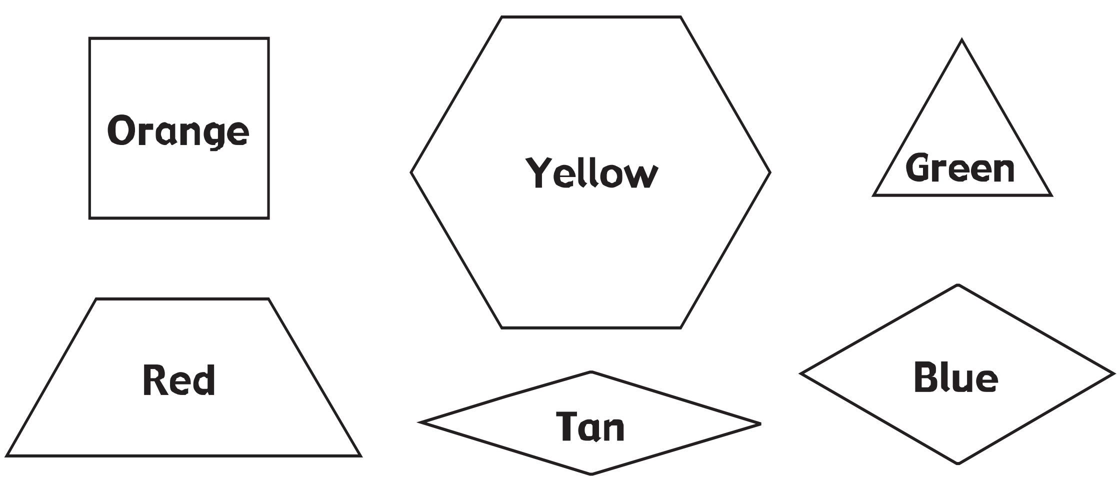
Homework & Family Connections

Find examples of fractions used in newspapers, magazines, and other sources. Be prepared to share these findings with the class.

Pattern Block Shapes

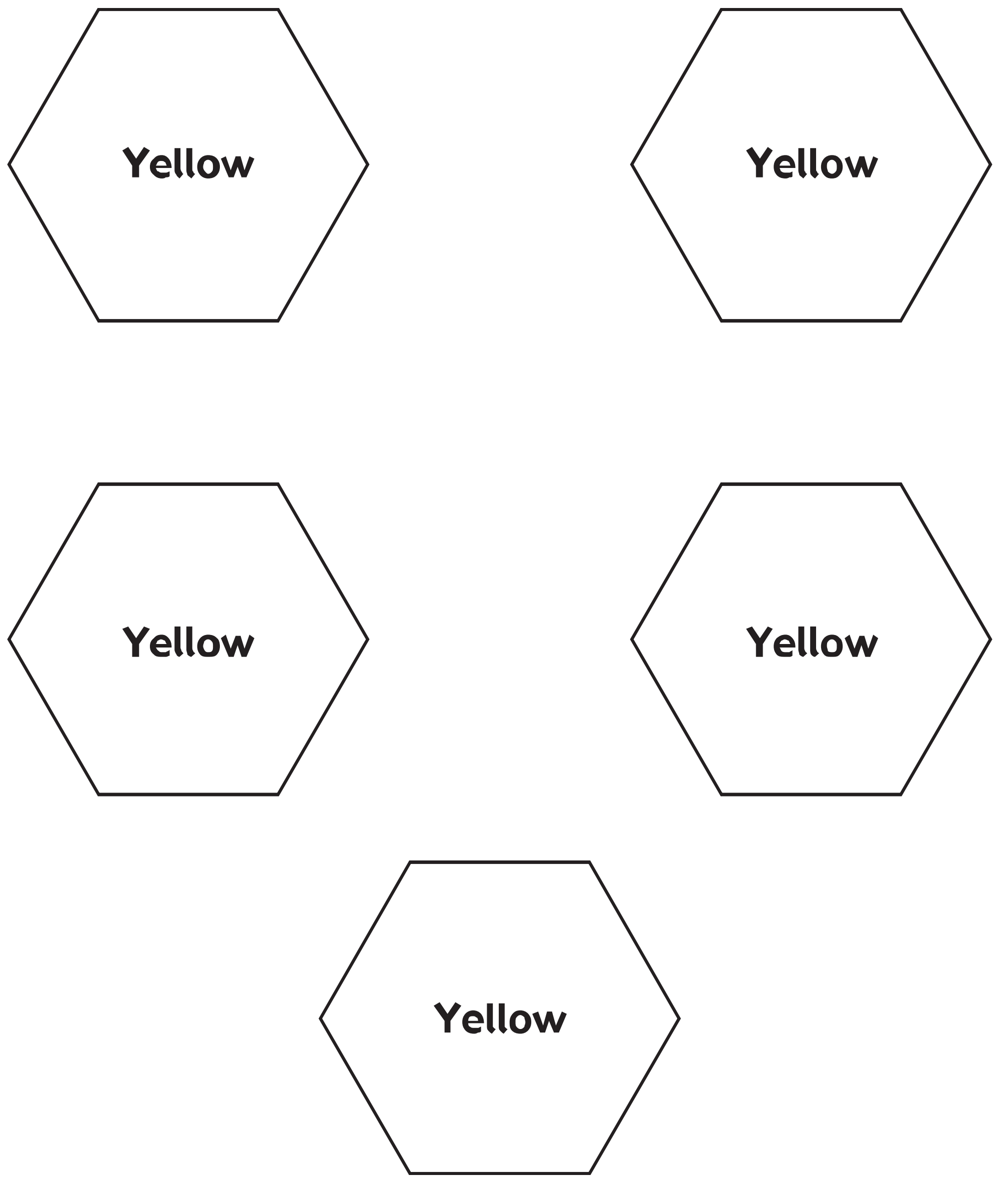






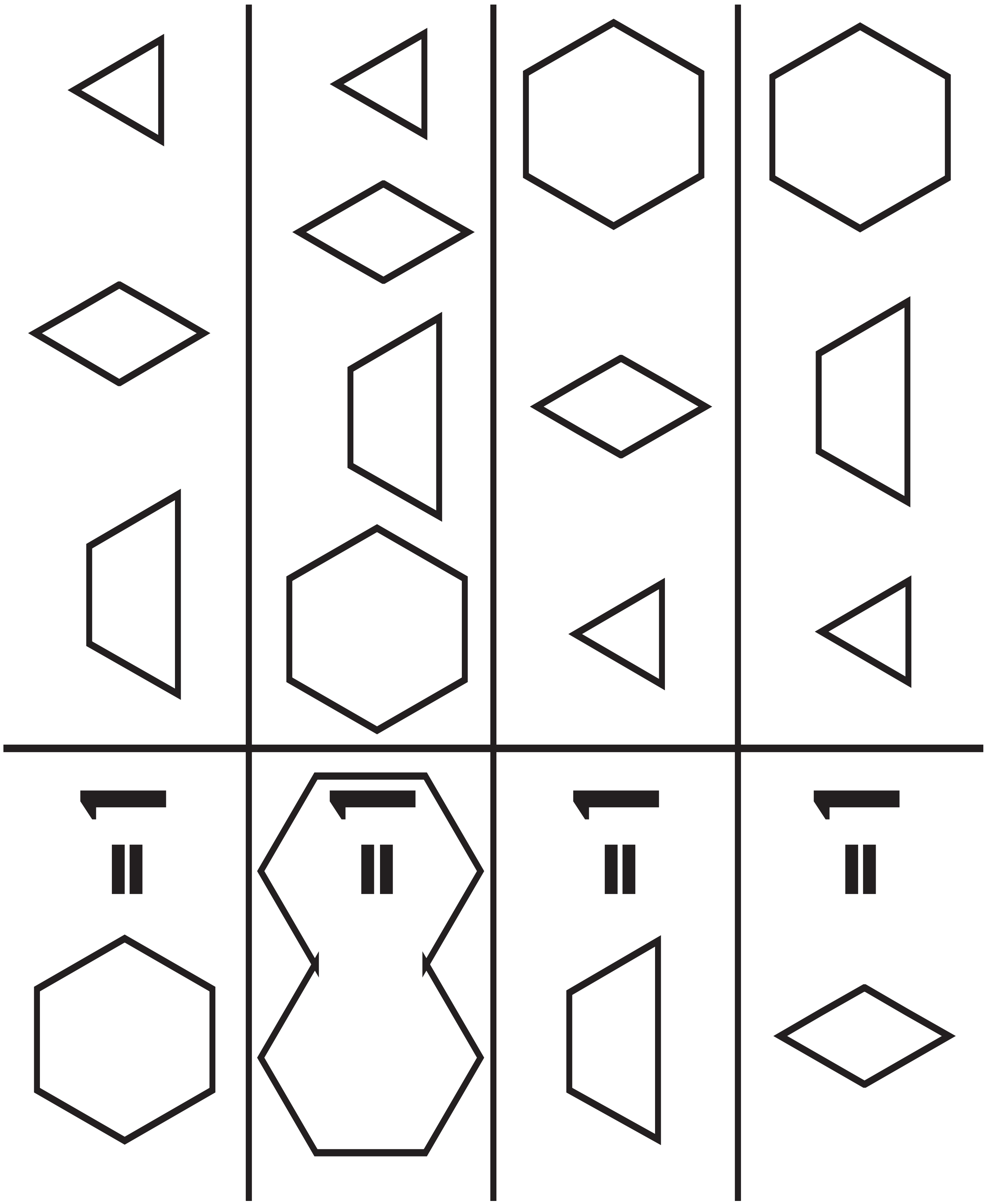
Name:______________________

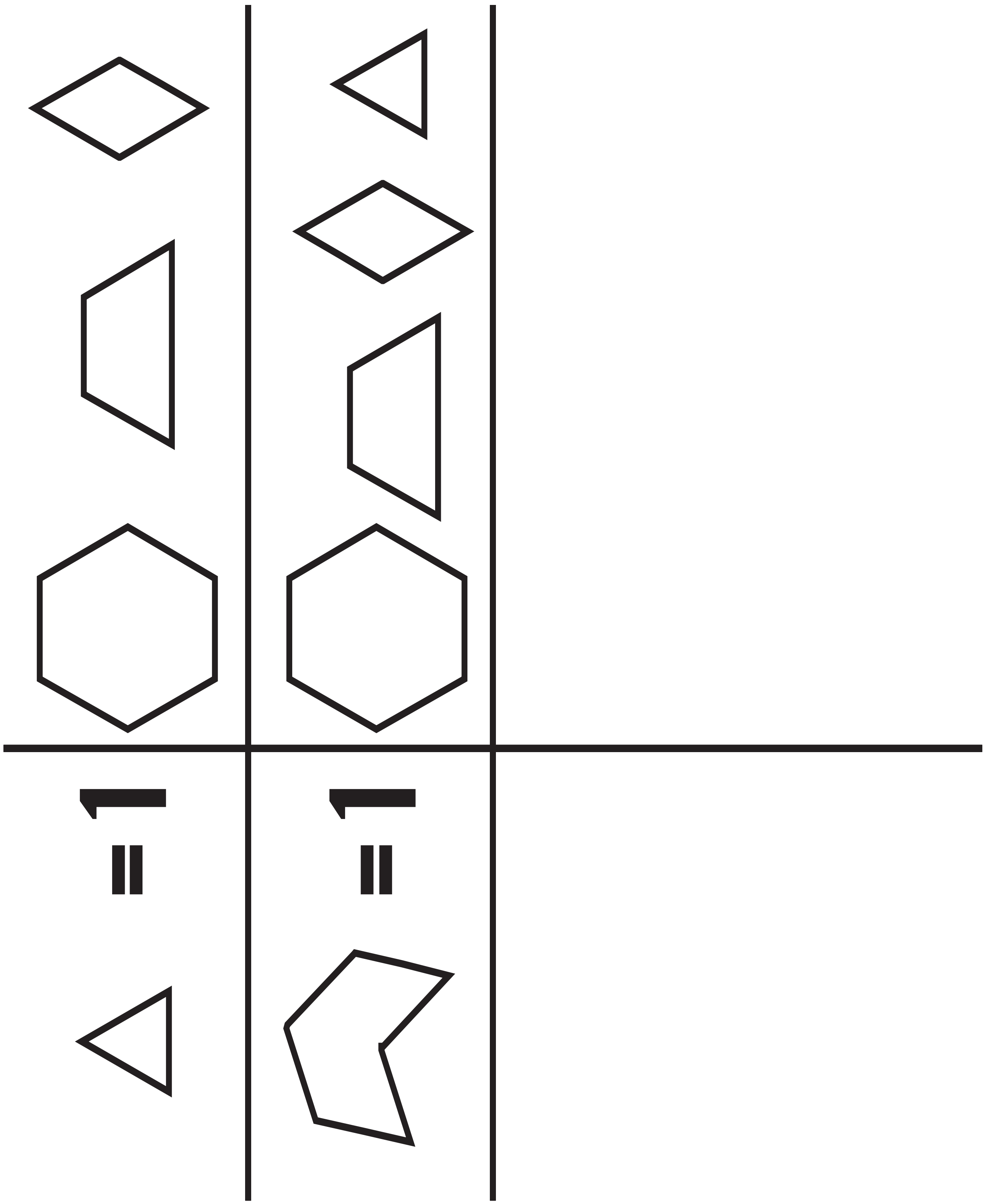
Exchange Game Score Sheet



Name:______________________

My Fraction Page





Math Standard II Activities

Activity—Spaghetti and Meatballs For All

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

Objective 1
Recognize, describe, and use patterns and identify the attributes.

Intended Learning Outcomes
6. Represent mathematical situations.

Standard II

Objective 1

Connections

Background Information

Review basic patterns with the students. This will give you a sense of their pattern experience.

Invitation to Learn

How many different ways could we seat 32 people around tables?

Instructional Procedures

1. Read the story through once without asking any questions. Simply acquaint the students with the story.
2. Give each student 8 rainbow tiles, 32 centimeter cubes, and a sheet of blank math paper.
3. Reread the story stopping at each table arrangement. Have the students make the arrangements with their manipulatives.
4. After the students have made all of the table arrangements, have them draw the arrangements on the math paper.
5. For each arrangement they have made, they can make a table using a T-chart.
6. Have the students write a rule for determining the number of chairs when given the number of tables.

Materials

- ❏ *Spaghetti and Meatballs for All!* by Marilyn Burns
- ❏ Math paper
- ❏ Rainbow tiles
- ❏ Centimeter cubes

Curriculum Integration

In the science area you could have the students take three or more rock types and place them in various pattern forms (e.g., AB, ABC, ABCD, ABBA).

Possible Extensions/Adaptations

Put the students in small groups and give them larger numbers to work with. This lesson would also work to teach area and perimeter.

Assessment Suggestion

Give the students a number. Have students write draw and label the steps of their arrangement in their math journals.

Homework & Family Connections

Give the students a different table arrangement to make. Have them draw their arrangement, make the table, and determine the rule for their arrangement.

Activity—Equivalent Equations

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

Objective 2
Recognize, represent, and solve mathematical situations using patterns and symbols.

Intended Learning Outcomes
2. Become mathematical problem solvers.
3. Reason mathematically.

Standard II

Objective 2

Connections

Background Information

Students must understand that equality is a relationship, not just an operation. They should understand that an equation is a kind of number sentence. Balancing equations consists of making each side of the equation equal to the same amount.

Invitation to Learn

What number sentence can you make using the number 14?

Instructional Procedures

1. Put 14 cubes on the left side of the balance.
2. Put a sum (two numbers added together) onto the right side of the balance.
3. What happens? Why?
4. List your equation on your paper (example: 14 = 10 + 4).
5. Write another sum that balances with 14. List as many others as you can on your paper or in your math journal.
6. Can you add up three numbers to equal 14? Can you add up four numbers?
7. Continue to explore different equations that you can balance and record them in your math journal or on your paper.

Materials

- ❏ Simple math balance
- ❏ Rainbow cubes
- ❏ Paper or math journal

Possible Extensions/Adaptations

1. Put 4 + 9 on one side of the balance.
2. Put something on the other side that will make it balance (example: 4 + 9 = 7 + 6).
3. Find as many answers as you can.

Assessment Suggestion

Students will turn in recording sheets with equations. A homework sheet is another good form of assessment.

Additional Resources

Online balance scales are available at www.illuminations.nctm.org.

Homework & Family Connections

Making Connections game

Homework sheet

Name______________________________

Solving Equations

Directions: Fill in the missing variable to make the equations balanced.

1. $x + 3 = 5$, $x =$ _______

2. $a – 6 = 9$, $a =$ _______

3. $32 = x + 3$, $x =$ _______

4. $29 – d = 13$, $d =$ _______

5. $2 + 6 = F + 4$, $F =$ _______

6. $7 + 8 = 10 + c$, $c =$______

7. $2 + 19 = 30 – p$, $p =$ ______

8. $b + 6 = 26 – 2$, $b=$_______

9. $46 = 47 – e$, $e =$________

10. $4 = 9$ k, $k =$ ________

Bonus
Create 3 equations of your own with a missing number and show how to balance them.
1. _______________ 2. _______________ 3. _______________

Activity—Messy Cookies

Standard II

Objective 2

Connections

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

Objective 2
Recognize, represent, and solve mathematical situations using patterns and symbols.

Intended Learning Outcomes

2. Become mathematical problem solvers.
3. Reason mathematically.
4. Communicate mathematically.
5. Make mathematical connections.

Background Information

Students should have a basic understanding of visual patterns and arrays. They should be able to represent mathematical ideas with objects, pictures, and symbols. Use this lesson to strengthen the idea of a missing factor in an equation. Students also need to have a basic understanding of multiplication facts.

Invitation to Learn

"We've been baking chocolate chip cookies and now we are ready to display them on our trays. It is important that we display them in equal rows. What are some different arrangements you can make on your tray?"

Instructional Procedures

Materials

- ❏ Rainbow cubes
- ❏ Recording sheet
- ❏ Adhesive dots

1. Tell the students to make an arrangement of cookies (use the cubes as cookies) on their recording sheets in equal rows.
2. Ask volunteers to tell you about their arrangement. For example: "Three rows of five muffins, fifteen muffins altogether." Model how to write a multiplication equation on the board that tells about the cookies on the tray. Say, "Three times five equals fifteen." Model how to write the equation: 3 x 5 = 15.
3. Repeat the above steps encouraging students to tell the multiplication equation that describes their cookie picture. Continue until you have five or six models on the board (make sure the students are making their models on their work mats as you go along).
4. Erase one factor in each equation you have listed on the board. Tell the students that some frosting fell on the equation and covered some of the numbers.

5. Ask students to help figure out what the missing numbers are. Some may need to use the rainbow cubes, and others may be able to solve the problem with their knowledge of math facts.
6. Students should now use their recording sheets to write new equations that tell about six different cooking arrangements
7. Have students pass their equations to another student. This student spills some frosting on one of the number equations by covering a number with an adhesive dot. Continue passing around until all six equations have frosting spilled on them.
8. Return Recording Sheets to original student. Allow time to figure out the missing numbers on their papers. They may again use the rainbow cubes to recreate the picture or use their math facts to solve the problem.

Possible Extensions/Adaptations

Try writing an equation that they have to balance. For example: 2 + 10 = 3 x __ The missing number has the frosting on it and they need to find the hidden number to make the equation equal.

Assessment Suggestion

Evaluate the students' recording sheets. Also have them record in their Math Journals how they figured out what numbers were missing.

Messy Cookies Recording Sheet

Directions: Align your cookies into an arrya and write the number sentence to match it. Try to come up with 4-6 different arrangements.

Cookie Trays

Activity—Red Walls and Green Doors

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

Objective 1
Recognize, describe, and use patterns and identify the attributes.

Intended Learning Outcomes
3. Reason mathematically.

Standard II

Objective 1

Connections

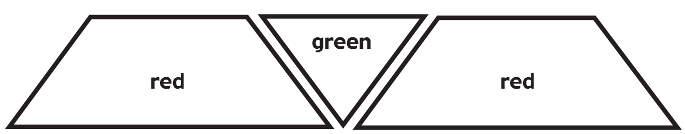
Background Information

Students should have experiences examining and extending patterns. This could include skip counting books and a daily number line.

Invitation to Learn

Ask the students to look at the pattern and give them this challenge: "How many pattern blocks in all do you think it would take to make a red wall with 50 green doors?"

On the overhead projector, place two red trapezoids and one green triangle in the pattern shown below:



Instructional Procedures

1. Put the students into groups of two. Give each pair 14 green triangles, 14 red trapezoids, and paper.
2. Have the students duplicate the pattern that is on the overhead. Ask the students how many blocks it took to make the wall.
3. Continue the pattern on the overhead, adding one more triangle and one more trapezoid. Say to the students: "Our pattern has two more doors. How many blocks does it take to make this wall?"
4. Have the students record their growing patterns on paper by tracing around the pattern blocks. Then have them make a table to record their findings.
5. After they have continued the pattern a couple of times, challenge the students to figure out how many pattern blocks would it take to make a red wall with 50 green doors. Discuss with the students their predictions.

Materials

- ❏ Red trapezoid pattern blocks
- ❏ Green triangle pattern blocks
- ❏ Paper

6. Have the students work in their pair groups to figure out the challenge question.
7. As you observe the students working, allow them to discover “the right answer” for themselves.
8. At the end of class, bring the students together to discuss their findings.

Curriculum Integration

Block patterns make wonderful art.

Possible Extensions/Adaptations

Ask the students to use their pattern blocks to construct their own growing-pattern designs.

Assessment Suggestions

Have the students draw a growing pattern in their journals. Then have them construct a table and state the rule that describes the relationship involving the number of pattern blocks used to make the pattern.

Activity—Decoding Machine

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

Objective 2
Recognize, represent, and solve mathematical situations using patterns and symbols.

Intended Learning Outcomes
2. Become mathematical problem solvers.
3. Reason mathematically.

Standard II

Objective 2

Connections

Background Information

This lesson is an introduction to variables and their uses. It does not require any prior knowledge of variables.

Invitation to Learn

1. Invite students to become FBI agents for the day. They are working with TOP SECRET tools that will enable them to decode and find the values of hidden messages and words.
2. Group students in pairs to work on this activity.
3. Cut notebook paper into two strips—one that is three inches wide and one that is five inches wide.
4. Down the right side of the 5-inch strip of paper, write the numbers from 0-25.
5. Down the left side of the 3-inch strip of paper, write the letters of the alphabet A-Z.
6. Attach the ends of the number strip together with a piece of tape.
7. Wrap the letter strip around the number wheel, matching the letters to the corresponding numbers–A to 0, B to 1, C to 2, and so on.
8. Tape the ends of the letter strip together.

Instructional Procedures

1. Begin by having students find the value of their first names, using the decoding machine (e.g., BOB is B=1, O=16, B=1, so 1 + 16 + 1 = 18). Use the leftover part of the notebook paper to record their data.
2. Have the students find the value of their last names and ask the following questions: Which name has the greater value – your

Materials

- ❑ Notebook paper
- ❑ Scotch tape
- ❑ Ruler

first or last name? What is the difference in the value of your first and last names?

3. Now have the students find the values of various words and asking questions such as: "What is the three-letter word with the greatest value?" "Are the greatest values always associated with words that contain the most letters?" Create a hidden message that your class can decode and have them work with their partners to decode it.
4. Challenge students to find words that are more than ten letters long with values that are less than the value of words having only three letters. Have them find words whose values are equal to 25, 36, or 100.

Curriculum Integration

Math/Science—Create a hidden message that your class can decode and have them work with their partners on decoding it. This could be one of your science questions or some math vocabulary.

Possible Extensions/Adaptations

Extend this activity by changing the number strips so that A= 7. This will realign all the assigned values. You can also change the number strip by writing different values such as decimals or fractional numbers.

Assessment Suggestion

Have students use their decoding machine to find the value of their spelling words. Encourage partners to create a message for each other to decode.

Homework & Family Connections

Have students create a message that a family member can decode and vice-versa.

Activity—Rock & Roll

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

Objective 2
Recognize, represent, and solve mathematical situations using patterns and symbols.

Intended Learning Outcomes
4. Communicate mathematically.

Standard II

Objective 2

Connections

Background Information

Students should have prior knowledge of what the symbols <, > , and = stand for.

Invitation to Learn

What do these symbols mean? <, >, =

Instructional Procedures

1. Write the statement $A + B$___C on the board.
2. Roll three dice but do not show the numbers to the class.
3. Have the students guess the numbers on the die. To do this, call on a student to guess a number. Hold up the appropriate symbol card (<, >, or =). This will narrow the choices. Continue until the students have guessed the three numbers.
4. Replace the variables in the equation with the numbers.
5. Have the students select the symbol that will make the number sentence true.
6. Run through several examples with the students using all of the operations.
7. After a few examples, put the students in pairs. One will roll the dice and the other will be the guesser.

Materials

- ❑ 3 dice for each pair of students
- ❑ Index cards with the <, >, and = symbols on them (one set for each pair of students)
- ❑ Large symbol cards for the teacher

Possible Extensions/Adaptations

1. Follow the same procedure using subtraction, multiplication, and division.
2. Use the game board (included) and have the students follow the same procedure, but this time comparing two equations.

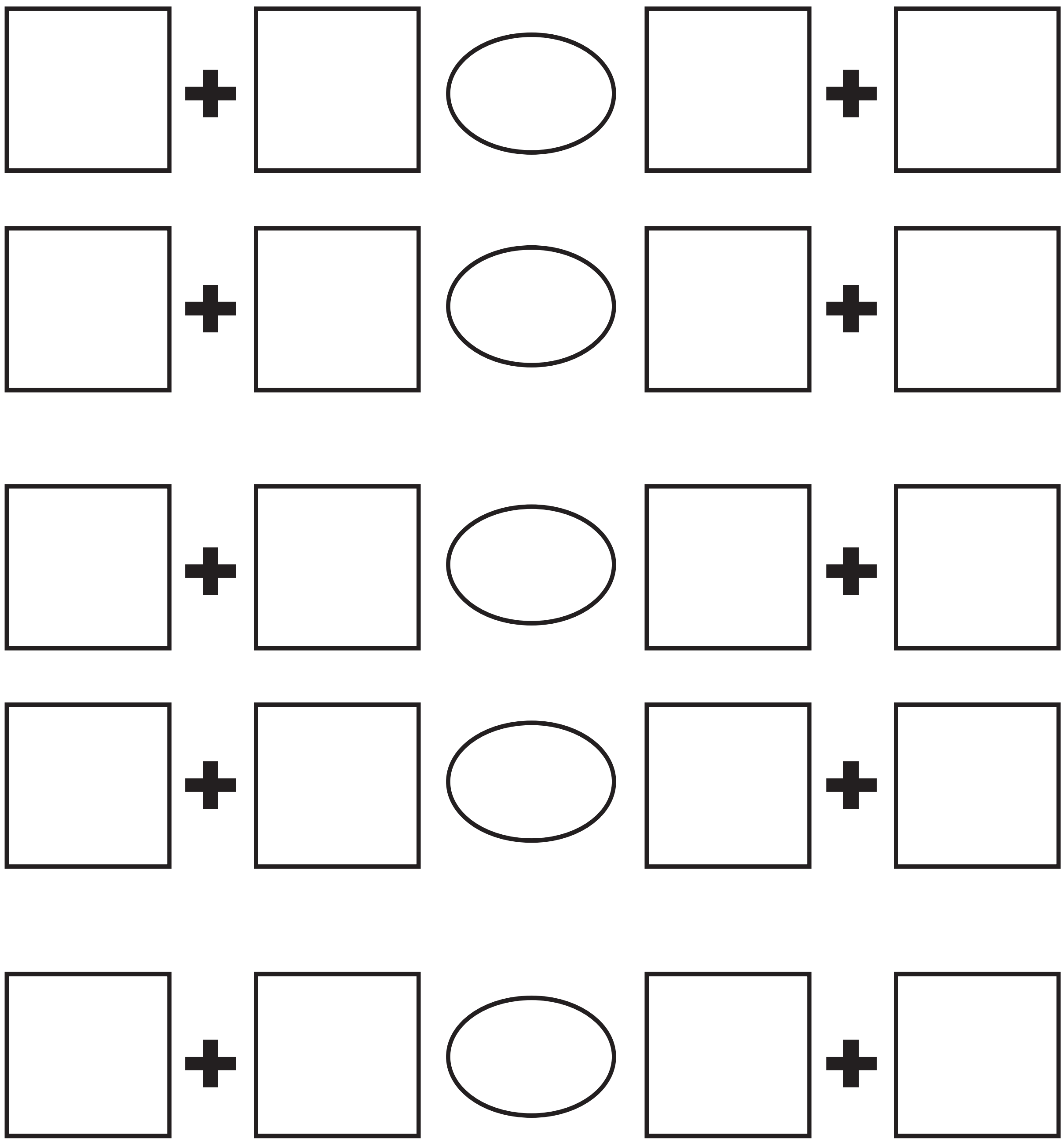
Assessment Suggestion

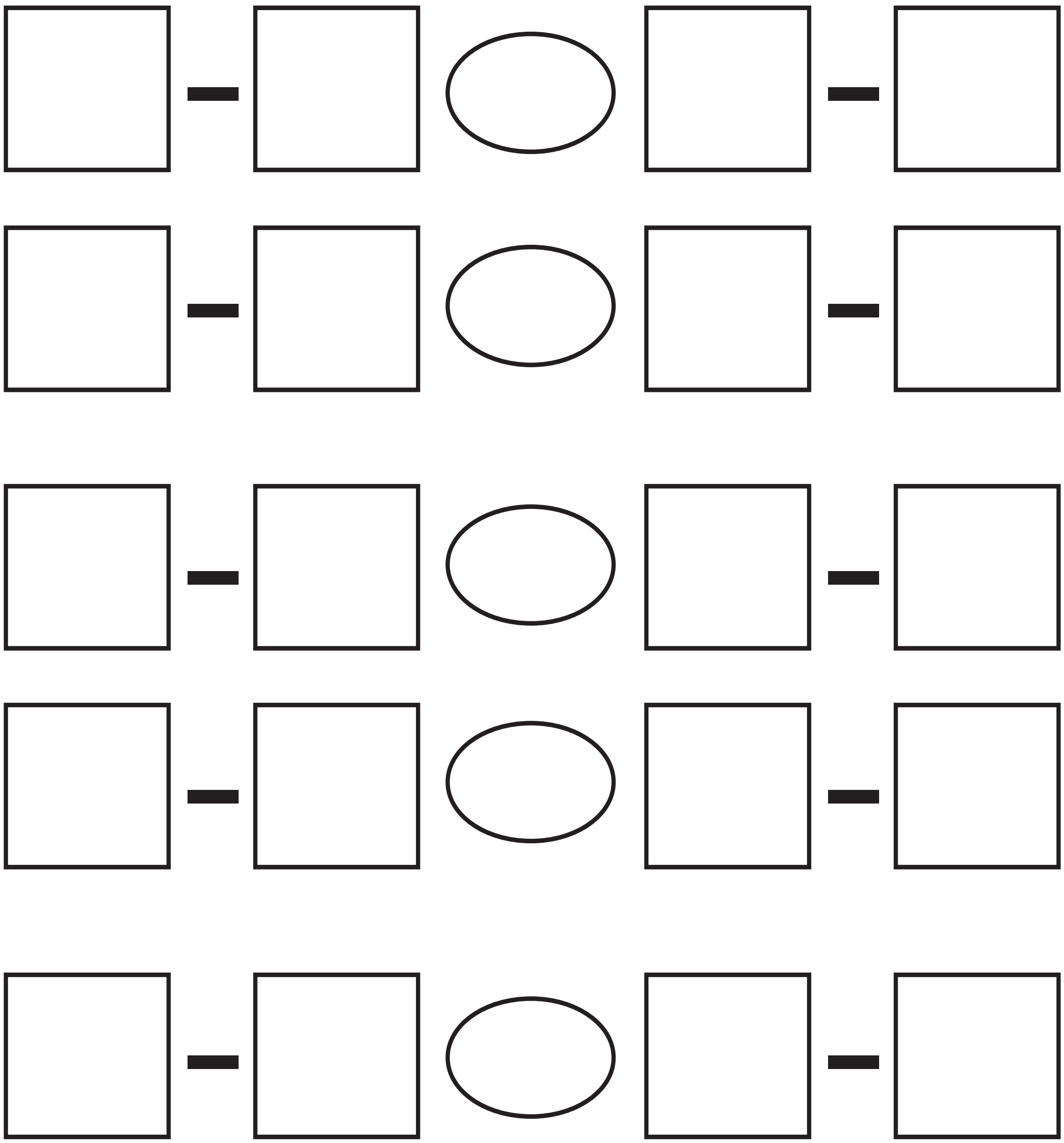
Walk around and observe the groups while they are participating in the activity.

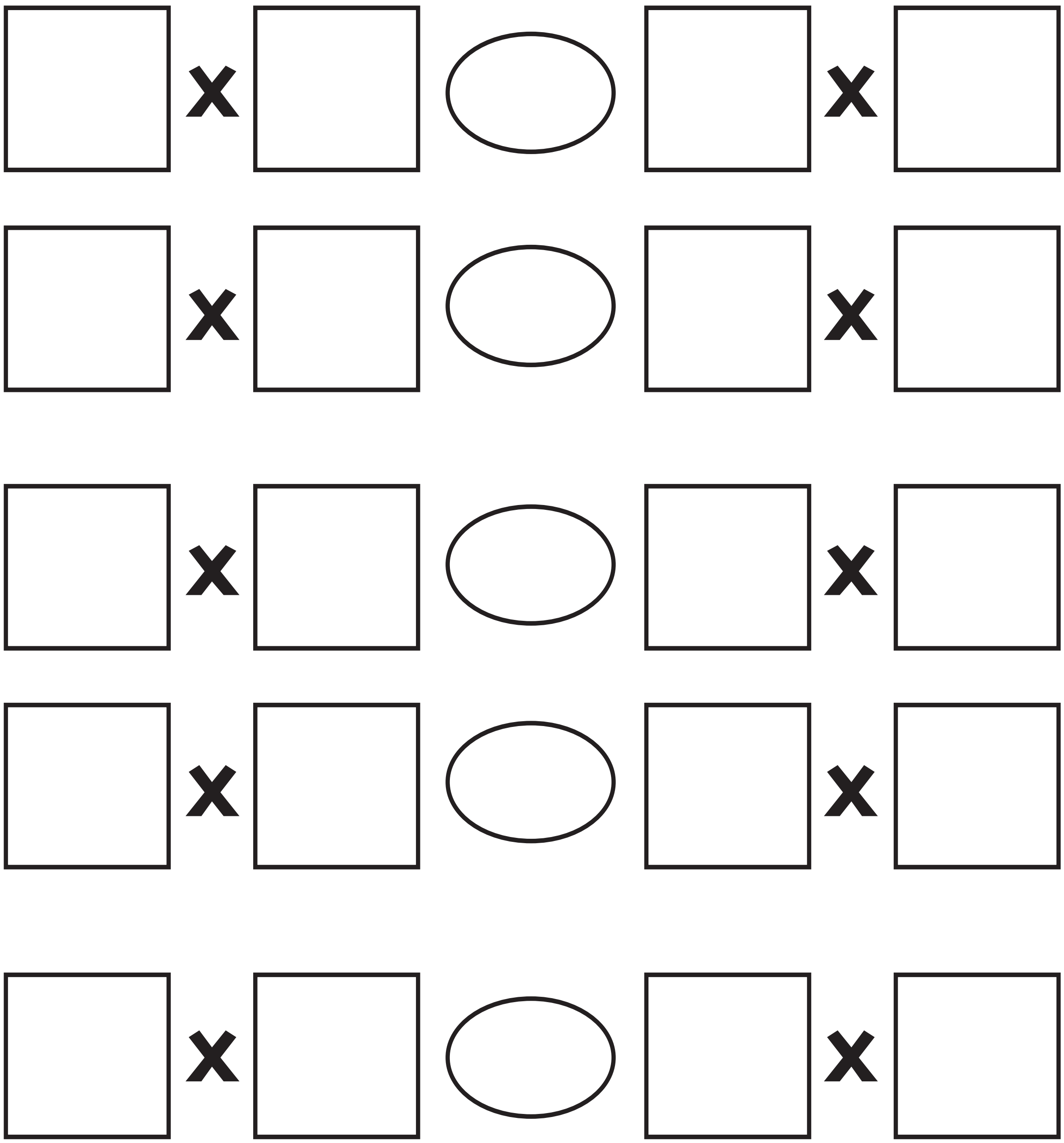
Homework & Family Connection

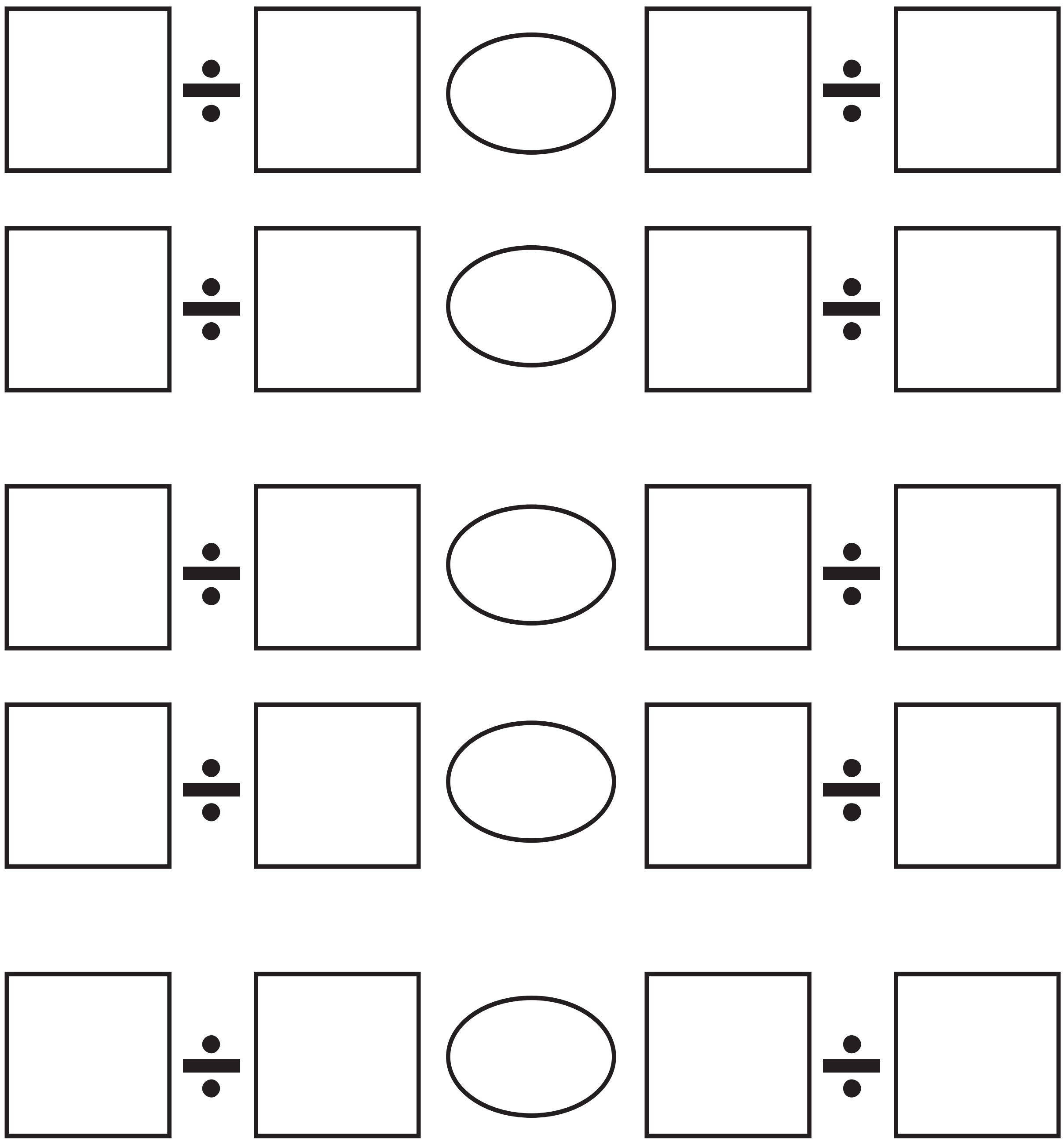
Give the students the game materials to take home and play with their families.

Rock & Roll Game Board









Math
Standard III
Activities

Activity—Quadrilateral Characteristics

Standard III
Students will use spatial reasoning to recognize, describe, and identify geometric shapes.

Objective 1
Describe, identify, and analyze characteristics and properties of geometric shapes.

Intended Learning Outcomes
3. Reason mathematically.
6. Represent mathematical situations.

Standard III

Objective 1

Connections

Background Information

Quadrilaterals are closed, four-sided figures. The quadrilateral family consists of regular figures such as the trapezoid, square, rectangle, rhombus, kite, and parallelogram. This group includes isosceles and right angle trapezoids, as well as concave and convex kites. The second group consists of irregular quadrilaterals, which have endless possibilities.

Invitation to Learn

What do all quadrilaterals have in common?

Instructional Procedures

Lesson 1

1. Give students an assortment of quadrilaterals. Tell them that they are all quadrilaterals. Have them look at them and identify the properties that quadrilaterals have.
2. Give them an assortment of polygons, but NO quadrilaterals. Tell them these are NOT quadrilaterals. Have them identify why they are not quadrilaterals.
3. Give them another more complex assortment of quadrilaterals and identify them as such.
4. What is a quadrilateral?
5. Identify what a quadrilateral always has, sometimes has, and never has.

Materials

- ❑ Quadrilaterals for sorting (see attached handout)

Lesson 2

1. Sort the following shapes into groups and then label each group by their common attributes (e.g., angles, number of parallel
2. Discuss the different sorting techniques. Give a definition for each group of shapes.
3. Identify each of the quadrilaterals and list the attributes of each.
4. Choose and complete the enclosed worksheet(s). They are intended to help students distinguish between different quadrilaterals:
    - Quadrilaterals for Sorting
    - Generic Worksheet
    - Quadrilateral, Parallelogram, Trapezoid
    - Quadrilateral Feature Analysis Grid
    - Inductive Reasoning Diagram

Curriculum Integration

Math/Science—Look at different crystal formations to see their similarities to quadrilaterals.

Possible Extensions/Adaptations/Integration

The purpose of this activity is to enhance sorting and classifying skills, in addition to adding clarity to the concept of quadrilaterals. Sorting and classifying skills are necessary when students are classifying animals, kinds of rocks, types of soil, etc.

Assessment Suggestion

Give a collection of shapes to students to sort and label them for a performance assessment.

Give students an assortment of polygons and have them sort into groups. Students who correctly identify quadrilaterals would score assessment points.

Homework & Family Connections

Have students look for quadrilaterals outside the classroom, making a list of the different quadrilaterals they can find around the house. Which of the quadrilaterals is the most often used in building? Why?

Quadrilateral Feature Analysis Grid

features

category															
square															
rectangle															
parellelogram															
trapezoid															
kite															
rhombus															

Quadrilateral Worksheet

Concept Name:	
Example	**Non Example**

Characteristics present in this concept		
Always	**Sometimes**	**Never**
Definition:		

Activity—Origami Cubes

Standard III
Students will use spatial reasoning to recognize, describe, and identify geometric shapes.

Objective 1
Describe, identify, and analyze characteristics and properties of geometric shapes.

Intended Learning Outcomes
3. Reason mathematically.
5. Make mathematical connections.

Standard III

Objective 1

Connections

Background Information

Student knowledge of parallel lines, and angles.

Invitation to Learn

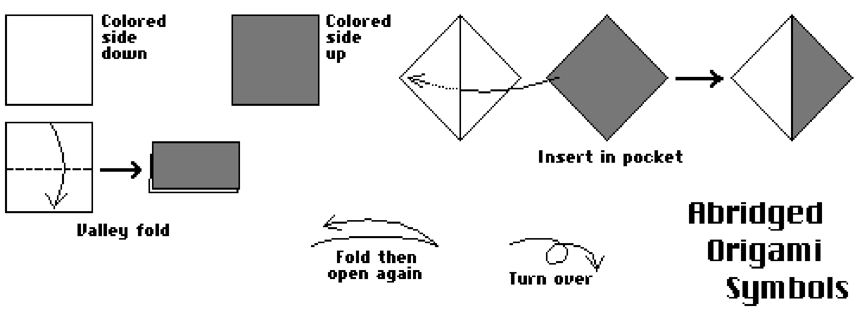
Which quadrilaterals can be used to make a cube? Can we fold paper to make a cube? Inform students they will be making paper folds that will be used to make a cube. During the process of folding, each quadrilateral will be identified and attributes will be listed. Fold cube using the directions that follow.

Instructional Procedures

Materials

- ❏ Six square pieces of multi-colored paper for folding (4", 5", or 6" sizes work best)

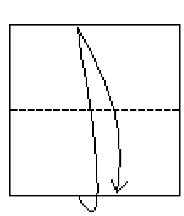
Symbol Guide



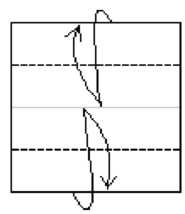
To make the Cube, six identical units must be folded. It is important to do all the folds the same way. Reversing/mirroring step three will change the unit so that it will not fit with the others.

Possible Extensions/Adaptations/Integration

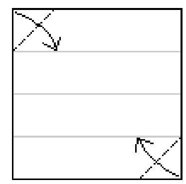
Step one



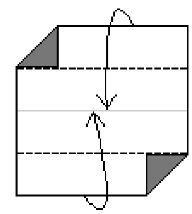
Step two



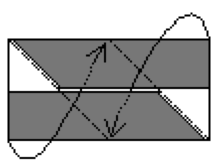
Step three



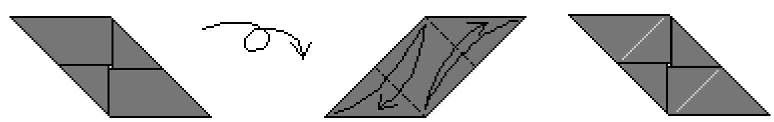
Step four



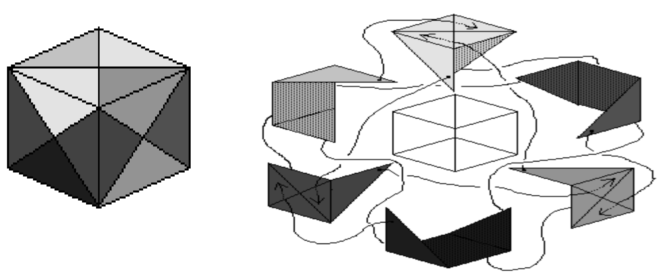
Step five



Steps six and seven



The completed unit



This can be an introductory lesson in learning the attributes of the different quadrilaterals. I teach geometry during the month of December, because there are so many shapes associated with Christmas. We paper fold many different items and use them to decorate the Christmas tree. I have a partnership with a local business where we decorate their Christmas tree in exchange for items we need in the classroom.

Additional Resources

At the end of the folding activity, have students complete the accompanying worksheet by listing each of the quadrilaterals and then give essential/ nonessential characteristics, examples and non-examples. See Quadrilateral Worksheet.

The semantic Feature Analysis Grid is an excellent activity to focus student attention to the attributes of each quadrilateral. See Feature Analysis Grid.

Homework & Family Connections

These cubes can be used as Christmas tree ornaments

Activity—Identifying Angles

Standard III

Objective 3

Connections

Standard III
Students will use spatial reasoning to recognize, describe, and identify geometric shapes.

Objective 3
Visualize and identify geometric shapes after applying transformations.

Intended Learning Outcomes
3. Reason mathematically.

Background Information

Students will use background information learned by paper folding quadrilaterals and sorting activities to identify attributes of angle.

Invitation to Learn

Are there different kinds of angles in the world? Why would we want to know about different angles? Which angles are used most often in buildings? Why?

Instructional Procedures

Materials

- ❏ See the Right Angle Guide explaining how to make a right angle guide to help students determine if the angle is right, obtuse, or acute.

Lesson 1

1. Use body parts to demonstrate the different angles
2. Define and give definition to the different angles.
3. Use laminated pieces and have students identify different angles.

Lesson 2

Have students examine different fittings for pipe. Explain how fittings are labeled, such as: tee, elbow (90 or right angle), or 45 degree angle. Find other examples in the world that demonstrates angles (e.g., a reclining chair is an obtuse angle).

Curriculum Integration

Math/Science—Discover different angles our bodies can make.

Assessment Suggestion

Geometry scrapbook assignment

Additional Resources

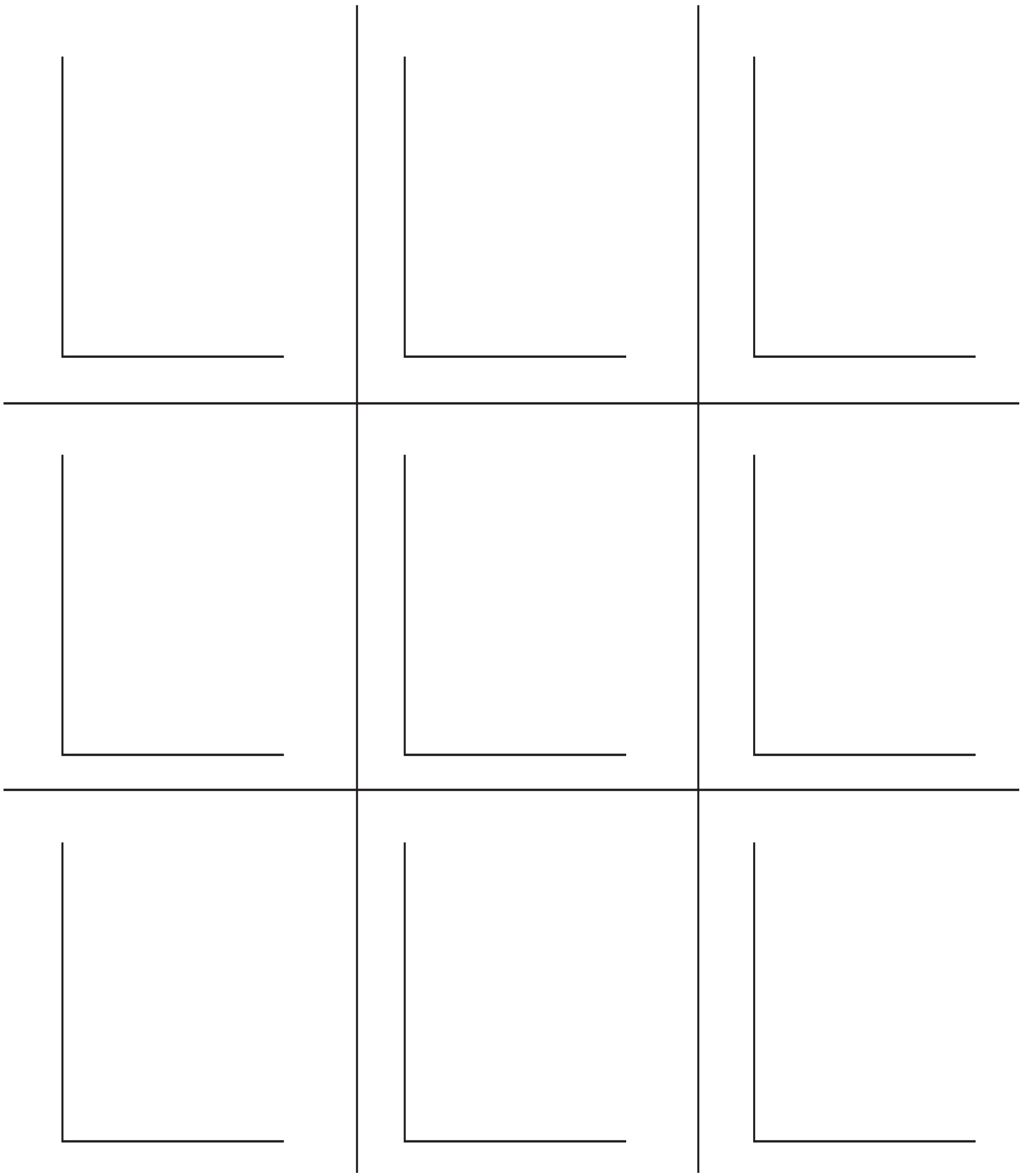
Shape Bait from bby Publications. This is a daily activity that analyzes shapes. Students have many opportunities to measure and determine angles and attributes of a shape.

Homework & Family Connections

Look at different houses that they drive past and determine which angles are present.

Right Angle Guide

Make a copy on a transparency. Laminate twice, then cut apart and allow to students to use as a guide to determine right, obtuse, and acute angles.



Geometry Scrapbook

For this assignment you will first give a definition for each word. Next, you will find correct real world piecture that depict the geometry term and paste them onto your scrapbook page. You may use pictures from newspapers, magazines, or photos. As a last resort you may use pictures from the Internet.

Scoring Rubric

Task to be Completed	Points Possible	Student Score	Teacher Score
Quadrilaterals			
Square	10		
Rectangle	10		
Trapezoid	10		
Parallelogram	10		
Rhombus	10		
Kite	10		
Irregular	10		
Lines			
Parallel Lines	10		
Intersecting Lines	10		
Angles			
Right	10		
Acute	10		
Obtuse	10		
Solid Figures			
Cube	10		
Rectangular Prism	10		
Cone	10		
Cylinder	10		
Your Choice	10		
Total Points	**170**		

Quadrilaterals

Definition of a Quadrilateral

Attributes of a Square

Attributes of a Rectangle

Attributes of a Trapezoid

Attributes of a Parallelogram

Attributes of a Rhombus

Attributes of a Kite

____

____

____

Lines

Parallel Lines

____

____

____

Intersecting Lines

____

____

____

Angles

Right Angle (90˚)

____

____

____

Acute Angle

____

____

____

Obtuse Angle

____

____

____

Solid Figures

Cube

Rectangular Prism

Cone

Cylinder

Your Choice

Activity—Making Nets for Solids

Standard III
Students will use spatial reasoning to recognize, describe, and identify geometric shapes.

Objective 3
Visualize and identify geometric shapes after applying transformations.

Intended Learning Outcomes
2. Become mathematical problem solvers.
3. Reason mathematically.

Standard III

Objective 3

Connections

Background Information

Nets are the two-dimensional shape that, when folded, would cover a three-dimensional solid.

Invitation to Learn

If we cut these containers at the seams what will they look like?

Instructional Procedures

For each cube, cone, rectangular prism, and cylinder, do the following:

1. Take apart each box or container at the seams.
2. Examine the two dimensional shape from which it came.
3. Discuss how the net was made and the two-dimensional shapes that made it.
4. Make a net that will fit the solid.
5. Allow students to work with geo-solids (blocks) and make the net that would fit it.

Materials

- ❏ A variety of commercial containers in the shape of cones, cubes, rectangular prisms, cylinders
- ❏ Geo-solids (e.g., cubes, cones, rectangular prisms, cylinders)

Possible Extensions/Adaptations/Integration:

Find solids in the world. Take a geometry hike and discover where and how solids are used in the building world.

Assessment Suggestion

Given any solid listed in the core, students should be able to make a net to fit. After the net is drawn, have students cut out, fold, and check it for fit.

Additional Resources

Geo-blocks Job Cards (Creative Publication)
Jacket constructions grades 4-8 (Creative Publications)

Homework & Family Connections

Have students show parents how to make nets listed in the objective.

Activity—Defining: Cylinders, Cubes, and Prisms

Standard III
Students will use spatial reasoning to recognize, describe, and identify geometric shapes.

Objective 1
Describe, identify, and analyze characteristics and properties of geometric shapes.

Intended Learning Outcomes
3. Reason mathematically.

Standard III

Objective 2

Connections

Background Information

This activity is intended to give students experience looking at solids and sorting them by their attributes. Prior experience in sorting and classifying would be helpful. This activity should be followed up with classifying lessons for each of the solids listed.

Invitation to Learn

Can you sort these solids into different groups? Sorting rules are:

1. All members of the group must have common attributes.
2. When finished sorting, label each group with the common attribute.

Materials

- ❏ An assortment of Geo-solids (cones, prisms, cubes, and cylinders are identified in the core)
- ❏ Characteristics Worksheet
- ❏ Boxes or nets of each solid that can be taken apart

Instructional Procedures

1. Students will sort the solids into the number of pre-determined groups and then list the common attribute of each group.
2. Class will discuss how to identify characteristics of each solid.
3. Do the worksheet which focuses students' attention on attributes of each solid, determining what is always, sometimes, and never present (one for each solid is best).

Possible Extensions/Adaptations/Integration

Go on a geometry walk through the building, identifying the different solids.

Assessment Suggestion

See scrapbook assignment at end of this lesson.

Homework & Family Connections

Identify common solids around the house.

Inductive Reasoning Diagram

Inductive Reasoning Diagram for ____

Concept Name:	
Example	**Non Example**

Characteristics present in this concept		
Always	**Sometimes**	**Never**
Definition:		

Characteristics Worksheet

Nonessential (Might Have) Characteristics:

Nonexamples:

Essential (Must Have) Characteristics:

Examples:

Activity—Lines of Symmetry

Standard III
Students will use spatial reasoning to recognize, describe, and identify geometric shapes.

Objective 1
Describe, identify, and analyze characteristics and properties of geometric shapes.

Intended Learning Outcomes
3. Reason mathematically.

Standard III

Objective 1

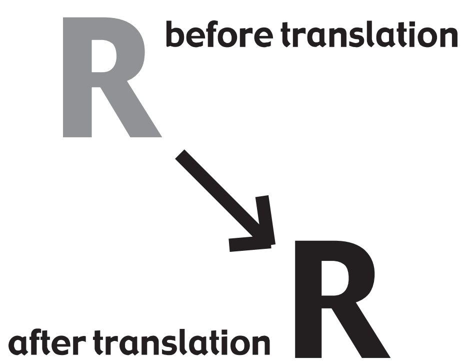
Connections

Background Information

A pattern is symmetric if there is at least one symmetry (rotation, translation, reflection, glide reflection) that leaves the pattern unchanged.

Slide/Translation

To translate an object means to move it without rotating or reflecting it. Every translation has a direction and a distance.



Reflection

To reflect an object means to produce its mirror image. Every reflection has a mirror line. A reflection of an "R" is a backwards "R,"

Symmetries create patterns that help us organize our world conceptually. Symmetric patterns occur in nature, and are invented by artists, craftspeople, musicians, choreographers, and mathematicians.

In mathematics, the idea of symmetry gives us a precise way to think about this subject. We will talk about plane symmetries (those that take place on a flat plane), but the ideas generalize to spatial symmetries, too.

Plane symmetry involves moving all points around the plane so that their positions relative to each other remain the same, although their absolute positions may change. Symmetries preserve distances, angles, sizes, and shapes.

1. A basic type of symmetry is a reflection. The reflection of a figure in the plane about a line moves its reflected image to where it would appear if you viewed it using a mirror placed on the line. Another way to make a reflection is to fold a piece of paper and trace the figure onto the other side of the fold.
2. A second type of symmetry is slide (translation). Sliding/ translating an object means moving it without rotating or reflecting it. You can describe a translation by stating how far it moves an object, and in what direction.

Instructional Procedures

Materials

- ❏ Display items with definite lines of symmetry (e.g., a slice of bread, an apple)
- ❏ Pattern block pieces
- ❏ Pentominoes
- ❏ Paper die cut letters of the alphabet

1. Using display items, demonstrate the meaning of symmetry. Make sure students understand definition of symmetry.
2. Using polygons, allow students to decide which polygons have lines of symmetry by folding each polygon. Students will explain their reasoning.
3. Do the same with pentominoes.
4. Pass out paper block letters of the alphabet. Predict which letters will have a line of symmetry. Have students fold and verify their predictions. This is reflectional symmetry.

Curriculum Integration

Math/Science—Where in nature do we find lines of symmetry? Brain storm and look for symmetry in butterflies, animal shapes, etc.

Possible Extensions/Adaptations/Integration

Pair students with a partner and give them a geoboards. Have one student draw part of a figure and then pass the geoboard to his or her partner to finish the figure so that it has a line of symmetry.

Assessment Suggestion

1. Scrapbook assessment included at the end of this lesson series.
2. Use pattern block stickers (can use die cut pieces) to make a design, and then draw lines of symmetry.

Additional Resources

Make symmetry name cards

Homework & Family Connections

Work together to complete the scrapbook assignment.

Activity—Tessellation Designs

Standard III

Objective 3

Connections

Standard III
Students will use spatial reasoning to recognize, describe and identify geometric shapes.

Objective 3
Visualize and identify geometric shapes after applying transformations.

Intended Learning Outcomes
3. Reason mathematically.
4. Communicate mathematically.

Background Information

A great source of information about tessellations and their art and math connections is found in M.C. Escher's work. Tessellations are a series of repeating patterns or designs that interlock. The positive and negative spaces work together to create images. Included is a diagram of how to make a figure that will tessellate from a quadrilateral. This project can become not only a math lesson, but an art one as well. (See Tessellation Example.)

Invitation to Learn

Can we make an art design by simply sliding and tracing a shape?

Instructional Procedures

1. Introduce the concept of slide (translation). Demonstrate by sliding the body.
2. To make tessellations, measure and cut a four-inch square piece of paper.
3. On the right side of the paper, draw a decorative and simple line design, from the top corner to the bottom corner. A wavy line is good. Cut your shape out along the line. Using a slide (translation) move the shape to the left side of your paper. With masking tape, tape the shape on the left uncut side of the paper, in the exact position it was cut from on the right.
4. Repeat the process on the top of the shape. Tape it to the bottom. Now you have your tessellation shape made from a square.
5. On your white paper, lay the shape down and trace lightly around the shape. Keep doing this by matching the shape fit to the previously penciled shape. The actual design will run downhill on the paper. This is normal.

Materials

- ❏ 4"x4" square pieces of cardstock
- ❏ masking tape
- ❏ scissors
- ❏ large pieces of art paper (at least 18"x18")

Possible Extensions/Adaptations/Integration

Escher art is a wonderful topic to explore for art, math, and science.

Assessment Suggestion

Use pattern block piece and ask students to make a tessellation.

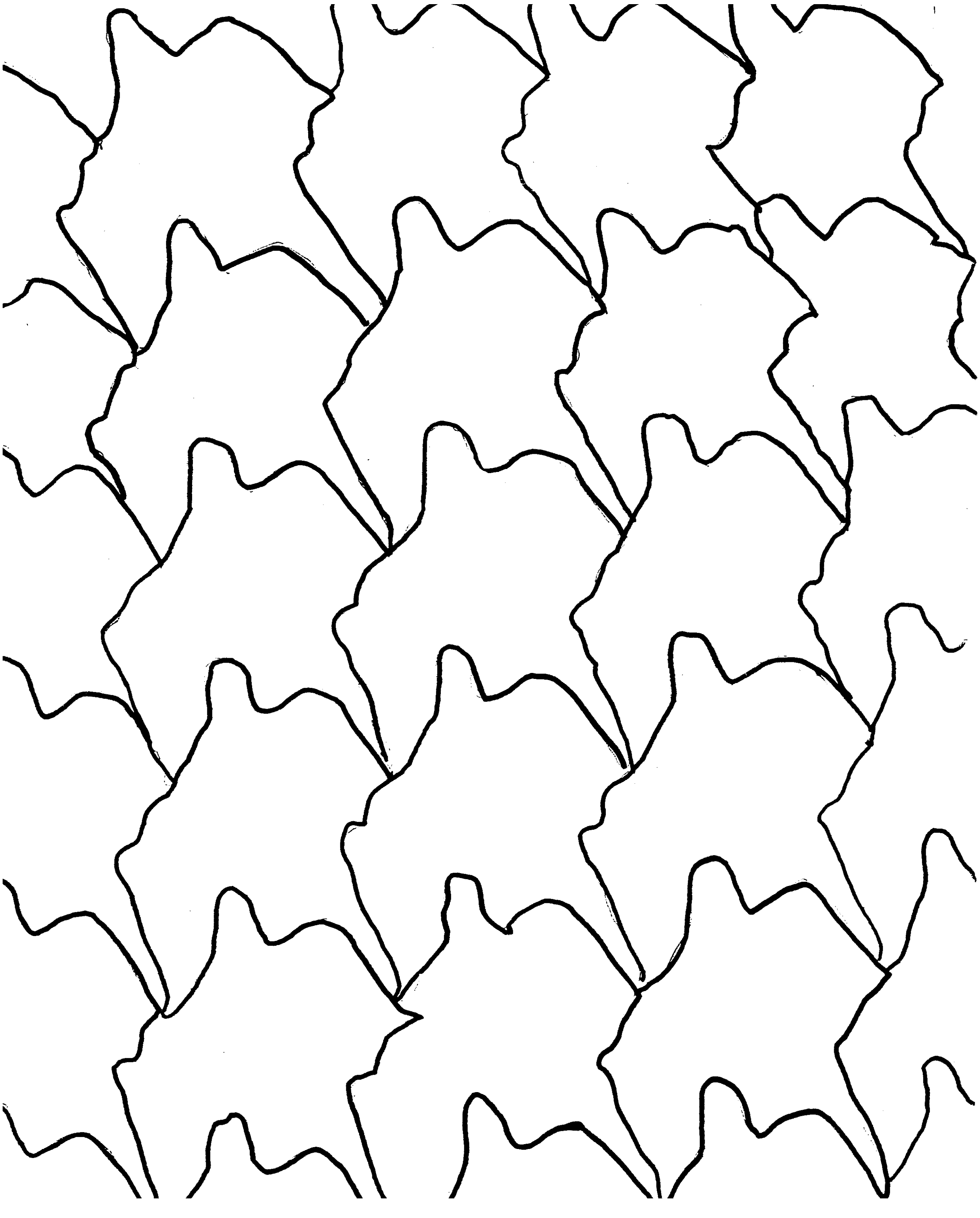
Additional Resources

There are wonderful Escher websites on the net. Visiting some of the sites could be a great homework or computer lab assignment for students.

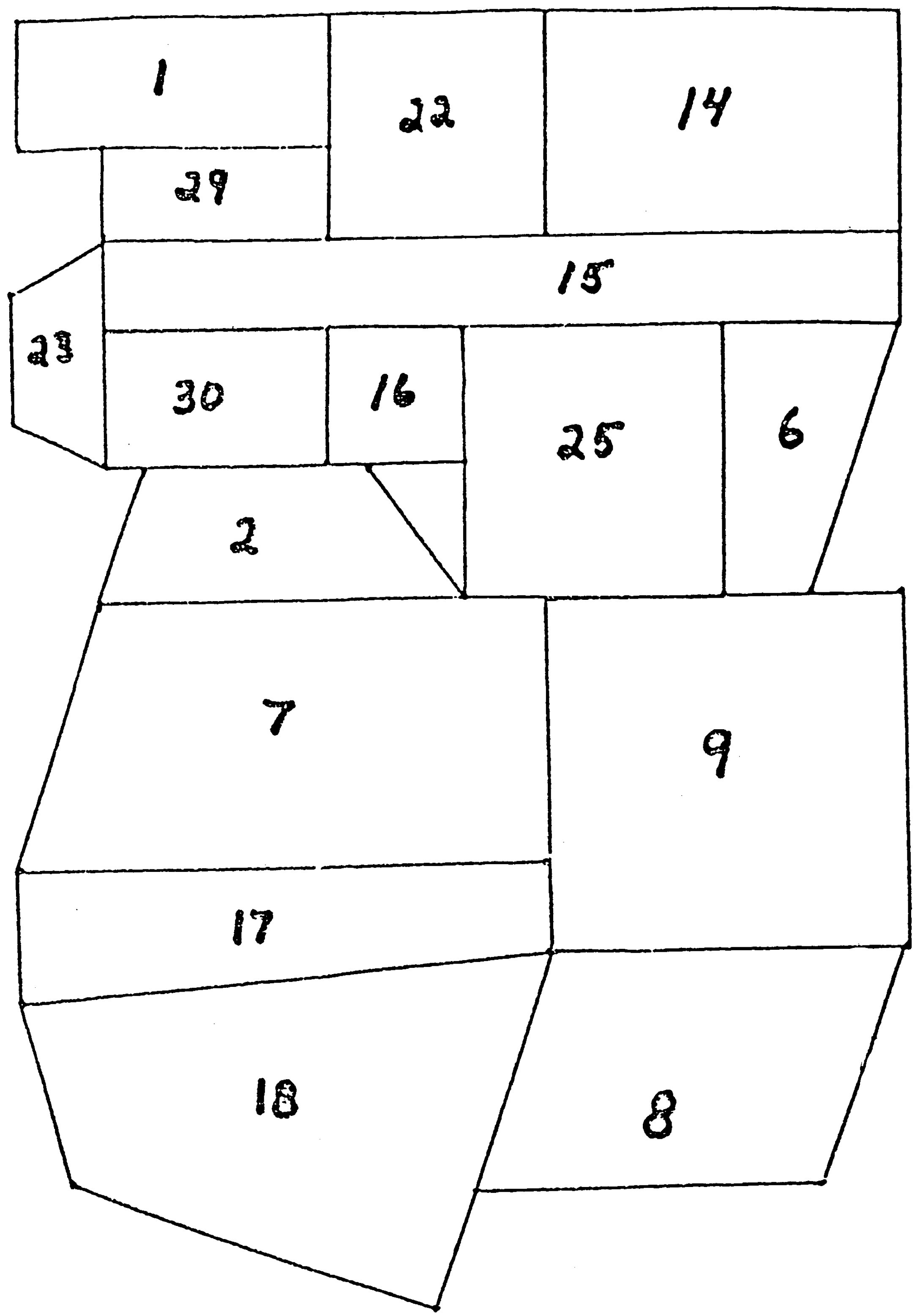
Homework & Family Connections

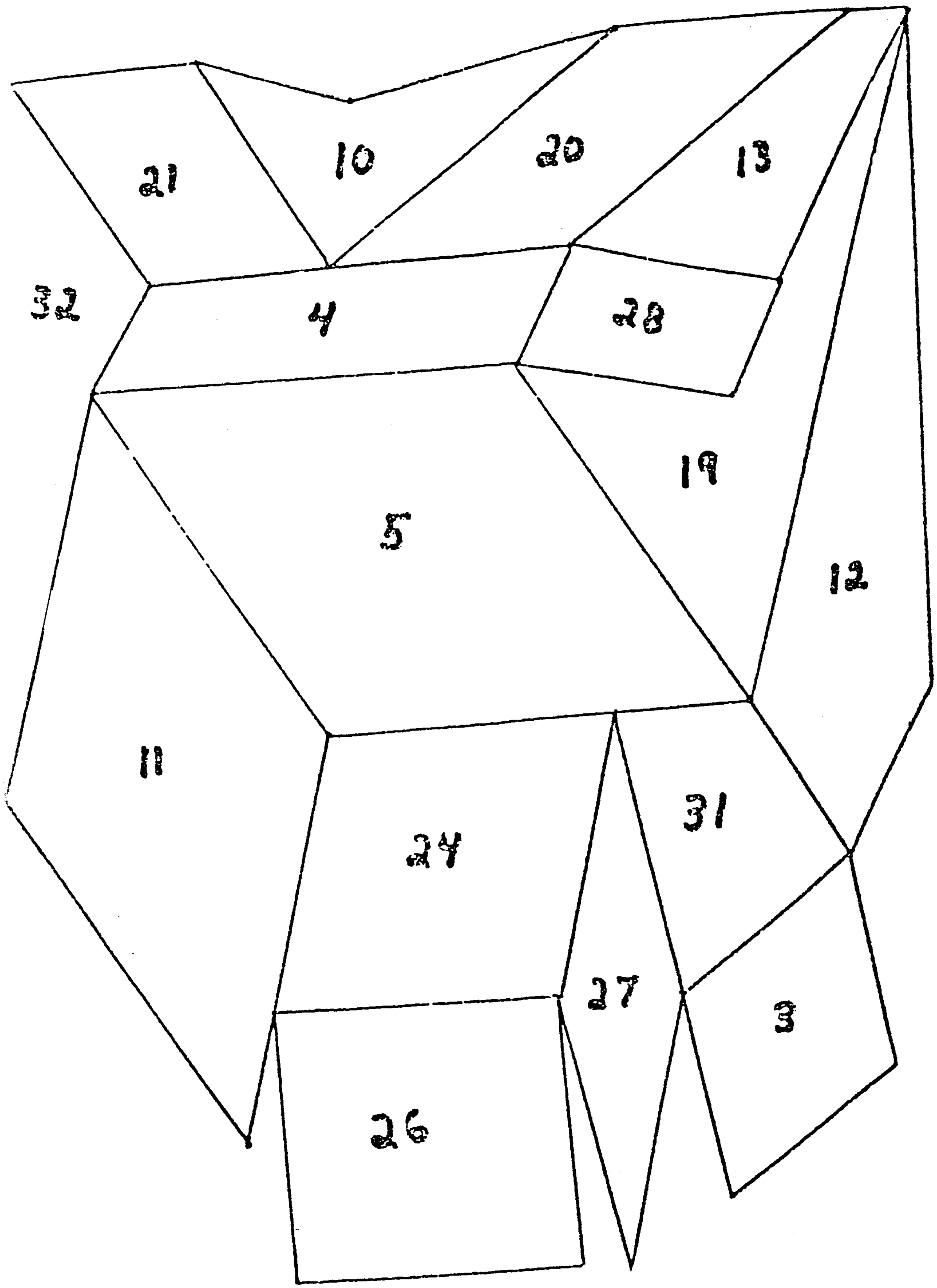
Share tessellations made at school with family.

Tessellation Example



Geometric Shapes




21
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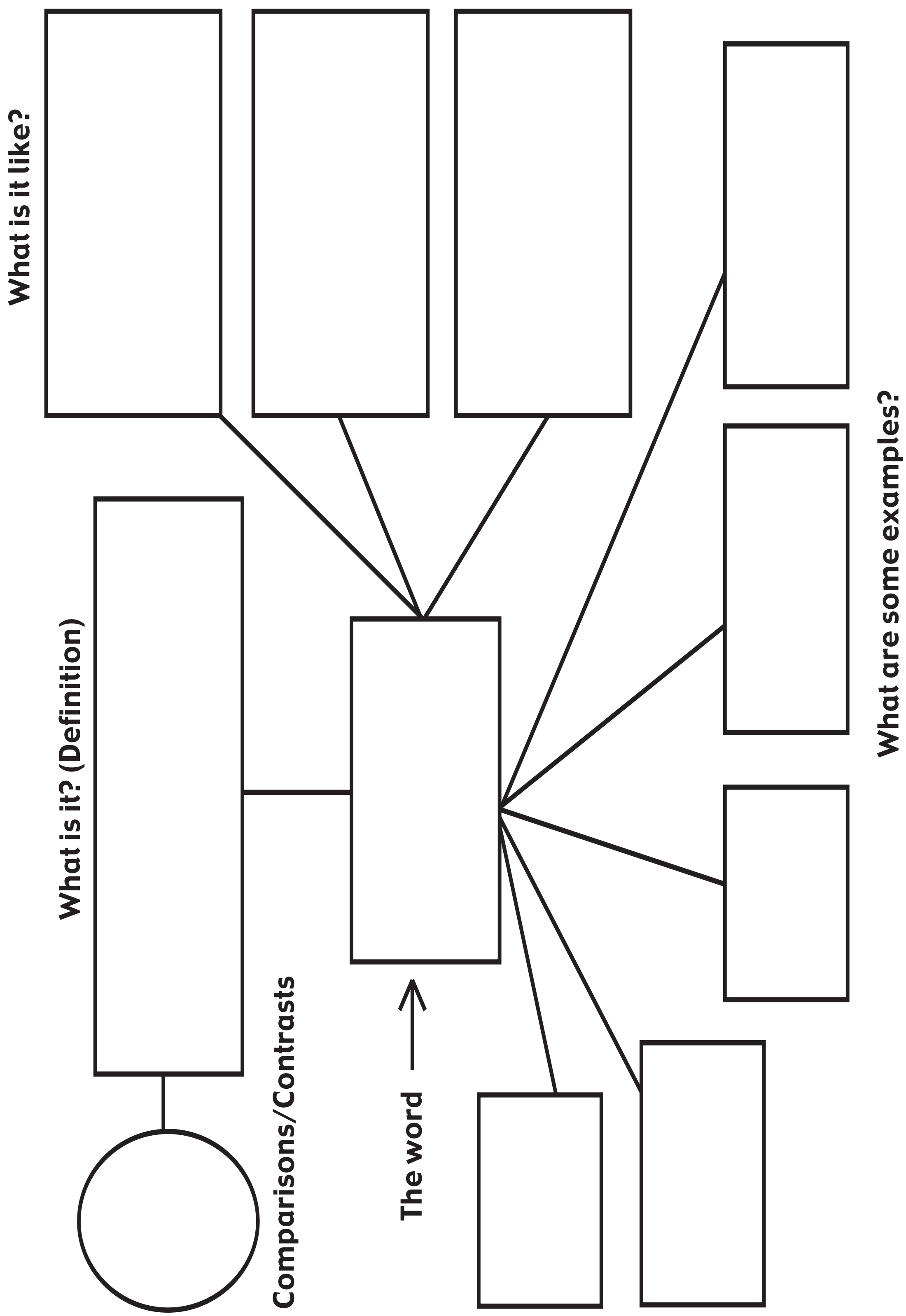
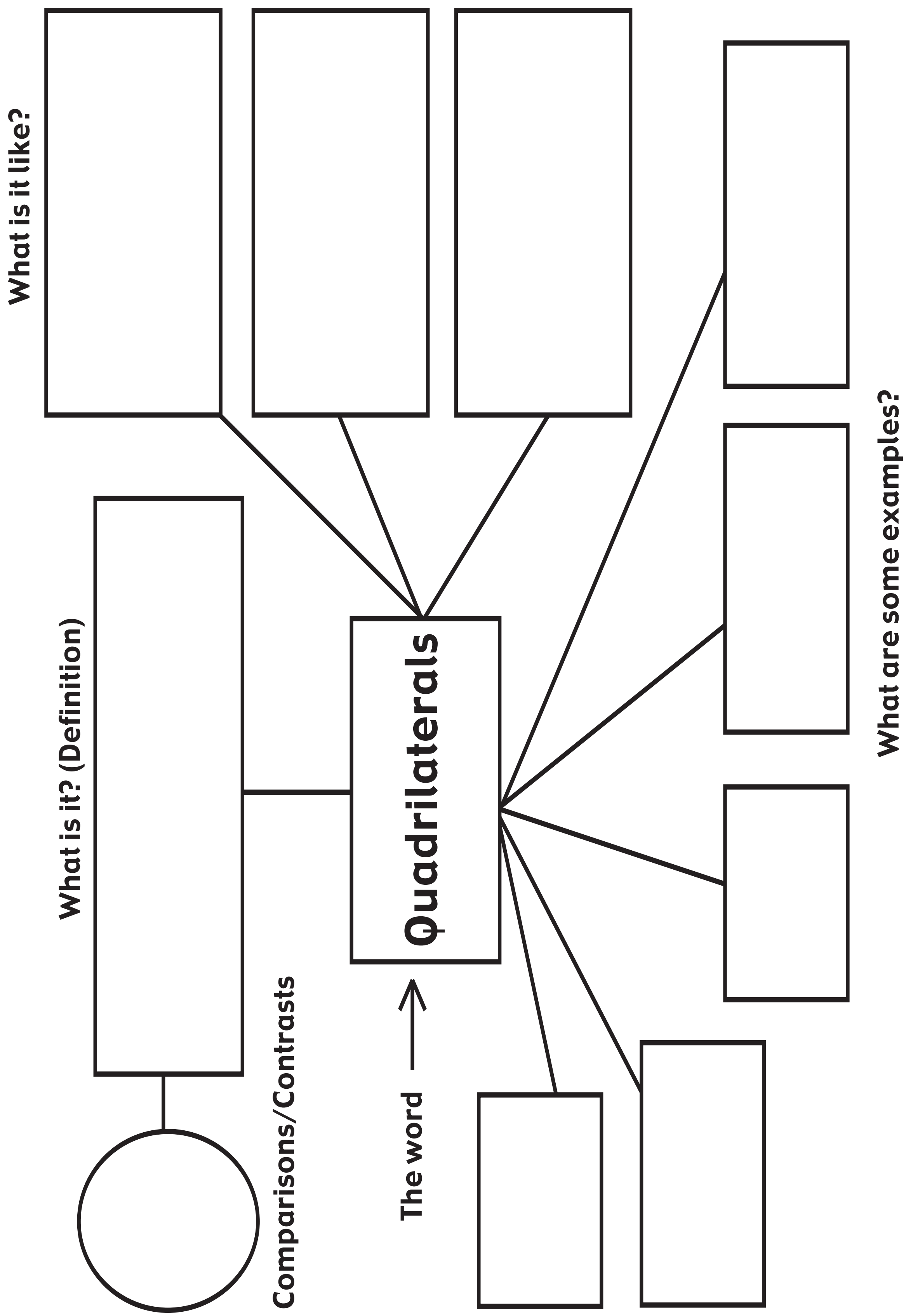
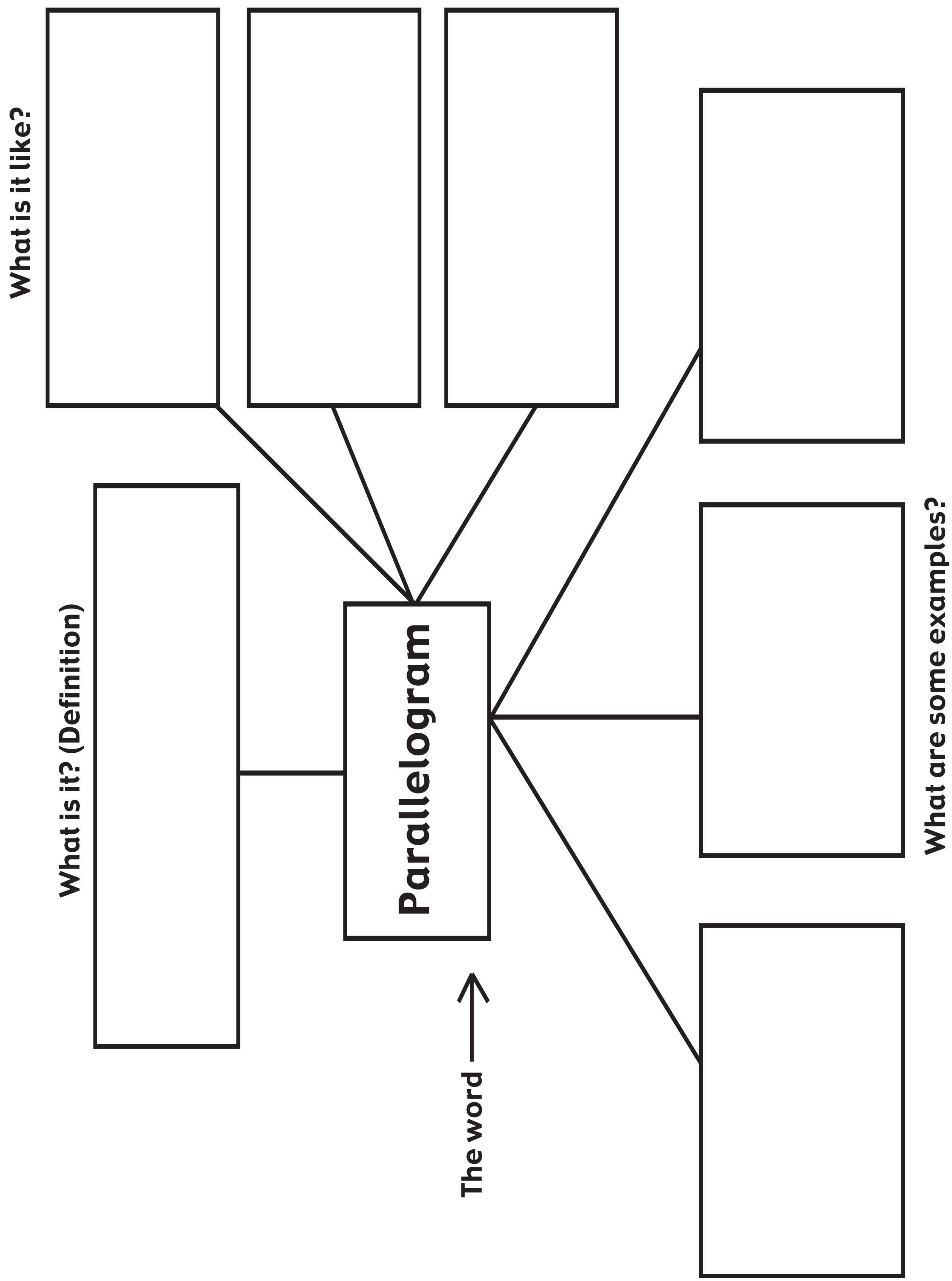
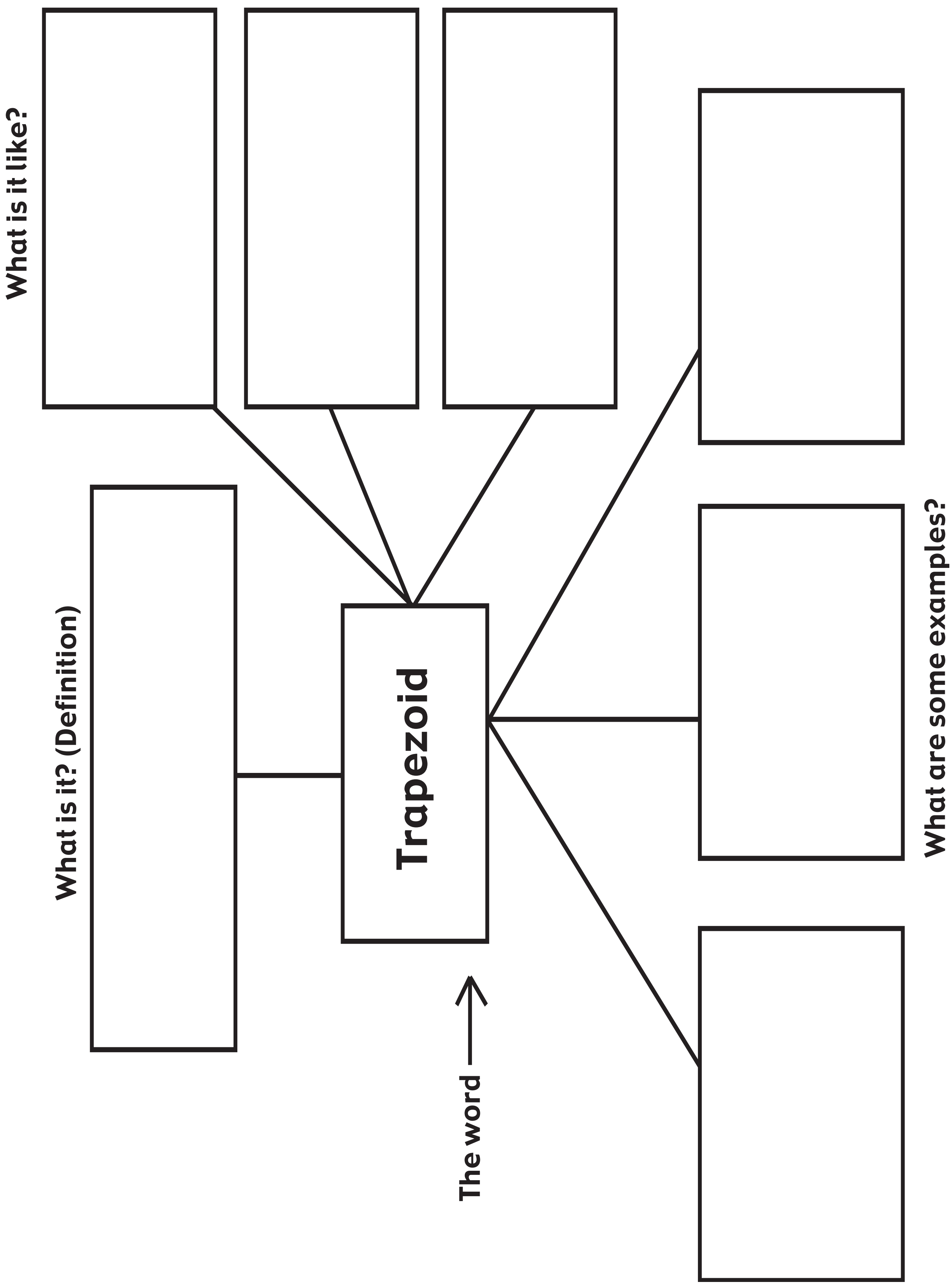
Geometric Vocabulary




What is it like?
What is it? (Definition)
Quadrilaterals
The word
Comparisons/Contrasts
What are some examples?


What is it like?
What is it? (Definition)
Parallelogram
The word
What are some examples?



What is it like?
What is it? (Definition)
Trapezoid
The word
What are some examples?

Geometry Brochure

Lines

1. parallel lines:

2. intersecting lines:

Quadrilaterals

1. square
2. rectangle
3. rhombi
4. trapezoid
5. isoceles
6. kites
7. parallelogram
8. irregular

Geometry Standard III Objective 1

Angles

1.

2.

3.

Congruence

Definition

Compare Polygons for Congruence

Symmetry

Identify and draw lines of symmetry

1. Identify

2. Draw

Cylinders

1. Attributes

2. Net

Rectangular Prisms

1. Attributes

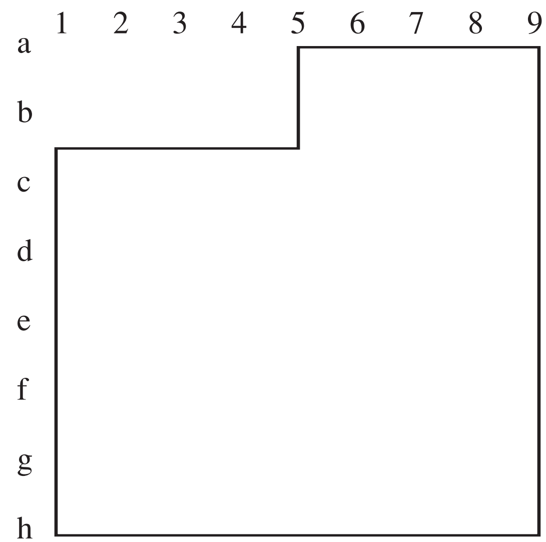
2. Net

Geometry
Standard III
Objectives 2 & 3

Specify Locations

1. Locate positions on a map using coordinates or regions.

2. Give coordinates or regions of a position on a map of Utah.



Transformations

Identify slides and flips

1. Flip (reflections)

2. Slide (translation)

Making Nets

1. cubes

2. cylinders

3. cones

4. rectangular prisms

Name________________________

Geometry Hike

1. square____
2. rectangle ____
3. rhombus ____
4. parallelogram ____
5. kite ____

   concave____________________________ convex __________________________

6. trapezoid ____________________________ isosceles ________________________
7. irregular ____
8. other polygons ____
9. right angles ____
10. obtuse angles ____
11. acute angles ____
12. cone ____
13. cylinder ____
14. rectangular prism ____
15. triangles____
16. other ____

Science
Standard I
Activities

Replace this page with *The Search for the Water Cycle* Teachers Edition and Findings Booklet

Science Standard II Activities

Activity—Minds-on Science

Standard II
Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns.

Objective 1
Observe, measure, and record the basic elements of weather.

Intended Learning Outcomes
2. Manifest scientific attitudes and interests.

Standard II

Objective 1

Connections

Background Information

There are many books, online activities, and resources to teach students about weather. The USOE fourth grade web page provides links to many sources of information. The Sciber Site has information and activities for students to use. The TRB (Teacher Resource Book) contains lesson plans and information. Teachers should become familiar with the ILOs listed there, along with the objectives and indicators for the unit on weather. The test-item pool is also a good resource for assessment items teachers can use. Finally, teachers can find children's literature books that can be placed in the classroom during this unit for student use.

Materials

- ❏ (optional) USOE science web pages for fourth grade on a computer linked to a projector & internet
- ❏ children's literature books (see corresponding list)
- ❏ copy of Teacher Resource Book for fourth grade science
- ❏ printed copy of Sciber Site lesson plans.
- ❏ copy of teacher resource books on weather (provided by presenter)
- ❏ copy of student journals

Invitation to Learn

Display children's literature books at the front of the room on the chalkboard tray or a table. Also display weather posters and charts.

Instructional Procedures

1. Hold up copies of children's literature books and give the title and author.
2. Show the resource books and materials available to learners.
3. If a computer with a projector and internet connection are available, show the USOE web site and some of the resources there.
4. Make the book available for students to check out.

Possible Extensions/Adaptations/Integration

Use "big books" when possible. Some children's books are also printed in Spanish. Enrichment activities are suggested in the Sciber Site lessons. Assign the students to present a written or oral report on one of the books they have read.

Assessment Suggestion

Have students check out the books by signing their name on a list. This will allow the teacher assess which books are being read, and by which students. Assess students understanding of writing and material through book reports.

Additional Resources

1. Students can access web sites on weather (i.e., www.brainpop.com and www.ksl.com)
2. There are videos available on weather through district media centers. DK Vision has a video called Eyewitness Weather that is good (www.dk.com).
3. Teachers can download videos from Digital Curriculum on the Pioneer website.

Homework & Family Connections

Teachers could assign students who have internet connections at home to visit the USOE Sciber Site and do some of the activities at home.

Students can use some of the science books available to conduct experiments or make projects at home. They could also display some of their projects at a school science fair.

Science Literature List

Weather

Can It Rain Cats and Dogs? by Berger (Scholastic)
The Wind Blew by Hutchings (Scholastic)
Looking At Clouds by Ring (Newbridge)
Cloudy with a Chance of Meatballs by Barrett (Scholastic)
Magic School Bus—Inside A Hurricane by Cole (Scholastic)
Weather Words by Gibbons (Scholastic)
Weather by Wyatt (Kids Can Press)
The Tornado Desk by Leavitt (Talon Printing)

Plants and Animals

The Water Cycle

Rocks, Soil, and Fossils

Suggestion: Start collecting children's literature books that go with the various science topics taught in fourth grade. Set them out as you begin each unit for children to borrow. Show each title and tell them what it is about to spark some interest. Read a few of them aloud as time permits. Have a sign-out sheet available.

Weather Words

Accuracy—correct, careful and exact

Air pressure—the weight of air in the atmosphere pressing down upon the Earth

Air temperature—degree of hot or cold that the air measures

Anemometer—instrument used to measure wind speed

Atmosphere—all the air surrounding the earth

Barometer—instrument for measuring air pressure

Cirrus—high, wispy or feathery clouds

Components—the parts of the whole (Example: wind is one component of weather)

Cumulus—big, puffy, white clouds

Forecast—to predict (a meteorologist will forecast the weather for the next week)

Hygrometer—instrument used to measure relative humidity

Meteorologist—a scientist who studies and forecasts weather

Phenomenon—an occurrence you can observe

Precipitation—rain, snow, sleet, hail, etc.

Rain gauge—instrument for measuring the amount of rain that falls

Relative humidity—amount of water vapor in the air compared to the amount of water the air could hold at that temperature

Severe—serious or intense (Example: a tornado is a severe type of storm)

Stratus—a long, low, gray cloud

Thermometer—instrument for measuring temperature

Weather front—meeting of two different types of air masses

Wind speed—measurement of the speed of moving air

Wind vane—instrument used to determine wind direction

Severe Weather

Have you ever planned an outdoor party or activity and had it ruined by bad weather?

The components or parts that make up our weather can be compared.

A hurricane is born over warm oceans. Winds are at least 75 mph. The width of a hurricane can be many miles.

A tornado is a whirlpool of windy air over land. Winds can be 300 mph. The path of a tornado can cover several miles, but the width of a tornado is much smaller than a hurricane, usually covering an area less than 100 yards.

A thunderstorm is a storm with rain, high winds, dark clouds, lightning and thunder.

Rainstorms have dark clouds, rain showers, and breezes.

TRY IT

Ask your teacher if you can create the sound of a storm in your classroom. Start by turning off the lights and having everyone tap one finger on their desk as it start to rain. Tap all of your fingers on your desk as it rains harder. Have someone switch the lights on and off quickly for the lightning. Add snapping fingers and stomping feet as the storm gets worse. Finally, do the sounds more quietly in reverse as the storm moves away.

The Sun will Rise again!

HERE COMES THE SUN!

The title above is just one of many songs that have been written about the sun. After all, we owe that big ball of fire in the sky quite a bit. The sun is responsible for the abundance of life that is found on Earth. Without the energy provided by the sun, this planet would be a dark, cold lifeless place. The sun is also responsible for the weather on planet Earth. One kind of energy we get from the sun is heat. The sun does not directly heat up the air. Air is heated by the land or water beneath the air. Because land and water heat up and cool down at different rates, the air also heats unevenly. This uneven heating of the air causes wind and changes in the weather.

YOU ARE THE SCIENTIST!

Do you think that soil will heat up more rapidly than water? Record your hypothesis and then perform the following activity to find out if you were correct:

MATERIALS: This is what you need.

2 identical paper or plastic cups

water

soil

2 thermometers

PROCEDURE: This is what you do.

Fill one cup half full of water and one cup half full of soil.

Let the cups sit in a room for a couple of hours. Make sure the sun isn't shining on them. You want them both to have time to become room temperature.

Place a thermometer in each cup. Be sure the bulb of the thermometers is deep into the water and the soil.

Record the beginning temperature of each thermometer.

Place both cups in the direct sun, or under a bright lamp. Make sure both cups get equal amounts of light.

After 15 minutes, record the temperatures of each thermometer.

Place both cups in the refrigerator for fifteen minutes.

Record the temperatures of each thermometer.

Explain your findings. Which material heats up faster? Which material cools down faster?

Graph your results.

WARMING UP!

While performing this activity you probably noticed that the soil warmed up faster than the water. You probably also noticed that the soil cooled down faster than water. The same is true on Earth. Land heats up faster than water. The air over warm or hot land heats up more rapidly than air over the oceans in the summer. The air above the land rises and the cooler air over the ocean moves in from the ocean to take the place of the rising air over the land. That is why it is usually cooler in places very near the ocean in the summer.

COOLING DOWN!

The opposite is true in the winter. Places very near the ocean in the winter will not be as cold as places further away. Water in the ocean will not cool down as fast as the land cools. San Francisco, California is usually cooler in the summer and warmer in the winter than Delta, Utah because Delta is not near the ocean. The air temperature over Delta is affected by the land of the Great Basin. The air temperature over San Francisco is affected by the water over the Pacific Ocean. There are other things that affect temperature, but this is one thing that makes a big difference.

GO THERE!

If you live near the Wasatch Front, you know that the cold weather and the mountains provide Utah with a great resource - tourism. People come from all over the United States and the world to ski and snowboard. Use a map and the internet to find out more about the climate in an Asian city that is near the ocean and at the same latitude as the city where you live. Write a report about the climate of the city. How is the weather similar to the weather in your city? How is it different? What economic impact does the climate have on the city you are writing about?

Text excerpt from: The Fourth Grade Sciber Site
http://www.usoe.k12.ut.us/curr/Science/core/4th/4thSciber/WEATHER/SUN/sun.htm

Activity—Hot Hands-on Science

Standard II

Objective 1

Standard II
Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns.

Objective 1
Observe, measure, and record the basic elements of weather.

Intended Learning Outcomes
1. Use science process and thinking skills.
4. Communicate effectively using science language and reasoning.

Connections

Background Information

A thermometer is a delicate instrument used for measuring temperature. It needs to be handled carefully so that it doesn't break. The liquid inside the glass tube expands as it is heated and rises in degrees Fahrenheit or Celsius that can be read on the scale. Soil generally absorbs heat from the sun faster than water, so it is usually warmer. Shiny or light-colored surfaces reflect more of the sun's energy than dark colors, so they are cooler. Heat rises in a room, so temperatures taken at the ceiling level are generally warmer than at floor level. Communicate with necessary school personnel to let them know that students will be measuring temperatures around the building. Students should be asked not to measure the temperature of certain areas such as fish aquariums and toilets. They should also let the thermometer rest on a surface for at least two minutes before reading the temperature.

Invitation to Learn

Learners will be given a thermometer and a baggie with ice cubes and asked to see if they can make the temperature rise and fall (without leaving their seat).

Instructional Procedures

1. Assess the learner's understanding of the use and care of a thermometer.
2. Assign them to take a recording sheet, a thermometer, and their pencil outside or somewhere in the school. Tell them to take five minutes to measure the temperature of some surface and write down the location and the temperature on their recording sheet. Then they are to return to the classroom.

3. Ask them upon their arrival to share their findings. At this point, the data can be written on the board or on a weather chart in their journal.
4. Pass out materials and provide directions to make a homemade thermometer. Fill containers with cold water. Add two drops of red food coloring to the water. Punch a hole in the center of the lid with the nail and hammer. Place the lid on the container and slide the straw through the hole.
5. Place white glue around the straw to seal it in place. As the water in the container gets warmer, the water will rise in the straw.
6. Have the students write their name on the back of the card. Carefully tape the card to the straw and mark the height of the column of water on the card.
7. Use a thermometer to find the current room temperature and write it next to the mark you made.
8. Place the container on a plate (in case of spills) next to a window or outside where the air temperature can be measured.
9. Check to see if the liquid changes over the next few days. Record any changes in your journal. Also check the daily temperature using a commercial thermometer or the media.
10. Record the data on a graph or table.

Materials

- ❏ water bottle with lid
- ❏ clear plastic straws (like the ones used in the school lunch program)
- ❏ red food coloring
- ❏ 3x5 index cards
- ❏ white glue
- ❏ hammer
- ❏ nail
- ❏ tape
- ❏ markers
- ❏ thermometers
- ❏ sandwich zip-lock baggies
- ❏ ice-cubes
- ❏ recording sheets

Possible Extensions/Adaptations/Integration

1. Provide cups with hot water or ice cubes in them if students cannot go outside. Have students notice what effect the temperature has on plants and animals, including people. Can they predict what type of activities people will be doing or the clothes they would be wearing at certain outside temperatures? Can they make observations about where people may choose to live because of the temperature? Do they notice changes in the temperature outside as it becomes windy, cloudy, or starts to rain?
2. Explain to students that the Celsius scale is used by people in other parts of the world. Ask them to make comparisons to temperatures on the Fahrenheit scale.

Assessment Suggestion

Observe students for accuracy as they make measurements of temperature for accuracy. Evaluate their success at making a homemade thermometer. Check their journals, graphs, and tables for accuracy.

Additional Resources

Students can bring in newspapers with daily weather maps and forecasts. They can also check weather web sites (www.ksl.com) for current temperature readings and forecasts. Some communities provide a current time and temperature phone number that students can call.

Homework & Family Connections

Students with internet connections at home can be asked to visit web weather web sites. They can also be assigned to watch the evening weather forecast on one of the TV news channels. Some of them may be able to purchase a thermometer to place outside at their home to check the daily temperature. They could investigate experiments dealing with temperature as part of a school science fair.

Activity—Clouds

Standard II
Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns.

Objective 1
Observe, measure, and record the basic elements of weather.

Objective 2
Interpret recorded weather data for simple patterns.

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

Standard II

Objectives 1 & 2

Connections

Background Information

Pressure and temperature are directly related. Squeezing the sides of a plastic filled with water and smoke bottle and then quickly releasing the pressure, lowers the temperature and a cloud forms. The smoke is required so that there will be a place for the vapor to condense. Particles in the atmosphere are also required for clouds to form. Clouds can only form when there is moisture in the air and a place for it to condense. As warm, moist air rises, it begins to cool and the cloud will begin to form.

Clouds are classified according to how they are formed. When a cloud forms close to the ground it is called fog. Stratus clouds are low, flat, gray clouds that cover the sky. They usually do not bring more than a drizzle of rain. Cumulus clouds are puffy and white, like pieces of cotton. They usually indicate fair weather. Cirrus clouds are high, wispy clouds that look like feathers or curls. They usually appear a few days before a storm.

Invitation to Learn

Walk outside (weather permitting) and look up at the clouds in the sky. Observe their shapes and movements for 5-10 minutes.

Materials
- ❏ cloud chart
- ❏ blue 9x11 art paper
- ❏ glue
- ❏ cotton balls
- ❏ markers
- ❏ weather forecasting data table (see associated worksheet)

Instructional Procedures

1. After looking outside at the clouds, the learner will discuss the shapes and movement of the clouds with the teacher and the group. Refer to a cloud chart and note any similarities to clouds they may have seen.
2. Present information about the basic cloud types–fog, stratus, cumulus, cirrus. Discuss how these clouds look and the kind of

weather with which they are associated. Students may write some of this information in a science journal.

3. Ask the students to make a cloud chart using the cotton balls, blue art paper, and glue. Label the clouds with the proper scientific name.
4. Use the weather data table to record the cloud cover, temperature, wind, humidity, and other data. Students can draw symbols to show "cloudy, partly cloudy, and clear skies" in the table.
5. Have them predict what the weather will be for the next day as individuals and as a class.
6. Help them evaluate how accurately they were able to forecast the weather by observing the clouds and using other data.

Possible Extensions/Adaptations/Integration

Have students create a cloud person or animal using art paper and chalk or cotton.

Assessment Suggestion

Check the student journals for accuracy of recorded information. Observe their cloud charts when completed.

Additional Resources

1. Students can bring in newspapers with daily weather maps and forecasts. They can also check weather web sites (www.ksl.com) for current temperature readings and forecasts.
2. Check school and local libraries for books on clouds.
3. Check district media centers for videos about clouds. There are also commercial weather videos available.

Homework & Family Connections

Students with internet connections at home can be asked to visit web weather web sites. They can also be assigned to watch the evening weather forecast on one of the TV news channels. They could demonstrate information about clouds as part of a school science fair.

Weather Forecasting Data Table

Key	Date	Time	Temp.	Wind Speed	Wind Direction	Humidity	Air Pressure	Class	Teacher	My Guess	Media	Actual

Make up symbols for different kinds of weather and draw them in the key. Record the daily weather data in the table. Predict what the weather will be for the next day according to class vote, teacher, my guess, and media forecast. Evaluate how accurate each type of forecast was over a two week period.

Activity—Air Pressure

Standard II

Objectives 1, 2 & 3

Connections

Standard II
Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns.

Objective 1
Observe, measure, and record the basic elements of weather.

Objective 2
Interpret recorded weather data for simple patterns.

Objective 3
Evaluate weather predictions based upon observational data.

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

Background Information

Air pressure is the weight of air in our atmosphere pressing down upon the earth. It can be compared to the weight of water pressing down on a person as they dive deep into a pool of water. People can feel the effect of air pressure on their ears as they go up higher in the mountains and as they return to a lower elevation. The barometric pressure and whether it is rising or falling is the greatest forecasting factor available to a weather watcher. A steady pressure means no change in the weather. If the air pressure rises (high pressure), it means fair, clear weather. If the air pressure is falling (low pressure), it means cloudy, stormy weather.

A barometer is a weather instrument scientists use to measure the air pressure. As the air pressure changes, the pointer moves. A barometer is a delicate instrument that needs to be handled carefully.

The Bernoulli principle can be demonstrated by using a hair dryer and a ping pong ball. This shows that air pressure going over the top of the ball is lower which creates the lift that holds up the ball. It is the same way an airplane wing works.

Invitation to Learn

Place the ruler on the edge of a desk so that half of it is extending over the edge. Lay two or three layers of newspaper over the part of the ruler on the desk. Strike down on the ruler quickly with your hand, causing the ruler to break. Repeat the previous steps. This time you will press slowly on the ruler, allowing it to lift the newspapers.

Instructional Procedures

1. Ask volunteers to explain why the ruler did or did not break. Explain that air pressing down on the papers holds them down so the ruler can be broken. When you press down slowly, it lifts the papers and the air moves upward.
2. Ping-pong ball experiment: Show the student a ping-pong ball and a hair dryer.
3. Ask them to write down the following information in their science journal or use the worksheet "Air Pressure."
4. Question: What will happen when I hold a ping-pong ball over a hair dryer and turn it on?
5. Hypothesis: I think it will______________________________.
6. Experiment: Try it.
7. Results: What happened? ______________________________.
8. Conclusion: What did I learn? ____________________.
9. Picture: Draw a diagram of the experiment.

Materials

- ❑ newspapers
- ❑ 2 rulers (or painting stir sticks)
- ❑ ping-pong ball
- ❑ hair dryer
- ❑ journal
- ❑ barometer (optional)

Possible Extensions/Adaptations/Integration

Use a barometer (if available) to show the air pressure.

Keep a chart of the air pressure each day for several weeks.

Analyze how daily changes in the air pressure affect the weather.

Try using a leaf blower and larger balls.

Assessment Suggestion

Check the student journals for accuracy of recorded information.

Additional Resources

Students can bring in newspapers with daily weather maps and forecasts. They can also check weather web sites (www.ksl.com) for current temperature readings and forecasts.

Check school and local libraries for books on weather

Check district media centers for videos about weather. There are also commercial weather videos available.

Homework & Family Connections

Students with internet connections at home can be asked to visit web weather web sites. They can also be assigned to watch the evening weather forecast on one of the TV news channels. They could demonstrate information about air pressure as part of a school science fair. Some families may want to purchase a barometer for home use.

Name______________________________

Air Pressure Weather Experiement

Why learn this? You can see what effect air pressure and the movement of air have on common objects.

What you need: Ping-Pong ball, Hair dryer

Question: What will happen when I hold a ping-pong ball over a hair dryer and turn it on?

____

____.

Hypothesis: This is what I think will happen _____________________________________

____

____.

Experiment: This is what I did____

____

____.

Results: This is what happened ____

____

____.

Inquiry: These are some other things I would like to try _____________________________

____

____.

Draw a picture:

Activity—Wind

Standard II

Objectives 1, 2 & 3

Connections

Standard II
Students will understand that the elements of weather can be observed, measured, and recorded to make predictions and determine simple weather patterns.

Objective 1
Observe, measure, and record the basic elements of weather.

Objective 2
Interpret recorded weather data for simple patterns.

Objective 3
Evaluate weather predictions based upon observational data.

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

Materials

- ❏ a directional compass
- ❏ 10" x 10" white oaktag
- ❏ markers
- ❏ 2" ball of modeling clay
- ❏ pencil
- ❏ straight pin
- ❏ 10" drinking straw
- ❏ 4" x 6" card
- ❏ tape
- ❏ scissors
- ❏ 2 paper clips
- ❏ fan (optional)
- ❏ ping-pong ball
- ❏ string
- ❏ 3" x 6" cardboard
- ❏ paper protractor (see associated worksheet)
- ❏ bottle connector (optional)
- ❏ 2-liter clear soda bottles

Background Information

Wind is one of the elements of weather. It is the movement of air that can be felt against our face and body. We can see the effect of wind by the movement of objects. The direction, temperature, and speed of wind can help us predict changes in the weather.

A wind vane is an instrument that tells the direction the wind is moving.

An anemometer is a weather instrument used to measure the speed of wind.

Invitation to Learn

Read the children's literature story *What the Wind Blew*.

Instructional Procedures

1. Assemble the wind vane and the wind gauge according to directions on the handouts.
2. Explain how both weather instruments work.
3. Go outside and observe them working. A classroom fan may be used if there is no measurable wind outside.
4. Discuss observations and questions.
5. Assign the students to record observations in their science journals.

6. Keep a daily chart of the wind direction and speed for several weeks.
7. Make weather forecasts based on changes in the wind speed and direction.
8. Refer to Beaufort Wind Speed Scale (handout) to measure the wind speed from visual clues.

Possible Extensions/Adaptations/Integration

Construct a tornado tube using soda bottles and commercial connectors.

Research the effects of severe windstorms on people and property.

Assessment Suggestion

Check the student journals for accuracy of recorded information. Use the test item pool assessments.

Additional Resources

1. Students can bring in newspapers with daily weather maps and forecasts. They can also check weather web sites (www.ksl.com) for current wind readings and forecasts.
2. Check school and local libraries for books on weather
3. Check district media centers for videos about weather. There are also commercial weather videos available.
4. *Utah's Weather Guide* by Dan Pope and Clayton Brough (News4Utah), 1997.

Homework & Family Connections

Students with internet connections at home can be asked to visit web weather web sites. They can also be assigned to watch the evening weather forecast on one of the TV news channels. They could demonstrate information about wind as part of a school science fair. Some families may want to purchase an anemometer for home use.

Windward Ho!

WIND IN THE WILLOWS

Will crouched low, peering through the willows at the grazing antelope. It tugged gently on the tips of the young grass shoots, pawed loose from earlier digging. Father had instructed him to always stay downwind of animals when tracking and trying to get closer to them. The antelope's alert head raised at the sound of a snapping twig underfoot as Will cautiously ventured closer. The tumbling dark clouds overhead momentarily broke his concentration. He recalled his mother's caution that a calm peaceful evening could quickly change with little warning with an approaching storm.

Will could feel the wind pick up around him. How hard it was to stand so close and not be seen by the antelope. Then large drops of rain splattered on his coat as he tried to get closer. A sudden boom of thunder echoed in the canyon, startling the unsuspecting antelope. Will watched as it leaped out of sight. With great excitement, Will returned to camp having successfully tracked and gotten close to the antelope.

AIR IN MOTION

What carries the sound of a snapping twig? How does a storm come racing through your town? What makes the smoke of a campfire angle as it rises? The Earth is surrounded by a protective blanket of air, the atmosphere, that is constantly moving. Moving air is called wind. You might feel a calm, gentle breeze on your face on a lazy summer evening, or experience the ravaging fury of a thunderstorm. Wind can cool you off when you're hot, or fuel forest fires caused by summer lightning. Wind can cause relief or it can cause disaster. Learning about wind can help you to know more about the weather.

STUDYING WIND

Meteorologists are weather scientists that observe and forecast weather. Wind is one of the important weather conditions that they study. Knowing wind direction and wind speed can help them predict how the weather will change. On this page, you will experiment with these two elements of wind.

GETTING DIRECTIONS

How do you observe the direction of the wind? Do you notice leaves as they are blown in the fall season? How important is knowing wind direction when flying a kite? Wind vanes have decorated barns, houses, and other public buildings for centuries. They turn with the wind, showing the direction of this moving air. You may have seen windsocks at airports or used as colorful decorations on people's homes. By observing wind vanes, meteorologists know a wind's direction and can predict how this moving air will change the weather conditions in an area.

DO IT!

Below you will find out how to make a simple wind vane that's easy to use.

MATERIALS: This is what you need.

4 x 6 inch index card

Ruler

Straight pin

Plastic drinking straw

Pencil

Clay

Marker

Directional compass

Fastening device (stapler, tape, or glue)

Paper clips

PROCEDURE: This is what you do.

1. On the 4 x 6 index card, draw a vertical line that divides the card into a 4 x 4 inch piece and a 4 x 2 inch piece.
2. Cut the card in the two pieces. The smaller piece will be the tail of the wind vane. The larger piece will be a base.
3. Stick the straight pin through the center of the straw so that the straw can spin around.
4. Then stick the pin into the eraser head of a pencil.
5. Paper clips may be added near the arrowhead of your vane to balance your straw.

You will use the remaining 4 x 4 inch piece of index card to make a wind direction base.

1. Draw straight lines through the center point to the opposite corners of your paper.
2. Label the corners on your card. North should be at the top, south at the bottom, west to the left, and east to the right.

USING YOUR WIND VANE

1. Find a spot outside away from any buildings. Hopefully the wind will be blowing.
2. Place a directional compass on top of your wind direction card. Locate magnetic north and turn your paper so the line on the card lines up with the compass arrow.
3. Place a glob of clay in the center of your card and stick the pencil wind vane into it. The direction of the arrow will indicate the direction the wind is blowing.

SPEED LIMIT

Along with wind direction, meteorologists measure wind speed. Wind speed is a measure of how fast the air is moving. It is measured using an instrument called an anemometer. As the spinning cups of an anemometer turn, the speed of the wind is determined. Knowing wind speed helps meteorologists forecast when an approaching storm will arrive, or how long the weather in an area will remain.

YOU'RE THE SCIENTIST!

The activities below show you how to make a simple instrument that will help to measure wind speed.

MEASURING WIND SPEED

MATERIALS: This is what you need.

Two strips of wood (2 x 18 inches)

Four small plastic cups (3 of 1 color and 1 a different color)

One piece of coat-hanger wire (12 inches)

Ruler

Glass medicine dropper

Thumbtacks

Small nails

Hammer

Strong glue

Wooden pole or base

Thin tie wire or strong string

PROCEDURE: This is what you do.

Use the ruler to find the middle of each piece of wood. Make a cross and glue them together. Use the hammer and small nails to hold them together securely.

Have an adult drill a hole through the center of the cross—large enough to snugly accommodate an eyedropper.

Pull the glass bulb from the medicine dropper and push the bulb into the hole in the cross.

Attach the 4 plastic cups to the ends of the wooden cross using the thumbtacks. Be sure the open ends of all the cups face the same direction.

Secure the piece of wire to either a wooden stand or a pole with the thin tie wire or string so it extends a few inches above its support.

Place the medicine dropper in the cross over the pointed wire in the stand. The cross and cups should spin freely.

USING YOUR ANEMOMETER

Place the base of your anemometer in a location where it can spin freely. As moving air blows against the cups, the anemometer will spin.

By counting the number of complete turns (observe the cup that is a different color) you can determine the wind speed.

Text excerpt from: The Fourth Grade Sciber Site
http://www.usoe.k12.ut.us/curr/Science/core/4th/4thSciber/WEATHER/WIND/wind.htm

Wind Speedometer

Materials:

5"x8" cardboard

glue

scissors

thread

tape

ping-pong ball

Assembly

1. Copy the paper protractor on the following page (enlarge 125 percent).
2. Cut out the protractor and glue it to a piece of cardboard.
3. Cut a piece of thread 10 inches long and tape one end to the ping pong ball and the other end to the protractor at the center dot.

Directions

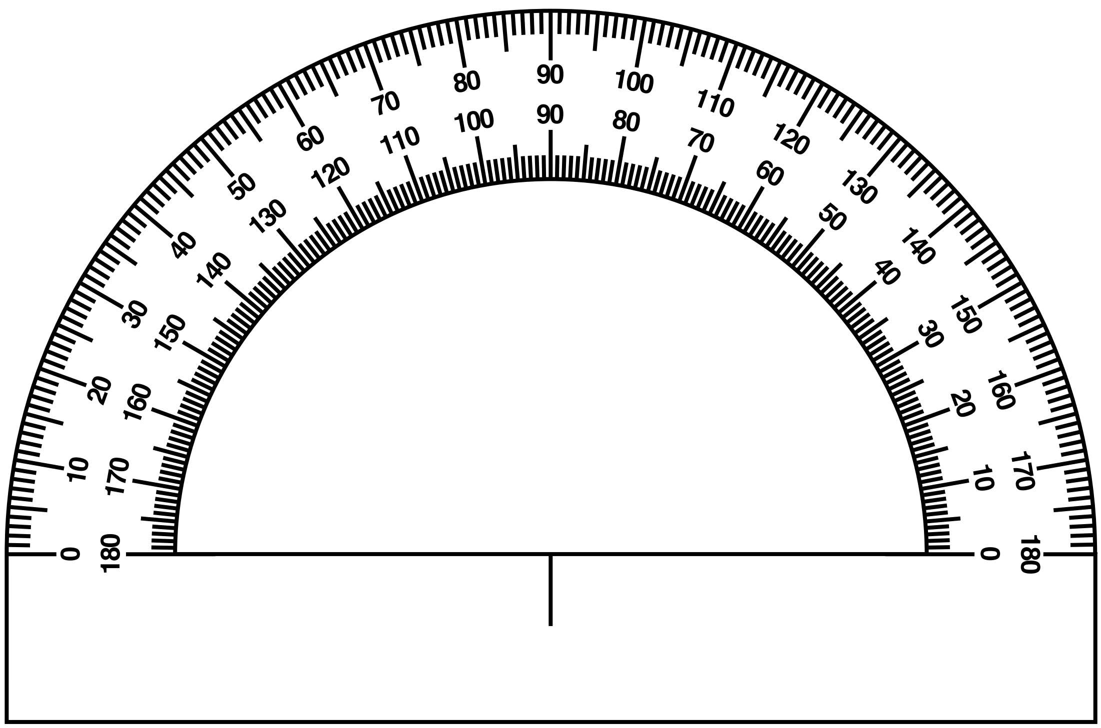
1. Face into the wind and hold the wind speedometer in front of you.
2. Hold the flat edge of the protractor parallel with the ground.
3. Check the angle of the ball and thread and record it.
4. Compare your data with other students.

Table

The following table is an approximate indication of the wind speed. Several factors may affect the angle of the ball and thread. Compare the results you get with the local weather report.

Degrees on Protractor	Wind Speed in MPH
0	0
5	9
10	13
20	19
30	24
40	29
50	34
60	41
70	52

Paper Protractor



Science Standard III Activities

Activity—Minerals vs. Rocks

Standard III
Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 1
Identify basic properties of minerals and rocks.

Intended Learning Outcomes
1. Use science process and thinking skills.
4. Communicate effectively using science language and reasoning.

Standard III

Objective 1

Connections

Background

Minerals are the building blocks from which rocks are made. Some minerals, such as gold and copper are made up almost entirely of one chemical element. Others are mixtures of elements. Rocks are nearly always made of mixtures of different minerals. More background in the Invitation to Learn.

Preparation

One week prior to this activity make mock rocks and allow them to air dry (do not bake). Recipe: Mix 1 cup white flour, 1/2 cup salt, 2 tsp alum. In a separate bowl mix 1/2 cup water, 5 drops red food coloring, 5 drops blue, 3 drops yellow food coloring. Add the water mixture to the flour mixture. Knead the mixture until it no longer sticks to the side of the bowl. Add 1 cup coarse sand, 1/4 cup aquarium gravel–mixed colors. Knead until it is well mixed. Divide the mixture in 18 equal pieces about the size of a ping-pong ball. Place one ball into the palm of your hand and with your thumb make a small indentation in the center. Place 3 or 4 pieces of seashell (or eggshell to represent fossils) in the indentation and mold the dough around them. Smooth the surface of the ball and flatten the rock so that it is about 1 cm thick. Let them air dry for a week.

Invitation to Learn

Explain that geologists study the earth. One thing that they study is rock. Geologists must make detailed observations of the rocks they discover. Ask students what they might observe about rocks (texture, shape, colors, smell, size). Tell students that these are the properties of the rock.

Show students a mock rock. Tell them that they are going to investigate this mock rock. To mock means to imitate or copy. This special rock imitates the properties of real rocks, but it is easier for young scientists with simple equipment to thoroughly investigate. They will be using some of the same observation techniques and skills that geologists use.

Geologists try to figure out what kind of rock they are examining. They do this by identifying the various ingredients in the rock. These ingredients are called minerals. The various materials in the mock rock represent different minerals. The goal of the student is to use different techniques to try to sort out all the materials in order to identify them.

Materials

For every student or pair of students

- ❏ Mock rocks (see list of ingredients in "Preparation" section)
- ❏ Paper plate
- ❏ Large nail
- ❏ Hand lens
- ❏ Crayons or colored pencils
- ❏ Piece of string
- ❏ Metric ruler
- ❏ 50-ml graduated cylinder
- ❏ Evaporation dish
- ❏ Pipette or medicine dropper
- ❏ Vial with lid (or small bottles such as spice bottles)

For class or one for each group:

- ❏ Scale

Instructional Procedures

1. Distribute a mock rock to every pair of students. Have them investigate the rock, recording all the properties they observe on their record sheet.
2. Draw the mock rock on the grid. Strive for details and accuracy.
3. Examine the mock rock with the hand lens. Have students draw what they see.
4. Measure the rock. Find its diameter, circumference, depth or height, and weight. Record the measures on the log.
5. Break the mock rock in half. Students should use a nail to separate all of the different ingredients, sorting them into different piles. List the ingredients in on the log. Include descriptions of colors, shapes, and textures. (If the mock rock is very hard, place it in a plastic bag between padding and use a hammer to break it up. Be careful not to pulverize the shells.)
6. Explain that rocks are made up of more than one ingredient, including different minerals. The colored gravel could represent different kinds of minerals. The shells were not observable without breaking the rocks open. They could represent fossils imbedded in sedimentary rock.
7. Ask students to describe the leftover material that is too small to be separated with a nail. Ask for ideas on how they might further separate these small pieces. Suggest they might mix this material with water.
8. Give each pair of students a vial with a lid. Have them fill the vials 1/3 full of material. Water should be measured and added so the vial is about 3/4 full. (Have them measure precisely. The amount depends on the size vial or jar being used.)
9. Put the cap on and shake vigorously.

10. Set the vial down and immediately sketch what the cloudy, muddy mixture looks like before settling. (If it starts to settle before they finish drawing invite them to reshake the vials.
11. Label the vials and set aside to settle overnight.
12. The next day have students carefully retrieve the vials and observe and draw what they see after settling.
13. Add to their list of ingredients (sand, silt (flour), and possibly a thin white mineral layer (alum)).
14. Ask students to look closely at the liquid in the vials. Ask if it looks as clear as it did when they added it the day before. Suggest that they might evaporate the water to see what, if any, materials are left behind.
15. Have the students use a pipette to withdraw some of the clear water. Pour just enough water into the evaporation dishes to barely cover the bottom. Set aside to evaporate for a few days.
16. This step could be done with the following activity: Crystals. They will be learning about crystals and should be able to identify the material as salt crystals. Have them draw and record what they see on their record sheets. Have them notice the little cubes with X's in them. They should add salt to their ingredient list.
17. Give students samples of minerals such as iron pyrite, and rock such as granite, and a piece of conglomerate. Instruct the students to observe the differences between the mineral (all one material, color, and texture) and the rock (made of pieces of different kinds of minerals and other materials).

Curriculum Integration

Math/Science—Determine measurements using appropriate tools and formulas.

Possible Extensions/Adaptations/Integration

In language arts, help the students build vocabulary and become more precise in their descriptions of the minerals and various components of rocks and the mock rocks. For example, texture is gritty, rough, smooth, or powdery. Colors are not just white, what shade of white? Grey-white, eggshell white, golden-yellow, lemon-yellow, speckled, banded, spotted, or streaks? Shapes include faces, edges, cubes, rectangular prisms, and other geometric terms.

Assessment Suggestion

Write what the difference is between a rock and a mineral.

Give students samples of pure minerals and rocks. Have them sort them into two groups and explain why they put the rock or mineral in the group they did.

Additional Resources:

Earth Materials (FOSS, Lawrence Hall of Science)

The mock rock activity is a modified version of "Mock Rocks" from the FOSS science module. Kits may be ordered through Delta Education at 1-800-258-1302.

SURWEB is an excellent, on-line resource. This site has over 180 image collections online, with over 38,000 images available for teacher and student projects. SURWEB allows people to create multimedia presentations in minutes using images, sounds & movies provided by SURWEB or other digital sources. This site is easy to use and there is a tutorial.www.surweb.org/ There are Learning Segments, Media Shows, and Image Collections. Click on Image Collections and type in your topic such as crystals. Or click on Media shows, then Earth + Physical Science + Geology.

Pioneer is Utah's on-line library and has excellent videos on many topics. Each video is broken up into titled sections so you can go the exact spot you want.pioneer.uen.org/ Choose Digital Curriculum. Select your preferred video player. Then choose Search and type in your topic. There are also still photos of rocks, minerals, crystals, etc.

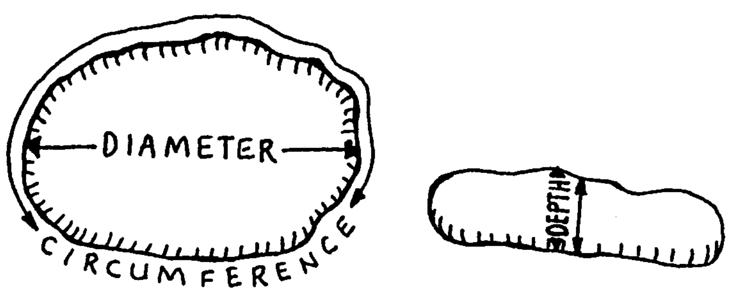
Name______________________________

Mock Rocks

Question: What is the difference between a rock and a mineral?

Trace and draw your mock rock.

Draw a magnified view of part of your rock.



Mock Rock Measurements

Diameter _________________________

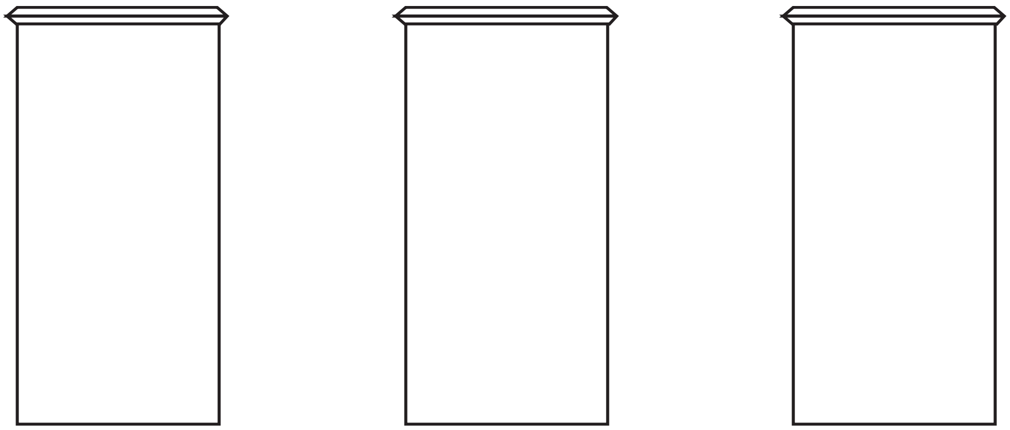
Circumference_____________________

Depth____________________________

Weight___________________________

Name______________________________

Mock Rocks in Water



Before Shaking After Shaking After Settling

Mock Rock Recipe

List the mock rock ingredients:

____

____

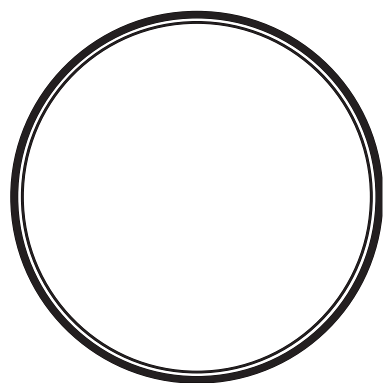
____

____

____

____

Evaporation Dish



What is a mineral? ____

____

What is a rock? ____

____

How is a mock rock like a real rock? _______________________________

____

Activity—Crystals

Standard III
Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 1
Identify basic properties of minerals and rocks.

Intended Learning Outcomes
1. Use science process and thinking skills.
3. Understand science concepts and principles.

Standard III

Objective 1

Connections

Background

A mineral is a naturally formed solid substance with a crystal structure that was not formed from living things. A mineral has a crystal structure even if it does not have a crystal shape that you can see.

A crystal is a solid substance with a regular shape. It has flat sides that are at specific angles to each other. The shape is determined by the pattern into which the atoms of a mineral have arranged themselves. There are only six main groups, or "crystal systems," into which all naturally occurring crystals can be placed. The particular shape of its crystal is one property that allows us to distinguish one mineral from another.

Crystals that form by evaporation will develop at different rates. Salt crystals forming in a warm, sunny window will generally form faster and have smaller crystals. Those grown in a refrigerator will grow more slowly and have larger crystals.

Preparation: Several days prior to the lesson

1. Mix 1 teaspoon of liquid detergent into a cup of water until it is mixed thoroughly. Dip the 5 petri dishes or plates into the soapy water so the surface is completely covered. Let the soap film dry.
2. Pour 2 tablespoons of Epsom salts into a glass measuring cup. Add 3 tablespoons of boiling water and stir to dissolve the salt. Pour just enough of this solution onto 3 of the dishes to just cover the bottom.
3. Place one on the overhead and turn the light on. Leave it on until the water has evaporated. Place another dish in the room and the third dish in a dark closet.
4. Just before lab, mix up a small batch of table salt and Epsom salt solution. Barely cover the bottom of the other two petri dishes – one with the salt solution and the other with the Epsom salt solution.

Invitation to Learn

Show students a sample of a salt crystal. Tell them they will be able to identify what kind of crystal this is by the end of this lab. Also explain that while they are examining and learning about crystals, they will be watching crystals grow before their very eyes on the overhead projector. (Place the prepared petri dish on the overhead and turn it on.)

Instructional Procedures

Materials

- ❏ Liquid detergent
- ❏ Measuring cups and spoons
- ❏ Glass measuring cup
- ❏ 5 Petri dishes (or 3 small, clear plastic plates, or 3 blank transparencies)
- ❏ Epsom salts (could also use alum, washing soda)
- ❏ Table salt
- ❏ Coarse sand
- ❏ Dark construction (blue or black) paper cut into small rectangles (1 for each student)
- ❏ Hand lenses
- ❏ Hot plate
- ❏ Chart of crystal systems
- ❏ One clear glass for each group of students
- ❏ One piece of string for each group
- ❏ Samples of minerals and rocks with clearly identifiable crystals
- ❏ Large salt crystal

A. Examining crystal shapes

1. Give each student a few grains of table salt, Epsom salt, a hand lens, a crystal system chart, and a student log.
2. Instruct students to carefully examine both kinds of salts. Discuss the difference in their shapes. Refer them to their crystal system chart and ask them to decide which shape their two kinds of salts appear to belong to. Use geometric terminology to discuss the shapes: faces, edges, right, obtuse and acute angles (find examples in the class), cylinders, rectangular prisms, squares, cubes, and rhombus.
3. Have them sketch the two crystals on their log and write a sentence describing the shape of each.
4. Give students a sample of coarse sand. Tell them that quartz is the most common of all minerals. It is made up of silicon (sand) and oxygen. Show them a picture of a quartz crystal. See if they can find some in their sand sample.
5. Observe the crystals growing on the overhead. Describe their appearances. (The Epsom salt dish looks like frost and has finger-like projections radiating from the center. The salt has squares with Xs in the middle.)
6. Have the students examine the crystals grown in the class and in the refrigerator. They should notice the difference in the size of the crystals. (The cold crystals should be the largest.)
7. Hold up the salt crystal sample and ask the class if they can now identify what kind it is.

B. Growing crystals

1. Give each group a clear plastic cup (easier to watch crystal growth).
2. Have them pour 1/3 cup hot water into their cup.
3. Stir in one teaspoon of a mineral (salt, Epson salt, alum, washing

soda). (Each group could choose a different mineral. Some groups could experiment with combining two minerals). They should stir until the salt dissolves.

4. Drape a piece of string over the edges of the cup. The middle should hang down into the solution. Use paper clips or clothespins to attach ends of string to edge of cup.
5. Over the next few days, observe crystal growth.
6. Have students examine and compare the crystal shapes. Record findings in their journals by drawing and writing descriptions. Their descriptions should include geometric vocabulary (faces, edges, rectangular prisms, cubes, etc.).

Curriculum Integration

Math/Science—Describe, identify, and analyze characteristics and properties of geometric shapes.

Possible Extensions/Adaptations/Integration

Have students experiment with crystal growth. Each group could manipulate a different variable (e.g., room temperature, adding color to the crystal growing solution, amount of material stirred into water). Have class brainstorm other possible variations.

Take photos of crystals grown in class as well as those from sample and categorize them according to crystal systems.

Assessment Suggestion

Give students samples of rocks and minerals. Have them identify crystal structures

Have students explain how they can identify a crystal (faces, edges, etc.)

Pioneer Online Library pioneer.uen.org/ Go to Digital Curriculum. Enter "Crystal" in the search box. Contains many excellent photos.

Additional Resources

SURWEB www.surweb.org/ Go to Image Collections and type in Crystals

Video: *They're Habit-Forming Crystals*. Excellent! Series in 3-2-1 Classroom Contact.Childrens Television Workshop, 1991.Salts, sugars, and snowflakes are crystals. Crystals are solid made up of molecules joined together in regular patterns. Crystals grow and have regular shapes, called habits. Every crystal is unique.

Name______________________________

What is a Crystal?

Question: What is a crystal?

Background

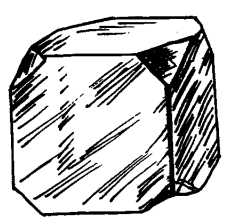
All things are made up of atoms, which are so small you can't see them – even with the most powerful microscope. There are different kinds of atoms. Atoms like to stick to other atoms. When they do this they form a molecule.

When molten (melted) rock from inside the earth cools, the minerals in the rock may form crystals that have a definite geometric shape. This happens when the atoms form themselves into a pattern. The way the atoms or molecules come together in a mineral determines the shape of the crystals. Crystals can be large or small depending on whether they formed slowly or rapidly. Crystals that form slowly will generally be larger than those that formed more rapidly.

Mineral collectors are often able to look at the crystal form of a mineral and identify that mineral by the shape of its crystal.

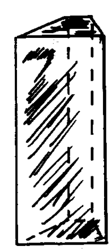
Quartz is the most common of all minerals. It is made up of silicon (sand) and oxygen. You can usually find quartz crystals just by walking along a gravel road or studying a sample of sand.

Crystals have flat sides and sharp edges and angles. There are six major types of geometric shapes that all naturally occurring crystals usually form. As you examine different samples of crystals, see how many of these shapes you can find.

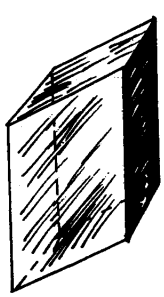


Cubic
(galena)

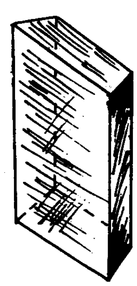
Tetragonal
(nickel sulfate)



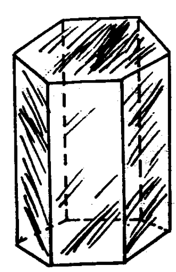
Orthorhombic
(sulfur)



Monoclinic
(gypsum)



Triclinic
(copper sulfate)



Hexagonal
(Quartz)

Examining Crystals

Materials: table salt (sodium chloride), Epsom salt (magnesium sulfate), quartz (found in sand), alum

Place a few grains of these minerals on a square of dark paper and examine with a hand lens.

Draw the shapes you see. Can you name the shape? Write a sentence to describe each crystal.

Sample 1 ______________ Sample 2 ____________ Sample 3 _____________

1. ____
____
2. ____
____
3. ____
____

Growing Crystals

Materials: salt, Epsom salt, washing soda, clear glasses or jars, hot water, spoons

There are different ways you can grow crystals. Here is one easy way.

1. Put 1/2 cup very hot water into a clear jar or glass.
2. Stir in a spoonful of one of the materials listed above. Keep adding and stirring in more spoonfuls until no more will dissolve and it starts staying on the bottom.
3. Leave the spoon in the jar.
4. Place the jar in a sunny window.

Results: Draw pictures and describe what the crystals look like.

Another question: Does temperature affect the growth of crystals? Size, shape, speed of growth? Repeat the above experiment. This time place jars in the refrigerator and in the room away from the sun. Compare the results.

Activity—Rock Identification

Standard III

Objective 1

Standard III Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.
Objective 1 Identify basic properties of minerals and rocks.
Intended Learning Outcomes 1. Use science process and thinking skills. 3. Understand science concepts and principles.

Connections

Background

Rocks are combinations of minerals found naturally on or in the Earth. Rocks record the history of the Earth in their structure. Rocks can be identified by properties such as color, crystal size or texture, banding patterns, presence of pores, and other characteristics (see student rock identification background sheet).

Invitation to Learn

Show students a rock such as a piece of granite. Ask them to describe the rock. Ask them what happened to make the rock look the way it does. Explain to students that the rock has a "story" and it can be told if you know about rocks. For example, if you chose to show them a piece of granite (igneous rock), the story might go like this: "I started life as a hot, hot liquid. Slowly I rose toward earth's surface and started to cool. As I cooled, minerals I was made of started to "find" each other and form crystals. I started to look speckled and very pretty. I cooled completely off and rose a little higher in Earth's crust. Soon, rain, water and even a glacier scraped off the rock on top of me. I was exposed to the light for the first time!"

Materials

- ❑ Set of rocks for each group of students (sedimentary: sandstone, conglomerate, shale; igneous: obsidian, granite, pumice, basalt; metamorphic: marble, gneiss, schist)
- ❑ Hand lens
- ❑ Student Rock Identification Background sheet
- ❑ Rock chart
- ❑ Rock poster or rock field guides

Instructional Procedures

1. Have the students read the background material about the three types of rocks.
2. Give each group a set of ten rock samples and a hand lens. Give them time to explore and study the rocks. Have them sort the rocks by appearance according to the descriptions they have read (sedimentary, igneous, metamorphic). They should record their observations in their log or on the "Kinds of Rocks" chart.

3. Students should identify each rock. Use the rock poster or field guide to check.

Curriculum Integration

Math/Science—Describe and identify geometric shapes.

Possible Extensions/Adaptations/Integration

1. Make a sedimentary rock. Fill a clear jar with pebbles, sand, twigs, and leaves. Add 1/4 cup (50 ml) Epsom salts (available at a drugstore). A jar with straight sides works best. Add water until there is only about 2 inches (5 cm) of space left at the top. Put the lid on the jar and shake. Once all of the ingredients begin to float, they should be called sediments. When thoroughly mixed, place the jar on a flat surface. Check the jar every hour or so. You will be able to see the heavier layers settle to the bottom first. When everything has settled, carefully pour the water out and let the layers dry completely. You will have a homemade sedimentary rock. The Epsom salts (magnesium and sulfur) act as glue to hold the rock together.
2. Here is a delicious, memorable way to make the 3 types of rocks. Materials needed are a bag each of chocolate, butterscotch, and white chocolate chips, small portion cups, sandwich bags, and gummy worm pieces.
   a. Sedimentary rocks

      Melt some of the three types of chips in a double boiler. This is the sedimentary "mud." Give each student a portion cup with 2–3 of each type of chip. This represents different kinds of rocks. (Optional: They could "weather" them by cutting them in pieces with a plastic knife.) Give each a piece of gummy worm to represent a fossil. Pour "mud" into their cups. (Remind them that mud found on lake/ocean bottoms is cold. But be careful that students do not burn themselves on the melted chocolate.) When their rock is hard, students could cut it in half to find their "fossil" and pieces of rocks.

   b. Metamorphic rock

      Give each student a few of each type of chip. Place them inside a sandwich bag. Squeeze the bag between hands. This represents heat and pressure. The chips will partially melt. When the rock has hardened, students will still be able to see the different "minerals" and rocks that make up their metamorphic rock.

c. Igneous rock

Melt some of the 3 types of chips in a double boiler. Have students put in samples of each. Note that the final color is different from the colors of the 3 "minerals" and rocks that make up this igneous rock. Pour melted mixture into portion cups for each student.

3. This activity demonstrates layering. Collect various types and colors of fabric. Cut into rectangles (4" x 12" or so). Place the fabrics on top of each other to represent the layers often seen in sedimentary rocks. Now fold the material over to represent the upheaval and movement in the earth. Cut the whole thing in half. Have the students examine the layers. This activity could also be done with clays of different colors.
4. Combine rock identification with the geography of Utah. Identify where the rocks might be found.

Assessment Suggestion

Have each student pick one of the ten rocks and write its "story" (see Invitation to Learn). Stories could be bound into a class rock book and used for review.

Additional Resources

Kits with rock, mineral, and fossil samples may be checked out
*Geology Rock*s by Cindy Blobaum (Williamson Publishing Co.), 1999
Rocks and Minerals Alfred A. Knopf, Inc. (Eyewitness Books), 1988
Rockhounds Information Page: www.rockhounds.com
Department of Natural Resources / Utah Geological Survey: http://geology.utah.gov
Rocks and Soil by R. Sneddon (Raintree Steck-Vaughn Company), 1999
Rocks and Minerals Reader's Digest Children's Publishing, Inc. (Weldon Own, Inc.), 1999
SURWEB www.surweb.org/ Go to Media Shows. Click on Earth + Physical Science. Click on Geology. Choose Earth Science: Where does sedimentary rock come from? Another site is on the Learning Segments. Choose Science 4th Grade Utah Rocks + Minerals
Pioneer's Online Library pioneer.uen.org/ Choose "Digital Curriculum" - "Rocks + Mineral" a RealWorld Science video

Video: *Rocks and Minerals*. Series in Real World Science, Science in the Real World.M1541: Mazzarella Communications, 1999.Footage of various rock formations and a "field trip" to a quarry, mine and cave will give students the ability to recognize specific rocks and minerals. Colorful graphics and animation show the layers of the earth and how rocks are formed.

Homework & Family Connections

Start a rock collection at home. Use an egg carton to sort and store them. Use separate egg cartons for the three types of rocks.

Name______________________________

How Are Rocks Formed?

Question: How are rocks formed?

Here is a delicious way to learn and remember the three ways rocks are formed.

Materials:

3 flavors and colors of chips: chocolate (brown), butterscotch (tan), white

(These are the chips for making cookies.)

plastic baggies, small double boiler, plastic knife, gummy worms to represent fossils

SEDIMENTARY ROCKS

1. Melt some of each flavor of chips in the pot.
2. Take a few chips of each color and "weather" them by breaking them into smaller pieces. (The plastic knife would be helpful.)
3. Place the "weathered" chips into a small cup. Add a piece of gummy worm to represent fossils – which are only found in sedimentary rocks.
4. Pour some of the melted "mud" over the chips.
5. When the "sedimentary" rock has cooled and hard, cut it in half and examine it.
6. Explain how your chocolate rock is like a sedimentary rock. Then you can eat it.

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METAMORPHIC ROCKS

1. Place several chips of different colors inside a plastic bag.
2. Apply heat and pressure by squeezing the bag between your hands until the chips have melted a little and have formed one chunky piece.

3. Let the chunk cool. Take it out, cut it in half and examine it.
4. Explain how it is like a metamorphic rock. Then you can eat it.

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IGNEOUS ROCKS

1. Put 3 different kinds of chips into the pot and heat until the chips have completely melted.
2. Pour into small cups and let cool. Cut your sample in half and examine it.
3. Explain how it is like an igneous rock. Then you can eat it.

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Explain how one type of rock can become another type of rock.

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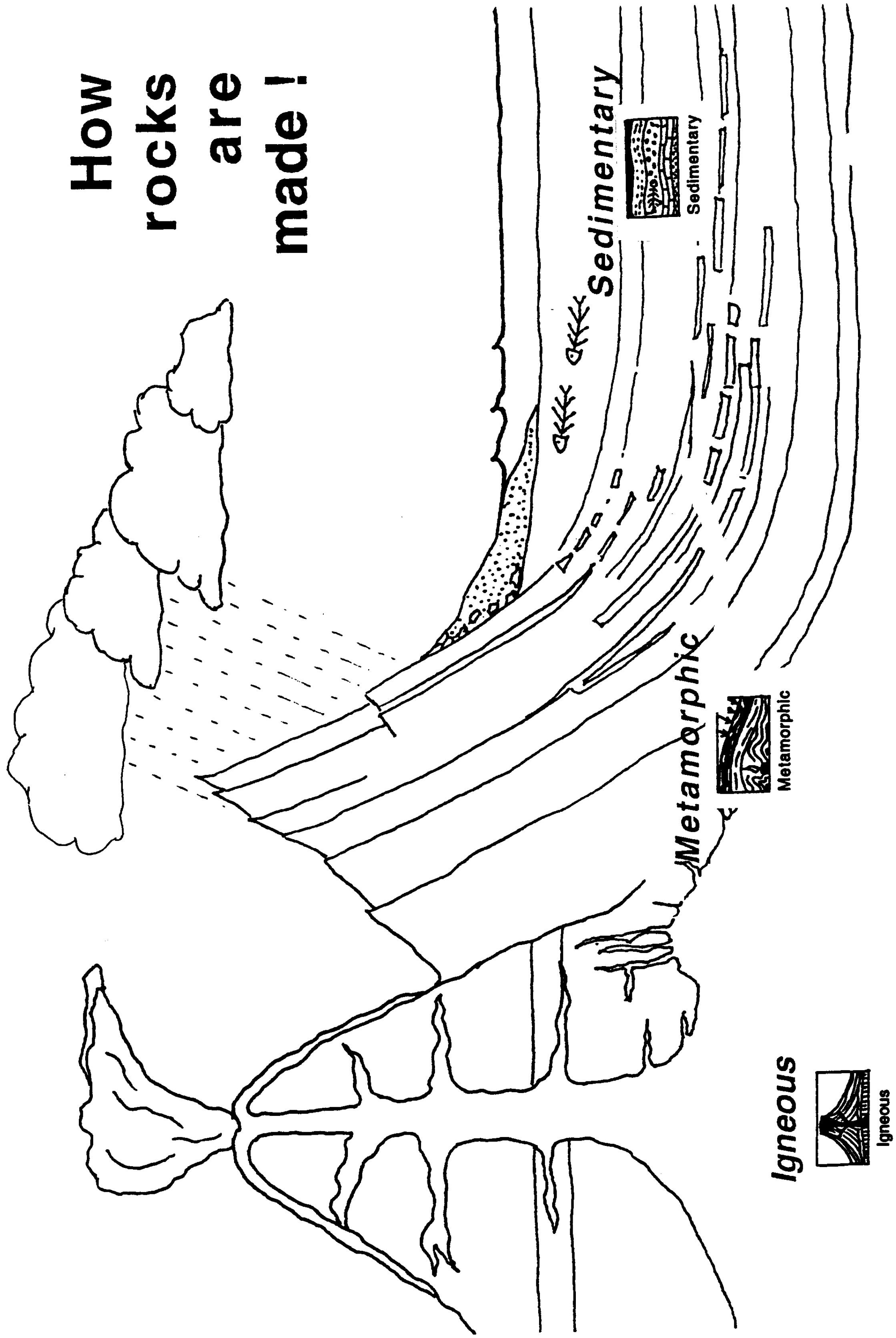

How rocks are made !
Sedimentary
Sedimentary
Metamorphic
Metamorphic
Igneous
Igneous

Identifying Rocks

Use the following descriptions to help you identify the rocks you have been given.

Record your findings on the "Kinds of Rocks" chart.

SEDIMENTARY rocks are formed from small particles of rock and other materials that are created through weathering. Most sediments are deposited by running water. Some are left by wind, glacial ice, or evaporation. The size of the sediments is determined by the speed of moving water. The faster the water, the bigger the rock it can move. Most sedimentary rocks were formed of sediments deposited or left by ancient shallow seas.

Sedimentary rocks usually have rounded sediments, or particles. They are often layered.

Some common sedimentary rocks found in Utah are sandstone, conglomerate, and shale.

Sandstone

Conglomerate

Shale

Shale is formed from particles of clay which were deposited in deep, quiet waters. It is usually red, brown, or gray. When it is wet it has a "muddy" smell.

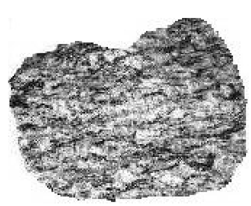
Sandstone is formed from particles of sand that were deposited near the shore where there was wave action. It is rough and grainy to touch. It may have fossils in it. Under a hand lens, you usually see sand grains.

Conglomerates are sediments, pebbles, and other size rocks cemented together by minerals from water.

METAMORPHIC rocks are rocks that have been changed by heat and pressure. The heat comes from volcanoes and other hot rocks under Earth's surface. Pressure comes from the layers of rock that press down on layers below them. Metamorphic rocks may have crystals or layers because they are formed from other rocks.

Some common metamorphic rock found in Utah are marble, gneiss (nice), and schist (shist).

Marble



Gneiss

Schist

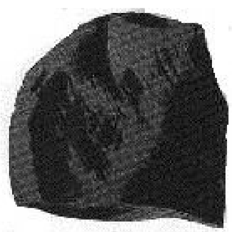
Marble is a large crystal rock formed from limestone. Its color depends on the presence of different minerals. It is generally pink, red, yellow, brown, green, or black.

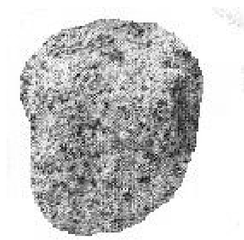
Gneiss is a coarse or rough rock. It has parallel streaks or bands of minerals in it. It may be formed from a variety of rocks, including granite and basalt.

Schist is a medium-grained rock. It is formed from shale or slate.

IGNEOUS rocks are formed when magma, or melted rock, from deep inside Earth rises and cools. This cooling may happen below the surface or on the Earth. When magma cools slowly below the surface, the igneous rock formed may have large crystals, which are very easy to see. Other igneous rocks form on the earth's surface and cool more quickly. Their crystals are usually extremely small. Igneous rocks are usually not layered. They may have air holes in them. Or they may be glasslike.

Some common igneous rocks found in Utah are obsidian, granite, pumice, and basalt.


Obsidian


Granite


Pumice


Basalt

Obsidian is a glass formed from rapidly cooled larva. It forms so quickly there is not time for crystals to grow. It has very sharp edges. Early people found this very useful for making tools such as arrow heads.

Granite is made up of mainly coarse (large) grains of quartz, feldspar, and mica. (Quartz is a colorless, transparent, hexagonal-shaped mineral. Feldspar is a glassy mineral. Mica is a translucent or colored mineral that comes in thin layers.) The individual grains in granite are large because they formed as the magma cooled slowly deep in the earth. Granite is usually speckled and varies in color from gray to red according to the different amounts of minerals.

Pumice is hardened lava froth. Because the froth contains gas bubbles, the rock is peppered with holes, like a honeycomb. Pumice floats in water.

Basalt is a common igneous rock. The grains in basalt are fine or small. It is often a heavy, dark colored rock. Large pieces of basalt may split into many-sided columns.

Activity—Weathering

Standard III
Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 2
Explain how the processes of weathering and erosion change and move materials that become soil.

Intended Learning Outcome
1. Use science process and thinking skills.

Standard III

Objective 2

Connections

Background

Soils form over millions of years from parent material that is broken down by weathering from wind, water, temperature, chemical changes, and living organisms. Over time, glaciers move over the land and grind rocks together, rubbing off particles of all sizes. By day, rocks are warmed by the sun and expand, while at night the rocks cool and contract.

Over time, enough expansion and contraction cause rock particles to chip off. In cold temperatures water in the cracks of rocks freezes and expands, causing the rocks to break into smaller pieces. Plant roots will grow into "soft" rock and cause them to break. Water and wind wear away at rocks carrying tiny bits of rock along until they get trapped by soil.

Many rocks are broken apart by lichens. Lichens are tiny crusty, coral-like plants (green, orange, gray, etc.) that live on rocks. These tiny plants secrete an acid that dissolves some minerals and breaks down the rock. Decaying plants and animals are organic matter. Organic matter is also acidic. When water and organic matter mix, they form a slightly acidic solution that breaks down rocks in soil. That is why soils in the eastern United States are more acidic than the soils in the west. They contain more organic matter.

Organic matter is good for plants. It keeps topsoil in its place, keeps soil particles together, retains soil moisture, and speeds up soil formation. It takes between 100 and 500 years for just one inch of topsoil to form, depending on the type of rocks and climate.

Invitation to Learn

Ask the students to consider these questions: Which is stronger, a plant or rock? Is water stronger than a rock? Would you expect water to damage or break apart large rocks?

Materials

- ❑ Paper cup
- ❑ Bean seeds
- ❑ Plaster of paris
- ❑ Modeling clay
- ❑ Straws
- ❑ Small plastic bags
- ❑ Vinegar
- ❑ Chalk
- ❑ Paper clips
- ❑ Ice cube trays
- ❑ Sand
- ❑ Chalk (or pieces of drywall)
- ❑ Newspaper
- ❑ Paper towels
- ❑ Colored chalk
- ❑ Salt
- ❑ Hot plate
- ❑ Glass bottle
- ❑ Plastic bottle with lid
- ❑ Small pieces of sandstone (about 3 pieces per bottle)

Instructional Procedures

Students should draw diagrams illustrating each of the following types of weathering processes. Some of these will occur over a period of days or weeks. They should draw and label a series of diagrams to show the progression of weathering.

A. Wind as an agent of weathering

1. Give groups of students a cup half-filled with salt and a colored piece of chalk. Have them take turns stirring the colored chalk through the salt.
2. Two things will happen: the salt will be colored and the chalk piece will wear away. Relate this to wind blowing sand on rocks and wearing them away like the formations seen in southern Utah. (Instead of wind blowing sand against Arches, tell them the chalk represents Arches and they are moving Arches through the sand.)

B. Running water as an agent of weathering

1. Compare river rocks with sharp-edged rocks. Rub two pieces of sandstone together and notice the pile of sand that collects.
2. Fill the plastic bottle 3/4 full of water.
3. Drop in three to four small pieces of sandstone.
4. Make sure the top is screwed on tightly. Have students observe the clean, clear water, and the shape of the rocks.
5. Shake bottle vigorously for three minutes.
6. Examine water. Take stones out. Observe the weathering (rounded edges).

C. Plant growth as an agent of weathering

1. Explain that plaster of paris hardens and will represent rocks in this demonstration. Mix the plaster of paris quite well and pour into a disposable 16 oz. cup. “Plant” several bean seeds in the wet mix so that some are covered and are just below the surface and the others are resting on the surface (about half submerged).
2. Assign a student to keep a wet folded paper towel on top of the cup. It must be moistened every day. (Soaking the seeds ahead of time will hasten their growth.)
3. Ask students to predict what will happen to the seeds. Record predictions and subsequent observations in their science log.
4. Over the course of two to three weeks you will see the seeds sprout. As they do, small fragments or flakes of the Plaster of

Paris will break away. These flakes represent rock flakes broken away from large rocks as plants take root and grow on them.

D. Freezing water as an agent of weathering

1. Wet a chunk of clay about the size of a grapefruit. Roll it into a ball.
2. Place the ball in a plastic bag and put it in the freezer. Leave it overnight.
3. Next day, remove the clay from the freezer. Its surface should be slightly cracked and broken. Ask students to record their observations.
4. Wet the clay again, taking care not to close up the cracks that have been formed. Put it back into the freezer for another night.
5. On the following day, take it out and have students observe what has happened to the cracks. Measure the cracks. You could repeat this process several more times, watching the cracks widen. Discuss how this relates to the breaking down of rocks on a larger scale. Compare this to autumn rains filling cracks in the rocks (and sidewalks) then freezing during the winter.

E. More freezing ideas

1. Plug the end of a drinking straw with clay. The clay should extend into the straw at least one inch.
2. From the other end, fill the straw with water. Plug that end also. Use a marker to mark the ends of the clay on the straw. Place the straw in the freezer. Try to keep it level.
3. Allow sufficient time for freezing. Ask the students to predict what will happen to the clay and the water. Show straw and have students measure the movement of the clay to the nearest 1/4 inch. (If several groups or every individual does their own separate straw, they could compare distances the clay moved.)
4. Another way to demonstrate ice weathering: Have students completely fill a film canister or other container with a lid that can pop off. Fill with water. Freeze overnight. Observe and draw the before and after.

F. Heat as an agent of weathering.

1. Heat a small glass bottle on a hot plate. Wear safety glasses. (This is just an extra precaution. The glass will usually just crack, not break apart.)

2. Using tongs, transfer the hot glass from the burner to a deep dish or pot of ice water. The glass will crack or break. (As an extra safety precaution, don't allow students near. They should be able to hear the crack.)
3. Relate this to the heating and cooling of rocks and how that process weakens the rock (you may be able to try this with a piece of limestone).

G. Glaciers an agent of weathering

1. The night before, place ice cubes in a dish of sand. Let them stand at room temperature for five to ten minutes. Then put entire dish in freezer overnight.
2. Give groups stacks of old newspaper, chalk, paper towels, and a "gritty" ice cube. Have them hold the ice cube using a paper towel. Instruct them to rub the sandy side of the cube over the stack of newspaper and along the chalk.

H. Chemical weathering

1. Give each student (or pair) a piece of real chalk and a paper clip to carve a design into the chalk. Mix one tablespoon (15 ml) water with equal amounts of vinegar. This will represent very strong acid rain.
2. Use a pipette to drop one drop of the mixture onto the chalk "statue". Watch closely to see the reaction. Students should record their observations in their science logs, and predict what would happen to their "statues" if they were exposed to the mixture or a long period of time.
3. Show students pictures of buildings or statues damaged by acid rain. Two good examples are the Parthenon in Greece and the Great Sphinx in Egypt.

Curriculum Integration

Math/Science—Measure the length of objects to the nearest 1/4 inch.

Possible Extensions/Adaptations/Integration

1. Use the different colored salts to make "sand" paintings. Gather baby food jars and pour layers of different colored salts to make colored "sand" jars. Fill completely and don't shake.

2. Another way to show weathering by acid –Place a piece of limestone in a small jar. Cover with clear vinegar. Have students observe the "fizzing." Explain that the calcite in the limestone is reacting with the weak acid of the vinegar. Together they create carbon dioxide gas that is released through the bubbles. This action breaks down some rocks. For added interest, let the fizzing continue over night. Pour some of the spent vinegar into an evaporation dish (petri dish or flat lid). Let the liquid evaporate and look at the calcite crystals that form. Examine the limestone for pitting caused by the acid.

Assessment Suggestion

Take a tour around the school grounds to look for evidence of weathering.

Show pictures and categorize types of weathering illustrated.

Additional Resources

Bill Nye Video, "Erosions." The "Rocks and Soil" episode also has a very good segment on weathering.

"Dirt: Secrets in the Soil" Video: The first segment after the introduction talks about how long it takes to form a layer of topsoil. After the words "Nitty-gritty," there is a five-minute segment that specifically talks about how rocks are broken down by water, roots, and chemicals.

Surweb–There are excellent slides of rock formations around Utah showing various kinds of weathering.

SURWEB www.surweb.org/ Go to Media Shows. Choose Earth + Physical Science. Choose Geology. There are several collections of images under "Weathering Forces"

Homework & Family Connections

Find examples of weathering around the home and on trips. Make a photo album showing examples of all types of weathering.

Student Log

WEATHERING reshapes the Earth

Weathering means ____

____

Types of Weathering

Wind	
Running Water	
Plant Growth	
Freezing Water	
Heat	

Name______________________________

What is Weathering?

Question: What is WEATHERING?

Which is stronger, a plant or a rock? Your hypothesis: ____________________________

Which is stronger, water or rock? Your hypothesis: ____________________________

Which is stronger, wind or rock? Your hypothesis: ____________________________

Now you will test your hypotheses. Draw a diagram of each experiment.

Label the parts of your diagrams. Underneath each diagram write your procedure - what you did to test your hypothesis. Then record what the results were.

Plant growth as an agent of weathering:

Procedure: ____

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Results: ____

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Frost Shattering as an agent of weathering

Procedure: ____

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Results: ____

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Ice as an agent of weathering

Procedure: ____

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Results:____

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Acid Rain as an agent of weathering

Procedure: ____

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Results:____

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Wind as an agent of weathering

Procedure: ____

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Results: ____

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Heat as an agent of weathering

Procedure: ____

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Results: ____

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Activity—Erosion

Standard III

Objective 2

Standard III Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.
Objective 2 Explain how the processes of weathering and erosion change and move materials that become soil.
Intended Learning Outcomes 1. Use science process and thinking skills.

Connections

Background

When sediments are formed, they are often carried away by the action of water, wind, or people and machinery. Wind erosion is most obvious in dry, desert places. In regions where there is no sheltering vegetation, the wind can strip off dry soils. The abrasive action of wind often wears away softer layers of rock, leaving the harder ones sticking out. Utah's Goblin Valley State Park is a great example of wind-created rock sculptures.

The wind carries only fine particles, but the force of flowing water can move much larger fragments. The faster the water flows, the larger the fragments it can carry. Water from rainfall or melting snow runs downhill, taking particles of rock and soil with it. Rocks carried along by water are gradually reduced in size and become smooth and rounded as they bounce along a riverbed or against each other.

Most of the power of wind, water, and ice that strip away rocks comes from the abrasive effect of the rock fragments they carry. In deserts, windblown sand scours rock surfaces into fantastic honeycomb shapes. Rocks carried by a river current widen the river by knocking out more material along the way. Along shorelines, the tides grind sand and pebbles against rock surfaces.

Natural erosion tends to happen very slowly. Humans speed up the process tremendously by altering the environment. When forests are cut down leaving exposed soil, erosion may be devastating. Overgrazing by animal herds and unsound farming practices also accelerate the process of erosion.

Invitation to Learn

Invite the students to think of times when it has been so windy that the air has been filled with dust. Where did that dust come from? Where does it go? Ask if they have walked along the Jordan River. Have they noticed what the water does to the bank? Where does the soil go that falls into the water?

Instructional Procedures:

A. Modeling Erosion

1. *Wind erosion:* Fill a clear shoebox about 1/4 full of dry sand or dry soil. Tape a piece of clear wrap over most of the top. Leave a space for your hand to reach in. This will prevent blowing sand from getting out and into eyes. Reach in with a syringe or spray bottle. Use it to blow air over the sand. Direct the syringe so you can carve gullies and valleys with wind. Observe the movement of sand – where it blows and the shapes it forms. Next place some stones around the sand. Again make wind with the syringe. Do the rocks make a difference in how the soil is eroded? Have students draw diagrams and label what happens.
2. *Water erosion:* Raise one end of the erosion tray. Fill the syringe or spray bottles with water. (You might try it both ways and notice the difference.) Sprinkle water on the sand. Notice the movement of sand. It should be forming gullies. Place several rocks across the surface and sprinkle again. Do the rocks change the way the water eroded the sand? Discuss the direction that eroded material travels (uphill, downhill?) Have the students build a mountain with the sand. Make one side rather steep. Aim water at the base of the cliff. Demonstrate how water can undercut a hillside and cause a landslide. Push the sand to one end to form a beach. Use fingers to cause waves and watch the sand erode away.
3. Does sod make a difference in how much soil is eroded? Place a piece of sod in one erosion tray. Fill another half full of just soil. Tilt both trays. Put an equal amount of water in two spray bottles. Spray each tray. Compare and contrast how much water and soil has collected at the bottom of the tray.

   Use a syringe to pull out the water and measure.

Materials

- ❏ Clear plastic shoe box (for each group) to make an erosion tray (or a seed tray)
- ❏ Syringes
- ❏ Spray bottles
- ❏ Sand
- ❏ Small rocks
- ❏ Piece of sod
- ❏ Journal or erosion log

B. Discovering erosion

1. Take the students on a walking field trip around the schoolyard. Look for evidence of erosion. Look especially where sand collects (e.g., around the swing set, at the edge of the playground, at the doors to the building).
2. Have them record their observations and explanations in a science log. Journal entry: How do eroded materials become part of soil? What has to happen to the sediments in order to support plant life?

Curriculum Integration

Math/Science—Measure volume using milliliters, liters, cups, pints, and quarts.

Possible Extensions/Adaptations/Integration

Study pictures of eroded land or fields. Students will identify the weathering agent and the force of erosion. Pictures such as these can be found on Surweb for Utah sites. Students could work together in cooperative groups to make posters about erosion.

Collect toy farm animals, trucks, tractors, etc. Using the erosion shoeboxes, have the students demonstrate ways that people cause erosion.

Assessment Suggestion

View the segment from “Dirt: Secrets in the Soil” video that shows the dust bowls in Utah. (Contact USU Extension at http://www.ext.usu.edu/aitc to order the video and binder of activities.)

Journal entry: How did the dust bowls in Utah affect the economy? Can that kind of erosion be prevented? Explain.

Additional Resources

Geology Rocks by Cindy Blobaum (Williamson Publishing Co.), 1999

“Dirt: Secrets in the Soil” by Debra Speilmaker (Utah State University)

SURWEB www.surweb.org/ Go to Media Shows. Choose Earth + Physical Science. Choose Geology. Choose “Erosion”

Homework & Family Connections

Find examples of erosion around the yard. Make a plan outlining how to stop the erosion (put in plants, arrange rocks, etc.).

Student Log

EROSION reshapes the Earth

Erosion means ____

____

Types of Erosion

Wind	
Rain	
Rivers	
Glaciers	
Gravity	
Animals	

List ways to prevent erosion. ____________________________________

____

____

Name________________________________

What is Erosion?

Question: What is EROSION?

Wind erosion

Describe what happens to the soil when you blow air across it.

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Place several rocks across the surface of the soil. Blow air across the soil. Do the rocks make a difference in how the soil is eroded? Explain and draw a diagram with labels.

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Water erosion

Raise one end of the erosion tray. Describe what happens to the soil when you sprinkle water on it.

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Can you see gullies forming? __________ Describe what they look like and how they are made.

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Place several rocks across the surface of the soil. Sprinkle water on it.

Does the presence of rocks change the way the water eroded the soil? Explain.

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What direction do the eroded materials travel in: uphill or downhill? ___________________

Does sod make a difference in how soil is eroded?

Repeat the wind and water experiments. This time place a chunk of sod on top of the soil. First blow air across the grass. Then sprinkle water on the sod. Write a statement that explains the difference in how soil is eroded when it has plants growing in it and when it does not have plants growing in it.

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Discovering *erosion* around the school.

Take a walk around your school playground and look for evidence of erosion. Look for where soil and sand could collect, such as around the swing set, at the edge of the playground, at the doors to the building, or around fence posts. Find bare patches in the grass. Find any hills—even small ones—and examine what is happening. Make a list of what you discovered.

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Are there any retaining walls to hold back soil? Where? ____________________

Explain the difference between weathering and erosion.

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Activity—What Is In Soil?

Standard III

Objective 3

Standard III Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.
Objective 3 Observe the basic components of soil and relate the components to plant growth.
Intended Learning Outcomes 2. Manifest scientific attitudes and interests. 4. Communicate effectively using science and language reasoning.

Connections

Background

Everything we have comes from the Earth or its elements. The most obvious things that come from the soil are the plants we eat. Trees also give us valuable lumber and the wood can also be used to make paper, paints, and numerous other products. Our animal food also comes from the soil. Cows eat grass, hay, silage, and grain to produce milk, meat, and leather products. Animals supply us with the by-products that are used in paints, camera film, pet food, rubber, crayons, lotions, soaps, medicines, etc. Fish live on insects, plants, and other animals that require dissolved minerals that are washed into the water from soil. Even natural gas, coal, and petroleum-based products (plastics are petroleum-based) come from organic material that grew on the earth ages ago. Minerals used for manufacturing are the parent material of soil. It is important that we recognize our dependence on soil.

Soil is made up of particles of rocks and minerals, dead plant and animal matter, tiny living organisms, gases (air), and water. The particles of rocks and minerals found in soil have broken away from larger pieces of rocks and minerals. Some particles are large chunks of rock and others are tiny mineral particles, which get dissolved by water in the soil.

Soil contains spaces filled with water and gases (air). Water soaks in the ground from rain (and other forms of precipitation). Gases come from the air, plants, and animals. Water in the soil makes minerals available for plants to use.

Soil also contains organisms. Living organisms (such as bacteria, fungi, insects, etc.) are an important part of soil. Living organisms break down nonliving organic plants and animals in the soil, which makes soil rich and healthy for plants to grow in.

Every soil consists of minerals, organic matter, water, and air. The proportions may vary but the following list is the average composition of the major soil ingredients: 45 percent minerals, 25 percent water, 25 percent air, 5 percent organic matter (both living and dead).

Invitation to Learn

Hold up a leather shoe to the class. Brainstorm with the class by asking: Where do you think this shoe came from? Where did it come from before it was there? Write all responses on the board. Try to lead the questioning until students recognize that the original source of the leather was in the soil. (shoe > store > shoe factory > leather > tannery > leather merchant > cow > grass > soil). Model the flow chart on the board or overhead. (You could have students record the flow chart for a leather shoe in their science journal.) Lead students to understanding that everything we eat, wear, build, etc, ultimately comes from soil. So let's see what is in our soil.

Instructional Procedures

***Part 1:* Looking for organic (living or once living) and inorganic material (nonliving).**

1. Give each student 1/4 cup of soil, plate, paper towel, lens, tweezers
2. Instruct them to use the hand lens to examine their soil. They are to look for organic matter (living and dead plants, insect parts, living insects) and non-living material (rocks and minerals). Have them make separate piles. They could put living insects in an insect view for better viewing and to contain them.
3. Students should record what they find in their logs.

***Part 2:* Water in the soil**

4. Have students place their soil on a paper towel. Fold it in half and gently press. Return the soil to the plate. Examine the towel. Ask them to describe the condition of the towel. They should observe that it is wet. Ask what ingredient was removed from the soil? (water)
5. Place one cup of damp soil in a container. Weigh it. Record weight in science log. Place soil in a sunny window. Weigh it after a few days. Record results and differences in weight. Discuss how much water was in the soil. How can they tell?

***Part 3:* Compacted vs. loose soil**

6. Put a cup of wet soil in a container with holes (sieve, can with nail holes punched in bottom). Use a spoon to compact the soil.
7. Ask the question, "Which holds more water– loose soil or compacted soil?"

Materials

- ❏ Scale
- ❏ Garden soil
- ❏ Hand lens
- ❏ Plates
- ❏ Paper towel
- ❏ Tweezers
- ❏ Insect viewers (optional)
- ❏ Measuring cups
- ❏ Containers for soil (preferably clear)
- ❏ Spoons
- ❏ Sieve or can with nail holes punched in bottom

8. Place a cup of soil in each of two containers. Pack the soil tightly in one container.
9. Using two separate measuring cup (filled with exactly 1 cup of water) slowly pour water slowly into each container until the soil won't hold any more and the water starts gathering on top.
10. Observe how much water is left in each measuring cup. Discuss which soil is holding more water. Discuss why plants do not do as well in compacted soil. Record results in log.

Part 4: Air in the soil

11. Give each group of students exactly one cup of loose soil. Have them pack it down as tightly as possible. What does the soil now measure? Ask them how they were able to pack it down? What is now not in the soil? (air)
12. With a spoon, loosen the soil so the top is again at the 1-cup line
13. Give the students another measuring cup of water. Have them pour it slowly into the soil until it starts collecting on the top. Observe the air bubbles rising up. Discuss why they see air bubbles. How much water is left in the measuring cup? How much water did you pour into the soil? How much air was in the soil before adding the water? How do you know? Where did the air go when you added the water? Why do we see lots of worms on the top of the soil after a big rainstorm? Answers to discussion questions should be recorded in science logs.
14. Discuss the soil pie. What percentage of soil is air? Have students convert the information from the pie graph to the mar graph.
15. Here is another way to show air in the soil. Have students loosely fill a measuring cup full of soil. Using a spoon, pack the soil down as tightly as possible. (Who can pack theirs down the most?) Examine the level of soil. Where does the top of the soil come to on the measuring cup? Ask the students if there is less soil. Why did the level go down? If no soil was removed, what was removed?

Curriculum Integration

Math/Science—Measure volume using milliliters, liter, cups, and pints. Measure weight using grams, kilograms, and pounds.

Possible Extensions/Adaptations/Integration

Brainstorm other objects that come from soil. Create flow charts that lead back to soil.

Additional Resources

Dirt by S. Tomecek (National Geographic)

Special project of Utah Agriculture in the Classroom in cooperation with Utah lStat

University Extension and Utah Foundation for Agriculture in the Classroom. 435-797-1657 www.agclassroom.org/ut. This is an excellent resource. It includes a video and lesson plans that align with the core.

SURWEB www.surweb.org/ Learning Segments: “Soil—Science”

Pioneer’s Online Library pioneer.uen.org/ Choose “Digital Curriculum” There is an excellent video called “Living Soil”

Video: “Earth's Crust - Rocks and Soil” Series in Bill Nye the Science Guy.M6535: Disney, 1995. In the rocks and soil section see how to make crystals, the three basic forms of rock and demonstrate how hot, molten magma could penetrate the Earth's layers through vents.

Name______________________________

What is in Soil?

Question: What is in soil? Soil Inventory

Use a hand lens and tweezers to examine a small sample of garden soil.

Look for: mineral matter - small pieces of rocks and minerals (the chunks you can't easily break) organic matter - leaves, sticks, insect parts (legs, antennas, etc.), living insects and worms

Make a list under each heading of what you found:

Living and Once Living Organisms   Nonliving (rocks and minerals)

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Water in the soil.

A. Place your soil sample on a paper towel. Fold the towel in half and gently press. Return your soil to its container. Examine the towel.
Describe the condition of the paper towel.______________________________
What ingredient did you remove from the soil?__________________________

B. Place a cup of wet in a container. Weigh it. Place it in a sunny window. Weigh it after a few days.

Date: ____________ Weight of wet soil sample ___________________

Date: ____________ Weight of dried out sample: ___________________

Difference in weight ___________________

How much water was in your soil sample? __________________________

Which holds more water - loose soil or compacted soil?

Materials: 2 cups soil, 2 containers, 2 cups water, 2 spoons

Procedure: Place a cup of soil in each container. Pack the soil tightly in one container.

Using separate measuring cups, pour water slowly into each container until the soil won't hold any more and the water starts gathering on top.

Which container of soil could hold more soil?

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What happened to the water in the container with the compacted soil?

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Why would plants not do as well in compacted soil?

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Name______________________________

Air in the Soil

Procedure:

Put 100 ml of sandy soil into a container. Measure 100 ml of water. Slowly pour the water into the soil until it is saturated - cannot hold anymore water. As soon as water starts collecting on top, stop pouring.

Did you notice air bubbles rising up from the soil? Explain why that would happen.

____

How much water is left in the measuring cup or beaker? ________________

How much water did you add to the soil? ______________________________

How much air was in the soil before you added the water? ______________

Where did the air go when you added the water?

____

We often see lots of worms on the top of the soil after a big rainstorm. Explain why.

____

Soil Pie. Components of Soil

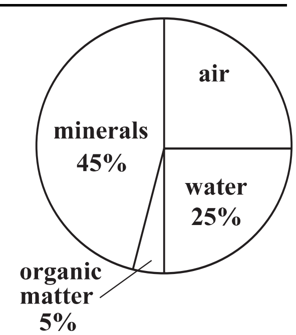
The pie graph at the right shows everything

that is in the average soil.

The numbers should equal 100 % (percent)

What percentage of the soil is air? ______

Convert the information from the pie graph to the bar graph below.



Minerals					
Water					
Air					
Organic Matter					
	0%	**25%**	**50%**	**75%**	**100%**

What percentage of soil is air and water? ______________________________

Which component of soil is the smallest percentage? ____________________

Which component of soil is the largest percentage? _____________________

Where does mineral matter in soil come from? __________________________

Where does organic matter in soil come from? __________________________

Name______________________________

Soil Shake

Put 4 inches of soil into a quart jar. Add water until the jar is 3/4 full.

Make sure the lid is on tight. Shake the jar vigorously for 2 minutes.

Set the jar down and let it settle for 1 minute.

Measure the amount of soil at the bottom of the jar.

After 1 minute: Measurement of bottom layer (sand) ________________________________

After 3-4 hours. Measurement of second layer (silt) ________________________________

After several days. Measurement of top layer (clay) ________________________________

Why do the largest particles settle firs? ____

Why do small sized particles settle last? ____

What is the stuff floating in the jar?____

How does your sample compare with the others.?____________________________________

____

____

Soil Textures

The mineral matter of all soils are made up of tiny particles (pieces) of rocks and minerals. Not all particles are the same size. There are 3 main kinds of mineral matter or soil.

They are sand, silt, and clay.

Rub each soil sample between your fingers - first a dry sample then a wet sample.

Record your observations below.

Traits of Mineral Matter

Type of Mineral Matter	Size Particles	Texture
sand		
silt		
clay		

These are the words you should be using to describe texture: : gritty, smooth and slick, stick

These are the measurements to describe particle size:

Biggest: 2.00-.05 mm Medium .05 -.002mm Smallest: less than .002 mm

Activity—Soil Profile

Standard III

Objective 3

Connections

Standard III
Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 3
Observe the basic components of soil and relate the components to plant growth.

Intended Learning Outcomes
4. Communicate effectively using science language and reasoning.

Background

A soil profile can consist of two or more layers. Most often a soil profile consists of four different layers known as horizons. Each layer may differ in thickness depending on where the soil is found. Each layer differs in color, texture, structure, consistency, and water absorbency. The characteristics of different soil determine what the soil is used for. Soil that is rich in organic materials and fairly water absorbent is good for growing plants.

A normal soil profile consists of three layers: topsoil, subsoil, and bedrock. Topsoil is the top layer. It is generally looser than the lower layers. It is made up of the smallest grains of rocks and minerals. The topsoil layer is usually darker in color because it contains the most dead and decayed organisms. These provide nutrients that plants need for growth. This is where plants can absorb water, nutrients and air. Subsoil is the layer below the topsoil. It is usually lighter in color because it has less living and once-living organisms. It is denser and grittier than the topsoil. It sometimes has larger rocks or pebbles mixed with small particles. Minerals in this layer are not easy for plants to use. Plants grow poorly in subsoil. Bedrock is the lowest layer or the solid rock that lies underneath the soil. It is the parent material from which much of the soil originally formed. Bedrock can be within a few inches of the surface or many feet below the surface.

Invitation to Learn

Show the students a picture of a road cut or construction site (photos can be found on the Surweb).

Instructional Procedures

1. Review with students what they observed in their soil samples in the activity "What Is In Soil?" Tell them that that is the kind of soil found on top. Record color, texture, and kinds of materials on their profile log (dark, loose, moist, full of organic material).
2. Give students samples of subsoil. Have them examine it with a hand lens. They should make comparisons. Record color, texture, and kinds of materials on their profile log (light color, denser, grittier – more stones and pebbles, little or no organic matter).
3. Give students samples of bedrock (stones or gravel).
4. Have students place gravel in bottom of jar. Then a layer of subsoil. On top place a layer of topsoil.
5. Students should draw their soil profile model and label the parts. Record characteristics and kinds of materials found in each layer.

Materials

- ❏ Jar (narrow with straight sides – spice jars work well and don't require as much material)
- ❏ Chunks of rocks (if using spice jars, gravel will work)
- ❏ Sample of soil from garden (or sample saved from "What Is In Soil?" Activity)
- ❏ Sample of soil from bottom of a big hole (perhaps at a construction site)

Possible Extensions/Adaptations/Integration

Soil Shake Activity as follows: The way a soil "feels" is called the soil texture. Soil texture depends on the amount of each size of particle in the soil. Sand, silt, and clay are names that describe the size of individual particles in the soil.

- Sand has the largest particles and they feel "gritty."
- Silt are medium-sized, and they feel soft, silky or "floury."
- Clay are the smallest sized particles, and they feel "sticky" and they are hard to squeeze.

Size comparison/Scale

Sand	2.00 - .05 mm	Would be the size of a barrel
Silt	.05 - .002 mm	Would be the size of a plate
Clay	< .002 mm	Would be the size of a coin in comparison to silt and sand

Activity

1. Place samples of each type of soil in small bowls. Invite students to use their fingers to feel and compare the textures of each.
2. Add water to the samples. Have students feel each sample. They should rinse their fingers between each test so as not to cross contaminate the samples.
3. Which soil holds water? Cut the top off of three 2-liter bottles. Invert the top and put inside the opening of the bottle. Line each inverted top with cheesecloth. Fill each top 1/2 full with a soil sample (clay in one, sand in another, silt in the third). Pour water over each soil sample. (Make sure it goes through the soil and does not spill over the edge.) Observe the speed the water goes through each sample. (It will pour through the sand. It will go more slowly through the silt. Very little may get through the clay.) When it dries, notice what happens to each sample. The sand is still loose. The silt sticks together but can easily be crumpled back into dust. The clay is hard. Show students a clay flowerpot.
4. Ask students why it would be important to know what kind of soil is in a garden. Tell them that one test that is done is called a soil shake. Put a sample of soil in a jar. Add water until 2/3 to 1/2 full. Shake for two minutes. Ask which particles would settle first and be on the bottom? (sand because it is the largest and heaviest) Which would be on top? (clay)

Additional Resources

The Amazing Earth Model Book: Easy-to-Make, Hand-on Models that Teach by D.M. Silver & P.J. Wynne (Scholastic Professional Books)

Name______________________________

Soil Profile: The Layers of Soil

Make your own soil profile.

Materials

a jar (such as a pickle jar)

chunks of rocks, sample of soil from the garden

sample of soil from the bottom of a big hole (perhaps at a construction site)

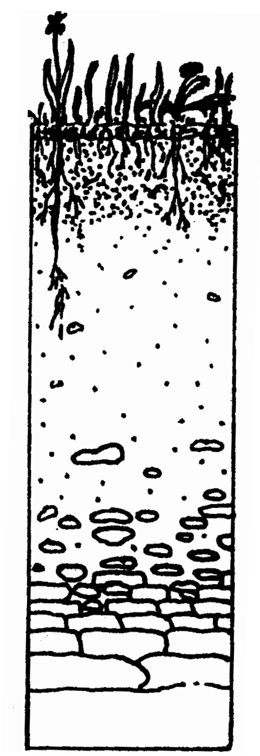
Procedure

Place large pieces of rocks and gravel in the bottom of your jar - (2 - 3 inches)

Pour 2 - 3 inches of subsoil on top of the rocks.

Place 1 - 2 inches of garden soil on top of the subsoil.

Label the parts of the soil profile below. Describe the traits of each layer. Tell what kinds of material are in each layer.



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Which layer of soil is the most important for plant growth?______________________________

Why is the topsoil darker than the other layers? ______________________________________

Which soil layer has the largest rocks? ____

About how thick is the layer of topsoil in most areas of Utah? ___________________________

About how many years does it take for nature to create one inch of new topsoil?_____________

Name______________________________

Soil Percolation

Percolation means how fast water runs through something such as soil.

Question: Which type of soil - sand, silt, or clay - percolates the fastest. That means they hold the least amount of water.

Hypothesis: ____

Experiment: Day 1

Materials:

3 two-liter bottles; cheesecloth; sample of sand, silt, and clay beaker, water

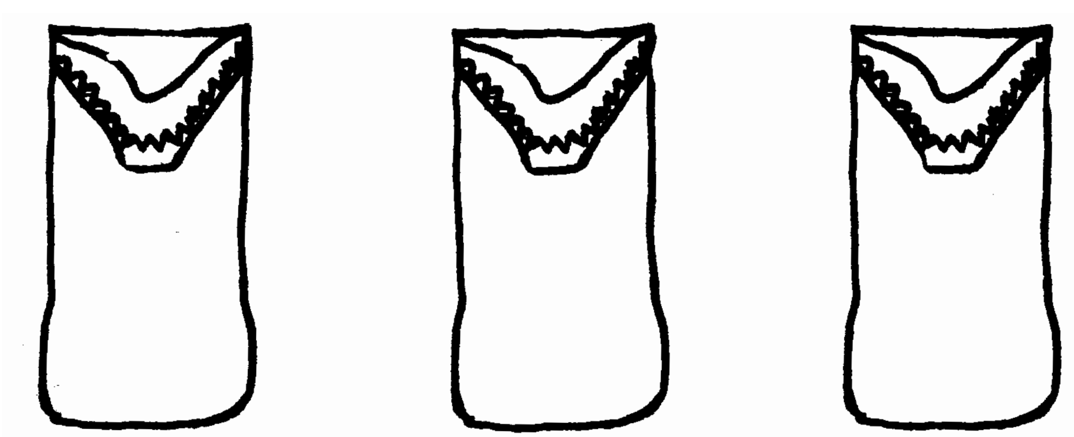
Procedure:

1. Cut the top part of each bottle off (just below the shoulder)
2. Turn the top upside down and fit it into the bottom of the bottle
3. Line the top with cheesecloth
4. Place 2 cups of each soil sample on the cheesecloth.
5. Pour 200 ml of water over each sample. Make sure it only goes through the soil sample - not around the edge
6. Measure how much water is in the bottom of each bottle

Results:

Draw what happens in the diagrams below. Under each bottle write how many ml of water percolated through the sample and dripped onto the bottom.

Sand Silt Clay



Conclusion: ____

Day 2.

Examine your percolating bottles from the day before.

A. Describe the condition of each soil sample. Include what happens when you pick up the soil.

a. The sand is ____

____

b. The silt is____

____

c. The clay is____

____

Which kind of soil dries out the fastest? ______________________

Which kind of soil dries out the slowest? ______________________

B. Applying what you learned to your garden

a. Every time you water the garden, the water seems to disappear. No matter how much you water your plants still look dry and thirsty.

What kind of soil do you probably have? __________________

Why would the plants be thirsty? Where did the water go? ______________________

____

What could you do to help solve this problem?__________________________________

____

b. When you water the garden the water seems to sit on top of the ground. You frequently have flooding. Despite all the water your plants still look dry and thirsty.

What kind of soil do you probably have? ____________________

Why would the plants be thirsty if they are standing in water?____________________

____

How could you solve this problem? ____

____

Activity—Plants in Soil

Standard III

Objective 3

Standard III Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.
Objective 3 Observe the basic components of soil and relate the components to plant growth.
Intended Learning Outcomes 1. Use science process and thinking skills. 2. Manifest science attitudes and interests.

Connections

Background

Plants are living things and have many of the same needs as humans. As plants grow, their development is influenced by light, water, mineral nutrients, and air. Plants absorb water and mineral nutrients through the plant's vascular system.

It is very important that you do not give students the impression that plants are "fed" from nutrients in the soil the same way a person is fed when they eat food. The "food" for plants comes from the air. The bulk of a plant's body is made from carbon dioxide from the air. Soil nutrients can be compared to a human taking a vitamin pill. You need the vitamin nutrients to stay healthy but the source of your energy and bodybuilding substances comes from somewhere else. In the case of plants, the bulk of nutrients come from air. A famous experiment showed that if you measure the weight of soil, plant an acorn seed, let it grow into a large tree, that the soil will only lose a very small amount of weight – nowhere near the weight of the tree. The weight of the tree came from the air and to a much smaller degree, water.

The reason hydroponics (growing plants in a water solution) is successful is that plants really don't need soil to grow. Soil helps plants to stay upright, provides mineral nutrients and stores water but it does not feed the plant. Plants will grow on paper towels or in a dish of water.

Invitation to Learn

Explain to the students that plants need water and nutrients from the soil to survive. Plants take in water and mineral nutrients from their roots through their stems. It is similar to drinking liquid from a straw. When plants take in water from the ground, they are also getting some of the nutrients they need from the soil. Tell students that only a small part of the plants' nutrients come from the soil. The largest part of plant nutrients comes from air. The nutrients in the soil are like "vitamin pills" for plants. There is a way to watch how water travels up the stems of plants using pieces of celery. The nutrients, which come from the soil, are dissolved in water and absorbed through a plant's roots. There are not always enough of these nutrients in the soil for a plant to grow healthy. This is why fertilizers are added to the soil to ensure the growth of plants.

(You could show the students a bottle of vitamins. The nutrients in the pills contribute to their health. But their body cannot grow and survive on just pills. People need to eat plant and animal material in order to grow. Plants do not "eat" the soil they grow in. They get their body-building food from the air.)

Instructional Procedures—Part 1

1. Fill a large bowl or basin with water.
2. Place the celery stalks in the water and use a knife to cut away the lowermost part of the stalk while it is under water. The cutting is done underwater so that air bubbles cannot enter the stem. Put the drinking glass in the bowl of water and transfer the celery stalk under water and into the glass.
3. Repeat procedure with second stalk of celery. Use a kitchen syringe to remove all but 3-4 cm of water in each of the glasses.
4. Add enough red food coloring to one glass to make the liquid very dark and save the other glass and celery stalk (the control example) to use for comparison later.
5. Assign students to write a hypothesis concerning what they thing will happen to the two celery examples and why.
6. Leave the stalks for several hours.
7. Check periodically until you can see evidence of color in the veins of the celery leaves.
8. Once you have detected the presence of the red food coloring in tips of the leaves of the experimental stalk, remove it from the water and place it on a cutting board.
9. Using a knife cut away approximately 3 cm from the lower end of the stalk.
10. Show the cut piece to the students and ask if they can see where the red food coloring has moved up the stem.
11. Continue to cut the stem in 3-cm pieces and follow the path of the colored water up the stem. Cut all the way up to the leaves.

Materials

- ❏ 2 fresh stalks of celery with leaves
- ❏ Bowl or basin
- ❏ 2 glass drinking glasses
- ❏ water
- ❏ knife to cut celery ends (for teacher use only)
- ❏ red food coloring (red is the best color to use for this activity)
- ❏ cooking syringe (baster)
- ❏ cutting board
- ❏ magnifying glasses
- ❏ science journals

12. Using a magnifying glass to examine the leaves, try to see where the water enters the veins of the leaves.
13. Cut the second piece of celery (the control example) and compare to the colored pieces of the cut celery. Students should write the results of the experiment using drawings and sentences. They should write their conclusion

Instructional Procedures—Part 2

Materials

- ❏ Seeds (bean or radish work well and grow quickly)
- ❏ Small bowls or other containers
- ❏ Various kinds of materials to use for structural support
- ❏ Student log or journal

Emphasize that plants do not need soil to grow. They use it for structural support. In other words, soil helps plants to stay upright. Soil is a medium for providing mineral nutrients and water but plants could obtain that without soil

Have students brainstorm different kinds of materials that plants could use for structural support. Some materials include floral foam, wet crumpled newspaper, wet gravel, paper towels, and cotton balls.

Have students design an experiment to show that plants grow without soil and to see what materials can be used for structural support.

1. Soak the seeds overnight.
2. Place seeds and growing medium in container.
3. Make sure medium is damp. Seeds need to be kept moist but should not sit in water.

   (Keeps seeds out of direct sunlight. They do not need it to sprout and the sun will hasten evaporation.)
4. Have students record all steps of the experiment in their log or journal

Curriculum Integration

Math/Science—Measuring to the nearest 1/4 inch

Possible Extensions/Adaptations/Integration

*Try this experiment using different types of white flowers to see which ones are the thirstiest.

- Make a multicolored flower by splitting the stalk of a white flower in two up the middle. Fill two glass containers with different-color dyes. Place 1/2 of the stalk in the one vase and one-half in the other.

- Using white carnation, create various bouquets for holidays using this method.
- Grow seeds under different conditions (temperature, light, heat, etc)

Homework & Family Connections

Raise sprouts for salad. Sprouting seeds can be found in many grocery stores and health-food stores. (Combinations of alfalfa and radish are tasty.) Soak one tablespoon of sprouts in water overnight. Drain and put in a one-quart jar. Cover the top with a piece of mesh or cheesecloth fastened with a rubber band. Turn upside down. Rinse sprouts twice a day. Sprouts will be ready to eat in 4-5 days. Keep them out of the sun.

Name______________________________

Observing the upward movement of water and mineral nutrients in a plant

Plants are living things and have many of the same needs as people do. As plants grow, their development is influenced by light, water, mineral nutrients, temperature, and air.

Plants, however, get their food in a very different way from people. People get their food by eating plants and animals. Plants get their food from certain gasses (dioxides) in the air. Plants absorb water and mineral nutrients through their roots and stem system. But that is like people who drink water and take vitamin pills. Plants are able to grow and get big – not from the minerals in the soil but from the air.

A famous experiment proved this. Scientists weighed an acorn and the soil it was planted in. The acorn grew into a large tree. The scientists weighed the soil and tree. The soil basically weighed the same. The plant got its weight from the air and sunlight. The water with the soil minerals helps plants stay healthy but plants can grow without soil. Soil provides minerals and stores water for plants to use. But soil does not feed plants.

Soil provides structural support for plants. In other words, soil helps plants stay upright.

Plants can grow without soil as long as they have something for their roots to hold onto and can get water.

Part 1

You can observe water nutrients traveling up the stems of plants using celery stalks. The celery sticks will be put into a glass with red food coloring. When you see red in the leaves it will be time to examine the celery stick. You will use a hand lens to help you see the path of the red food coloring as it moved up the stem. Examine the leaves and try to see where the colored water enters the veins of the leaves.

Record the results of this experiment by drawing pictures of the celery. Use a red crayon or pencil to show the path the water took. Use labels on your diagram.

Part 2: Research ways to grow plants without soil

Remember that plants do not need soil to grow. They need something for their roots to hang on to. And they do need water and the nutrient minerals that are usually found in the soil. If you put fertilizer in water and provide structural support (something for the plants roots to hang on to) the plants will grow fine.

Some structural support materials might include wet gravel, paper towels crunched up, cotton balls, or floral foam from a flower shop. Can you think of other materials?

My question is: Will plants grow in ______________________________

My hypothesis is: ____

My experiment to prove my hypothesis:

Materials:

The kind of seeds I planted: ______________________

The kind of material I used for structural support: _________________________

Procedure: These are the steps I took:

____

____

____

____

____

Results: This is what happened.

(Record which days you observed your plants. Write a statement telling how big your plant is and what it looks like – how many leaves, what color, etc)

Day	**Height**	**Appearance**

Conclusion: Write a statement that answers your question. You might add other facts that you learned.

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Science
Standard IV
Activities

Activity—Mold and Cast Fossil Formation

Standard IV
Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Objective 1
Describe Utah fossils and explain how they were formed.

Intended Learning Outcomes
1. Use science process and thinking skills.

Standard IV

Objective 1

Connections

Background Information

When an organism dies and is covered by sediments, the process of decomposition may be slowed. As the sediment particles are cemented together and begin to harden on the way to becoming rock, the original remains may decay completely. The cavity or hole left in the rock will retain the shape of the organism that has decayed away, and is called a mold. If this cavity later fills with minerals, it produces a fossil called a cast which physically looks like the original organism.

Invitation to Learn

Ask students, "How are fossils formed?" Check for understanding of what may be a fossil, and how different kinds of fossils may be formed. (See the attached "FOSSILS" glossary for more information about fossils and how they are formed.)

Instructional Procedures

1. Explain how mold and cast processes form fossils. Tell them that they can make a "fossil" using this process.
2. Have each student choose a piece of clay, a shell from which to make a mold, a plastic cup with powdered plaster of paris, and a craft stick.
3. Flatten the clay into a circle that is about 6 cm in diameter and 1.5 cm thick.
4. Press the shell into the clay to make an impression that can be used as a mold.

   Add water to the plaster of paris and stir with the craft stick. When the plaster of paris has the consistency of a thick milkshake, pour it into the mold. Mark your initials in the clay and set it aside for the plaster to harden. (Take the "fossil" home at the end of the day.)

Materials

- ❏ stick of modeling clay for each student
- ❏ 1 seashell selected by each student
- ❏ 1 plastic cup and a craft stick for each student
- ❏ Plaster of paris
- ❏ water

Possible Extensions/Adaptations

Have the students compare the "fossil" they made to the shell that was the source of the mold. How closely do they match?

Assessment Suggestion

Have students write a paragraph describing how fossils are formed through the mold and cast process.

Additional Resources

See the Additional Resources list at the end of this set of activities.

Homework & Family Connections

Send clay and plaster of paris home with students. Have them explain mold and cast fossil making to their family members. The student may select another object to make a mold and cast "fossil" to show how it is done. Bring back the homemade "fossil."

Fossils Glossary

Amber: fossilized tree sap from evergreen trees. It may or may not contain the remains of insects or other Arthropods.

Carbon Imprint: very thin objects such as leaves, feathers, and fish, which may be compressed between rock layers until only the carbon of the cells remain as an imprint.

Cast: a solid formed when a mold fills with minerals which hardens in the same shape as the original organism.

Fossils: the remains or other evidence of a once-living organism.

Freezing: whole organisms have been found frozen below the permafrost line in the Arctic, such as Mammoths.

Mold: the empty space left in a rock where an organism was trapped and decomposed. The space has the exact shape of the decomposed organism.

Paleontologist: a person who studies fossils.

Paleontology: the study of fossils.

Petrification: when minerals have replaced each cell of an organism, thereby turning it into a rock.

Tar Pits: animals have been trapped in pools of soft tar and preserved as fossils. For example, the LaBrea Tar Pits in California.

Trace Fossils:

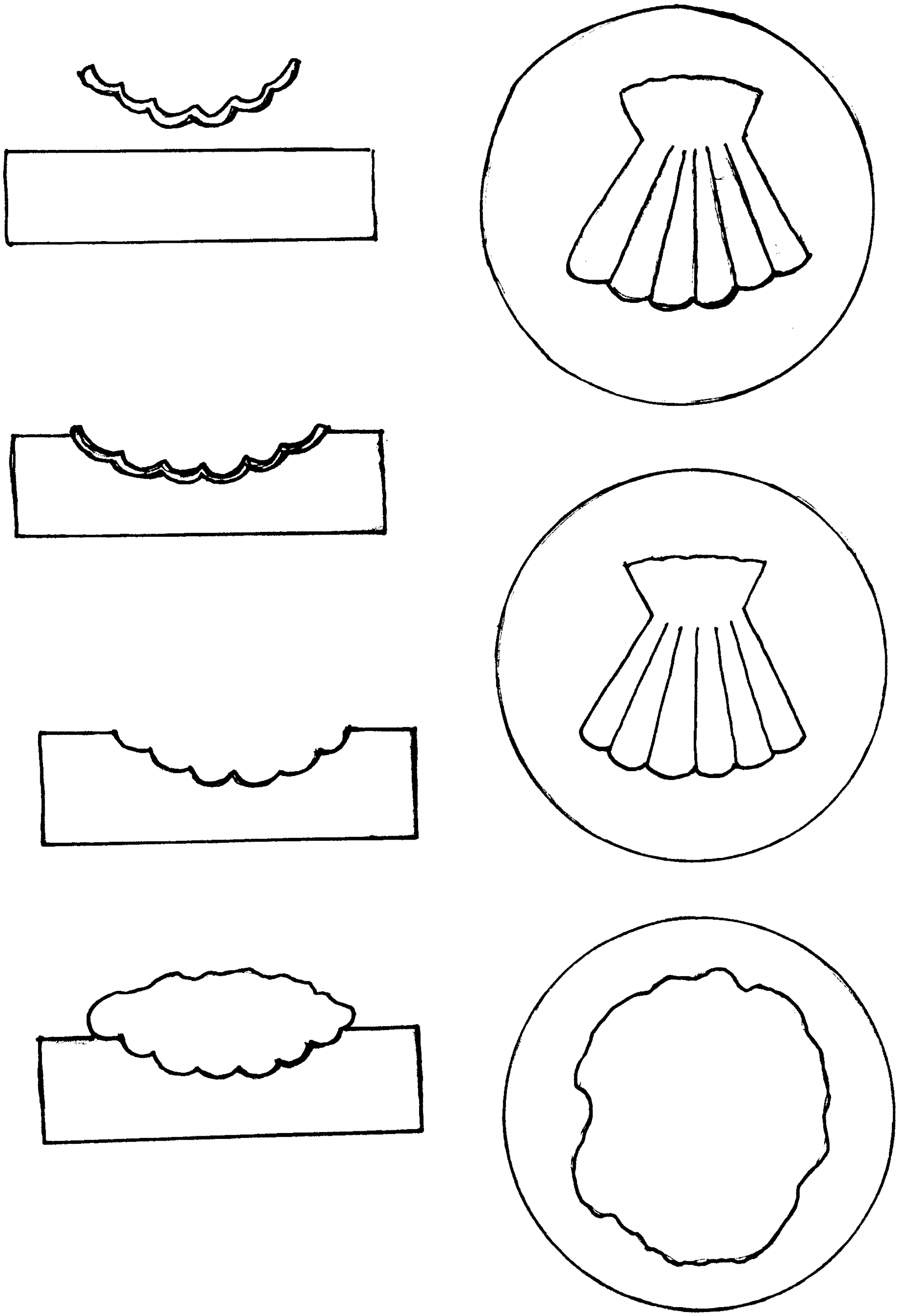
A. *Dinosaur Tracks:* footprints made in mud and preserved when the mud turns to stone.

B. *Gastroliths:* polished stones used to grind food inside dinosaur gizzards.

C. *Fossilized Eggs and Eggshells:* one was found in Utah that contained an identifiable embryo.

D. *Coprolites:* fossilized animal dung.

Creating a Fossil



Activity—Making a Geological Timeline

Standard IV
Students will understand how fossils are formed, where they are found in Utah, and how they can be used to make inferences.

Objective 2
Explain how fossils can be used to make inferences about past life, climate, geology, and environments.

Intended Learning Outcomes
1. Use process and thinking skills

Standard IV

Objective 2

Connections

Background Information

Many kinds of fossils appear in various parts of Utah. By creating a geological timeline, we can infer what the environmental history different parts of the state could have been. Because some fossils come from sea animals, we can infer that at one time, a shallow sea once covered the area where those fossils were found. Because other types of fossils are associated with tropical swampy areas, we may infer that those areas were once warm and wet. By knowing the time period that representative animals lived on the earth, we can infer when a sea or tropical swamp existed in a particular area.

As we look at the timeline, scientists have determined when certain animals lived. For example, trilobites first appeared 600,000,000 years ago and lived for a period of about 100,000,000 years. Trilobites lived in shallow seas. Fossil trilobites are found in Millard County, Utah. It is therefore possible to infer that at sometime between 600,000,000 years ago and 500,000,000 years ago, a shallow ocean covered that area of Utah.

By constructing a timeline of when various plants and animals lived and then comparing it to sites in Utah where those fossils are found, we can learn how inferences are made about the geological past of areas of the state.

Invitation to Learn

What can you learn about the history of Utah by examining the fossils that are found in those areas?

Materials

- ❏ meter stick for each team
- ❏ Rolls of adding machine tape
- ❏ Masking tape
- ❏ metric ruler for each team
- ❏ Geological Timeline information sheet for each student
- ❏ set of fine line markers for each team
- ❏ Utah map with fossil dig sites marked

Instructional Procedures

1. Have each team select a person to get the materials.
2. Give each team a five-meter-long piece of adding machine tape, a meter stick, a metric ruler, a set of fine line markers, and a roll of masking tape.
3. Give each student a Geologic Timeline information sheet and a map of Utah with fossil dig sites.
4. Pull the adding machine tape out so that it lays flat on a surface (across tables set end-to-end, the floor, or a counter top).
5. Using masking tape, tape the ends of the adding machine tape to the surface so that it doesn't roll up. Use a meter stick to measure distances on the adding machine tape.
6. Using the metric ruler, draw a line across the adding machine tape near one end. Label the line "Present Day." Using this as the baseline, measure the distances on the tape to the important dates listed on the Geological Timeline information sheet. (One meter equals one billion years; a millimeter equals one million years.)
7. Once the distances have been marked, draw lines across the tape at the measured distances and label them. (See the attached sheet for an example). Small pictures may be glued to the tape corresponding to the important dates.

Curriculum Integration

Math/Science—Metric measurement, drawing to scale.

Possible Extensions/Adaptations

Associate the fossils on the geologic timeline with fossil sites on the Utah map. From the dates and types of fossils, infer what the area where the fossils were found might have looked like when the organism was living there (i.e., Jungle, forest, ocean, marsh, etc.).

Assessment Suggestion

Give the students the name of a type of fossil and the part of the state in which it was found. Have them write a one-paragraph description of what that area of the state might have looked like when that organism lived there.

Additional Resources

See the attached Additional Resources list.

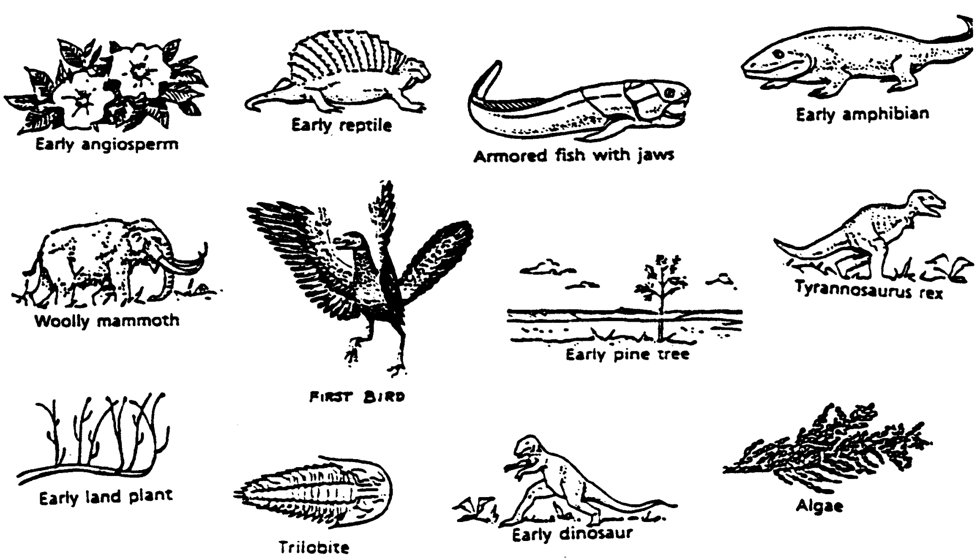
Homework & Family Connections

Parents can help students add to the fossil sites on the Utah map. A good family excursion would be to go to the “U-DIG” fossil quarry site west of Delta Utah and spend some time digging for fossil trilobites. (See the additional resources list for a web site where information about this opportunity can be found.) Visit any of the fossil sites that are open to the public.

Geologic Timeline Information Sheet

Using adding machine tape and meter sticks, make a timeline to demonstrate how life developed on Earth. Let one meter equal one billion years. Draw a line across one end of the tape and label it "present day." Every measurement made on the timeline should begin at the line marked "present day"! Measure from this line and mark the following distances by drawing a line across the tape.

3mm	first humans	3,000,000 years ago
4cm	first elephants	40,000,000 years ago
6.5 cm	dinosaurs die out	65,000,000 years ago
13.5 cm	flowering plants appear	135,000,000 years ago
16 cm	first birds appear	160,000,000 years ago
22.5 cm	first dinosaurs appear	225,000,000 years ago
27 cm	first coniferous plants	270,000,000 years ago
30.5 cm	first reptiles appear	305,000,000 years ago
40 cm	first amphibians	400,000,000 years ago
44 cm	first land plants	440,000,000 years ago
50 cm	first fish appear	500,000,000 years ago
60 cm	first trilobites appear	600,000,000 years ago
1.2 M	first animals	1,200,000,000 years ago
3.2 M	first plants (algae)	3,2000,000,000 years ago
4.5 M	oldest Earth rocks	4,500,000,000 years ago



Sample of a Geologic Timeline

Present Day

First Humans

First Elephants

Dinosaurs Die Out

Flowering Plants Appear

First Birds Appear

First Dinosaurs Appear

Activity—Digging for Fossils

Standard IV

Objective 1

Connections

Standard IV
Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Objective 1
Describe Utah fossils and explain how they were formed.

Intended Learning Outcomes
1. Use science process and thinking skills.
4. Communicate effectively using science language and reasoning.

Background Information

This activity is the result of a weeklong field experience with nine other teachers and the paleontologists from Brigham Young University working at the Dry Mesa, Colorado dinosaur quarry. While there, we had the opportunity to learn and use some basic skills in finding fossils. We learned about the care that must be taken in excavating and preserving the fossils that were found. We also learned that the exact location where each fossil that was found needed to be carefully entered on a map of the quarry. A grid system for establishing the location of fossils was set up with surveyed stakes and ropes. Before a prepared fossil could be moved from the site where it was found, it had to be entered on the map. Each of us had the opportunity to work side-by-side with professional paleontologists using the same tools and equipment to remove fossil specimens from sandstone. Each of the teachers made fossil discoveries of their own, from an allosaurus tooth to a brachiosaurus femur.

The challenge was to make this experience into a hands-on unit that could be shared with students in the classroom. Because the activity is based on digging for "fossils," it was necessary to develop a dinosaur dig that could be done in the classroom. The search for a box to house the "digs" turned up in the school lunch program a box used to ship frozen corn dogs. The box has a lid than can be folded back to allow students to work inside. (See the attached drawing.) These boxes filled with coarse sand to a depth of about eight centimeters provide an excellent place to dig for "fossil" bones. The bones used in the box are specially prepared turkey bones and rodent bones. (See the instructions for preparing fossil dig boxes.)

A grid is set up in the dig for mapping purposes by stretching string between brass fasteners at the front and the back of the box, and from end to end of the box. Students receive an 81/2x11 inch piece of paper with a grid drawn on it which they label and use to "map the dig." No bone may be taken from the dig until its position has been plotted and drawn on the map.

Invitation to Learn

What is it like to work in a fossil dig? What do paleontologists do to help them see the relationships between the fossils they are digging?

Instructional Procedures

1. Organize participants into cooperative teams of four.
2. Teams will prepare to map their "fossil dig" by labeling their 2" x 2" grid paper to match the grid on the dig box (journaling).
3. Once the "map" is ready, each team will open their dig box – remove the paper plate, spoon, fork, and brush and set them beside the box.
4. Set up a grid across the top of the dig box by stretching the string between the brass fasteners.
5. Students will take turns digging for bones, charting on the map where each bone is found, labeling each bone, and placing the labeled bones on the paper plate.
6. The spoon, fork, and brush may be used as tools for digging up bones. Be sure that the students are aware that there are large bones and small bones in the box, and that they need to dig carefully to find the ones.
7. No bone may be removed from the "dig" until its position has been plotted and drawn on the map and given an identification number.
8. Digging will continue until each participant has found at least two bones. (The bones from the dig will be saved on the plate along with the map to be used in the next activity.)

Materials

❏ Previously prepared "dinosaur dig" boxes

Heavy paper plates

Plastic spoons and forks

1 inch wide paint brushes

81/2 x 11 inch paper with a 2" x 2" grid

Pencils

1" x1" sticky notes

Curriculum Integration

Math/Science—Using coordinates to plot positions on a map.

Additional Resources

See the attached Additional Resources list.

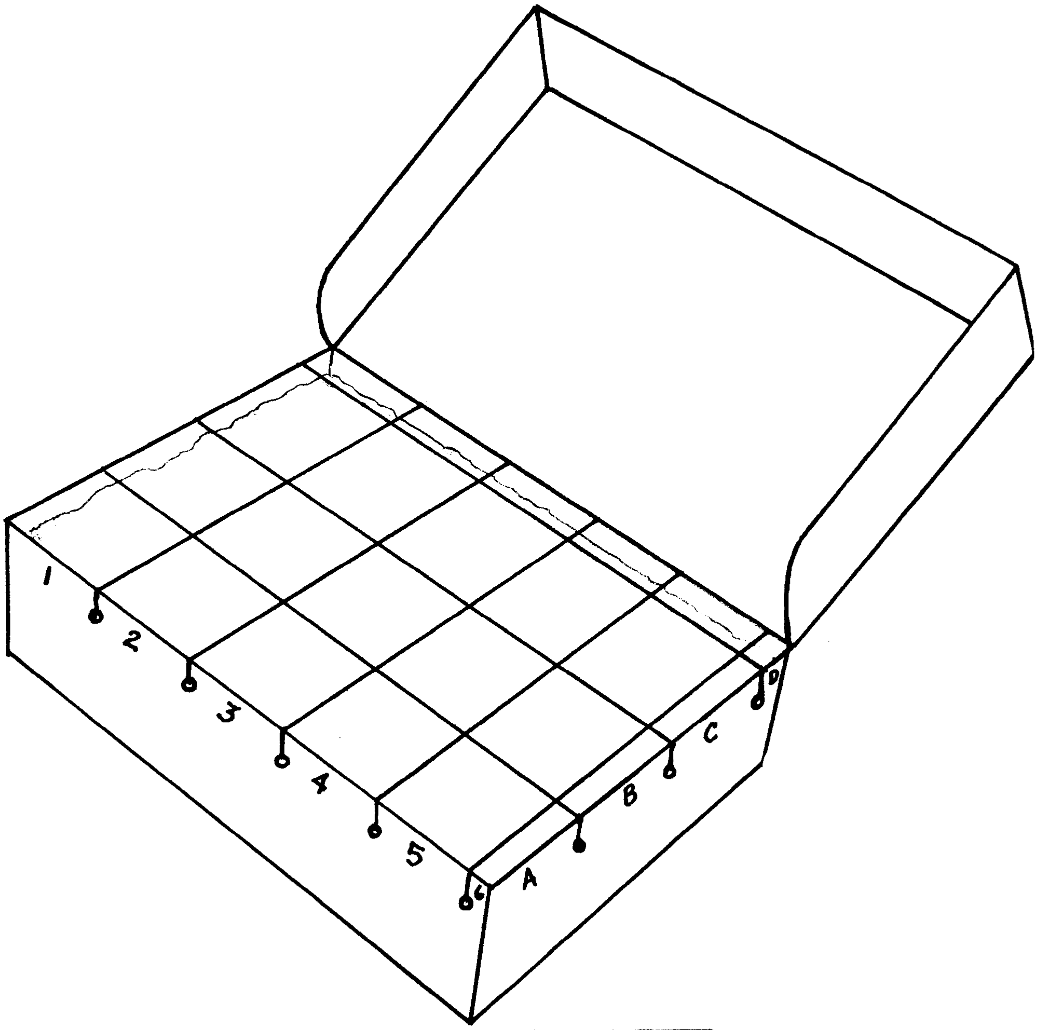
Family Connections

Share a variety of options for teachers to explore and use.

Preparing Fossil Dig Boxes

1. Obtain boxes. Ideal boxes for fossil digs are the boxes frozen corn dogs are shipped in. You may obtain some from the lunch program at your school. These boxes are 42 cm long, 28 cm wide, and 13 cm deep. They have an attached lid that can be folded back to allow students to work inside (see drawing).
2. Fill 8 cm of each box with coarse cement sand. This provides an excellent place to dig for "fossil" bones.
3. Find something to use for "fossil" bones. Leftover turkey bones from thanksgiving dinner work exceptionally well as larger fossils. Boil the bones until all traces of fat and tissue are removed. With the connective tissue gone, the bones separate nicely to provide many individual bones with which to work.
4. Place the bones on a cookie sheet and bake them for two hours in the oven at 110 C. until they are completely dry and germ-free.
5. Divide the bones between ten sand boxes.
6. For smaller "fossils," disassemble barn owl pellets, which can be obtained from a commercial science supply house. Each pellet should provide enough small rodent bones for one of the dig boxes, including one or more rodent skulls. The small bones force the students to search slowly and carefully through the sand so that none are missed.
7. Bury the bones in the sand and prepare to watch your students get excited about digging for "fossils."
8. Name each of the boxes after a Fossil Dig Site in Utah.
9. Use brass fasteners and heavy string to form an 8x8-cm grid across the top of the box. As students locate a bone, they can use the grid to locate the map coordinates to show where each bone is found.
10. Across the front of the box, label the spaces 1 – 6. Across the side of the box, label the spaces A – D. (Once again see the attached drawing of the box.)
11. You now have created fossil dig cites you can use with students to help them understand how paleontologists work. Talk to the students about how the relationships of bones to each other in the dig may give them clues to make inferences about the interrelationships of the animals.
12. Place a heavy-duty paper plate in each box with a plastic spoon, plastic fork, and an inch-wide paintbrush. These are the digging tools students will use to extract bones from the boxes. When the bones have been assigned a number and mapped on the grid sheet, use a 1" x 1" sticky note to label and number each bone.

Fossil Dig Boxes



1	2	3	4	5	6
					D
					C
					B
					A

Activity—Bone Identification

Standard IV

Objective 1

Standard IV
Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Objective 1
Describe Utah fossils and explain how they were formed.

Intended Learning Outcomes
1. Use science process and thinking skills.
4. Communicate effectively using science language and reasoning.

Connections

Background Information

Once students have dug the "fossil" bones, mapped and labeled them, they have the opportunity to do another part of the objectives for this standard. They may now compare the bones to the bone structure of living organisms. Students will identify what part of the animal the bones that they found came from by comparing them with bone structure charts for mammals, reptiles, and birds.

As they identify ribs, femurs, skulls, etc., they need to be able to explain why they identified them as they did. What is it about the appearance of the bone that made them identify it as they did? (The bones are from modern animals and the identification should be fairly easy, but they will have to make good observations and be able to explain them.)

Invitation to Learn

You have collected bones from your fossil dig box. What kind of animal do you think they came from? Can you tell what part of the animal your bones came from?

Instructional Procedures

Materials

- ❏ Bones taken from the fossil dig boxes
- ❏ Mammal bone structure chart
- ❏ Reptile bone structure chart
- ❏ Bird bone structure chart

1. Have the same teams that worked together on the Digging for Fossils Activity work together on bone identification.
2. Give each team a mammal, reptile, and bird bone structure chart. The team will work together to identify the type of bones and what part of the animal they came from.
3. The team will write a one-sentence explanation for each of the bones that they identify and give the reasons for their identification.

Possible Extensions/Adaptations

Place copies of the book Fossils by Walker and Ward on a table with some real fossils. Have the students use the pictures in the book to identify the fossils. The book contains a fossil identification key and a visual guide (photographs) to more than 500 species of fossils from around the world.

Assessment Suggestions

Read the identification sentences and check for thinking that went into making the identifications. Were the reasons for making the identification valid?

Set up a matching test – have students match pictures of bones with bones shown on bone identification charts.

Additional Resources

See the attached Additional Resources list.

THE LOCOMOTOR SKELETON.

MAIN MOTION.
ROTATION A
FLEXION B/EXTENSION B'

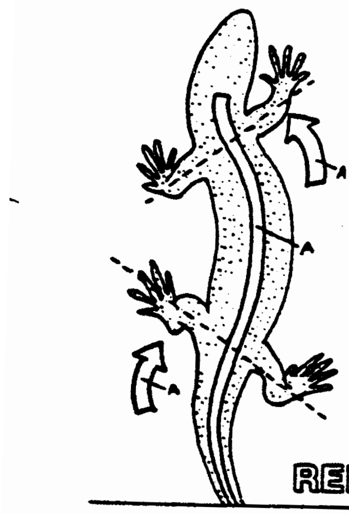
APPENDICULAR SKELETON.

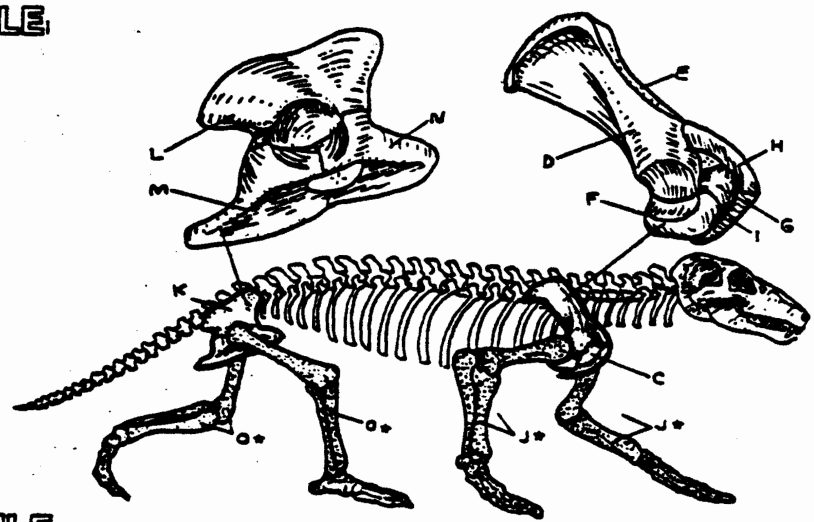
PECTORAL GIRDLE C
SCAPULA D
CLEITHRUM E
CORACOID F
PROCORACOID G
CLAVICLE H
INTERCLAVICLE I

BONES OF THE FORELIMB J*

PELVIC GIRDLE K
INNOMINATE*
ILIUM L
ISCHIUM M
PUBIS N

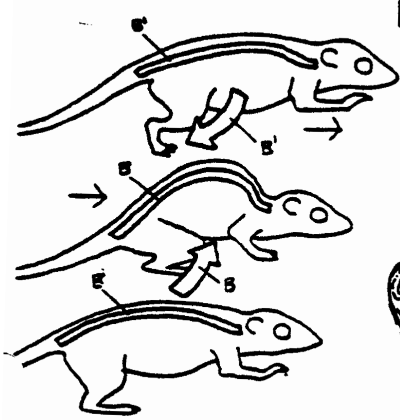
BONES OF THE HIND LIMB O*

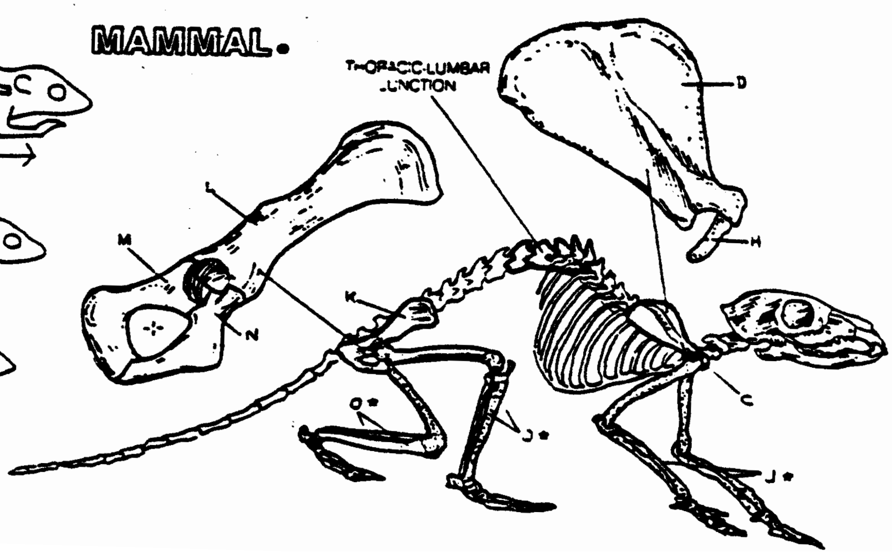




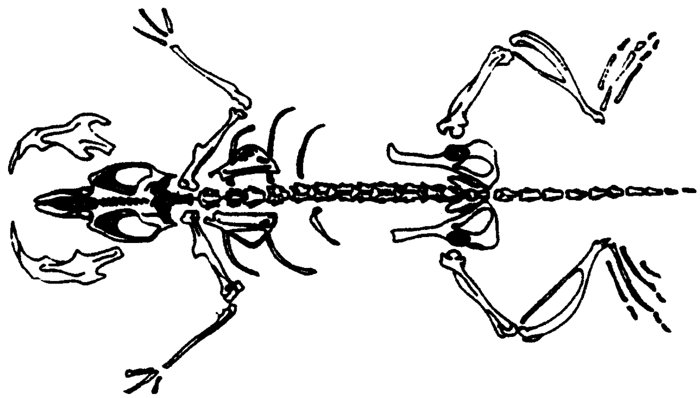
REPTILE.

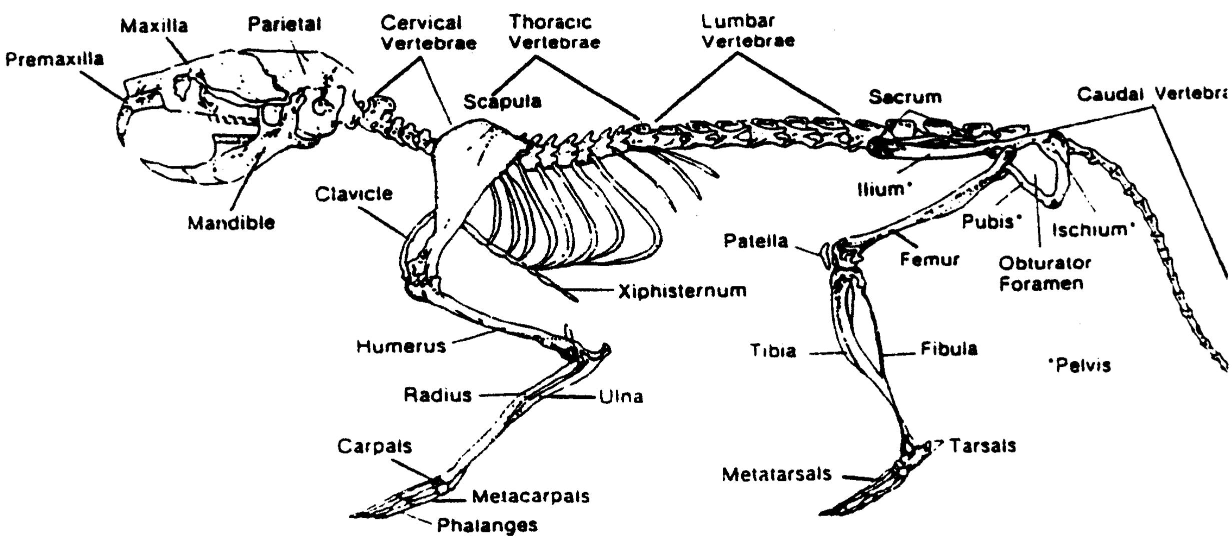
MAMMAL.





Rodent Skeleton





Activity—Interpreting Dinosaur Tracks

Standard IV

Objective 1

Standard IV
Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Objective 1
Describe Utah fossils and explain how they were formed.

Intended Learning Outcomes
1. Use science process and thinking skills.
4. Communicate effectively using science language and reasoning.

Connections

Background Information

Dinosaur tracks are one type of fossil that has recently received attention in Utah. Near St. George on a ten-acre section of the Johnson Farm, over 1,000 dinosaur tracks have been found. According to the Utah Outdoors article by Dave Webb on the internet, "Most of the tracks are actually 'negative impression' casts which appear as bumps on the stone. The area was the bottom of an ancient freshwater lake in the center of the super-continent Pangea. Footprints left in the mud filled with silt and sand, and more sand was deposited over the top. The mixture eventually solidified into sandstone and mudstone, forming the casts. Now when the slabs are flipped over, the casts appear, much like Jell-O popping out of a mold." Scientists have determined that most of the tracks were made by "dilophosaurus-like" animals and are three toed, 13-18 inches long. Some smaller tracks have been found along with skin prints and tail drag impressions.

For more information on the Johnson Farm Dinosaur Walkway go to http://utahoutdoors.com/pages/dinowalkway.htm. How fossil dinosaur tracks are formed in sedimentary rock is one of the concepts to be taught as part of Standard IV.

With this background information to set the stage, we would propose to do an activity where students interpret what they think happened based on sets of dinosaur tracks.

Invitation to Learn

What inferences or interpretations can be made from sets of dinosaur tracks in sandstone?

Instructional procedures

1. Give each student a dinosaur track sheet and lined paper.
2. Have each student study the “dinosaur tracks” and develop an explanation of what happened at the time the tracks were made.
3. Have each student infer in story form on the lined paper what they think took place as these tracks were made. Each must support the inferences they make by telling how they reached that conclusion.

Materials

- ❏ 8.5 x 11" sheet of paper with drawings of dinosaur tracks for each student. (See the attached drawing.)
- ❏ Lined paper for the students to write their interpretation of what happened based on the tracks.

Possible Extensions/Adaptations

Students may be paired or placed in teams to give those who have difficulty writing an opportunity to verbalize their ideas.

Some students may want to create their own dinosaur track sheet and then see if another student can interpret the story of the tracks.

Assessment Suggestion

In this activity, it is not whether the student is wrong or right about what happened that is important. It is the science process and thinking skills that go into developing an interpretation of the tracks that is important. Look to see how they used the data (dinosaur tracks) to construct a reasonable conclusion.

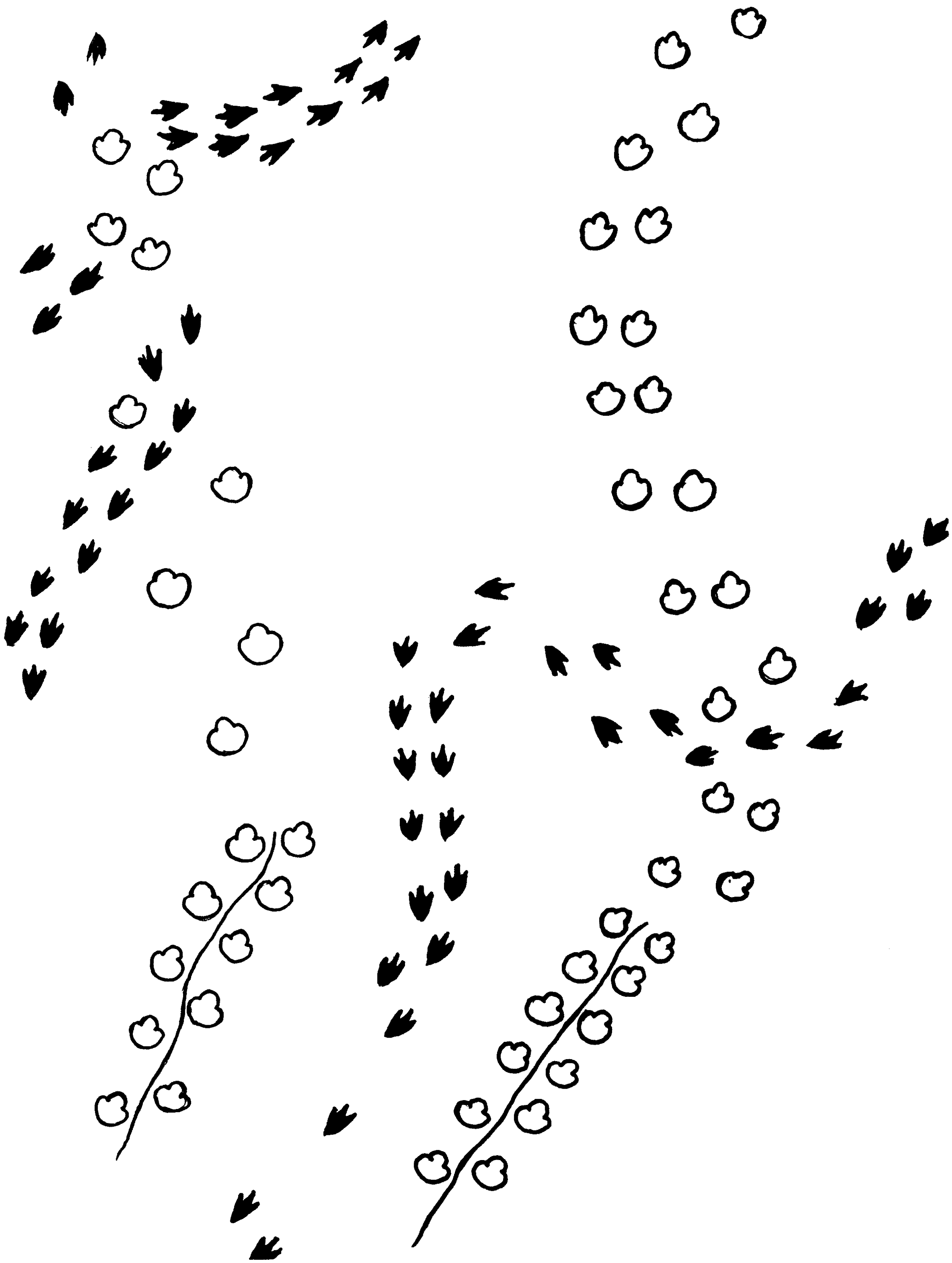
Additional Resources

See the attached Additional Resources.

Homework and Family Connections

Allow the students to take home a copy of the “Dinosaur Tracks” sheet. Encourage them to tell members of their family their interpretation of the tracks. They in turn may ask family members to come up with a different interpretation of the tracks.

Dinosaur Tracks



Activity—Preparing a Fish Fossil

Standard IV
Students will understand how fossils are formed, where they may be found in Utah, and how they can be used to make inferences.

Objective 1
Describe Utah fossils and explain how they were formed.

Intended Learning Outcomes
1. Use science process and thinking skills.
4. Communicate effectively using science language and reasoning.

Standard IV

Objective 1

Connections

Background Information

It is best to have real fossils in the classroom for students to see and touch. It is also desirable for a teacher to have the experience of cleaning and preparing a fossil for display, so they may explain the process to their students. With this in mind, a piece of shale containing a fish fossil will be given to each fourth grade teacher who attends the summer science academy. Tools and instructions will be provided for them to begin to expose their fish fossil from the shale matrix in which it is found. In the short time we will have to work on this in the Academy, we will only begin to scratch the surface (ha ha!) of exposing the fossil. From there, the participant will take the fossil home to complete the preparation.

The fish fossil that we will be working on lived in a lake in what is now southwestern Wyoming between 60,000,000 and 55,000,000 years ago. The lake was in an area with mountain barriers to the north and south. The size of the lake is estimated to have been 15 miles wide and 60 miles long. Because of the lake's depth, something which other Eocene lakes lacked, this lake has produced some of the most perfect fossil specimens in the world. The record of the lake is exposed in strata that are near 300 feet thick, and composed mainly of calcareous shale. The fish that died settled to the sediments on the bottom of the lake, and were covered with additional sedimentary materials. The deposits were cemented and compacted over a period of 50 million years. The resulting fossils of fish have become carbon imprints. The fossils are very thin and require patience and careful work to expose them without doing damage.

Invitation to Learn

Why must paleontologists work very carefully as they prepare fossil specimens for display? How would you like to have the opportunity to prepare a fossil specimen?

Materials

For each participant:

- ❏ Piece of shale that contains a fish fossil
- ❏ Testing needle
- ❏ Small, soft brush
- ❏ Art gum eraser
- ❏ Instruction sheet for preparing fish fossils

Instructional Procedures

1. Give each participant a bagged set of materials to prepare a fish fossil.
2. Caution the participants that the fish fossils are thin and fragile. Tell them to work carefully and patiently.
3. Read and follow the printed instructions that accompany the shale.

Possible Extensions/Adaptations

Fossil shale is available from:

Ulrich's Fossil Fish Gallery, Fossil Station #308, Kemmerer, Wyoming 83101, Phone (307) 877-6466, Fax (307) 877-3289

You can request a price list an information packet. Fossil shale specimens are not cheap. In quantities of six or more, "B" kits are $9.50 each and "A" kits are $15.50 each. If funds were available, this would be a way to encourage students to have an interest in geology or paleontology.

Assessment Suggestion

Assess the students' fully-prepared display of the fossil fish specimen.

Additional Resources

See attached resources list.

Homework & Family Connections

Give the Ulrich Fish Fossil Gallery information to parents and students.

Additional Resources

Books

Kappele, William A.; Rockhounding Utah, A Falcon Guide; Falcon Press Publishing Co., Inc.; Helena, Montana, 1996. ISBN 1-56044-446-0
(A good source for fossil sites in Utah where amateur fossil hunters may legally collect fossils.)

McFall, Russell P. and Wollin, Jay C.; Fossils for Amateurs, Revised Edition, Van Nostrand Reinhold Co., New York, N.Y., 1983. ISBN 0-442-26350-3

Parker, Steve; Dinosaurs and How They Lived, Dorling Kindersley Inc., New York, New York, 1991. ISBN 1-879431-13-0

Visual Dictionary of Dinosaurs, The; Dorling Kindersley Inc., New York, New York, 1993. ISBN 1-56458-188-8

Visual Dictionary of Prehistoric Life, The; DK Publishing Inc., New York, New York, 1995. ISBN 1-56458-859-9

Walker, Cyril and Ward, David; Fossils; An Eyewitness Handbooks; Dorling Kindersley Inc.; New York, New York, 1992. ISBN 1-56458-071-7
(A personal favorite for easy to understand information about fossils and how they were formed.)

Internet Information Sources:

I did a search on the internet for "Maps Utah Fossil Sites" and found 828 web sites that contained information about Fossils. I have only looked at about 50 of them so far.

Some sites you may be interested in viewing are:

http://www.threedee.com/u-dig/ This will give you information about a private fossil quarry west of Delta where for a small fee you may dig for Trilobite fossils and keep what you find.

http://utahoutdoors.com/pages/dinowalkway.htm Provides information about the Johnson Farm Dinosaur walkway near St. George where dinosaur tracks have been recently found.

http:www.desertusa.com/cldqut/cldquarry.html Provides information about the Cleveland-Lloyd Dinosaur Quarry in Emery County, Utah.

Science Standard V Activities

Activity—Web of Life

Standard V
Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 2
Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environments in which they live.

Intended Learning Outcomes
1. Use science process and thinking skills.
4. Communicate effectively using science language and reasoning.

Standard V

Objective 2

Connections

Background Information

Each of the environments studied in this objective has many interactions between living and non-living things. The animals, plants, rocks, and soil of an area form a community that depends on every other thing within the group. While animals depend on physical features to provide many different types of shelter and plants as a food source or shelter, they are also vital to most plants because they help pollinate flowers and disperse seeds. At the same time, animals such as deer, rabbits, and insects may eat certain plants, greatly reducing their numbers. Some insects can damage an ecosystem if their numbers get too high. Insect-eating birds play an important role in keeping insect populations in check. When creating a web of life for an environment, the web will show eating and shelter relationships.

Invitation to Learn

Play a game of 20 questions. Have one student come to the front of the class and mentally choose an animal or plant from a habitat. (They can pick from a list if they need to.) They will then take questions from other students that can only be answered with a "Yes" or "No" answer. The class will try to guess 1) the name of the animal, and 2) the environment in which it lives. The questions they ask will also help the teacher pre-assess the prior knowledge of students about this topic, or do formative evaluation if the lesson is part of previous study about ecosystems.

Instructional Procedure

1. Explain that all things in an environment depend on other things within that environment in order to live. Brainstorm with students about what things humans need to live. The list should include

Materials

- ❏ Nametags prepared for a specific environment with its plants, animals, physical features, etc. written on them
- ❏ Large ball of yarn or string

food, shelter, and water. Discuss with children that all living organisms within an ecosystem will need these elements as well.

2. Gather students into a circle. Pass out a habitat nametag to each student. Each student is what his or her nametag says. In this activity, students will make connections to other animals or parts of an ecosystem.
3. Explain that all things depend on sunlight, air, and water to live. All students/organisms are connected to these elements. Place these nametags in the center of the circle.
4. The activity can begin with any student. Give one end of the ball of string to a student. Ask them to look around the circle and find another students that either depends on or can be connected to them. Help them tell what the connection is, then they will toss the ball to that student or the teacher can pass it to them. This student holds on to a point on the string and continues the connection or influence by the last student. Continue passing the ball of string around until all the students are connected at least once. You will have built a connective web between all the students.
5. Step into the center of the web. Pick a single string and pluck it. Who felt the vibrations of the string?
6. What if one thing was taken out of the habitat? For example, all the mosquitoes die from pesticides or a dead tree is removed. Ask students to pick one organism in the system that seems less important than the others, and have him drop his string. Ask if anyone else was connected to that organism, and have them drop their string. After one or more have dropped out, ask the students again to identify an organism that seems less important and repeat the procedure. If anyone was connected to any of those students, they drop their string. Continue until everyone has either dropped their string or they were not connected in a way that they were affected, and ask these questions:
   - What happens when we remove a link in the ecosystem? (Organisms that depend on it are affected.)
   - Were the changes more significant when the system was composed of many parts or when it had fewer parts? (fewer, because they happen quickly)
   - Discuss the web of life. What happens when one part of the web is lost? (Many others are lost or affected.)
   - What are other ways the web of life could be disturbed? (Human impact, draining wetlands, clearing trees, disease, drought, etc.)

- Why were some things not affected?

Possible Extensions/Adaptations

Create food web mobiles that visually show student research about an organism and its place in the food web.

Role-play a dynamic food web. Choreograph interdependence and use student selected music that reflects a particular environment.

Discuss some webs of life within the school or community. (Students go to school, teachers teach them, cafeteria workers feed them, parents pay taxes so teachers and cafeteria workers can buy food, etc.)

Assessment Suggestion

By asking questions as the activity progresses, the teacher can correct or redirect misinformation.

Have students choose an environment, and then describe and draw an interaction between animals and plants in their science journals. State two inferences that they can make after participating in the activity (i.e., Plants and animals in a food web are connected or When one organism is taken from a food web, it causes other parts to be affected).

Extension ideas can also work as performance assessment tools. Use the rubric found at www.uen.org/Rubric

Additional Resources

Utah Society for Environmental Education

Division of Wildlife Resources

Project Learning Tree

Homework and Family Connections

Have students take a walk in their neighborhood. As they journey, have them write down a list of at least ten living things that they see. Create a web of life on paper like the one in the activity they participated in. For example, perhaps they see a tree. They would then connect the tree to something else they see that relies on the tree for either food or shelter, such as a magpie. If they saw an insect, this could connect to the bird. Have them continue until everything hooks together. Then have them take one of the links out of their web. Will it affect the other items? Have students share their results and discuss findings.

Food Web Connections in the Scrub Oak Forest

Scrub Jay uses Gambel's Oak for shelter and food; eats Caterpillars or Gall Wasps	**Beetles** relies upon Scarlet Gilia for survival; eaten by Spotted Towhee and Spiders
Caterpillars or Gall Wasps relies upon Gambel's Oak and Chokecherry for survival; eaten by Robin and Scrub Jay	**Bluebunch Wheatgrass** relies upon sun, soil, and water for survival; eaten by Mule deer, Pocket Mouse, and Pocket Gopher
Chokecherry relies upon sun, soil, and water for survival; cherries eaten by Robins and Humans; used for shelter by Caterpillars, Gall Wasps and Spotted Towhee	**Gambel's Oak (Scrub Oak)** relies upon sun, soil, and water for survival; seeds eaten by Scrub Jays; leaves are eaten as forage by Mule Deer; used as shelter by Caterpillars or Gall Wasps
Spotted Towhee uses Chokecherry for shelter; eats Beetles and Spiders	**Bitterbrush** relies upon sun, soil, and water for survival; eaten by Mule deer and Picket Mouse
Pocket Gopher relies upon Bluebunch Wheatgrass and Wasatch Penstemon for survival; eaten by Badger	**Human** uses Chokecherry and Gambel's Oak for food and shelter and hunts Mule Deer and Cougar
Hummingbirds rely upon Scarlet Gilia for survival; is the only pollinator of Scarlet Gilia	**Bigtooth Maple** relies upon sun, soil and water for survival; eaten by Mule deer
Wasatch Penstemon relies upon sun, soil, and water for survival; Bumblebees use the flowers for food while pollinating plant; used for shelter by the Pocket Gopher, Pocket Mouse and Flies	

There Once Was a Daisy

There once was a daisy that grew on a plain
Where the sun helped it grow, and so did the rain –
Links in a food chain.

There once was a bug who nibbled on flowers,
Nibbled on flowers for hours and hours!
The bug ate the daisy that grew on the plain,
Where the sun helped it grow, and so did the rain –
Links in a food chain.

There once was a wren who gobbled up bugs,
And creepies and crawlies and slimies and slugs.
The wren ate the bug, who nibbled on flowers.
Nibbled on flowers for hours and hours!
The bug ate the daisy that grew on the plain,
Where the sun helped it grow, and so did the rain –
Links in a food chain.

There once was a snake who often grabbed birds,
And swallowed them whole, or so I have heard.
The snake ate the wren, who gobbled up bugs,
And creepies and crawlies and slimies and slugs.
The wren ate the bug, who nibbled on flowers.
Nibbled on flowers for hours and hours!
The bug ate the daisy that grew on the plain,
Where the sun helped it grow, and so did the rain –
Links in a food chain.

There once was a fox and I'll make a bet
He'd eat anything he could possibly get.
The fox ate the snake who often grabbed birds,
And swallowed them whole, or so I have heard.
The snake ate the wren, who gobbled up bugs,
And creepies and crawlies and slimies and slugs.
The wren ate the bug, who nibbled on flowers.
Nibbled on flowers for hours and hours!
The bug ate the daisy that grew on the plain,
Where the sun helped it grow, and so did the rain –
Links in a food chain.

The fox he grew older and died one spring day,
But he made the soil rich when he rotted away.
A new daisy grew where he died on the plain.
The sun helped it grow, and so did the rain –
Links in a food chain.

Elements of an Ecosystem

Forest Habitat	**Desert habitat**	**Wetland habitat**
stream	**jack rabbit**	green algae
fallen log	**coyote**	willow
lark	tortoise	**cattail**
fir	bighorn sheep	reed
mountain	**cougar**	water hyacinth
quaking aspen	prairie dog	salt grass
mushroom	bat	sago pondweed
wild raspberries	bat	**bulrushes**
oak brush	swallow	avocet
spruce	mourning dove	tundra swan
columbine	**sagebrush**	great blue heron
lichen	**cottonwood tree**	egret
scrub jay	**prickly pear cactus**	white face ibis
red tail hawk	mesquite	mink
crow	**juniper**	**beaver**
woodpecker	**pinion pine**	**muskrat**
trout	yucca	**catfish**
elk	**lizard**	bat
red tailed squirrel	**tortoise**	water skeeter
beaver	**rattlesnake**	dragonfly
bobcat	**pinion jay**	spider
mountain goat	spider	mosquito
white tailed deer	**ants**	minnow
wasp	**housefly**	**trout**
ants	**butterfly**	**frog**
deer mouse	rock	**gopher snake**
barn owl	soil	turtle
mule deer	stream	**salamander**
housefly	**kangaroo rat**	**cottonwood**
bee	bristle cone pine	**pillbug**
butterfly	scorpion	rock
red fox	**crow**	**carp**
moose		**moose**
grasshopper	**grasshopper**	**grasshopper**

The elements of each ecosystem will vary according to its geographic location and elevation. Use elements that will be appropriate for the area in which your students will visit, or where they live. Some animals are found in many areas.

Activity—Wetland Mud Cloth

Standard V
Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 2
Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environments in which they live.

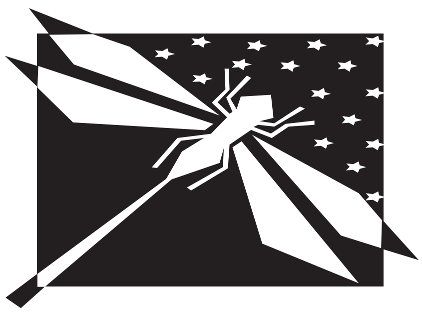
Intended Learning Outcomes
1. Use science process and thinking skills.
4. Communicate effectively using science language and reasoning.

Standard V

Objective 2

Connections

Wetland Mud Cloth



Mud cloth is a type of textile painting that is traditional in some areas of Africa. This adaptation takes the tradition and makes it a part of the study of wetlands through the use of art. The cloth can be used as a unique cover for a book of classroom poetry about the wetlands, or perhaps each student can create a unique science journal for specific use in the study of this ecosystem.

Instructional Procedure

1. Pre-wash material to remove any sizing. Tear into individual pieces the size of the book covers (if each student is creating a journal). Place on a piece of cardboard or old magazine (something that will protect the surface below the material).
2. Mix flour paste with the flour and water that is just thin enough to squeeze out the bottle's tip as a paste.
3. Students will need to draw designs on the muslin material with the flour/water mixture. This project can connect with art targets for fourth grade. Repeat elements in artwork to create a sense of movement. Encourage students to look for repeated patterns in anything they see in the ecosystem (ripples in the water, waving bulrushes, etc.).

Materials

- ❏ Muslin or similar cloth material
- ❏ Flour
- ❏ Water
- ❏ A bottle with lid that will squeeze out a thin line of paste.
- ❏ Mud
- ❏ Tempera or textile paint (green and blue are good "wetland" colors)

4. Allow the designs to harden and dry on the material.
5. Using mud from the wetland, add enough water to get a a mixture with the consistency of paint. Add the tempera or textile paint to get a desired color. (The mud will darken the color, so students might want to do test samples before making a large quantity.)
6. Paint over the entire surface, letting it soak into the material.
7. Let dry completely.
8. Wash and rinse the material under running water. The mud should dissolve and wash off along with the flour paste. The results should look like batik with a "wetland" colored background.
9. Use the material as the outer cover for a journal. If only doing one large book, tear leftover strips and let each student have one to decorate an item such as their pencil. Attach plastic beads to the end for color.

Activity—Bird Migration/Wetlands

Standard V
Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 3
Use a simple scheme to classify Utah plants and animals.

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

Standard V

Objective 3

Connections

Background Information

Migration is a seasonal movement from one area to another, usually a breeding and a non-breeding area. Migration allows birds to take advantage of the seasons. Most migrant birds spend only two to four months of the year on their nesting grounds. The majority of the year is spent elsewhere.

Not all birds migrate. Some find the resources they need throughout the year; others switch to different food sources as the seasons change, and a few become inactive during lean times.

Research shows that approximately 75 percent of the bird species in the state of Utah (about 300) are dependent on the corridors of trees and shrubs that grow along streams and rivers throughout the state. Areas like the Jordan River are especially important. Local biologists suspect that about 150 species of birds in Utah absolutely require riparian habitat. If this habitat disappears from our state, these 150 species of birds will disappear with it. In the western United States we have less than five percent of our riparian habitat remaining in its natural condition. Because western riparian habitat is scarce and rapidly becoming more so, wetland areas are of vital importance to breeding and migrating birds. The Jordan River offers a migration and habitat corridor between Utah Lake and the Great Salt Lake, and a biological sanctuary between Utah's Western Desert and the Wasatch Range. This area is known as the Great Salt Lake flyway, and is a crucial stopover for hundreds of thousands of migrating birds each season. The Great Salt Lake has been identified as a vital link in an international chain of sites that provide critical habitat for birds.

Invitation to Learn

Ask students to imagine that the next time they, or their parent, went to the grocery store, it has disappeared. What would they do? Go to another store? What would happen if the next store they tried has also gone? Where would they get their food? How would this affect their behavior?

Because wetlands are so important to birds, they are often called "quickie marts" or places where they can get a "snack" that will help them as they travel. When these areas disappear, it causes problems for them, just like it would for humans if all the grocery stores and "quick stop" places were no longer around.

Instructional Procedures

Materials

- ❑ Ten hula-hoops
- ❑ Situation cards (included in this handbook)
- ❑ (For extension) one small zip-lock bag filled with four beans for each student

1. This is an outside activity. The teacher will place large sized hula-hoops in an open area. If hula-hoops are not available, draw large circles.
2. Have students line up at the beginning of the course along a predetermined line. Tell them they are birds starting their journey northward. Each circle represents a wetland along the migration path close to the school (Ex. Utah Lake to the Great Salt Lake along the Jordan River.) The students' job is to migrate northward on the course (which is connected by circles) and finish at a line opposite where they began. They do not have to step on every hoop; however, they must not go outside the course. Set up the course in such a way that taking away too many hoops would make it difficult to stay on course.
3. All students should be successful in the first migration. Have them make the return trip southwards to where they began.
4. Now, tell the students you are a developer, or real estate salesperson. You will have to destroy a wetland in order to buy land for a group of apartments you want to build. Put down two of the cards in two of the hoops. Tell students to make the migration again. They may not set foot in the destroyed wetlands. It they do, they die and may not participate in any further migrations.
5. Leave some of the wetlands open, but continue to add the situation cards that will pollute a wetland and make it unfit for wildlife survival.
6. After all students have run through, continue to read one of the situations on a card and add it to a wetland hoop. Repeat this

until most students will fail to make the migrations. Try to destroy wetlands in such a way that not all are destroyed, but are so far apart students can not make the jump easily.

7. When only a few students are left to survive, have them make the return trip south.
8. Gather students together to discuss what happened in the activity. What happened to the birds when the places they would stop for rest and food disappeared? Can they make some inferences about what they learned by participating in this activity?

Curriculum Integration—Math/Science

1. Using the poster called Shorebird Migration Stopover Locations on the Pacific Flyway, have students compute the distance between various identified stopovers.
2. One of the Fourth grade math targets states: Draw or paint from a different point of view, such as a bird's-eye view. Have students imagine what the world looks like to a migrating bird. Then have them draw or paint a picture of the world from this angle and, if desirable, include a view of the clouds, wetlands, towns, etc. Encourage students to accurately portray the habitat the bird might pass over, but to use their imagination so that their picture conveys the length of the journey, the altitude the bird flies at, and the feel of the air.
3. Create wetland patterns to make a Wetland Mud Cloth (see previous activity). Use the mud cloth to highlight wetland poetry that students have created after a visit or study of birds and wetlands.

Possible Extensions/Adaptations

1. Play the game a few more times. You might want to have each student carry a small ziplock bag of beans to represent eggs. If any of the birds survive, they can trade their beans for students that will represent young birds who were hatched in the breeding grounds. (These can be students who originally did not survive.) These birds will need to remain with their parent to journey back. If they land in a wetland that cannot support that number of birds, the last one to get to the site will die.
2. Another extension to the activity would be to have students gather poker chips from each hula-hoop (all colors). Each chip will represent food. At the end of the first migrations, have each

student tally different colors and amounts. Then tell them that red "food" is polluted with chemicals and blue "food" is also polluted. Only the white "food" is safe. Discuss how this affects their survival. Would food supplies that are unsafe create problems for migrating birds?

Assessment Suggestion

Create a graphic organizer to show cause and effect of loss of wetland areas and bird populations in individual student journals (see attached suggestions). Have students write two statements of conclusions they draw from their experience. (Ex: Wetlands are places where migrating birds can rest and eat during migration. Birds need to have places to stop along their journey to survive.) Collect journals and evaluate for correct use of science vocabulary, information, and student inferences.

Additional Resources

Utah Society for Environmental Education (USEE) will visit classrooms and help students explore a variety of issues relating to birds and wetlands.

Project Wild

WOW, The Wonders of Wetlands, an educator's guide, Environmental Concern, Inc.

Utah Division of Wildlife Resources

Homework and Family Connections

Encourage families to find an area that might contain a wetland and then go on a hike. Use the scavenger hunt attached as a way for family members to focus on different aspects of the area.

Situation Cards for Migration Game

This popular marshy wetland has become polluted by chemicals from the fertilizers local farmers used. It is no longer a safe stopover site.	This critical wetland has been drained and filled to build four apartment buildings. The developer leveled the area so there are no plants or water. It no longer exists.
Some loose dogs from a nearby group of homes has made this area unsafe. If you land here, you will be destroyed.	Several new housing developments have been built. This wetland is much smaller that it was last year. Only two birds can stop at this site.
This wetland has lots of predators. If you land here, you will be eaten by a red-tailed hawk.	Some kids on bikes have flattened areas in this wetland where you stopped to rest and eat. There is no safe place to land.
A local business accidentally spilled some poisonous material into the water of this wetland. If you land here, you will die.	There is a golf course where this wetland was, and only a small lake remains. Three birds can land in this area.

Wetland True/False Quiz

TRUE: Wetlands absorb excess water caused by runoff.

FALSE: On rare occasions, a few birds use wetlands as a resting or wintering place. (Eighty percent of all breeding bird populations in the United States, along with more than half of the protected migratory birds, rely on wetlands at some point in their life cycle.)

TRUE: Wetlands mix nutrients and oxygen into the water.

TRUE: Wetlands help neutralize toxic substances such as fertilizers and sewage waste.

FALSE: Wetlands are all dark, mucky, and stinky places. (Wetlands can be along rivers, ponds, and the coastlines. They can have fresh, salty, or stagnant water, and be in cities, agricultural fields, or wilderness areas.)

TRUE: Wetlands provide habitats to a diverse range of birds, mammals, reptiles, insects, fish, and invertebrates.

TRUE: Some wetlands are not natural, but were built by people.

FALSE: Wetlands tend to make flooding situations worse. (Wetlands retain excess water, absorbing it like a sponge and allowing it to drain into streams and rivers and enter the soil gradually.)

FALSE: There are three things that define a wetland: water, hydric or saturated soils, and people. (Wetlands are defined by the presence of water at or near the surface of the Earth. Most of the time, they contain hydric or saturated soils and hydrophilic or water-loving plants.

Activity—Bird Study

Standard V
Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 4
Observe and record the behavior of Utah animals.

Intended Learning Outcomes
1. Use science process and thinking skills.

Standard V

Objective 4

Connections

Background Information

Birds are a group of animals with very specific characteristics. They are warm blooded, have feathers and hollow bones, and lay eggs. All birds have wings, but not all birds fly. They all have beaks, but each type of bird has a different type of beak, depending on the kind of food it eats.

Common birds in Utah include the red-tailed hawk, barn owl, lark, robin, pinon jay, magpie, and crow. There are also many other birds that live here, as well as the thousands that migrate through Utah on their journeys to warmer climates, or those returning north in the spring. This activity not only helps students learn about specific bird characteristics, but also makes them more aware of the ecosystems that support each bird. Students will practice using binoculars and identifying various birds by color, size, and physical characteristics.

Invitation to Learn

Play "What Am I?" to introduce this activity. Give descriptions of some locally common birds, one part at a time, and have the students try to guess what you are describing. Don't tell them that you are describing birds (e.g., "The chin is black," "The chest is yellow," "Favorite food is sunflowers," "Enjoys winter in South America").

Instructional Procedure

1. Use a large diagram of a bird, with various species on a bulletin board to help students learn the parts of a bird. On several days, quiz students on bird parts. This activity becomes a lot more fun if the teacher or a student draws the quiz bird on the chalkboard freehand.
2. If possible, provide each student with a pair of binoculars (see additional resources). Have students take the binoculars out of the cases and experiment with how they work. Through

Materials

- ❏ Chart of a bird with labeled parts
- ❏ Binoculars
- ❏ Number flash cards for teacher
- ❏ Pictures of Utah birds

inquiry, they will find out how to focus the image. Encourage peer teaching if some students have used binoculars previously. After investigation, each student should be able to adjust the eyepiece and focus. Emphasize that these are expensive pieces of equipment and help the class develop a set of rules for using the binoculars and penalties for misusing them.

3. Use a set of cards with small letters and numbers printed on them to have binocular speed quizzes. To pass the quiz, a student must take a pair of binoculars that is out of focus and set for the wrong eye width and adjust them so that they can read the card in 5 seconds or less. This activity can go very quickly if a relay game is set up. It is also a good time to practice the proper precautions in handling the binoculars.
4. Discuss some of the variety of bird species that will be found in your area. Using the correct names for bird parts, show pictures of these birds and discuss their behavior. (Use pictures from the sources given.)
5. Show the pictures one at a time and have the students practice focusing the binoculars on the bird and identifying its name. As each is named, review the colors, bird parts, and beaks that help identify the bird.
6. Repeat the last activity, but this time have the birds fly through the air. (Take each card and have it pass in an arc through the air for about five seconds.) This will help students learn to focus their binoculars quickly. Most birds are constantly moving to stay away from predators and look for food, so this behavior will occur when students move to the neighborhood for practice.
7. Now we are ready to stalk those birds!! With permission from your principal and prior arrangements, begin direct observation and recording of birds and their behavior. Be sure to set up ground rules for behavior and respect for people's property. If students know that the class will come in immediately if these rules are broken, behavior is much more appropriate.
8. After several days of bird walks, take a special mapping walk. Help students draw a map of the area by providing them with a handout with the blocks around the school outlined. As you walk, draw in landmarks and use symbols to show the locations of birds and nests that you have found in the area. Keep the map up to date by adding newly discovered nests and birds by recording the activity in and around the same area. Develop a map key to use on this sheet.

Curriculum Integration

Math/Science—Create maps of neighborhood bird recording activity.

Possible Extensions/Adaptations

Place bird feeders in areas around the school that are visible to students and have them record species and number of birds that visit. (This can be done very successfully with the Cornell Feeder Watch Program.)

Visit a nearby habitat and practice identifying birds. If possible, visit two different ecosystems, such as a freshwater wetland and the Great Salt Lake, and then compare the birds that live in each. Do they have different adaptations to survive in that environment? Do they eat the same food?

Assessment Suggestion

Have cooperative learning groups create posters of bird characteristics. Use a rubric that will outline information students need to have for their poster. Have each group share in the creation and presentation of the poster. Display them in the classroom.

Additional Resources

There are several agencies that have sets of binoculars available for checkout in many areas of the state. Some of these are:

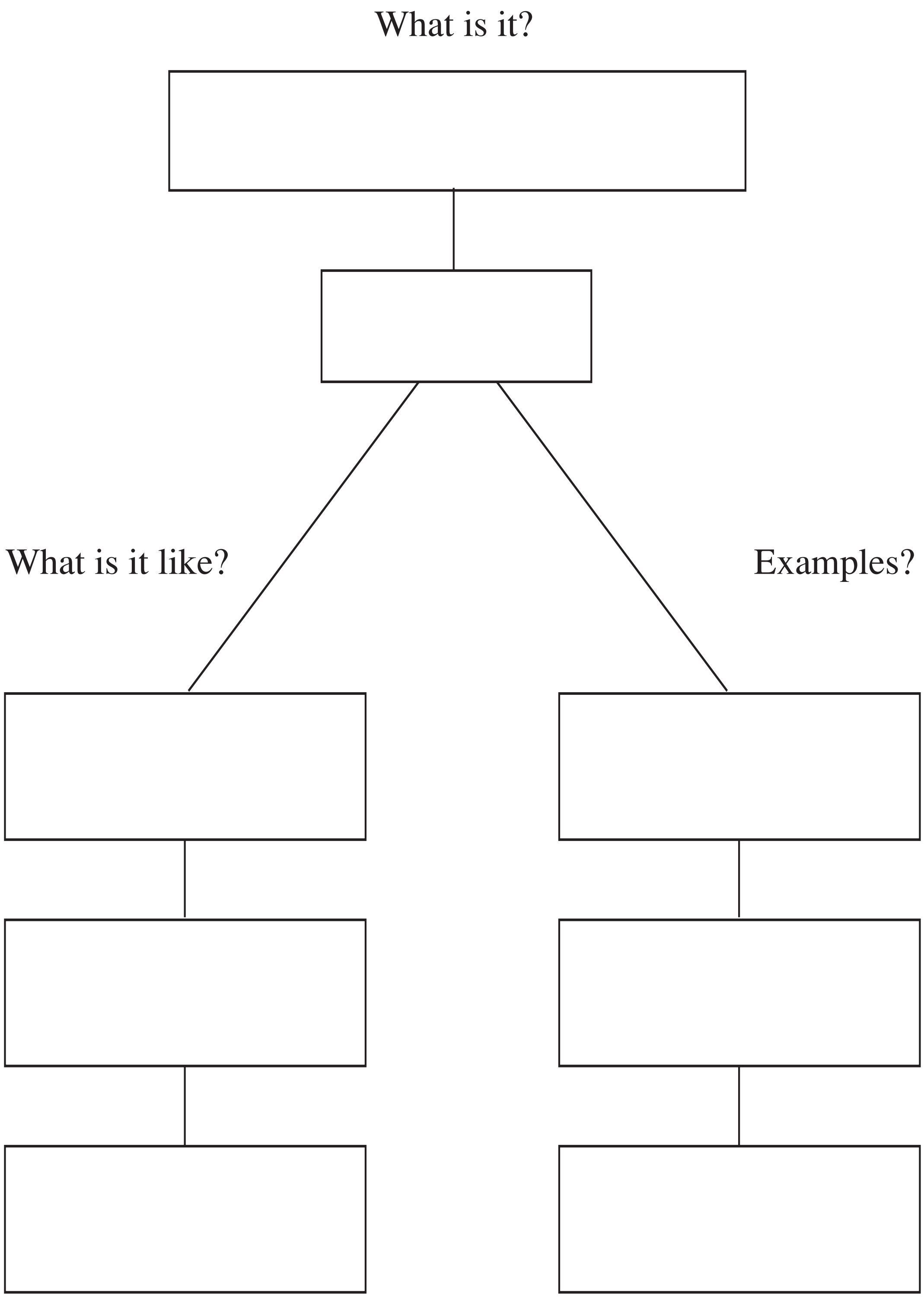
Utah Society for Environmental Education (USEE) 328-1549
Utah Audubon Society
Division of Wildlife Resources/ Project Wild
National Park Service
Forest Service
Bureau of Land Management

Homework and Family Connections

Have students take home a handout so that they can teach their parents about birds.

Encourage families to practice behavior for bird watching together at home. Take a "quiet" walk and see how long they can go without talking. Sit and record ten things they hear in nature and ten things they hear that are manmade.

Word Map



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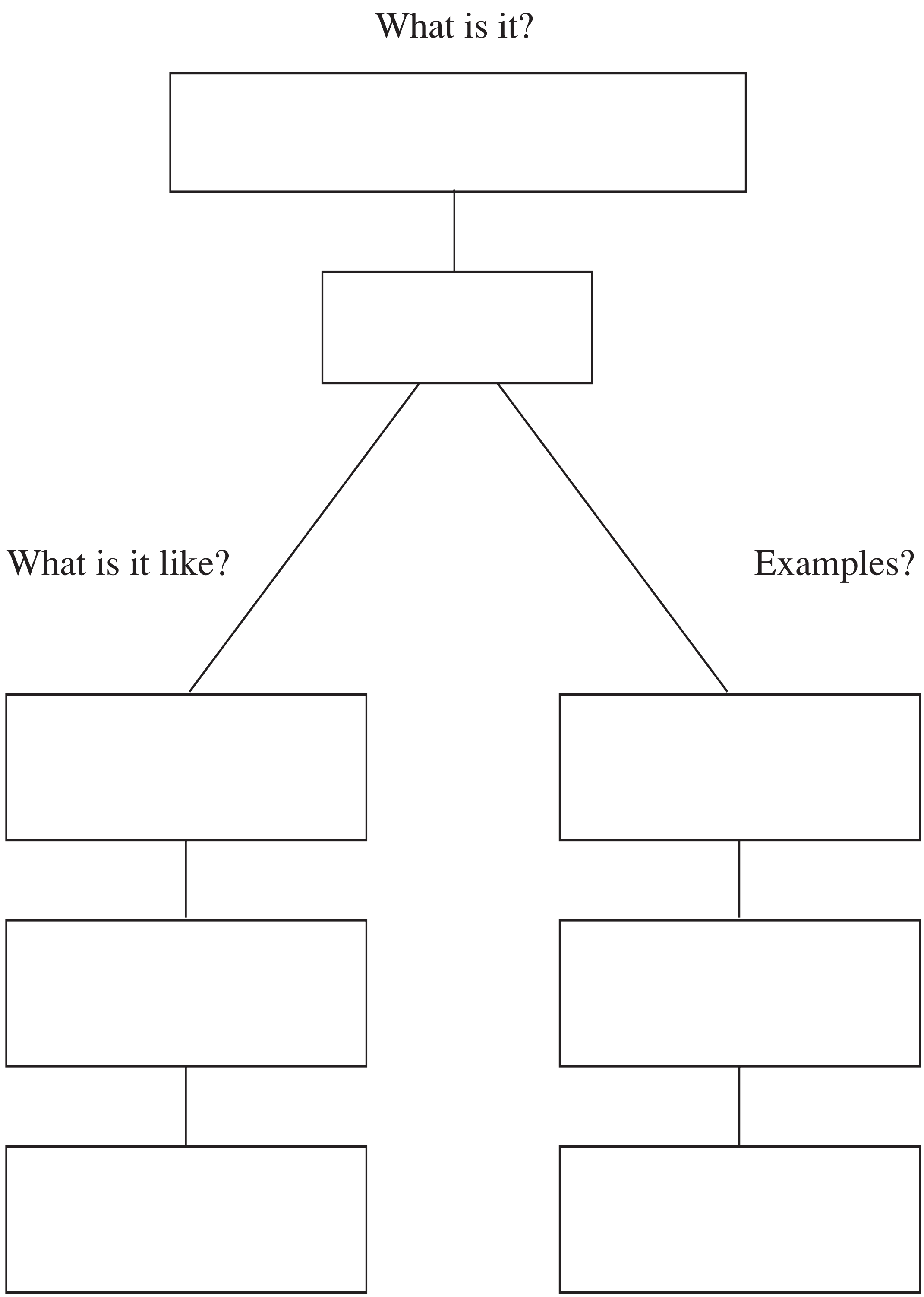


Activity—Desert Dynamics

Standard V

Objective 2

Standard V
Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 2
Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live.

Intended Learning Outcomes
1. Use science process and thinking skills.

Connections

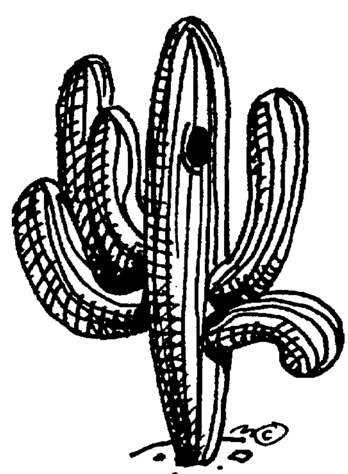
Background Information

Desert plants adapt to their environment in a variety of creative and useful ways that allows them to survive. One way is through changes in stomata. Stomata are the holes in plants leaves where water transpires. Many desert plants have very small stomata or fewer than normal. Cacti have stomata that are deep in the plants' tissues, which reduces water loss.

The leaves and stems of many desert plants have a thick, waxy covering. This waxy substance also helps reduce moisture loss. Small leaves mean less evaporative surface per leaf. It also means that it won't get as hot as a large leaf would in the sun.

Some plants, such as Mormon tea and cacti, carry out most of their photosynthesis in their green stems. Some grow leaves during the rainy season and then shed them when it becomes dry again. Blackbrush only has photosynthesis during these rainy periods, and other plants can totally shut down photosynthesis to reduce water loss. Junipers have the ability to cut off water to a major branch during a drought, resulting in a dead branch but a live tree.

Other desert adaptations can be shallow widespread roots that will absorb a maximum of rainfall, or spines and hairs that shade the plants and break up drying winds across the leaf surface. Desert annuals avoid drought and heat by surviving as seeds stored in the soil, sometimes for many years.



Some desert plants take advantage of cooler temperatures at night to become "active." Plants like evening primrose and y bloom at night. The paintbrush plants use another adaptation. They are partial parasites. Their roots tap into nearby plant roots, usually sagebrush or grasses, and suck food and moisture from their host.

Invitation to Learn

Ask a volunteer to stand. Point out the parts of a human body that relate to plant parts. Feet would be roots, legs and torso are stems, arms are branches, hands are leaves and the head is the flower or seed head. Tape paper labels of plant parts to these human parts and review.

Materials

- ❑ Magnifying glasses
- ❑ Riddle cards prepared
- ❑ Pictures of cacti and desert plants
- ❑ Journals
- ❑ Selection of leaves (preferably from the desert showing adaptations)
- ❑ Adaptation objects from suggested list

Instructional Procedures

1. Discuss how plant adaptations are physical ones, such as extra long roots to find water, hairy leaves to shade leaf surfaces, leaves growing only in rainy seasons. Use the visual props in the kit for this lesson as reminders of the different adaptations. Ask, "What would be the conditions in a desert environment that would require a plant to adapt in order to survive?" (lack of water, hot temperatures, cold nights, hot winds, being eaten by animals).
2. These activities will help students practice identifying desert plant adaptations in preparation for investigating their own leaves. Prepare the riddle adaptation cards, adaptation objects, and plant cards before beginning these activities. Discuss the adaptations that desert plants use to survive, and display and discuss the ones you have prepared (sponge, water bottle, sock with pipe cleaners, etc.). Match the adaptations to specific plants on the vocabulary list for this standard. Use pictures if available.
3. Have students use the list as reference during the following activity. Divide students into small groups. Using the riddle cards read each riddle and then give the groups about five seconds to discuss and write the answer on a card. One student in each group stands ready to show the answer to the riddle. Each must be able to justify their answer. If correct, the group gets a point. There may be more than one right answer to some clues. Accept all plant answers that are explained correctly with logic. Every team can earn points for each question.
4. After playing the riddle game, each group will do scientific inquiry to answer the following question: "If we investigate eight different leaves, how many of them will have one of the adaptations that we've listed for the desert environment?" (Adjust the number as needed.) This hypothesis will be written in their journals and data will be recorded.

5. If students can collect their own leaves, this would be the most optimum method of collection. If not, the teacher can provide a set of varied leaves in a baggie for each group. Students should draw each leaf and describe its adaptation, if it has one. They should also label any identifying or unique aspects to the leaf.
6. As a class, have each group present their findings and some pictures or descriptions. Discuss why some leaves did not have adaptations. Some may be annuals with seed adaptations rather than leaf adaptations, or may have different adaptations. Discuss as a group and read a conclusion about what was learned, and what the results mean to the study.

Curriculum Integration

Math/Science—Desert Math Activity included in this handbook (Some Like it Hot! Some Like it Cold!).

Using information about plants, create an origami folded book that summarizes written information using quality sentence structure and illustrations.

Possible Extensions/Adaptations

Compare the two deserts found in Utah (Mojave and Great Basin) and list plants that they have in common. Which are unique to each area?

Use plant pictures if leaves are unavailable and compare adaptations.

Assessment Suggestion

Desert origami books are a good product to assess student understanding of this concept. Use the attached rubric for grading. Share student products with a buddy class.

Additional Resources

Access Project Wild's past issues of Nature's Call at www.wildlife.utah.gov/projectwild.

Red Rock Adventures, a teacher's guide to Canyon Country Outdoor Education, available for check out with USEE, Utah Society for Environmental Education.

Homework and Family Connections

Go on a scavenger hunt in the family's backyard or an area nearby. Observe different kinds of plants and make observations about adaptations and physical characteristics they possess.

Riddle Cards

My roots spread out underneath the ground. When it rains they soak up any water to be found. The shallow roots wait for rains to fall. Soaking it up I trap it all.	The prickly spines don't feel very nice, If you think you want dinner, you'd better think twice! A mouthful of me is a painful surprise. Don't bother to taste me, you'd better be wise!
Although it's been weeks since there was rain, I stored up water so I won't complain. My thick stem stores the H_2O So I can survive the sun's hot glow.	My leaves are colored lightly or gray. They reflect the sun and keep it away. My leaves are quite small, as a rule, In hot temperatures they keep me cool.
My leaves and stems have a waxy touch. Water trapped inside me helps so much. When rain does fall I fill up fast, So when it stops, my water will last.	My prickly spines are really leaves, That stop the wind and help relieve My losing moisture to the wind. I'm grateful for a spiny skin.
My deep taproot drills down very deep. To underground water, where it may seep. Sometimes my root is 40 feet down. That's a long way to go underground.	

(SPINES PROTECT FROM ANIMALS) (Any cactus with spines)	(SHALLOW ROOTS) (Creosote bush, pinon pine)
(LIGHT COLORS ABSORB LESS HEAT) (Globemallow, rabbitbrush)	(WATER STORED IN THICK STEM) (Joshua tree, beavertail cactus)
(HAIRS, SPINES LESSEN EVAPORATION) (Prickly pear cactus, sage brush)	(WAX TRAPS MOISTURE) (Juniper, cliffrose)
	(ROOTS FIND AVAILABLE WATER) (Mesquite, Yucca)

Name_____________________________

Science Journal Rubric

Description: Assessing my Journal Entry on ________________

(4) You've Got It!

(3) Almost There!

(2) Getting Close!

(1) Take Another Look!

Following Instructions:

4 I described in detail all of the things my teacher asked me to describe.

3 I described most of the things my teacher asked me to describe.

2 I described a few of the things my teacher asked me to describe.

1 I didn't describe anything.

Legibility:

4 I used neat handwriting.

3 I used neat handwriting most of the time.

2 My handwriting could have been neater.

1 My handwriting was difficult to read.

Drawing Effort:

4 I drew my pictures neatly and carefully.

3 I drew most of my pictures neatly and carefully.

2 I drew carelessly.

1 I didn't draw pictures.

Total score _______

(Adapted from UEN Rubrics)

Name_______________________________

Science Investigation for Desert Plant Adaptation

Check Out These Leaves!

Question: If we collect ___different leaves, how many of them will have at least one of the desert adaptations we have studied?

Prediction of Hypothesis:

Procedure: (Draw a picture or attach leaf)

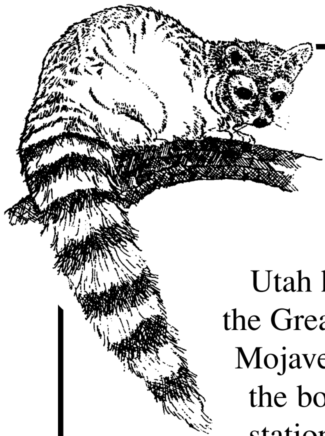
Leaf #1: Characteristics:	Leaf #3 Characteristics:
Leaf #2: Characteristics:	Leaf #4 Characteristics:

Results: (What actually happened?)

Conclusions: (What did we learn?)

Objects to represent physical characteristics of desert plants

Bag of crayons: Barrel brush
Narrow mouth water bottle: Blackbrush
White cloth: rabbitbrush, sagebrush
Sponge: Prickly pear cactus
Fuzzy cloth: Sagebrush
Sock w/pipe cleaners sticking up: Prickly Pear Cactus
Garden hose: Yucca, mesquite

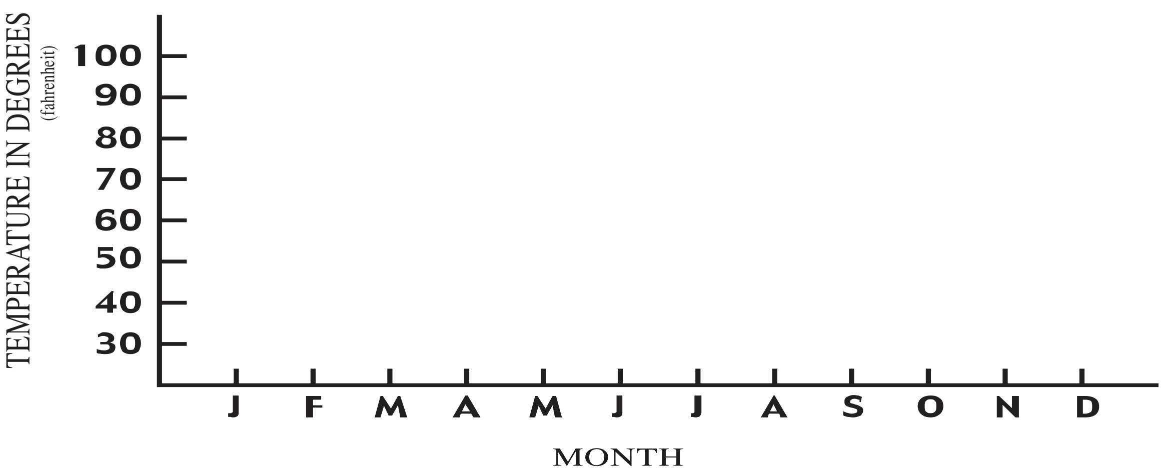


Some Like It Hot! And Some Like It Cold!

Utah has both hot and cold deserts. The Mojave is considered a hot desert, and the Great Basin is considered a cold desert. What is the difference between the Mojave and Great Basin deserts? One of the big differences is temperature. In the box below are the average monthly maximum temperatures for two weather stations in Utah. Wendover is in the Great Basin desert, and Lytle Ranch, west of St. George, is in the Mojave desert.

Graph the average monthly maximum temperatures for Lytle Ranch on the graph. Connect the data points with a red line. On the same graph, plot the maximum monthly temperatures for Wendover. Connect the data points with a blue line.

Month	J	F	M	A	M	J	J	A	S	O	N	D
Lytle Ranch	55	60	66	80	85	95	100	98	93	80	64	55
Wendover	36	43	52	61	72	82	92	89	78	63	47	37



- Which months show the greatest difference in temperature between the two sites?
- Which location is found in a hot desert? Whis is in a cold desert?
- In which location would you like to be in June? In December? Why? Describe how you think the desert would look at these times of year? How would you adapt to the temperatures?

—Used with permission by Project Wild

Activity—Potato Chip Classification

Standard V
Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 3
Use a simple scheme to classify Utah plants and animals.

Intended Learning Outcomes
1. Use science process and thinking skills.
3. Understand science concepts and principles.

Standard V

Objective 3

Connections

Background Information

This activity can be used at the beginning of the year to introduce the structure and function of a dichotomous key preparatory to asking students to identify Utah plants and animals in the wetlands, forests, and deserts. The word dichotomy means "division into two." A dichotomous key reduces the task of identifying something into a series of questions that are based on physical features. Each set of questions offers opposing answers from which to choose. As you make choices and eliminate others, you will eventually find out the name of the mystery item.

This activity will help students to classify "specimens" according to observable characteristics, prepare a "key" showing their classification system, use their key to identify a specimen, and see the diversity that can be observed in classmates' classification systems.

Invitation to Learn

Ask students to think of their favorite song (or kind of music). Accept all answers and mention how diverse the kinds might be. Ask, "Does it matter that everyone likes different kinds of music? What makes it different?" (words, melodies, notes used, rhythms, singers). All of these answers are called characteristics. They are ways we identify different types of music. Music can be divided into groups, or classes that show the diversity they contain. Let's try to do the same thing with some food.

Materials

- ❏ Six different types of potato chips selected for differences in observable characteristics (e.g., color, texture, brand name, flavoring)
- ❏ Paper for recording group keys
- ❏ Samples of each type of chip in labeled plastic bags
- ❏ Overhead or chalkboard for initial modeling of procedure

Instructional Procedures

1. Display bags of potato chips and discuss their similarities and differences.
2. Ask a volunteer to divide the chips into two groups using an observable characteristic (i.e., flavored/unflavored).
3. Record the results of the first division.
4. Continue to divide groups of chips, using a different characteristic each time, until only one bag of chips remains in each group. Continue recording results.
5. Using the class key, identify unknown chips.
6. Divide class into small groups.
7. Provide each group with a sample set of chips.
8. Ask each group to devise and test a dichotomous key that is different from the class key.
9. Record and share results.
10. Eat the chips!

Curriculum Integration

Math/Science—Graph the chips according to student preference. Brainstorm other ways of graphing information using the chips (calories, fat grams, etc.).

Possible Extensions/Adaptations

Repeat the activity with other objects such as candy, shoes, etc.

Share the story of the potato chip from Mistakes that Worked by Charlotte Jones.

Classify classroom students by characteristics such as clothing color, hair color, eyes, etc. (Be sensitive to characteristics that will demean or exclude students unfairly.)

Assessment Suggestion

Have students create a key and record it in their science journals. The key needs to be labeled and correctly follow the procedure for dichotomous keys. Students can explain their example using correct vocabulary and scientific information.

Additional Resources/Literature

This activity easily leads into most activities that will classify plants or animals.

Homework and Family Connections

1. Encourage students to check at home for any potato chips they might have and try to classify with family members.
2. Choose another group to categorize from someplace in the house (socks, silverware, shoes, junk drawer, books, etc.)

Activity—Classifying Utah's Bats

Standard V

Objective 3

Connections

Standard V Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.
Objective 3 Use a simple scheme to classify Utah plants and animals.
Intended Learning Outcomes 1. Use science process and thinking skills. 4. Communicate effectively using science language and reasoning skills.

Background Information

There are 18 species of bats found in Utah. These nocturnal creatures are fascinating. They are the only major predators of night-flying insects and in Utah, that is all they eat. (In other areas bats also eat fruit or nectar. Some hunt small fish, lizards, frogs and mice. There is even a vampire bat that makes a small cut in their prey in order to lap up some blood.) The little brown bat, the most common specie in North America, can catch up to 600 mosquitoes in an hour.

During the day, bats find safe places to roost (or sleep), using the sharp claws on their feet to hang upside down. Utah's bats roost in interesting places–behind rocks, under the bark or in the leaves and branches of trees, in caves, in attics, and under the roofs of buildings.

Scientists who study bats often identify them by giving them names that describe how they look. As students use the information on bats, have them be aware of these interesting names.

Invitation to Learn

Have students take a survey about bats. Each student will record short responses to questions such as: Do you like bats? Are bats helpful to humans? Are you afraid of bats? How many kinds of bats do you think live in Utah? What animal group do bats belong to?

Explain to students that the following activity will help them practice classification skills as they read and compare information on the bats that live in Utah.

Instructional Procedures

1. Using the cards made from the bat poster, have students work in groups to develop a classification system with bats. The information on the back of each card can be grouped in a variety

of ways (by geographic location, size, habitat, food source, etc.).

2. Have each group arrange their cards on a large piece of poster paper and label their key.
3. Students should share their keys with the class.
4. Display the posters around the room.

Materials

- ❑ bat poster for classroom display
- ❑ Bat posters for student use in classification
- ❑ Create bat classification cards made using BLM poster (or assemble other pictures of bats)

Curriculum Integration

Math/Science—Create a brochure about bats that conveys information to inform people of the benefits of bats. (See sample)

Compare and contrast the size of Utah bats in a graphing activity.

Create different shaped bats using tangrams.

Possible Extensions/Adaptations

Investigate a service-learning project that will benefit bat populations and the scientists studying them. Create bat houses with community partners as part of the study. (Be sure students are aware of bat etiquette and safety.)

Assessment Suggestions

In a learning center, place materials for individuals to record the bat classification information in a key. Have students trade with one another, and attempt to classify the bats. If they can use the key successfully, they can continue sharing with others. If the key needs changes, help students work to make their key successful.

Additional Resources

Stellaluna by J. Cannon (Harcourt, Inc.), 1993
Bats of Utah by R. Hasneyager (Division of Wildlife Resources), 1980
Bats (Zoobooks), 1989
About Bats (Educator's Activity Book, Bat Conservation International), 1991

Homework and Family Connections

Have students take the survey about bats home and use with family members. Encourage them to share anything they learned about this unusual animal with their family.

BAT MYTHS

Bats are frightening to many people because they fly at night and swoop over people's heads. Some think that bats are dangerous because they can get rabies from them. Studies have shown that hardly any bats have rabies. You would be at higher risk getting rabies from a dog or cat.

Food

All bats in Utah are insects eaters. They feed on thousands of mosquitoes, mothe, beetles and grasshoppers. The little brown bat, the most common bat in South America can catch up to 600 mosquitoes in an hour. Many tropical bats eat fruit or nectar. There are a few bats that feed on small fish, lizard, frogs and mice.

Description

Bats are a nocturnal (night active) mammal and the only one that can fly.

Bats

Utah's Nocturnal Friends

Appendix

Trading Off Worksheet

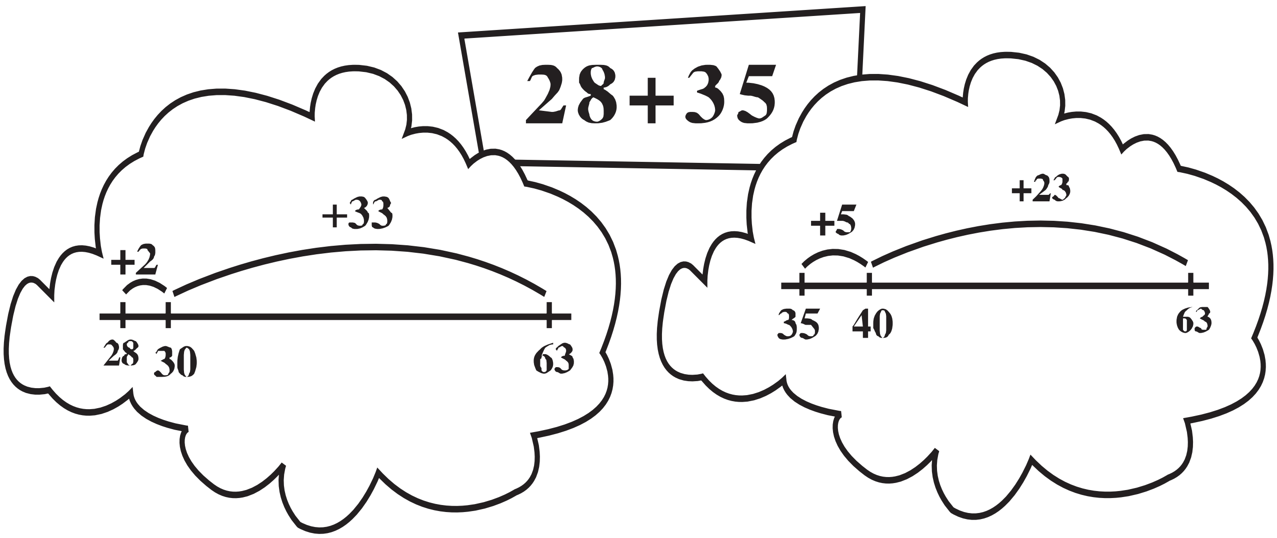
Find the two numbers that total 10.

5 6 1 4 9

5 2 7 8 3

It is easier to use tens.

You can "make tens" to make mental addition easier. Here's how...



"Make tens" with 28 then adjust the 35.

OR

"Make tens" with 35 then adjust the 28.

Mental Math:
Make tens with one number and adjust the other.

1. 59 +33
2. 38+46
3. 47+55
4. 37+49
5. 67+34
6. 38+67
7. 54+29
8. 47+26
9. 28+36
10. 55+49

Balancing Subtraction Worksheet

$$\begin{array}{r} 47 \\ -28 \\ \hline \end{array} \qquad \begin{array}{r} 49 \\ -30 \\ \hline \end{array}$$

$$\begin{array}{r} 33 \\ -15 \\ \hline \end{array} \qquad \begin{array}{r} 38 \\ -20 \\ \hline \end{array}$$

$$\begin{array}{r} 77 \\ -40 \\ \hline \end{array} \qquad \begin{array}{r} 76 \\ -39 \\ \hline \end{array}$$

Which problem in each pair is easier? Why?

"Making tens" can help you subtract in your head.

**Adding 2 to 28 makes 30.
That's easier to subtract.
Then adjust 45, too, to balance.**

$$\begin{array}{r} 45 \\ -28 \\ \hline \end{array}$$

$$\begin{array}{rcr} 45+2 & \longrightarrow & 47 \\ -28+2 & \longrightarrow & -30 \\ \hline & & 17 \end{array}$$

Remember: Adding the same amount to both numbers leaves the difference unchanged!

**MENTAL MATH:
Make tens and balance.**

1. $\begin{array}{r} 73 \\ -28 \\ \hline \end{array}$

2. $\begin{array}{r} 54 \\ -29 \\ \hline \end{array}$

3. $\begin{array}{r} 62 \\ -45 \\ \hline \end{array}$

4. $\begin{array}{r} 71 \\ -54 \\ \hline \end{array}$

5. 50 – 33
6. 75–38
7. 80–36
8. 72–47
9. 65–17
10. 83–39

Name:______________________

Square Facts

1 x 1 = ______

2 x 2 = ______

3 x 3 = ______

4 x 4 = ______

5 x 5 = ______

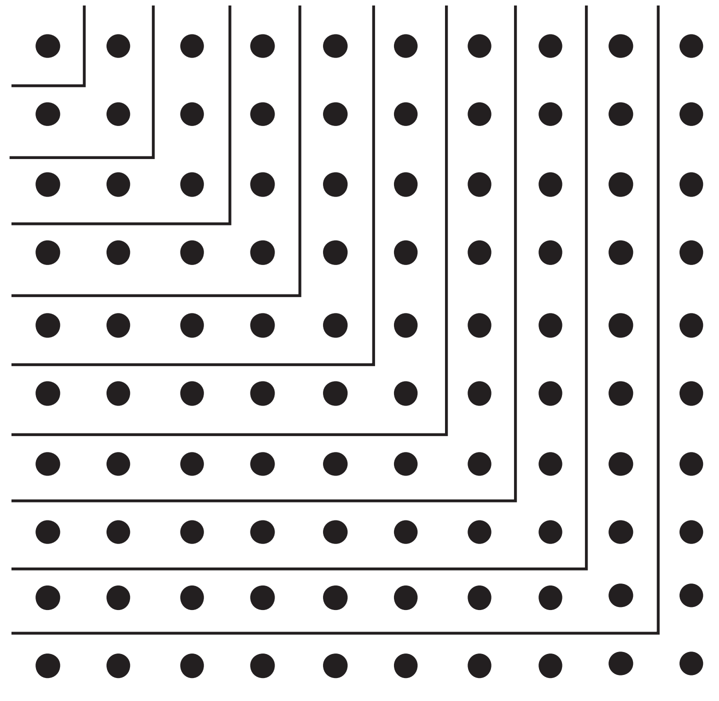
6 x 6 = ______

7 x 7 = ______

8 x 8 = ______

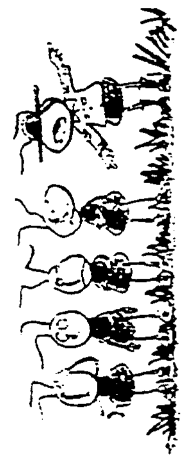
9 x 9 = ______

10 x 10 = ______



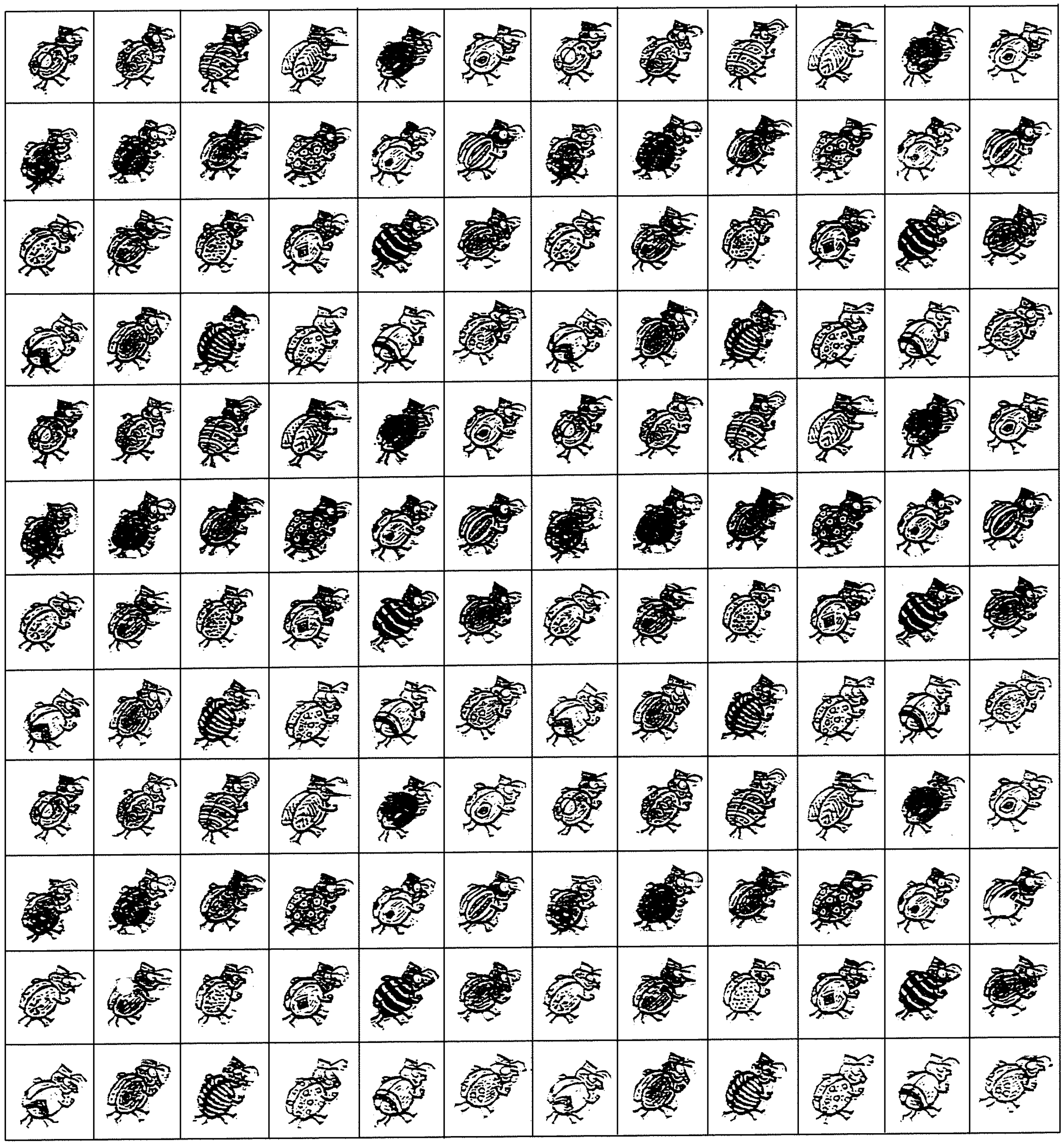
Generation	Model	New Added	Total Squares	Perimeter
1				
2				
3				
4				
5				

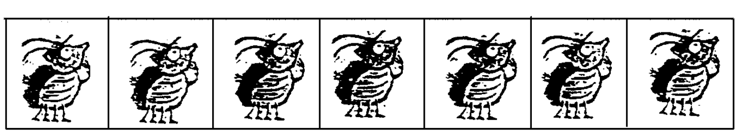
One Hundred Hungry Ants



Graph Paper

Bugs in an Array





Hundreds Board

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	8	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Remainder of One Riddle

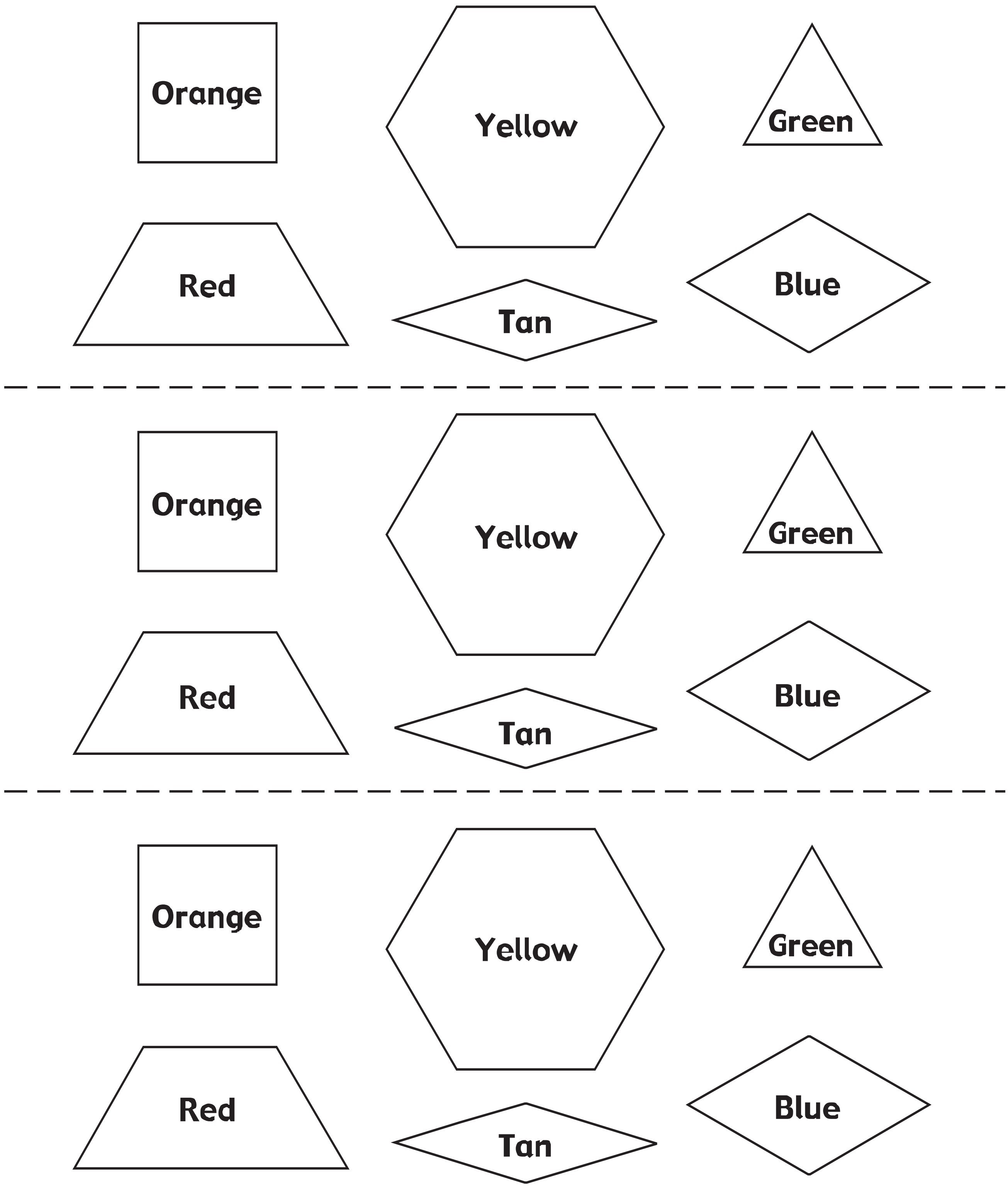
Written by: ________________________________

Solved by: ________________________________

1. When you divide my number by 1, R=
2. When you divide my number by 2, R=
3. When you divide my number by 3, R=
4. When you divide my number by 4, R=
5. When you divide my number by 5, R=
6. When you divide my number by 6, R=
7. When you divide my number by 7, R=

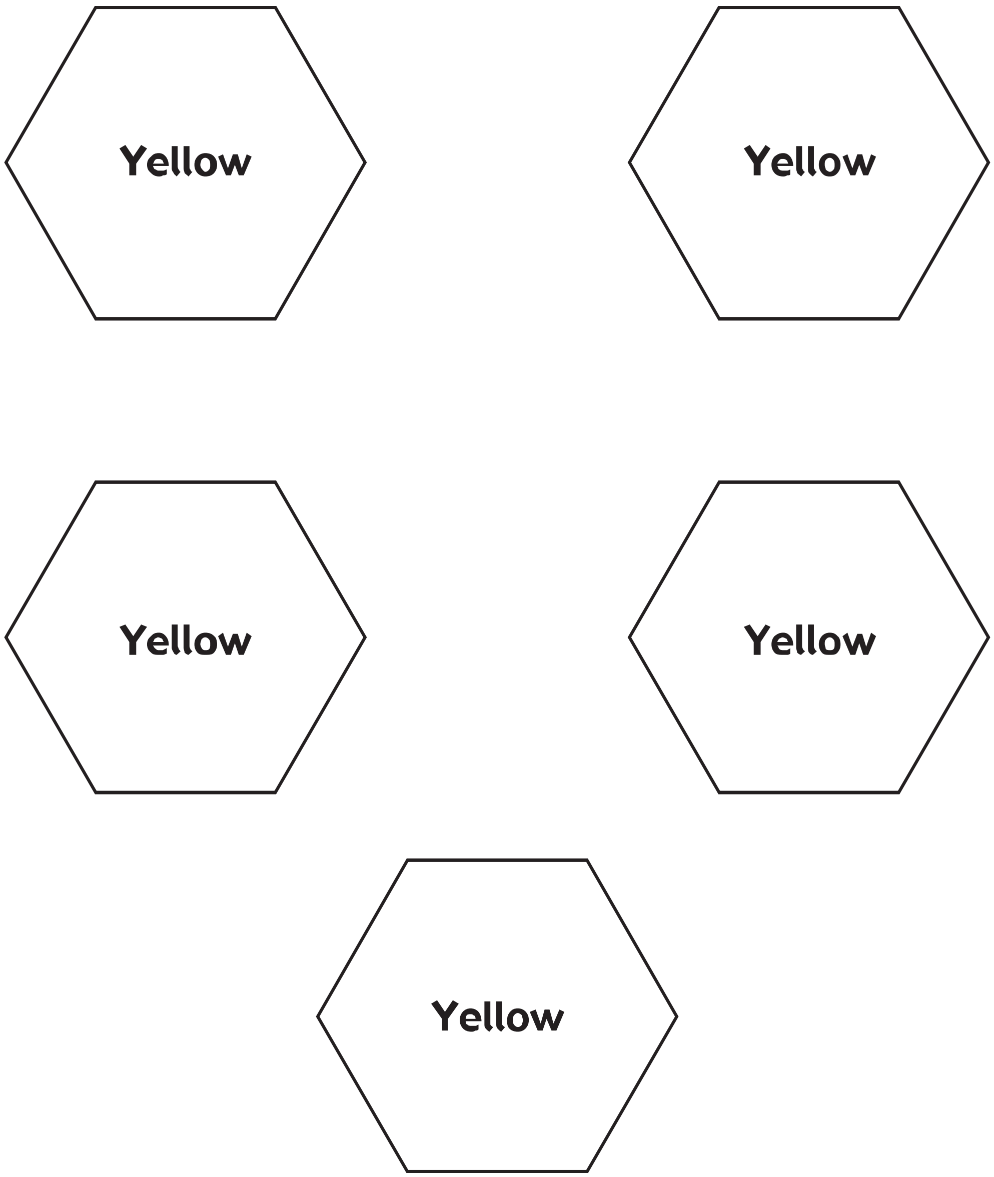
1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
21 22 23 24 25

Pattern Block Shapes



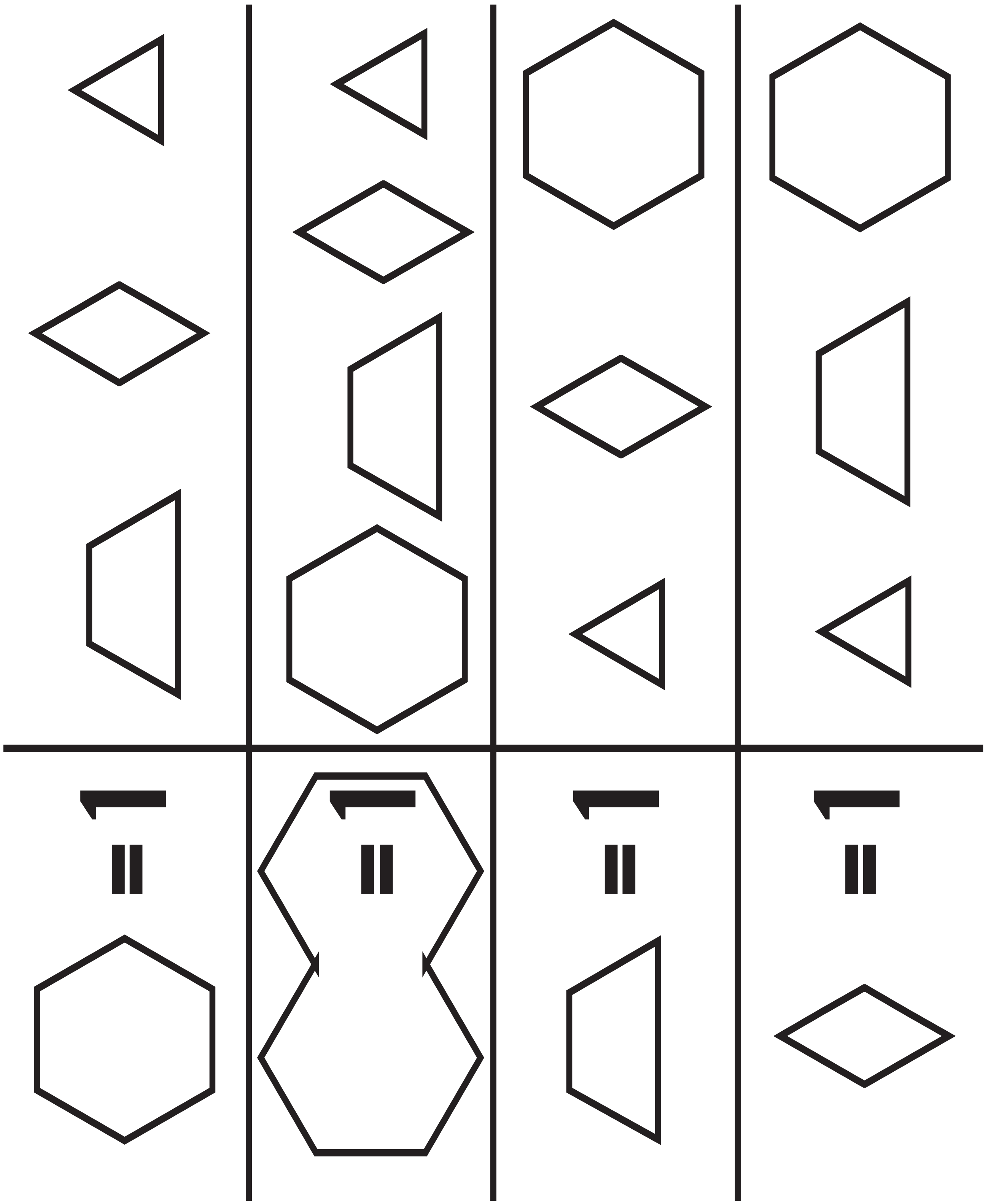
Name:______________________

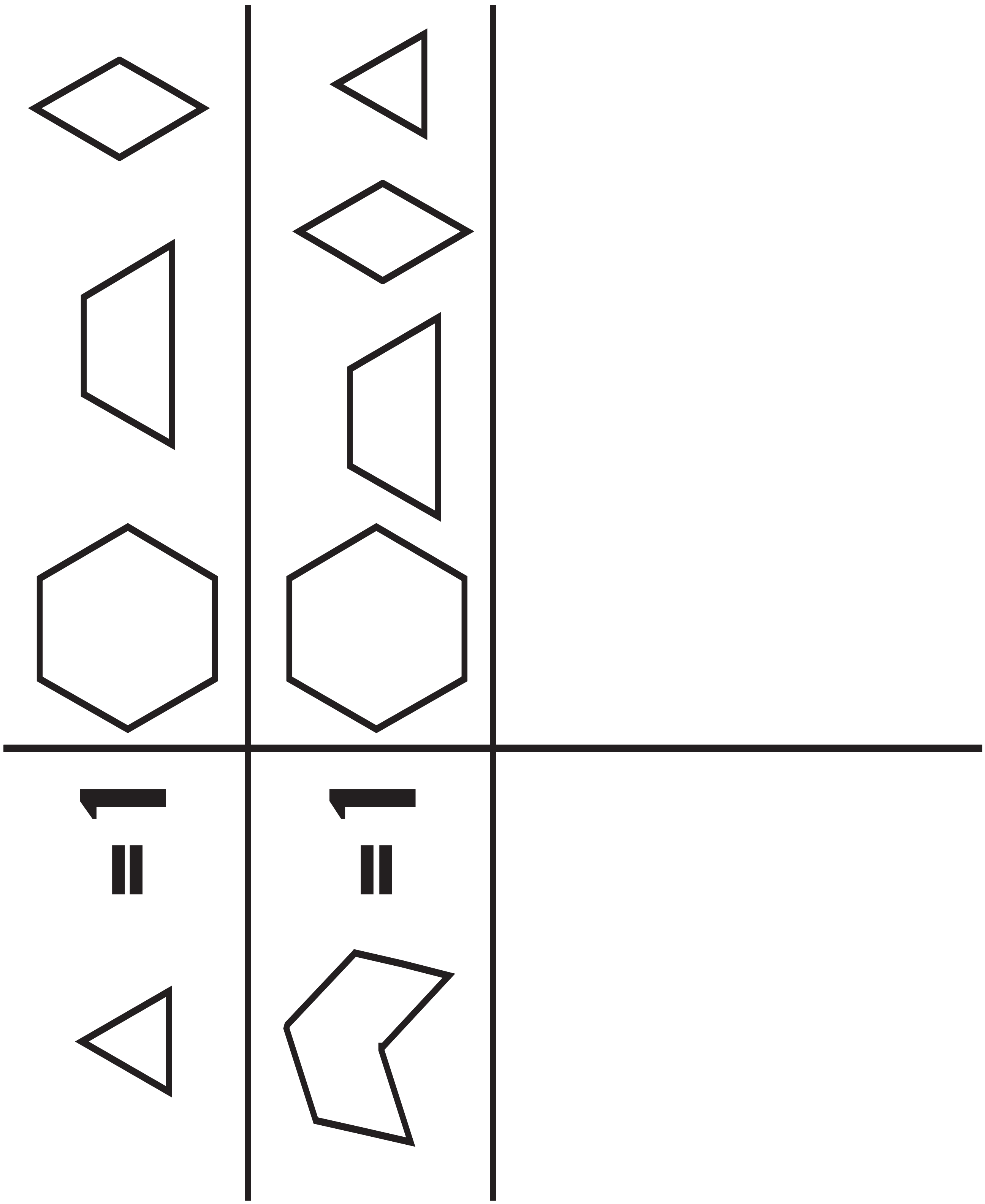
Exchange Game Score Sheet



Name:____________________

My Fraction Page



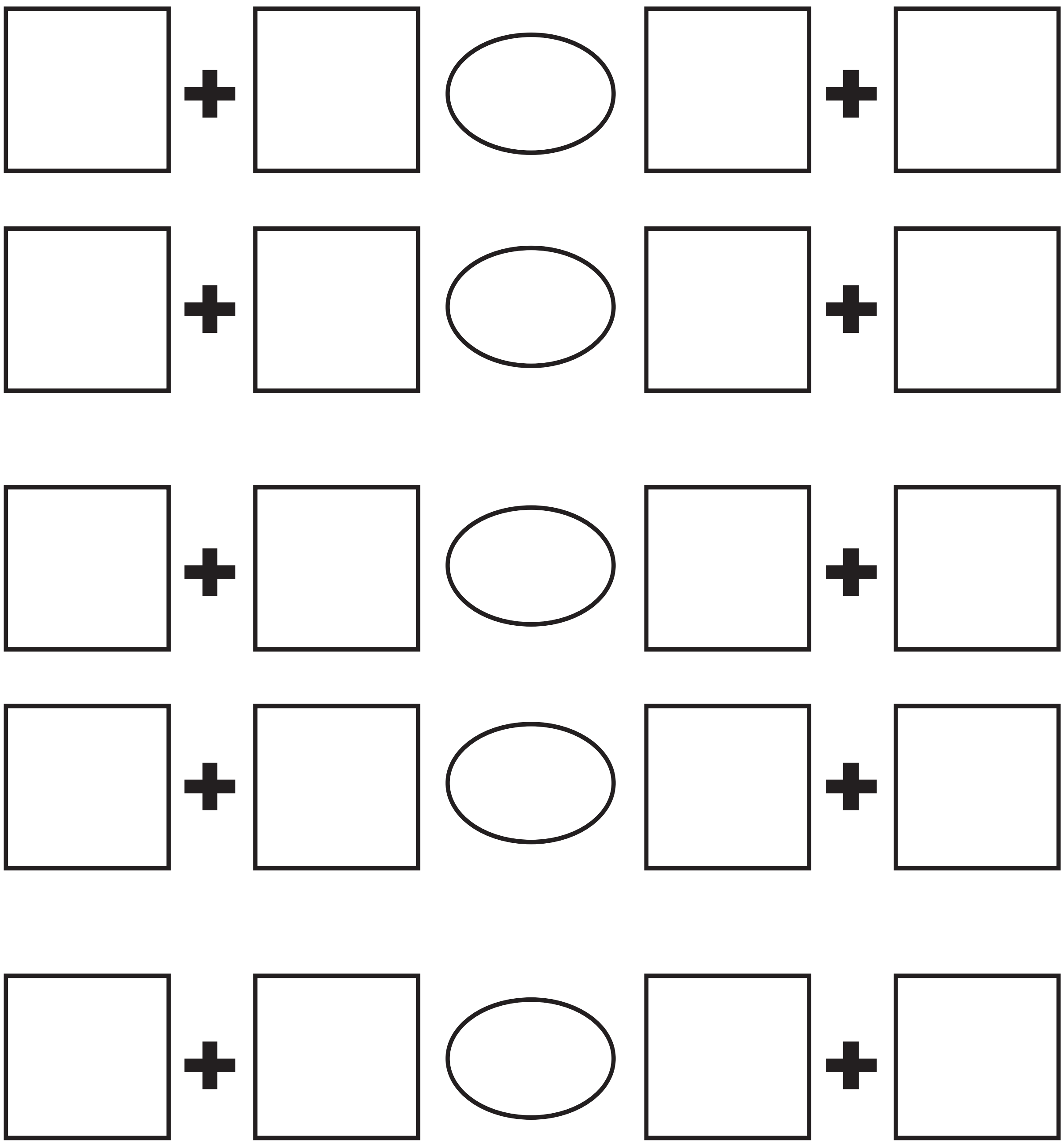


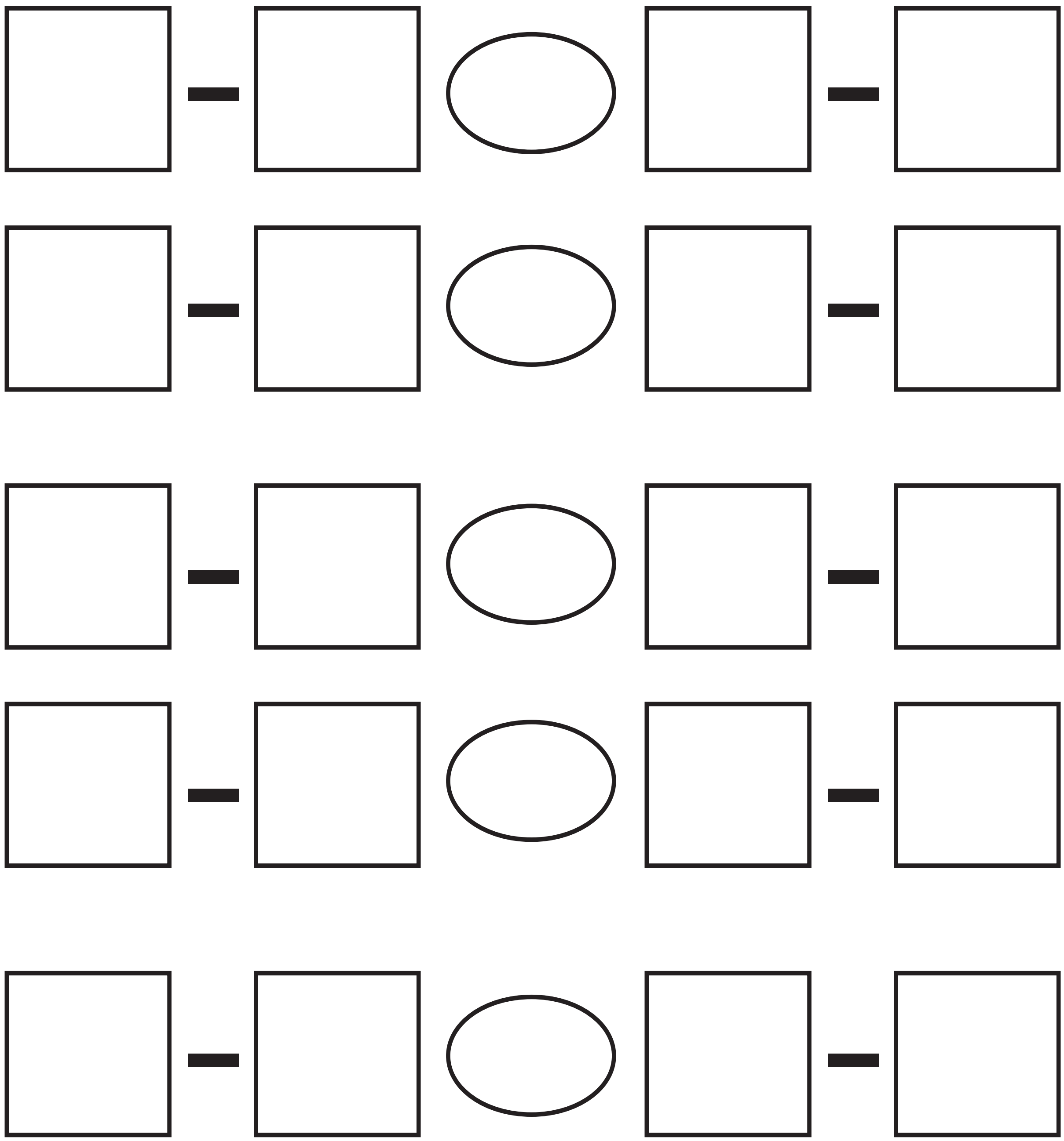
Messy Cookies Recording Sheet

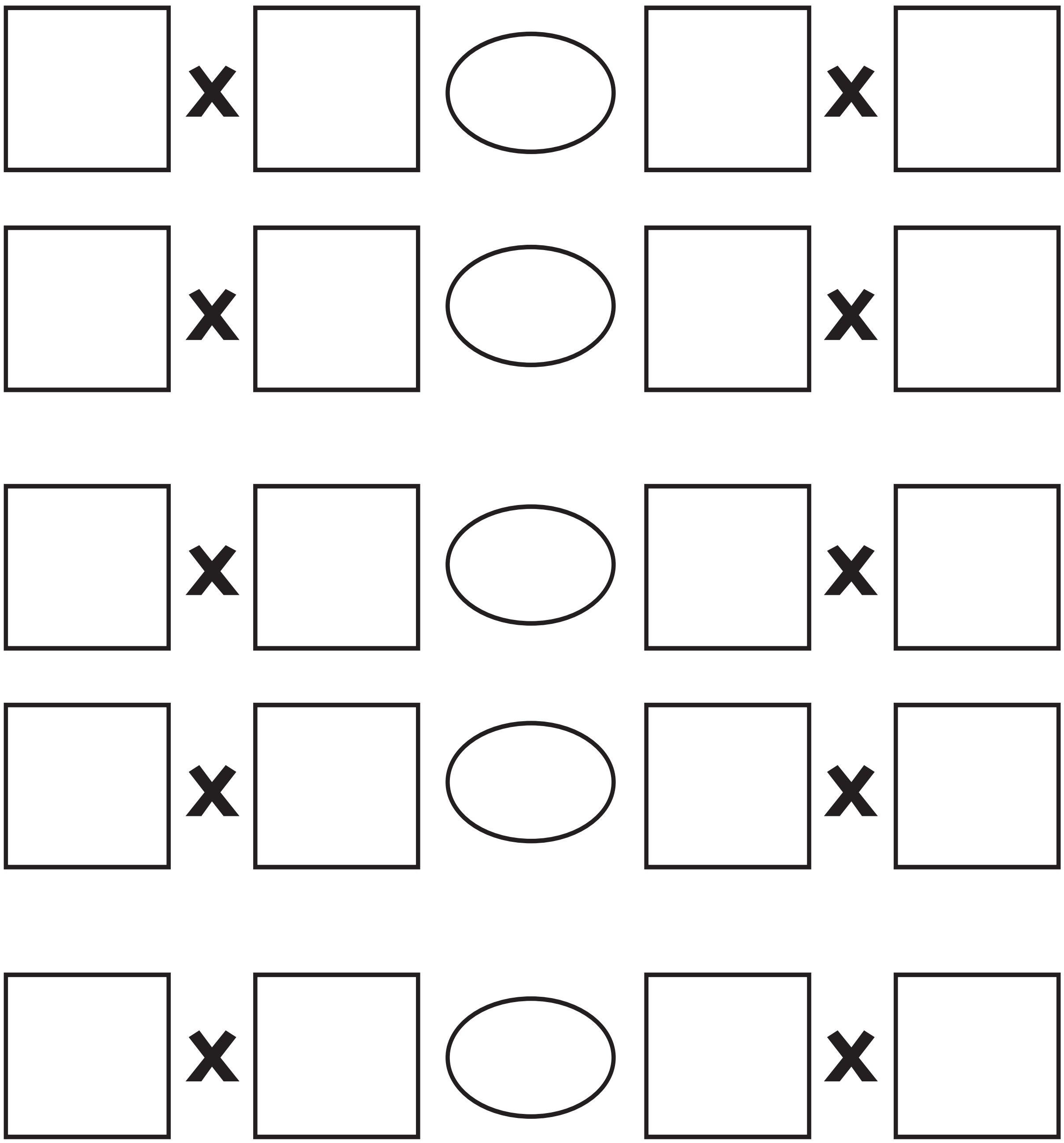
Directions: Align your cookies into an arrya and write the number sentence to match it. Try to come up with 4-6 different arrangements.

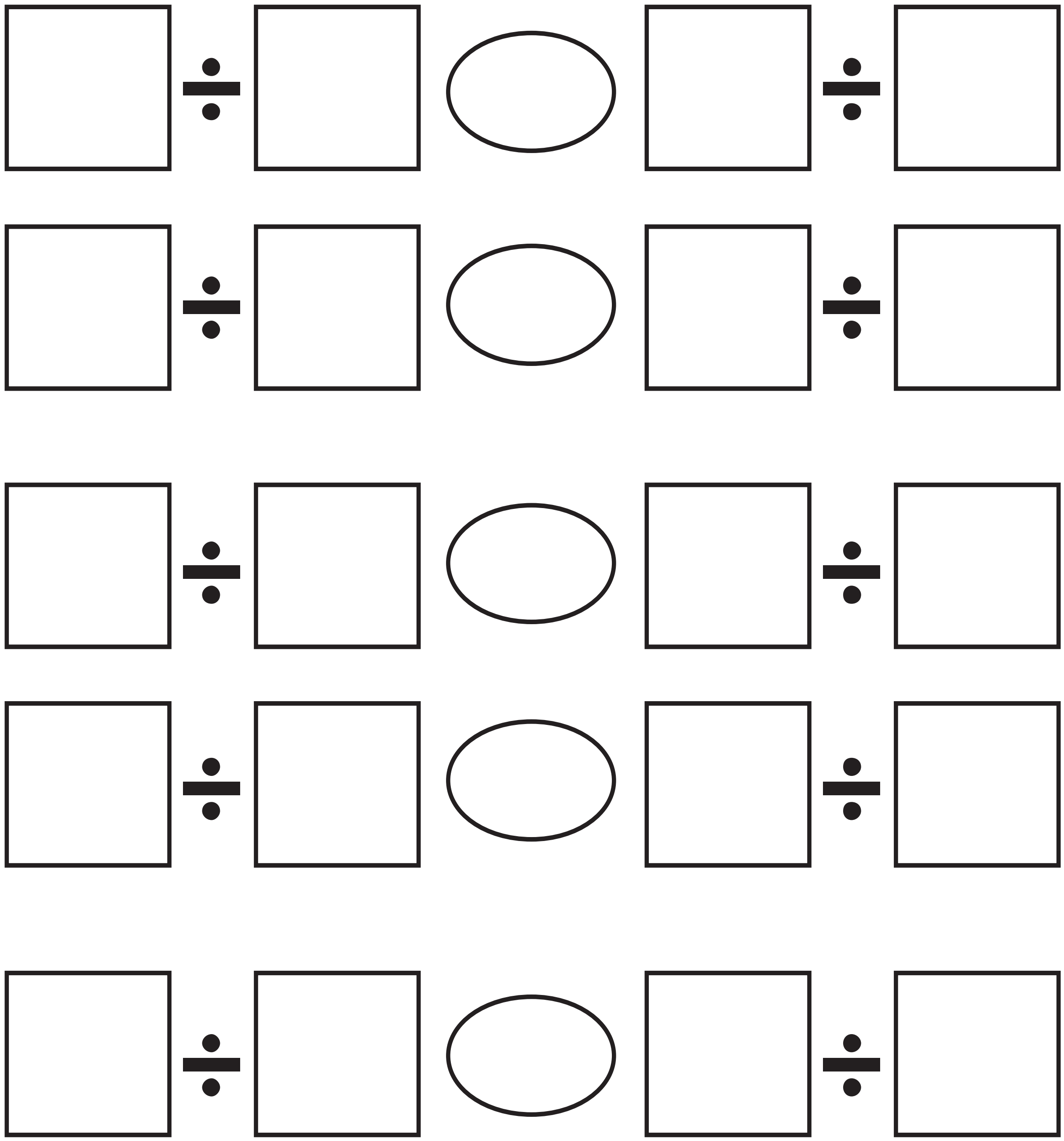
Cookie Trays

Rock & Roll Game Board









Quadrilateral Feature Analysis Grid

category	features														
square															
rectangle															
parellelogram															
trapezoid															
kite															
rhombus															

Quadrilateral Worksheet

Concept Name:	
Example	**Non Example**

Characteristics present in this concept		
Always	**Sometimes**	**Never**
Definition:		

Geometry Scrapbook

For this assignment you will first give a definition for each word. Next, you will find correct real world piecture that depict the geometry term and paste them onto your scrapbook page. You may use pictures from newspapers, magazines, or photos. As a last resort you may use pictures from the Internet.

Scoring Rubric

Task to be Completed	Points Possible	Student Score	Teacher Score
Quadrilaterals			
Square	10		
Rectangle	10		
Trapezoid	10		
Parallelogram	10		
Rhombus	10		
Kite	10		
Irregular	10		
Lines			
Parallel Lines	10		
Intersecting Lines	10		
Angles			
Right	10		
Acute	10		
Obtuse	10		
Solid Figures			
Cube	10		
Rectangular Prism	10		
Cone	10		
Cylinder	10		
Your Choice	10		
Total Points	**170**		

Quadrilaterals

Definition of a Quadrilateral

Attributes of a Square

Attributes of a Rectangle

Attributes of a Trapezoid

Attributes of a Parallelogram

Attributes of a Rhombus

Attributes of a Kite

Lines

Parallel Lines

Intersecting Lines

Angles

Right Angle (90°)

Acute Angle

Obtuse Angle

Solid Figures

Cube

Rectangular Prism

Cone

Cylinder

Your Choice

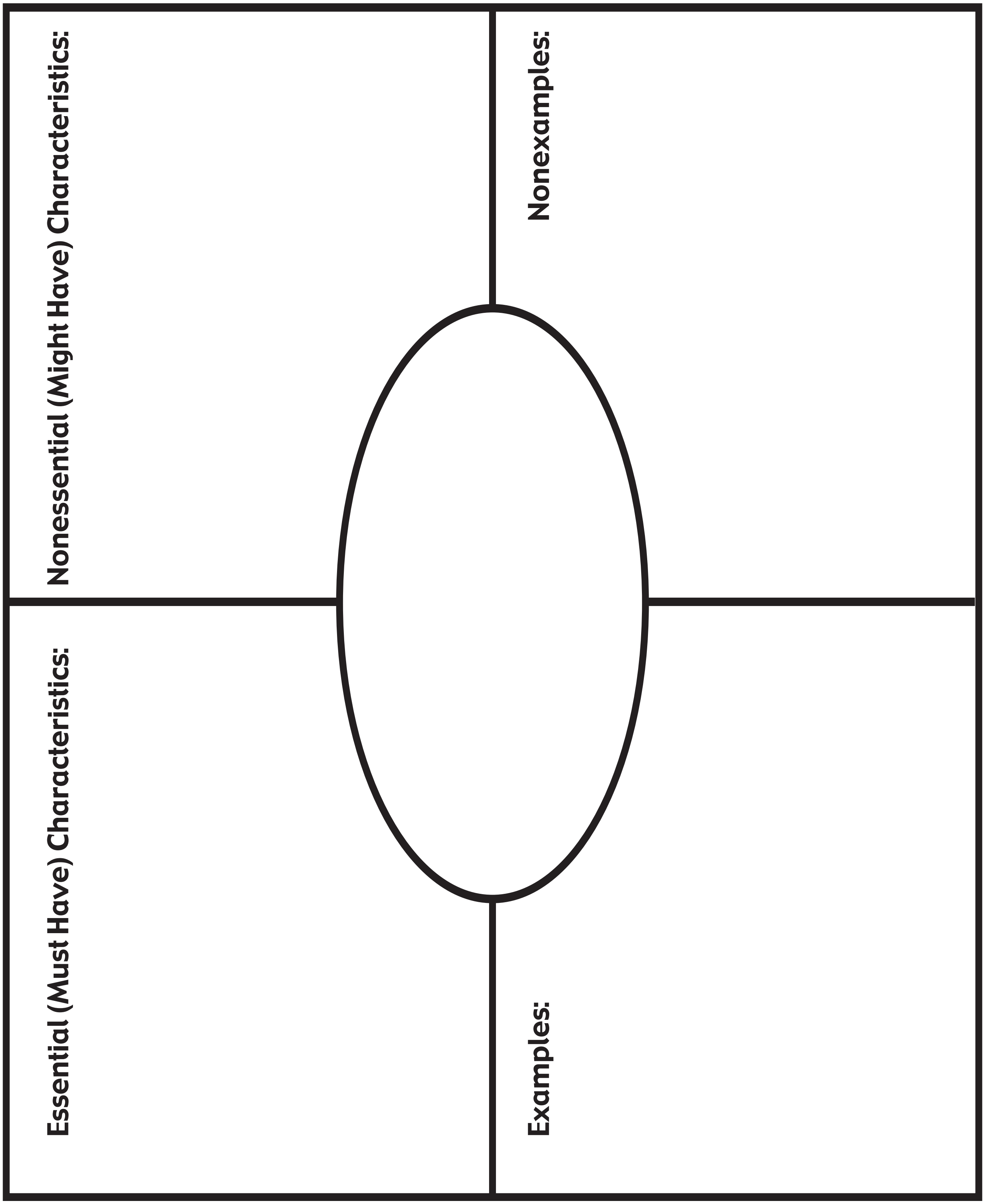
Inductive Reasoning Diagram

Inductive Reasoning Diagram for ____

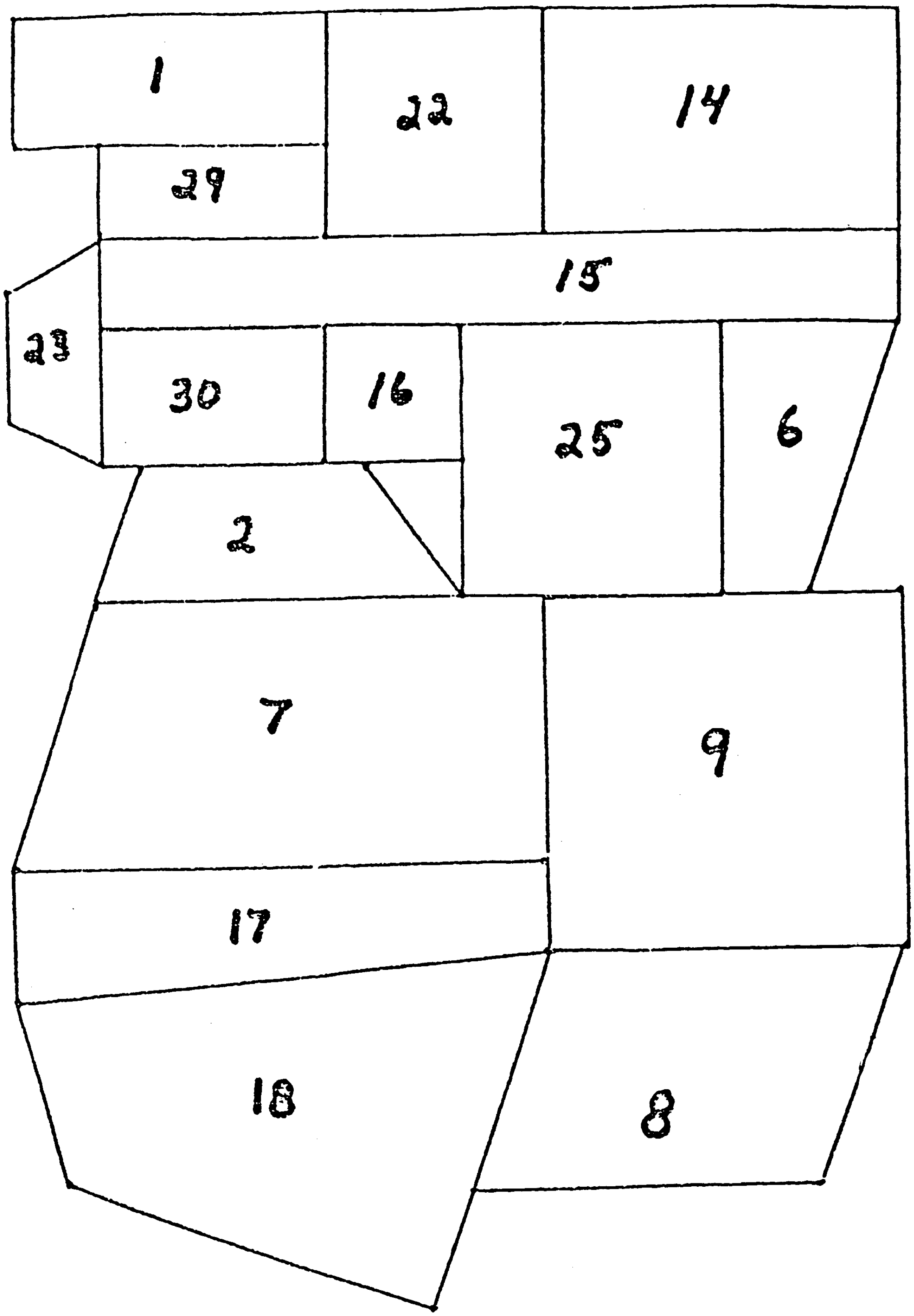
Concept Name:	
Example	**Non Example**

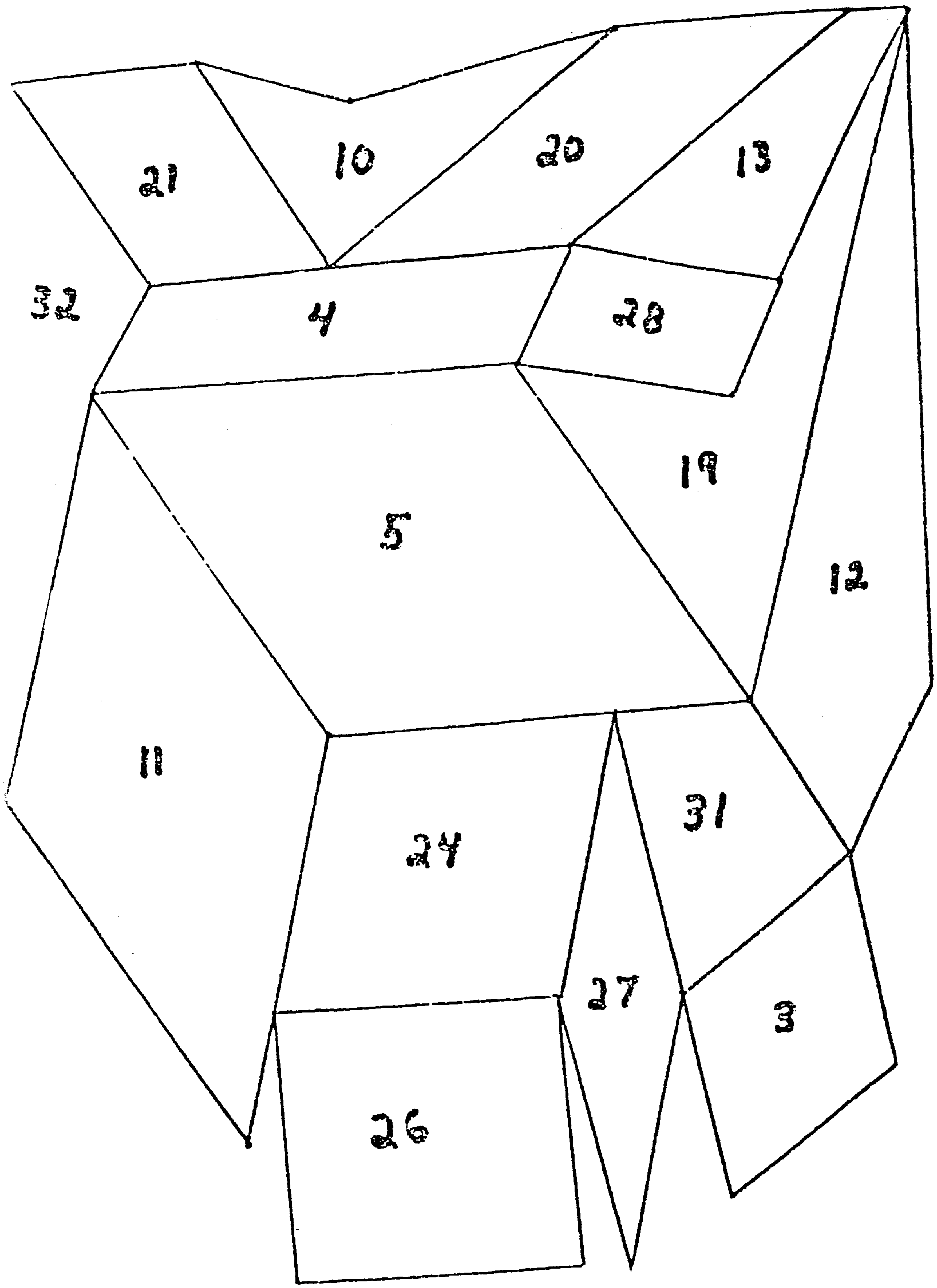
Characteristics present in this concept		
Always	**Sometimes**	**Never**
Definition:		

Characteristics Worksheet



Geometric Shapes




21
10
20
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32
4
28
19
5
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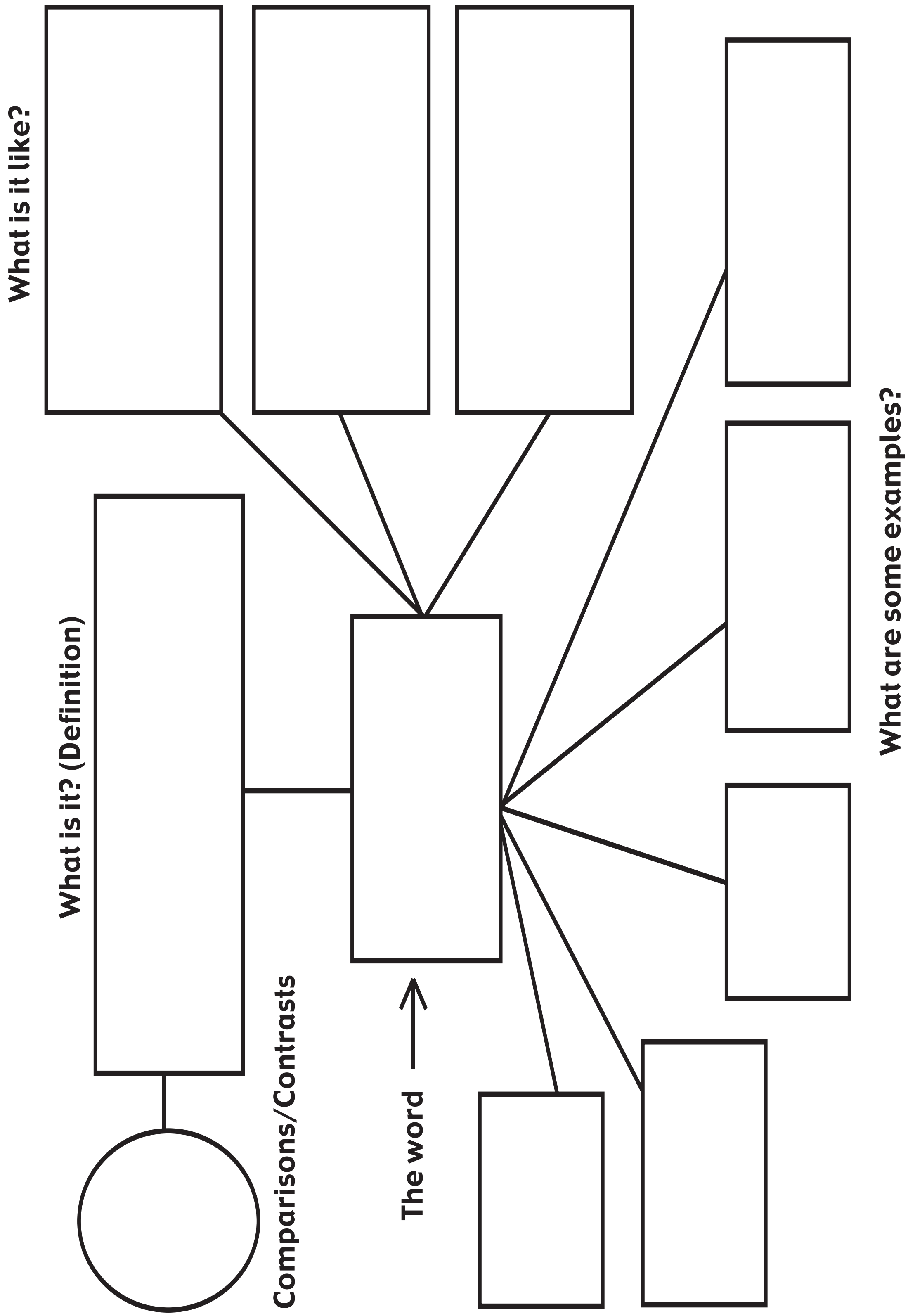
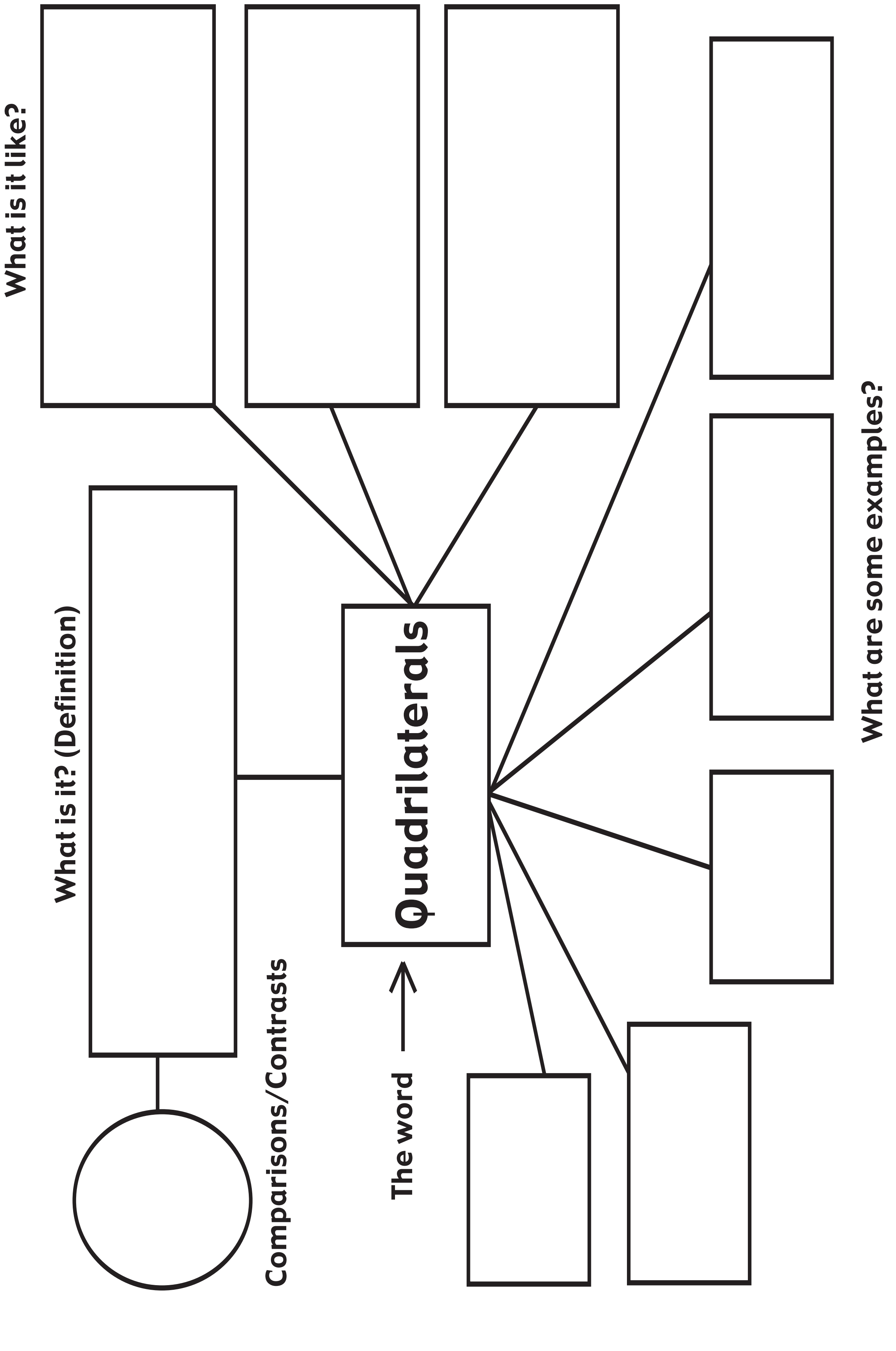
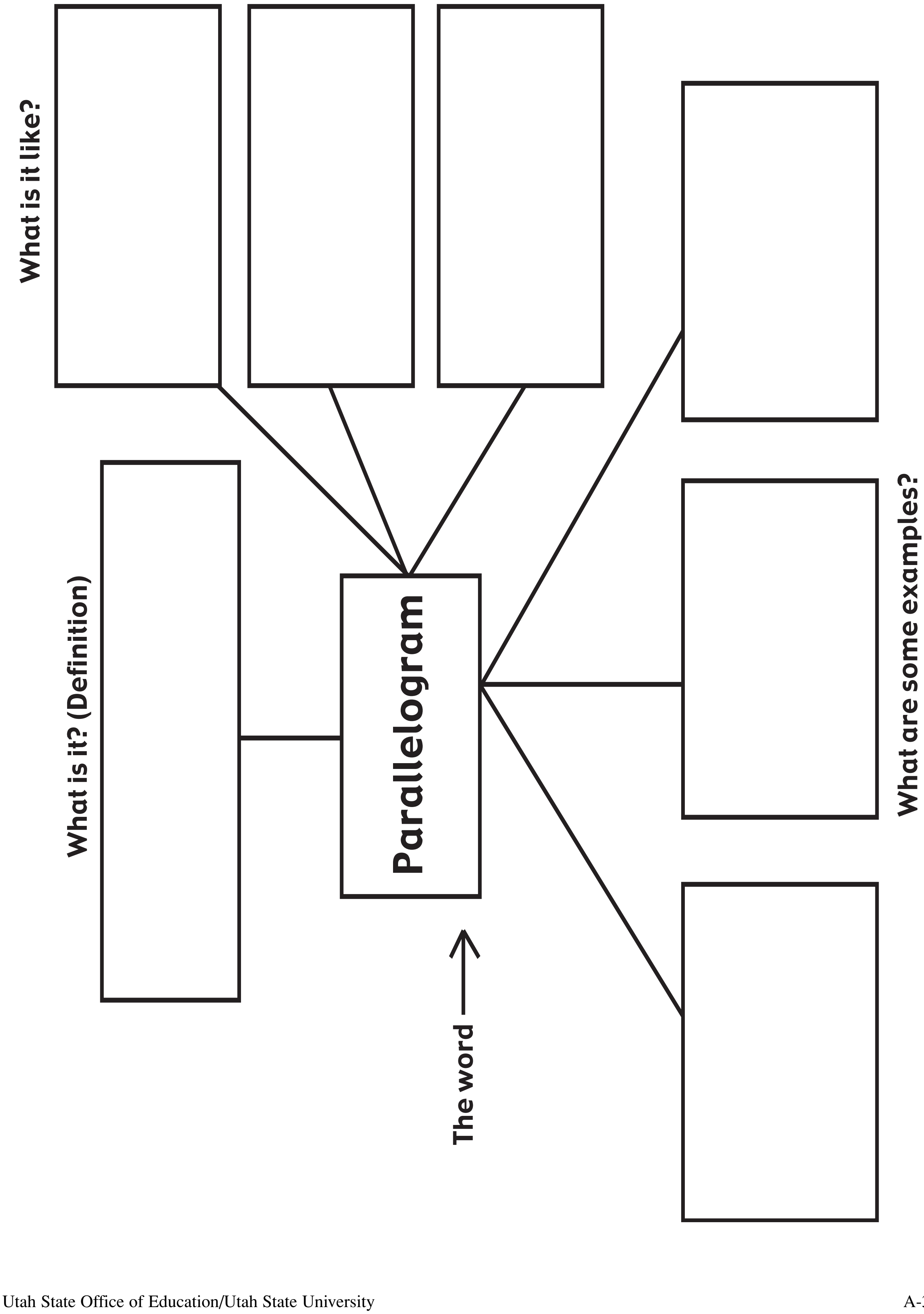
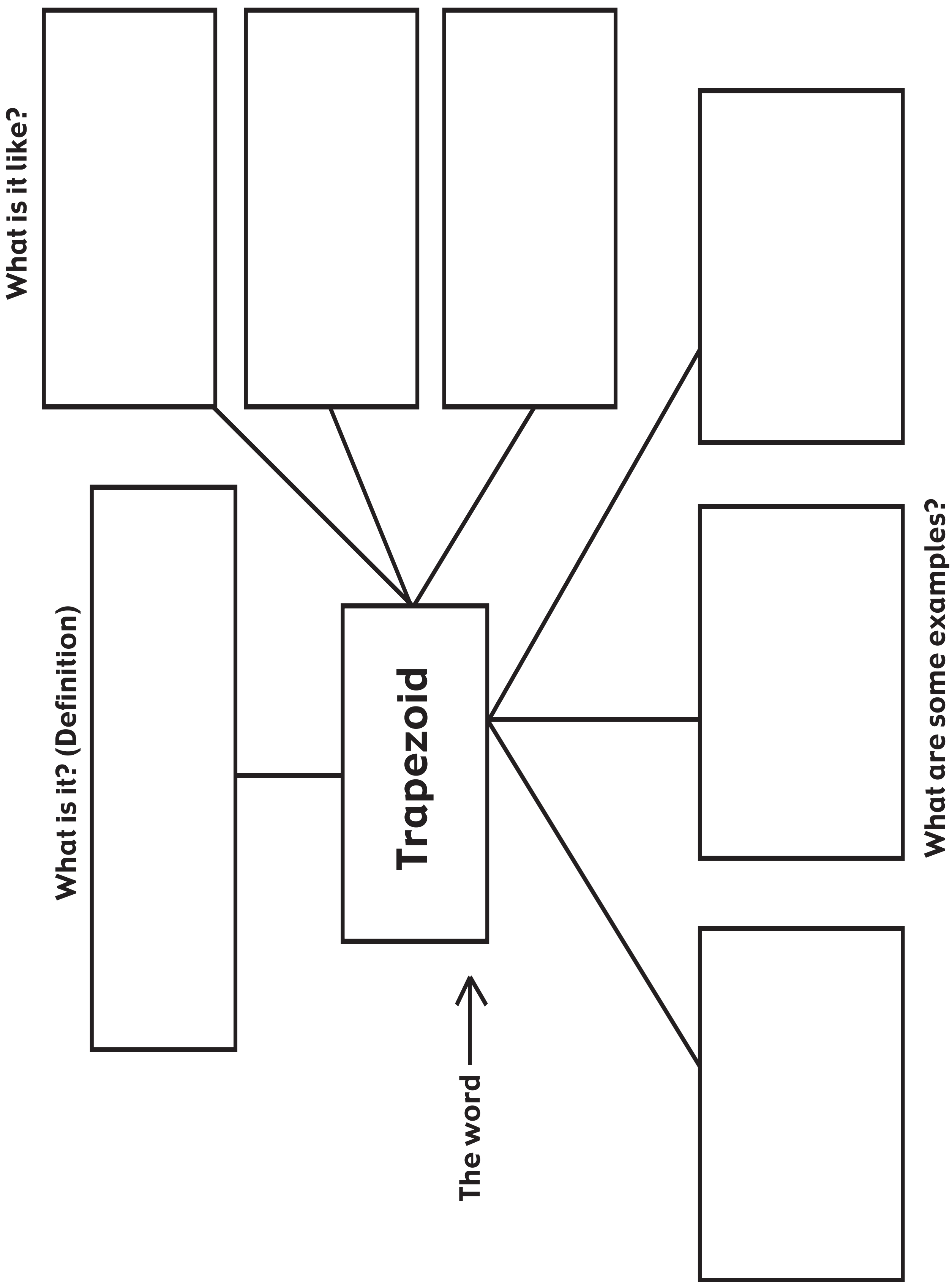
11
24
31
27
3
26

Geometric Vocabulary




What is it like?
What is it? (Definition)
Quadrilaterals
The word
Comparisons/Contrasts
What are some examples?


What is it like?
What is it? (Definition)
Parallelogram
The word
What are some examples?


What is it like?
What is it? (Definition)
Trapezoid
The word
What are some examples?

Geometry Brochure

Lines

1. parallel lines:

2. intersecting lines:

Quadrilaterals

1. square
2. rectangle
3. rhombi
4. trapezoid
5. isoceles
6. kites
7. parallelogram
8. irregular

Geometry Standard III Objective 1

Angles

1.

2.

3.

Congruence

Definition

Compare Polygons for Congruence

Symmetry

Identify and draw lines of symmetry

1. Identify

2. Draw

Cylinders

1. Attributes

2. Net

Rectangular Prisms

1. Attributes

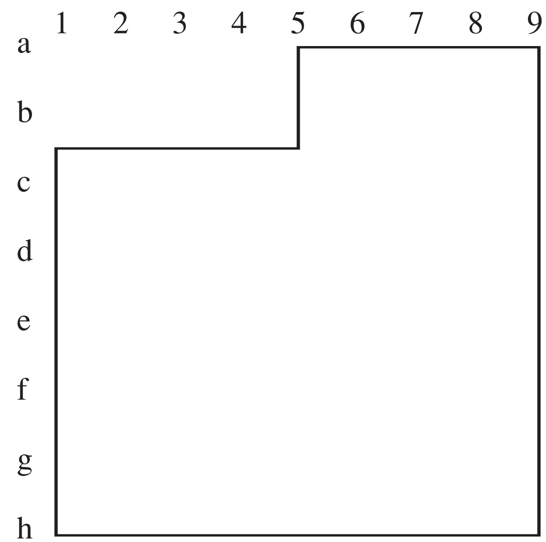
2. Net

Geometry Standard III Objectives 2 & 3

Specify Locations

1. Locate positions on a map using coordinates or regions.

2. Give coordinates or regions of a position on a map of Utah.



Transformations

Identify slides and flips

1. Flip (reflections)

2. Slide (translation)

Making Nets

1. cubes

2. cylinders

3. cones

4. rectangular prisms

Name________________________

Geometry Hike

1. square____
2. rectangle ____
3. rhombus ____
4. parallelogram ____
5. kite ____

   concave____________________________ convex _________________________
6. trapezoid ____________________________ isosceles ________________________
7. irregular ____
8. other polygons ____
9. right angles ____
10. obtuse angles ____
11. acute angles ____
12. cone ____
13. cylinder ____
14. rectangular prism ____
15. triangles____
16. other ____

Weather Forecasting Data Table

Key	Date	Time	Temp.	Wind Speed	Wind Direction	Humidity	Air Pressure	Class	Teacher	My Guess	Media	Actual

Name______________________________

Air Pressure Weather Experiement

Why learn this? You can see what effect air pressure and the movement of air have on common objects.

What you need: Ping-Pong ball, Hair dryer

Question: What will happen when I hold a ping-pong ball over a hair dryer and turn it on?

____

____.

Hypothesis: This is what I think will happen ______________________________

____

____.

Experiement: This is what I did_______________________________________

____

____.

Results: This is what happened _______________________________________

____

____.

Inquiry: These are some other things I would like to try ____________________

____

____.

Draw a picture:

Wind Speedometer

Materials:

5"x8" cardboard

glue

scissors

thread

tape

ping-pong ball

Assembly

1. Copy the paper protractor on the following page (enlarge 125 percent).
2. Cut out the protractor and glue it to a piece of cardboard.
3. Cut a piece of thread 10 inches long and tape one end to the ping pong ball and the other end to the protractor at the center dot.

Directions

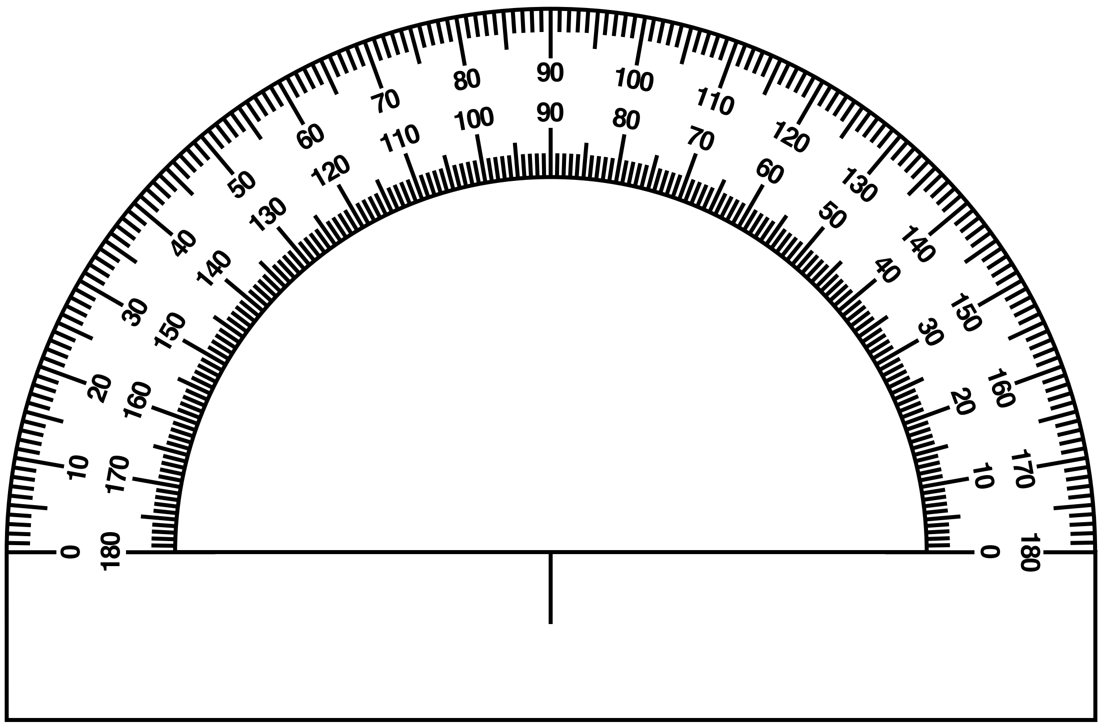
1. Face into the wind and hold the wind speedometer in front of you.
2. Hold the flat edge of the protractor parallel with the ground.
3. Check the angle of the ball and thread and record it.
4. Compare your data with other students.

Table

The following table is an approximate indication of the wind speed. Several factors may affect the angle of the ball and thread. Compare the results you get with the local weather report.

Degrees on Protractor	Wind Speed in MPH
0	0
5	9
10	13
20	19
30	24
40	29
50	34
60	41
70	52

Paper Protractor



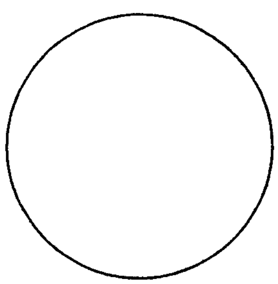
Name________________________________

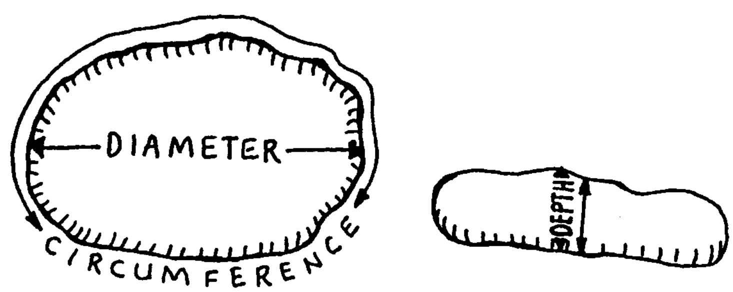
Mock Rocks

Question: What is the difference between a rock and a mineral?

Trace and draw your mock rock.

Draw a magnified view of part of your rock.





Mock Rock Measurements

Diameter ___________________________

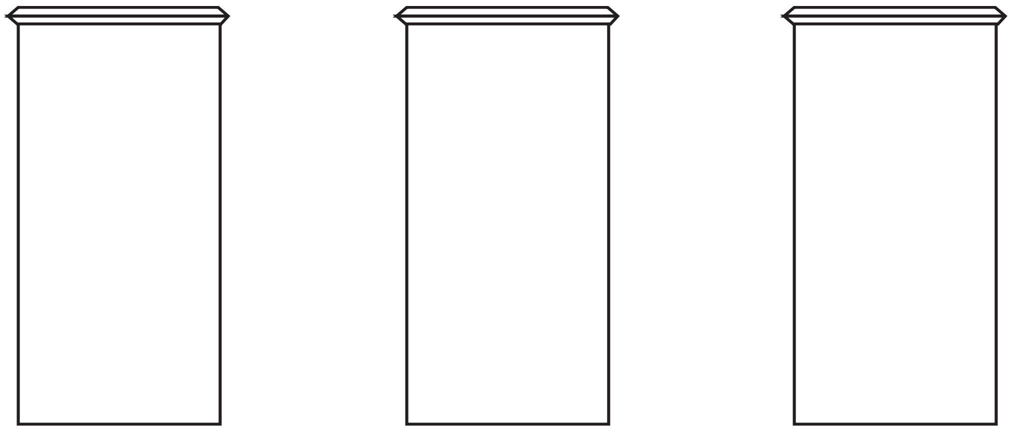
Circumference______________________

Depth_______________________________

Weight______________________________

Name______________________________

Mock Rocks in Water



Before Shaking | After Shaking | After Settling

Mock Rock Recipe

List the mock rock ingredients:

____

____

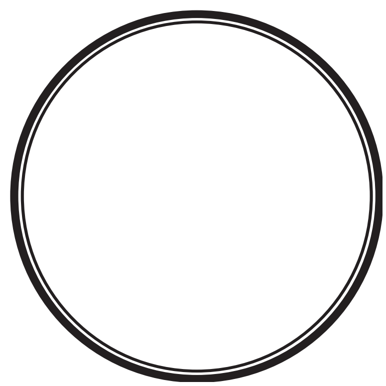
____

____

____

____

Evaporation Dish



What is a mineral? ____

____

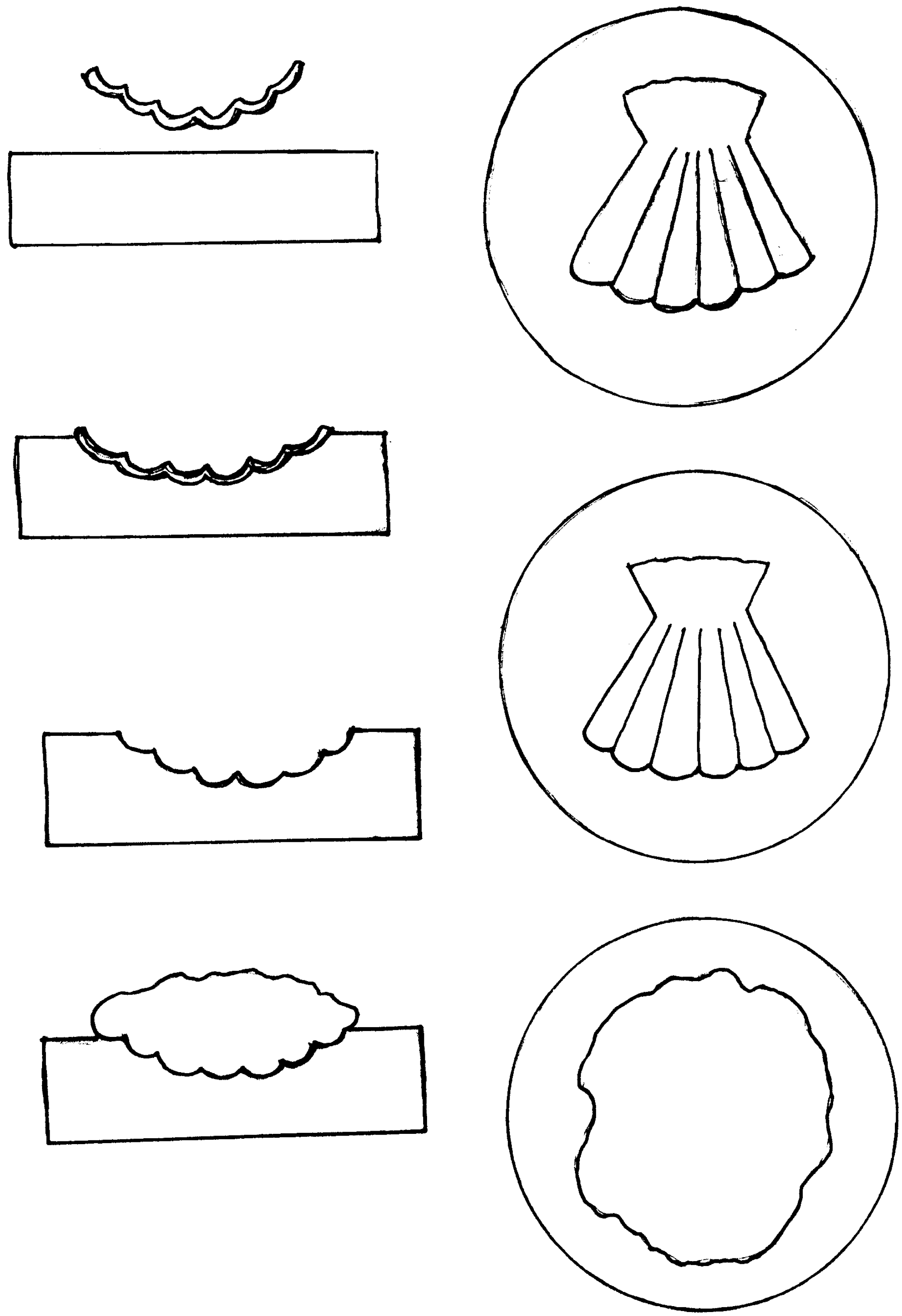
What is a rock? ____

____

How is a mock rock like a real rock? ____________________________

____

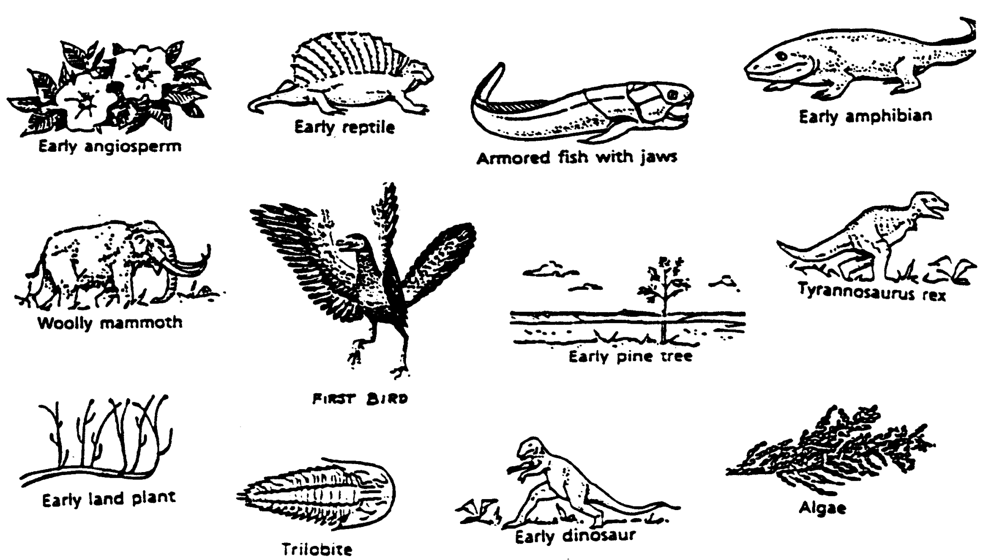
Creating a Fossil



Geologic Timeline Information Sheet

Using adding machine tape and meter sticks, make a timeline to demonstrate how life developed on Earth. Let one meter equal one billion years. Draw a line across one end of the tape and label it “present day.” Every measurement made on the timeline should begin at the line marked “present day”! Measure from this line and mark the following distances by drawing a line across the tape.

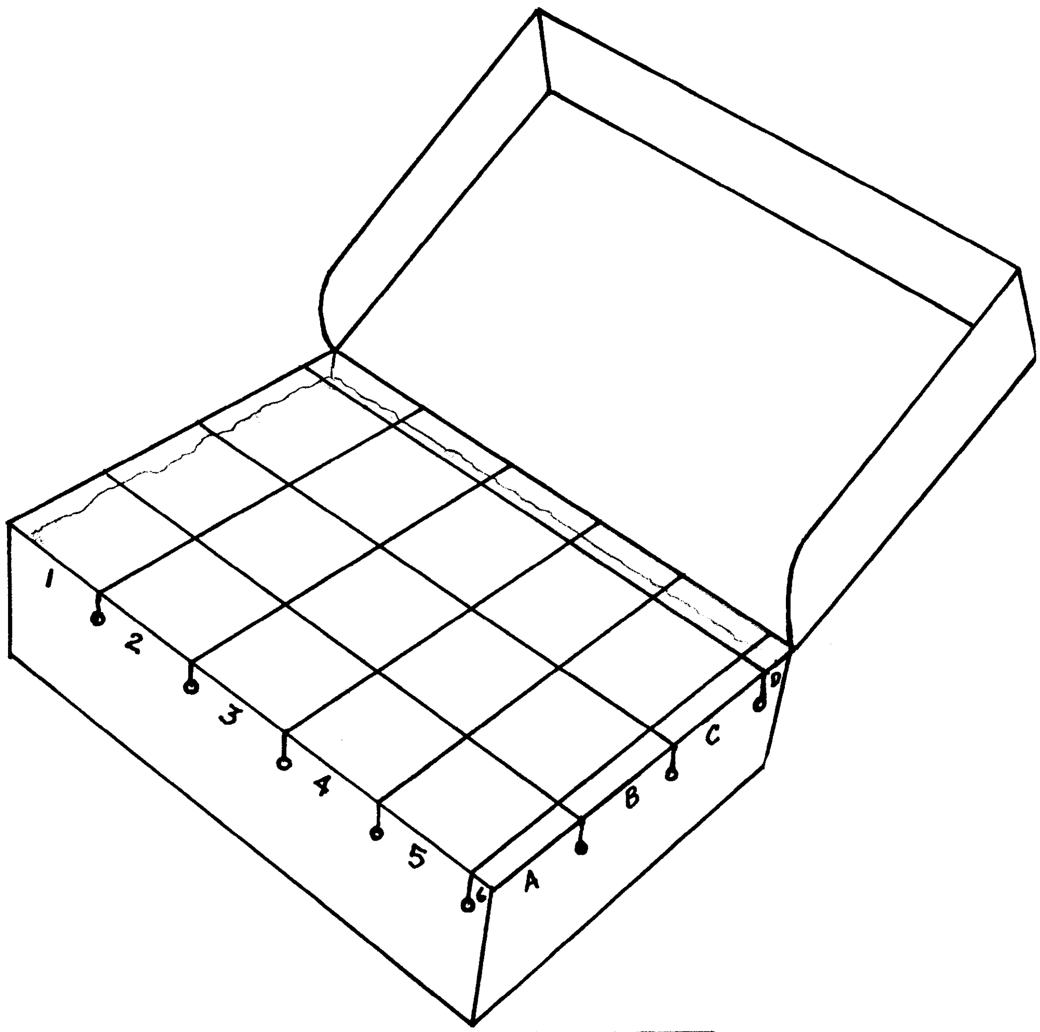
3mm	first humans	3,000,000 years ago
4cm	first elephants	40,000,000 years ago
6.5 cm	dinosaurs die out	65,000,000 years ago
13.5 cm	flowering plants appear	135,000,000 years ago
16 cm	first birds appear	160,000,000 years ago
22.5 cm	first dinosaurs appear	225,000,000 years ago
27 cm	first coniferous plants	270,000,000 years ago
30.5 cm	first reptiles appear	305,000,000 years ago
40 cm	first amphibians	400,000,000 years ago
44 cm	first land plants	440,000,000 years ago
50 cm	first fish appear	500,000,000 years ago
60 cm	first trilobites appear	600,000,000 years ago
1.2 M	first animals	1,200,000,000 years ago
3.2 M	first plants (algae)	3,2000,000,000 years ago
4.5 M	oldest Earth rocks	4,500,000,000 years ago



Sample of a Geologic Timeline

Present Day
First Humans
First Elephants
Dinosaurs Die Out
Flowering Plants Appear
First Birds Appear
First Dinosaurs Appear

Fossil Dig Boxes

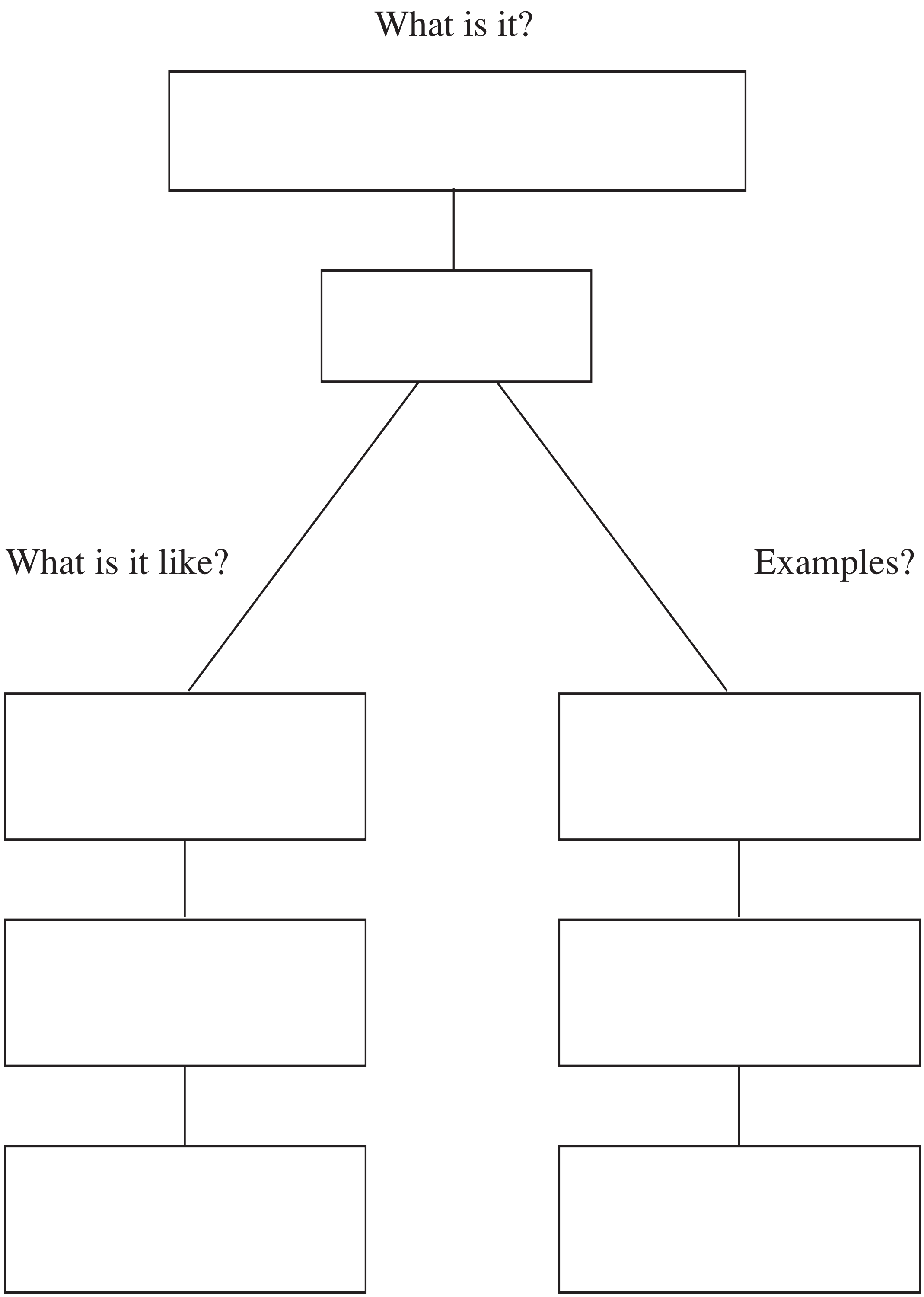


1	2	3	4	5	6
					D
					C
					B
					A

Situation Cards for Migration Game

This popular marshy wetland has become polluted by chemicals from the fertilizers local farmers used. It is no longer a safe stopover site.	This critical wetland has been drained and filled to build four apartment buildings. The developer leveled the area so there are no plants or water. It no longer exists.
Some loose dogs from a nearby group of homes has made this area unsafe. If you land here, you will be destroyed.	Several new housing developments have been built. This wetland is much smaller that it was last year. Only two birds can stop at this site.
This wetland has lots of predators. If you land here, you will be eaten by a red-tailed hawk.	Some kids on bikes have flattened areas in this wetland where you stopped to rest and eat. There is no safe place to land.
A local business accidentally spilled some poisonous material into the water of this wetland. If you land here, you will die.	There is a golf course where this wetland was, and only a small lake remains. Three birds can land in this area.

Word Map



Riddle Cards

My roots spread out underneath the ground. When it rains they soak up any water to be found. The shallow roots wait for rains to fall. Soaking it up I trap it all.	The prickly spines don't feel very nice, If you think you want dinner, you'd better think twice! A mouthful of me is a painful surprise. Don't bother to taste me, you'd better be wise!
Although it's been weeks since there was rain, I stored up water so I won't complain. My thick stem stores the H_2O So I can survive the sun's hot glow.	My leaves are colored lightly or gray. They reflect the sun and keep it away. My leaves are quite small, as a rule, In hot temperatures they keep me cool.
My leaves and stems have a waxy touch. Water trapped inside me helps so much. When rain does fall I fill up fast, So when it stops, my water will last.	My prickly spines are really leaves, That stop the wind and help relieve My losing moisture to the wind. I'm grateful for a spiny skin.
My deep taproot drills down very deep. To underground water, where it may seep. Sometimes my root is 40 feet down. That's a long way to go underground.	

(SPINES PROTECT FROM ANIMALS) (Any cactus with spines)	(SHALLOW ROOTS) (Creosote bush, pinon pine)
(LIGHT COLORS ABSORB LESS HEAT) (Globemallow, rabbitbrush)	(WATER STORED IN THICK STEM) (Joshua tree, beavertail cactus)
(HAIRS, SPINES LESSEN EVAPORATION) (Prickly pear cactus, sage brush)	(WAX TRAPS MOISTURE) (Juniper, cliffrose)
	(ROOTS FIND AVAILABLE WATER) (Mesquite, Yucca)

Academy Notes

Academy Notes

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Academy Notes

Professional Development Activity
Evaluation Form 2002-03
Utah State Office of Education

Course Title ______**Elementary CORE Academy**____________________________

Facilitator ____

Dates ______________________________ to ___________________________

Location ____

		N/A	Strongly disagree	Disagree	Agree	Strongly Agree
1.	Inservice aligned with the Utah Core Curriculum.	0	1	2	3	4
2.	Useful assessment practices related to subject were presented.	0	1	2	3	4
3.	Time allocated for this professional development was appropriate to meet my learning needs. If your answer was “strongly disagree” or “disagree”, please check one of the following:	0	1	2	3	4
			___More time needed ___Less time needed			
4.	Inservice was well organized.	0	1	2	3	4
5.	Facilitator(s) and presenter(s) clearly stated objectives of professional development.	0	1	2	3	4
6.	Presenter(s) had adequate knowledge of subject matter.	0	1	2	3	4
7.	Professional development provided information relevant to my classroom.	0	1	2	3	4
8.	Accommodations and facilities promoted learning.	0	1	2	3	4
9.	I will recommend this professional development experience to other teachers.	0	1	2	3	4

10. Rate the use and effectiveness of each mode of instruction in this professional development.

	Not Used	Used Occasionally	Used Often	Not Used Effectively	Used Effectively
a) Lecture	0	1	2	0	1
b) Hands-on	0	1	2	0	1
c) Cooperative Groups	0	1	2	0	1
d) Discussion	0	1	2	0	1
e) Technology	0	1	2	0	1
f) Field Trips	0	1	2	0	1

11. How do you plan to implement the information from this professional development into your classroom instruction?

12. In what way will this professional development provide long-term benefit to the quality of your instruction?

13. What suggestions do you have for improving this professional development?

If you wish to send additional comments regarding this professional development experience, or to indicate other professional activities you would like to take in the future, please email or phone:

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1. Check the category that best describes your school position:
_____Teacher _____School and/or District Administrator / Supervisor
_____Grade Level
_____Pre-service teacher candidate _____Other (Specify:_______________________)

2. Gender: _____Male _____Female

3. How many students, total, did you teach during the previous school year? ___________
How many students do you expect to teach in the coming school year? ___________

4. Are you teaching at a Title I School?
❏ Yes I am ❏ No I am not ❏ I don’t know

School _______________________________ District ___________________________